**CLIMATIC CHANGE AND AGRICULTURAL ADAPTATION:
THE REGIONAL MUNICIPALITY OF OTTAWA-CARLETON CASE STUDY**

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Abstract

Growing evidence that Earth's climate is experiencing rapid and unprecedented rates of change has stimulated a significant body of research into the implications of climatic change for agriculture. While much of this research has focused on impacts on crop yields and farm economies, a critical knowledge gap exists in the treatment of human responses to climatic change. This paper studies the human dimensions of agricultural adaptation to climatic change in the Regional Municipality of Ottawa-Carleton, Ontario, Canada. An analysis of 58 farm interviews conducted in 1998 helps situate perceived climatic changes relative to other factors important to agricultural decisions in the recent past and short term future. Two distinct types of farm operations were identified: (a) larger, highly capitalized livestock operations, and (b) smaller, more diversified forms of agriculture. The livestock farms typically implemented a greater number of changes in response to past perceived climatic changes and a future scenario, and were most often motivated by economic factors. The smaller, more diversified farms tended to be more constrained in terms of their responses to climatic change. Economic factors remained a primary motive for change, but social and environmental factors also played an important role. The research revealed that farmers do not view climatic change in isolation, and as a result their capacity to adapt must be examined in light of the social, economic and political context of agriculture as well as changes to climate.

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CHAPTER 1: CLIMATIC CHANGE AND AGRICULTURE: INTRODUCTION

1.1 Evolution of Research Contexts

Over the last 15 years, relationships between global climatic change and agriculture have been examined widely. Much of this research has been stimulated by a growing scientific consensus that human activities are contributing to a rapid and unprecedented rate of change to atmospheric systems on a global scale (Schneider 1989). Not surprisingly, research frameworks founded upon the specification of scenarios for global climatic change have flourished. Scenarios specified changes to climatic conditions and then the impacts of these changes on agro-climatic properties or crop yields were estimated. More recently, these frameworks have been expanded to include human dimensions of climatic change impacts (e.g. economic impacts, farm-level adaptive strategies).

Within these research frameworks are many approaches to studying how potential climatic changes affect agricultural practices. Some studies seek to investigate the impact of climatic change on various agro-climatic properties important to agriculture (for Canadian examples, see Stewart 1989, Stewart and Muma 1990, Delcourt and van Kooten 1995), while others explore effects on land and resource potential (Smit et al. 1989, Brklacich and Tarnocai 1991, Singh and Stewart 1991, Parker and Cowan 1993, Mills 1994, Brklacich et al. 1996), or crop development and yields (Brklacich and Stewart 1995, Toure et al. 1995, Tubiello et al. 1995, Brklacich et al. 1997a, El Mayaar et al. 1997, Singh et al. 1998). Still others examine higher-order impacts on agricultural economies, at various scales, including international, national, regional and farm-level

(Arthur and Abizadeh 1988, Williams et al. 1988, Brklacich et al. 1989, Mooney and Arthur 1990, Arthur and Van Kooten 1992).

While the research frameworks used in many of these studies have facilitated assessments of the sensitivity of specific attributes of agricultural systems (e.g. agro-climatic conditions, crop yields, etc.) to climatic change, the studies have to a large extent relied on formal modelling procedures and have not engaged agricultural communities directly. These studies are often characterized because of their limiting assumptions about farmers' levels of knowledge, the degree to which they adjust their practices as climate changes, or the degree to which they respond to other factors such as economic or technological forces. The overall result is that despite considerable progress in studies examining the implications of climatic change for food production, there remains little consensus about farmers' abilities to adapt to climatic change and variation (Smit 1993, Chiotti and Johnston 1995).

As the climatic change - agricultural systems interface has matured as a research field, debates over the merit of these climatic change-based research frameworks have intensified. These debates do not refute earlier research but do acknowledge limitations associated with effectively isolating climatic change as the dominant driving force and relying heavily on mathematical models of various attributes of agricultural systems (e.g. crop models, agricultural land evaluation models) (Chiotti and Johnston 1995). When human adaptation has been incorporated into these research frameworks, its treatment has often been restricted to the identification of adaptation options or feasibility assessments relative to biophysical conditions only, so that the extent to which farming communities have the social and economic capacity to implement certain adaptive strategies has

seldom been addressed (Brklacich et al. 1998). Research based on these sorts of approaches tends to marginalize agricultural decision-making at the farm level and it does not explicitly consider the dynamic and adaptive nature of agricultural systems.

Emerging research on climatic change and agriculture is increasingly focusing on agricultural decision-making contexts in general, and specifically on the potential for farmers to adapt to changing socioeconomic and biophysical conditions, including climatic change. This research builds upon a political economy perspective, attempting to place climatic change in the wider decision-making context of individual farmers (Brklacich et al. 1997b, Bryant et al., forthcoming).

Climate impacts literature often recognizes the need to incorporate farm adaptation into studies of the climatic change-agricultural systems interface, while researchers employing a political economy perspective seek to address the lack of treatment of the human dimensions of adaptation. Yet there has been limited interchange between the two areas of work. This is not surprising since working with climate models and crop models requires a specialized knowledge quite different from that of studying the political economy or behavioural aspects of agriculture. As early climate and crop models were applied to study the possible implications of climatic change on agriculture, conclusions about the economic and social implications of the results were often left with a small group of people who possessed the technical expertise to operate such models (Smit 1994, Chiotti and Johnston 1995). When it became difficult to apply or even hypothesize how one might apply the results across different regions and scales and in "future" technological and social settings, the importance of the human dimensions of adaptation became increasingly apparent. The scenario-based frameworks employed to

this time have developed largely separately from agricultural decision-making research; this paper is based upon merging the two approaches as a means to understand more clearly the potential for agricultural adaptation to climatic change.

1.2 Purpose and Objectives

The purpose of this study is to set long-term climatic change and its potential implications for agriculture at the farm level within the broader context of agricultural decision-making. This approach was chosen because climatic change is recognized as an important but certainly not primary reason for changes at the farm level.

In order to satisfy this purpose the following four related objectives are specified:

- Objective 1: Place the project in the context of contemporary research into agriculture-climatic change linkages and agricultural decision-making;
- Objective 2: Move beyond an a priori assumption that climatic change will result in adjustments at the farm level and explicitly explore farm-level perceptions of climatic change;
- Objective 3: Enhance understanding of farm-level adaptive strategies to changing socioeconomic and biophysical conditions, and
- Objective 4: Explore the role of climate-related information (e.g. current variation, long-term change) in farm-level decision making vis-a-vis other information (e.g. market information, technological innovation, changing family needs) which also influence farm-level decisions.

Setting the project in the context of contemporary research into agriculture-climatic change linkages and agricultural decision-making will help to identify

knowledge gaps in the current understanding of agricultural adaptation to climatic change, and to show how climatic change scenario-driven frameworks can benefit from employing information about the ways in which farmers adjust to forces other than climatic ones. Studies of agricultural decision-making in the face of economic, technological, political and social pressures (e.g. urban pressures) are examples of some of the work which has investigated the dynamics of agricultural decision-making under changing conditions. By combining this information with current understanding of climatic change-agriculture linkages our understanding of farmers' abilities to adapt to climatic change will be enhanced.

Exploring farm-level perception of climatic change is important since it is this perception which determines where and how climatic change enters into individual farmers' decision processes (Fischhoff and Furby 1983). In order to understand how farmers may be affected by climatic change it is important to ask whether the farmer has a working knowledge of climate information, and what aspects of climate concern them most. How has the farmer perceived past climatic changes? Does the farmer actively search for climate information or are decisions based on climate made on a more subconscious or reactive level? Answers to these sorts of questions will be crucial for understanding the decision process, and relate closely with the next objective, aiming to examine the outcomes of these decisions.

This study aims to enhance understanding of farm-level adaptive strategies in terms of not only identifying response options to climatic change, but also attributing reasons for certain responses or non-response that could be related to the farmers' wider decision-making environment. Understanding of these adaptive strategies will also be

enhanced by assessing what types of information would help farmers make adaptive decisions. This is important given the significant volume of research studying climatic change impacts on agriculture (Chiotti and Johnston 1995), much of which is being carried out with little direct input from farmers themselves. The concern is whether the types of information about climate change and agriculture that are currently available are in a form farmers are able to use (Phillips 1991). For instance, at what scale (national, regional, local) does the farmer find climate forecasts most useful? How relevant is the climatic change information given the nature and timing of agricultural activities popular in a particular region? Answers to these sorts of questions will help assess the extent to which farmers are able to adapt and cope with changes in climate given our current knowledge base, and how this knowledge might be refined or developed to improve farmers' abilities to cope with climatic change.

Exploring the role of climate-related information in farm-level decision making vis-a-vis other information will involve detailed examinations of the nature of farmers' enterprises, as well as a thorough understanding of the factors which have influenced past and current decisions, and will influence potential future changes. In cases where farmers have perceived a change in climate but did not make any associated adjustments, it is particularly important to explore why no adjustments were made. This may indicate some of the factors playing a larger role in the decision-making process than climatic conditions alone. By studying the decision-making environment from the perspective of the farmer, it will be possible to gain a better sense of the position of climatic change in the farmer's own thought process.

The four objectives presented in this paper are overlapping in the sense that the

interactions of several processes must be recognized in understanding farm decisions. The objectives are identified separately so as only to identify some of the dynamics of the agricultural decision-making process more clearly (for instance, being able to relate farmers' choice of adaptive strategies not only to their perceptions of climatic change but also to the relative importance of other factors affecting agricultural decisions).

1.3 Research Scope

This study has several objectives all of which relate to gaining a better understanding of how climatic change fits into the decision-making environment of farmers. This entails a close examination of decisions made by individual farmers, not just those related to climate but any decisions significant to the operation of their enterprise. Thus it will be important to study farmers' own accounts of the factors that have influenced their past decisions, the nature of and reasons for planned future changes, what they see as important opportunities and challenges, and any other factors that might weigh significantly in their decisions.

While this study is concerned with climatic change and agricultural adaptation, the focus will not be on determining the validity of predictions for global and/or regional climatic changes. Rather, this research examines in what ways farmers are sensitive to past and current climatic variation vis-a-vis other factors important to agriculture, in order to determine farmers' sensitivities and vulnerabilities to a changing climate.

The case study employed in this thesis draws upon active farmers in the Regional Municipality of Ottawa-Carleton. Direct involvement of the farm community is an

essential element of research into the potential of agricultural systems to adjust to changing conditions. The unique nature of agriculture in this area, described in Chapter 3, must be recognized as part of the broader set of conditions which ultimately affect specific decisions on specific farms. Assessing the extent to which findings from this case study may be generalized is beyond the overall scope of the research.

1.4 Thesis Outline

Following this introduction, the second chapter reviews research frameworks employed in studies of climatic change-agriculture linkages and demonstrates how research into farm-level decision-making may be integrated with this work. Specific attention is brought to agricultural decision-making and adjustment in the face of three major forces: urbanization, globalization of agricultural economies, and environmental hazards. Chapter 3 focuses on the methods involved in bringing this information together in order to assess how farmers in the Ottawa area perceive climatic change as affecting their operations and their choice of adjustment strategies. This chapter includes a section describing the nature of agriculture in the Ottawa-Carleton region so that the research survey is placed in the context of the local agricultural environment. Once this has been accomplished, characteristics of the decision-makers responding to the survey are presented in Chapter 4. Analyses of recent changes on RMOC farms are presented in Chapters 5-6, starting with an analysis of the nature of these changes and reasons for change on survey respondents' farms. Climatic change and its impacts on recent and future decisions will be addressed specifically in Chapters 7 and 8. The final chapter includes a discussion of the analyses presented in previous chapters, with

recommendations for future research directions.

CHAPTER 2: RESEARCH FRAMEWORKS: CLIMATIC CHANGE- AGRICULTURE LINKAGES AND FARM-LEVEL DECISION MAKING

2.1 Introduction

This chapter begins by outlining the research frameworks traditionally employed in studies of climatic change and agriculture. Other geographic subfields which have examined the socioeconomic aspects of agricultural adjustment to a variety of forces (e.g. urban pressures, globalizing economies, environmental hazards) are introduced later in the chapter. By emphasizing the human dimensions of agricultural adaptation common to these studies, a better understanding of the decision processes which need to be detailed in studies of climatic change and agriculture begins to emerge.

2.2 Climatic Change Impacts Research Frameworks

Studies of climatic change and agriculture have been conducted at various geographical scales and have examined themes ranging from impacts of climatic change on agroclimatic properties, yields and crop and livestock productivity, to land and regional production potential and higher-order impacts on agricultural economies. While this represents considerable variety in terms of themes studied, much of this work originates from a clearly established research framework (Parry 1990, Brklacich et al. 1998, Parry & Carter 1998).

The conventional framework (**Fig. 2.1**) starts with "scenarios" of global climatic change, most often generated from the results of general circulation models (GCMs) under a doubling of CO₂ in Earth's atmosphere. Next the results of the models are

Figure 2.1 Conventional approaches to studying climatic change impacts on agriculture.

(Source: Brklacich et al. 1997b)

translated to discern "first-order" impacts (Parry and Carter 1998) on important biophysical or agro-climatic properties such as frost-free season length (Brklacich et al. 1998). Often the results are combined with crop productivity models to determine second-order impacts on crop yields and production potential, and sometimes to derive higher-order impacts on farm and regional economies (Brklacich et al. 1998).

This approach is often referred to as the "impact approach" (Kates 1985, Parry 1990, Parry and Carter 1998) because the impacts of a change to Earth's climate are modelled in one direction: a change to climate affects crop growing conditions, in turn

affecting yields and subsequently agricultural profits and regional agricultural potential. More recently, however, there has been increasing recognition of the need to treat climatic change and agriculture as a series of "interactions" as opposed to unidirectional "impacts" alone (Kates 1985, Parry 1990). This comes from the recognition that climatic events are one of several processes, both biophysical and socioeconomic, affecting agriculture and interacting with each other simultaneously (Parry 1990).

The idea of studying climatic change and agriculture from an "interactions" perspective demonstrates the importance of studying the capacities of, and constraints on, farmers and societies in their ability to adapt to a changing climate (Kates 1985). But, while linking farm economies with regional agricultural economies and interactions with other sectors, this approach still tends to neglect the role of human adaptation. Adaptation has received little attention due to its complexity and a lack of methodologies for studying it (Parry and Carter 1998).

This paper proposes to integrate findings of conventional research on climatic change impacts with some important conclusions made by researchers studying the human dimensions of agricultural change, and in so doing it is hoped that considerable progress may be made in understanding agricultural adaptation to climatic change. This integration involves placing some of the conventional climate impacts findings in the context of agricultural change and human decision-making. Other geographic subfields which have involved attempts to understand the socioeconomic aspects of agricultural (and more generally, human) adjustments to change include studies focusing on agriculture in near-urban settings, the globalization of agricultural economies, and human

perception and response to environmental hazards. Several contributions from these selected geographic subfields are relevant in identifying the human dimensions of agricultural adaptation that will be crucial to understanding the linkages between climatic change and agricultural systems. Although there are research bodies which investigate agricultural decision making in other contexts, these three subfields were selected specifically for this research for a number of reasons. Studies of agricultural adjustment to environmental hazards help illuminate the decision process as it relates to climatic variation and extremes, features which are an important part of the current climate of the Ottawa-Carleton study area (see **Section 3.5.1**). Decisions on the highly-industrialized farms found in this region are also likely to be influenced by forces such as the globalization of economies tied to agriculture, and increasing capitalization pressures. And the proximity of a major urban area, Ottawa-Hull, affects agricultural decisions not only by placing a range of pressures on farmers but also by opening many opportunities to agriculture on the urban fringe. Thus, these three subfields are highly relevant to agricultural decision making in the study area. A short review of these subfields follows, with specific attention devoted to identifying links between each subfield and climatic change research.

2.3 Studies of Agriculture in Urbanizing Areas

2.3.1 Nature of problem

Geographers have long examined the influence of proximity to urban areas on agricultural systems. As urban areas expand and grow, the way in which farming systems

adjust and change has captured much attention. This is not surprising given the potentially wide range of effects of urbanization on agricultural systems and the need to develop policy responses in areas where productive agriculture is threatened by many competing land uses. Much of the research on agriculture in near-urban areas also appears to have been stimulated by the increasing recognition that farms in these areas are developing along very different paths from those in predominantly rural areas. One fundamental difference is that farms operating on the urban fringe are characterized by very high levels of change (Ilbery 1985). This high level of change stems from both metropolitan and non-metropolitan forces (Bryant et al. 1982, Bryant and Johnston 1992) which interact to create a very complex and dynamic agricultural environment.

The effects of rising land values and pressures from competing land uses (e.g. residential, industrial, commercial) on farmer decisions is one important area of inquiry. Here, questions arise about the extent to which the possibility of development and sale of land affects farming practices and long-term planning (Bryant et al. 1982, Ilbery 1985, Bryant 1986, Ilbery 1987). Much emphasis is placed on studying how land speculation affects farmers' land management decisions. In some areas this has been studied heavily since farmers' choices of strategies have tended to include those which temporarily increase productivity but also result in considerable land degradation (Ilbery 1985).

Access to large urban markets is another metropolitan force important in understanding processes of agricultural change in near-urban areas (Bryant et al. 1982). These urban markets open up unique opportunities for many local producers, and sometimes result in specialization or diversification of farm enterprises. The result is a

high level of change to the nature of farm enterprises, especially on the inner-most parts of the rural-urban fringe (Ilbery 1987). Here farmers frequently make enterprise decisions to take advantage of quickly developing market opportunities.

Urban areas also offer opportunities for off-farm work (Bryant et al. 1982). The higher off-farm employment opportunities relative to those of rural farmers can have many effects on the day-to-day operation of farms and on the way in which farmers make long term decisions (Moran 1988), for several reasons. First, in some cases off-farm work decreases farmers' dependency on the farm as a source of income. Second, income obtained from off the farm may provide additional capital for the farm operation, opening up opportunities for changing the nature of the enterprise. However, this may be counterbalanced by a third effect, since as a farmer's commitment to off-farm work increases, they may lose time and labour resources for the farm itself and become restricted in the types of enterprise that may be operated effectively. In any case, these examples demonstrate that the greater employment opportunities associated with near-urban areas often affect important agricultural decisions, including the nature of the farm enterprise itself.

The effects of increasing non-farm rural populations (Hay 1992) on farm decisions is another important domain of agriculture-urban fringe research. Much of this work demonstrates that the frequency of land use conflicts increases as development expands into rural areas (Thompson Jr. 1981). This includes conflicts over agricultural odours, noise, dust, and chemical spraying which often result in public complaints against farmers. But other conflicts involve those of livestock predation by domestic animals,

trespass, theft, vandalism and highway traffic which affect farmers' livelihoods directly (Thompson Jr. 1981, Bryant et al. 1982, Bryant 1986, Ilbery 1987). The construction of highways and the threat of continued development can lead to farm fragmentation, making continuity and expansion increasingly difficult (Ilbery 1987). These processes may affect farm-level decisions in both the short and long term, although the influence of such processes on farm decisions varies greatly, often depending on the extent of the non-farm population in a given area (Ilbery 1987).

2.3.2 Adaptive Strategies

Faced with land pressures that they are often unable to compete with, farmers in developing urban areas must often make decisions about the timing of the sale of their land and the price they are willing to accept, as well as the type of farming they pursue in the meantime (Munton 1974, in Ilbery 1987). Once the land has been sold, the farmer may 'farm to quit' (Bryant et al. 1982, Ilbery 1985, Bryant 1986, Ilbery 1987) by intensifying the operation to increase production while abandoning rotation or conservation measures. Another possibility is that the farmer may adopt an 'idling' policy (Ilbery 1987), withdrawing both capital and labour given future capital returns acquired from the sale of the land. As urbanization increases and the value of land goes up, some farmers see the opportunity to sell their property as an important source of retirement funds. A third option is to change to a 'safer' enterprise (Ilbery 1987) of a less intensive or short-term nature. Where land has become fragmented through urban development, many farmers employ a system of low cost, low productivity farming since they are restricted to small holdings when it becomes difficult to purchase additional land for

expansion (Bryant et al. 1982). The choice of adaptive options depends on several factors, including not only the nature of the land tenure and past experiences of urban development, but also personal factors such as the farmers' attitudes and non-economic motives such as the maintenance of privacy and status (Ilbery 1987).

The influence of increasing urban markets has meant that highly specialized activities, such as horticulture, direct marketing, pick-your-own and farm-based recreation schemes are becoming increasingly incorporated into existing enterprises (Ilbery 1985). Farmers using such diversifying adaptive strategies are often concentrated close to cities (Ilbery 1987, Deslauriers et al. 1992). These diversified operations are often not subject to the land and capital requirements of some of the larger operations found in rural zones (e.g. cash cropping, dairy), and tend not to be integrated into regulated sectors allowing them more flexibility in responding to rapid changes. This means that individual behaviour becomes important in understanding processes of change in urban fringe agriculture (Deslauriers et al. 1992).

Since increases in off-farm employment often limit the time and labour resources a farmer can allocate toward their enterprise, one or more of several adaptive strategies may be employed. One option is to substitute extra capital inputs for personal labour in order to maintain the intensity of production (Ilbery 1985). However, a common set of adaptive strategies employed by farmers in urbanizing areas involves decreasing the intensity of production. This is accomplished by changing to more extensive types of farming (e.g. switching from dairy to beef farming) or to abandon full-time farming in favour of a part-time operation (Ilbery 1985, Bryant 1986, Ilbery 1987, Gasson 1988) in

which intensity of production lowers considerably. One strategy being increasingly employed is to split time and income resources quite evenly between on- and off-farm work, reflecting not only a desire for economic benefits but also lifestyle ones. The emergence of this strategy demonstrates the diversity of socioeconomic structures on farms in the urban fringe (Deslauriers et al. 1992) and the wide range in the motivations of individual farmers which must be examined if processes of agricultural change are to be understood.

Adaptive strategies to deal with pressures from increasing non-farm rural populations are often difficult to implement. In some areas the only means of limiting the amount of conflict is to form local agricultural protection or to limit suburban growth through the creation of agricultural districts, lower tax assessments on working farms, zoning rules, and the opportunity for farmers to sell development rights while retaining title to the land and the right to continue farming it (Thompson Jr. 1981). Where such strategies are not feasible the farmer is often required to adjust the timing and nature of certain practices (e.g. spraying, manure) in response to public demands. The nature of this response, however, often depends on social factors such as the way in which farmers perceive the non-farm population and public demands and attitudes.

2.3.3 Research Frameworks Used

Several approaches to studying agricultural change in near-urban areas have been used. Early emphasis was on economic and physical approaches to explain patterns of agricultural land use (as described by Ilbery 1978, Ilbery 1985) but by the 1980s research tended to focus on the attitudes and behaviour of farmers on the urban fringe as a set of

influences in addition to those related to economic and physical environmental factors (Ilbery 1985). This approach was very different from geographical and economic determinist or optimizing models in that it argued that farmers are not homogeneous, but rather they react differently to urban development (Ilbery 1985).

This approach, often termed the 'behavioural' perspective (Ilbery 1978), emerged from the recognition that traditional economic and physical models were failing to provide realistic explanations of agricultural land use patterns (Ilbery 1978, Ilbery 1986). The objectives of such a behavioural approach were clearly articulated by Harvey (1966):

... if we recognise the all-important fact that geographical patterns are the result of human decisions, then it follows that any theoretical model developed to explain agricultural location patterns must take account of psychological and sociological realities, and this can only be achieved if the normative theories of agricultural location are made more flexible and blended with the insights provided by models of behaviour.

(in Ilbery 1986)

Consideration of farmer behaviour and attitudes began to receive greater attention in studies of farmer responses to the threat of urban development in particular, and emphasis began to be placed on the motivations of individual farmers in explaining land-use patterns (Ilbery 1986). The behavioural approach recognizes that the fundamental unit of study in agricultural geography is the farm and the farmer, often overlooked in previous approaches (Ilbery 1986).

Several methodologies for studying agricultural change from the perspective of the farmer have been developed. A common theme among many of these approaches is to consider individual farmer's own accounts of the factors and values influencing their agricultural decisions (Gasson 1973), often using questionnaires (Ilbery 1983, Gasson

1988). The importance farmers place on different factors in the decision-making process may be elicited through semantic differential tests, or point score analysis, where farmers are asked indicate the importance they attach to different factors from a pre-selected list in terms of its degree of influence on farm decisions (Ilbery 1978). The factors may be grouped under broad headings (e.g. economic, political, socio-personal) to search for wider patterns (Ilbery 1987). Results are sometimes also related to farmer socio-personal characteristics such as age, education, and training (Ilbery 1978). Other approaches have related farm decisions to the aspirations of farm family members and to family life cycles (Moran 1988).

These methods are not without criticism. Farmer response to questionnaires often masks the fact that farmers themselves may be unaware of the bases of their own decisions, and influenced by factors that they have never recognized (Ilbery 1978, Ilbery 1986). However, the approaches used by those adopting a behavioural perspective have demonstrated that in order to understand processes of agricultural change on the urban fringe, a greater understanding of the importance of socio-personal considerations in the decision-making process is needed (Ilbery 1978). For example, given the importance of changing family needs and labour resources over time, some have argued for making the family the unit of analysis (Gasson 1988) in studying processes of agricultural change.

2.4 Studies of Agriculture in a Globalizing Economy

2.4.1 Nature of Problem

While the previous section has examined farmer behaviour in response to urban

encroachment, other forces affecting agricultural decision-making are also working simultaneously, including the globalization of economies tied to agriculture. Although many farms are only indirectly linked to the agri-food chain, changes in the markets of large corporations controlling the agricultural, manufacturing and distributive phases of these chains (Wallace 1992) can have considerable implications for local producers. This integration brings a major force of change to the social and productive relations of family-based farming (Marsden et al. 1989). As farmers extend their linkages with external capitals they are increasingly placed on a 'treadmill' (Marsden et al. 1989) in which they must further capitalize their operations, for example through the use of credit and formal contracts with food manufacturers. As a result, farm management decisions become increasingly dependent upon technical and economic factors controlled by external capitals, and this external financial dependency produces constraints for managing the farm (Marsden et al. 1989). The strategies employed by local producers making farm management decisions under conditions of increasing capitalization have become a subject of inquiry significant to current understanding of agricultural decision-making.

2.4.2 Adaptive Strategies

Farmers have developed several 'restructuring' (Chiotti et al. 1997, Ilbery et al. 1997) or 'coping' strategies (Marsden et al. 1989) in order to continue viable family enterprises while faced with increased external capital linkages and world market realities. These adaptive strategies may be grouped as different 'pathways of farm business development' (Ilbery et al. 1997): first, those which involve continuing agricultural production as a full-time business; those involving diversifying the farm

income base; and those in which the intensity of production lowers considerably and farm income is marginalized.

Strategies designed to maintain full-time production on the farm have taken on several forms. One such strategy is to continue the current enterprise through the intensification of production of traditional products. The viability of this strategy, however, depends on the farmer's access to and ability to pay for increasing farm inputs and technologies and an expanding land base. An alternative is to change the types of crops grown or livestock raised to take advantage of new opportunities as access to international markets opens. This is an important strategy since changes occurring in world markets may have as significant an influence on local agriculture as changes in domestic production prospects (Clark 1988, Brklacich et al. 1998).

Maintaining full-time production is sometimes also achieved using various "accumulation" strategies (Marsden et al. 1989). These strategies depend on farms being established over generations, and the willingness of farm family members to pool capital, technical skills and managerial abilities through partnerships (Marsden et al. 1989). Generational transfers are an important means of freeing up large amounts of capital that are necessary to intensify production as farms become increasingly linked to international markets. When children lose interest in maintaining the farm business, however, such accumulation strategies need to be re-examined (Marsden et al. 1989, Pile 1990) and farm decisions may take on a very different nature. In this case, while market conditions exert considerable influence on farmer decision-making, social considerations such as the motivations of different family members must also receive priority in assessing the

choice of adaptive measures.

Other strategies have been employed in adjustment to globalizing economies which do not follow the "bigger is better" path taken by many of the approaches already discussed. These involve diversifying the farmer's income base, often by redeploying farm resources into new non-agricultural products or off-farm employment opportunities (Ilbery et al. 1997). Developing both on and off farm alternative enterprises, sometimes referred to as strategies of "pluriactivity" (Ilbery et al. 1997) allow farmers to lower their dependence on one or two sources of income, often becoming less vulnerable to the vagaries of international markets while capturing new market opportunities. Decisions to implement such diversification strategies have been found to depend on both external factors (e.g. macro-scale processes of agricultural change, formal institutions, availability of agricultural information) and those internal to farm households, including relations within the family, stages in the family's life cycle, age of children, succession, and educational and occupational experiences of family members (Ilbery et al. 1997).

Sometimes the farm itself is marginalized considerably as a source of income and farmers rely heavily on other sources of livelihood. This is achieved through a substantial lowering of inputs and a switch to part-time or hobby farming, where off-farm sources of income become much more important to a family's financial survival. The ability to implement such strategies depends on social factors such as the aspirations of family members, off-farm interests and the nature of farmer goals and values with respect to their agricultural operation. For example, part-time and hobby farmers often place high importance on expressive and intrinsic values such as leading a healthy lifestyle and

meeting challenges (Gasson 1988). The extent to which these goals are valued relative to those of earning business profits is often a factor in determining an individual's willingness to switch from full-time to part-time or hobby farming.

2.4.3 Research Frameworks Used

Studies of farm adjustment to globalizing agricultural economies vary considerably in terms of the scale of analysis. Some seek to examine the implications of international-level restructuring on agriculture at local, regional and national levels, or to model the effects of broad changes in world food markets. An understanding of the implications of such restructuring for farm-level decisions, while requiring analysis of changes happening in international agricultural markets, must also capture the way such macro-scale processes are perceived by farmers at the individual farm level. Much research in this subfield has tended to underestimate the dynamic processes operating between industrial, finance capital and the farm family, and to underplay the role of internal family processes in bringing about change, often assuming rational forms of behaviour associated with wider macroeconomic forces (Marsden et al. 1989). Instead there is a need for a greater understanding of the forces affecting decisions internal to the farm family and the way in which external forces are perceived.

While external factors (e.g. fluctuations in international wheat markets) are recognized as having major impacts on local producers (Clark 1988, McLeod 1988), it is the way in which these producers perceive external forces and the way in which external forces interact with those internal to farm families that is beginning to receive greater attention. In order to understand the interactions between these internal and external

forces, the use of detailed and largely open-ended surveys with individual farm households is a valuable methodological tool (Ilbery et al. 1997). The reason for using intensive open-ended surveys is that agricultural decision-making is a complex process, and decisions are related very closely to the specific context of individual farms. Thus an intensive survey is favoured over one covering a greater number of farms but with less individual detail. The development of such methodologies demonstrates that processes of agricultural decision-making are as diverse as the variety of economic, social and personal goals of individual farmers. In particular, studies identifying the importance of sociopersonal goals of farmers (Gasson 1988) have helped to explain why family farms persist when conventional economic or industrial wisdom argues that small family operations would be squeezed out by larger corporate farms as world market linkages develop.

2.5 Studies of Agricultural Adjustment to Drought - Natural Hazards Perspective

2.5.1 Nature of Problem

Strategies of agricultural adjustment to natural hazards, particularly the drought hazard in the North American context, offer a plausible analogy to how farmers cope with the changing but as yet uncertain conditions of the physical environment associated with long term climatic change (Nigg 1993, Meyer et al. 1998). The decision processes of farmers faced with drought hazards are relevant to understanding farmers' adjustments to climatic change in several ways: in both cases, agricultural decisions must be made under uncertain future environmental conditions; impacts are high in terms of their effects

on human livelihoods; impacts are wide in their areal coverage; conditions leading to both involve slowly and rapidly varying human and physical parameters; onset is often slow; and the event is of long duration (Dagel 1997). Due to these similarities and the fact that long term global climatic change may affect the frequency, distribution and magnitude of many hazards (Bruce 1993), climatic change has emerged as the latest frontier of natural hazards research (Chiotti and Johnston 1995).

Part of understanding farmers' adjustment decisions to drought involves assessing the way in which farmers determine and evaluate uncertainties in their physical and economic environments. Therefore, farmer perception of drought becomes critical toward understanding the choice of farm-level adaptive strategies (Saarinen 1966, Saarinen et al. 1984, Dagel 1997). In a study of agricultural adjustment to drought in the Great Plains, farmer expectations of drought were found to be crucial in determining the types of responses implemented and ultimately the sustainability of ranching activities in the region (Dagel 1997).

Another challenge facing researchers studying agricultural adjustment to drought hazards has been to explain why agriculture persists in highly marginal agricultural areas subject to extensive climatic fluctuation. Adjustment decisions and drought impacts are both recognized to depend partly on human goals and perceptions, so that agricultural vulnerability to drought does not rest solely with measures of temperature, moisture levels or other climatic attributes. Instead, researchers seek to define more clearly the different elements of what they describe as the "multidimensional" nature of drought (Dagel 1997).

2.5.2 Adaptive Strategies

Adaptive strategies to drought hazards vary considerably depending on the nature of the hazard, farm resources and human dimensions such as farmer goals and perception of the drought hazard. Two broad types of responses to drought are identified: those involving spreading risk or lowering the loss potential on individual farms; and responses associated with bearing drought losses or in which no adjustment to drought hazards are made. The variety of individual strategies illustrates that agricultural decisions are not simply derived from the physical environment but rather involve expectations of physical conditions mixed with a wide range of human goals and constraints.

Farmers have utilized a number of strategies involving lowering potential losses associated with drought hazards on the Great Plains. Some involve lowering loss potential by changing land management practices, such as increasing irrigation or adopting stubble mulching. However, while many farmers perceive such strategies to be an effective adaptation to drought, these strategies are not always employed. For example, reasons for not adopting stubble mulching include economic constraints such as the need for special machinery or lack of available land. Sometimes farmers did not adopt the practice simply due to being unwilling to give up old ways (Saarinen 1966). These observations show that a farmer's perception of the effectiveness of different strategies is only one of many factors involved in the decision-making process.

In some cases, losses are reduced through responses designed to lower the individual farmer's level of risk associated with the drought hazard. This may be accomplished by strategies of diversification, where farmers plant more than one variety

of a given crop each year. Other strategies employed to lower risks associated with drought losses include keeping regular crop rotations and storing reserves in productive years. But whether a farmer chooses to make any significant changes to their operation depends both on their perception of drought risk and their perception of choices available to them. Farmers in the Great Plains generally do not perceive a wide range of choice available in the way they use their land (Saarinen 1966). As farmers age, the possibility of major changes to their operations may become less, but also the farmer may become more aware of environmental limitations because of their increasing drought experience (Saarinen 1966). In this way, human factors such as a farmer's age and experience, their degree of involvement with tillage agriculture, the extent to which drought affects their financial well-being and their perception of the physical environment all affect the meaning of drought to an individual farmer (Dagel 1997). In turn, these factors shape the type of adaptive strategies used.

Bearing drought losses is another broad type of adaptive strategy. By enrolling in insurance programs the farmer is able to some extent to safeguard their livelihood without having to make major changes to agricultural practices. Sometimes farmers who choose to bear the losses are also awarded drought compensation payments from government sources. The fact that some farmers do not take measures to modify their loss potential in drought-prone areas may be difficult to explain but when placed in the context of local insurance, compensation and price-support provisions the "bearing the losses" strategies make good sense to many farmers. Many agricultural decisions are not just made in reaction to physical attributes but also in the context of local social, political and

economic conditions. In fact some have observed that agriculture is adapted more to its political-economic environment than the climatic and biophysical environment in which it operates (Smit 1993).

2.5.3 Research Frameworks Used

Research into agricultural adjustment to drought often begins with an exploration of farm-level perception of the hazard rather than starting with a drought "scenario" and asking farmers how they would respond. The reason for this is the recognition that drought characteristics must first be perceived before decision alternatives are defined and responses ultimately implemented (Boulding 1983, Fischhoff and Furby 1983).

Using perception as a starting point (Saarinen 1966, Dagel 1997), researchers seek to gain insight into farmers' thought processes independent of a drought scenario. By using personal interviews with open-ended questions the researcher gains an indication of the conditions which the farmer perceives to affect their operation, without biasing the results by asking farmers directly about their drought experiences at the outset (Dagel 1997). Farmers may also be asked general questions about their background in farming and characteristics of their operation such as types of livestock and crops. This sort of information often becomes useful in explaining how one's perception of the drought hazard may relate to the nature of their enterprise. For example, drought may be defined as the conditions of the farm at a given time, rather than the lack of certain amounts of moisture or rainfall. Rainfall may be near-normal, but if the farmer has to move cattle to areas of better pasture, or if crop yields are low, they may perceive the period as a drought (Dagel 1997). Thus it is important to study how perceptions of drought may be

influenced by the state of operations of the farm as opposed to prevailing weather conditions. These perceptions, shaped by a farmer's current sensitivities to not only weather but also their current economic circumstances and nature of their operation, combine to elicit the farmer's choice of responses.

Studies of drought perceptions recognize that drought hazards clearly involve a physical trigger, but the way in which drought is manifested on the farm depends largely on how different aspects of the farmer's social environment play out in processes of decision-making. Thus studies of agricultural adjustment to drought hazards seek to understand the farmer's wider social environment, for example, whether they have opportunities to work off the farm, whether children wish to inherit the operation, and other family considerations. These approaches are not unlike those of researchers studying the human dimensions of adjustment to drought in Third World settings, where it is argued that droughts have physical triggers but disaster results from a set of social conditions which leave certain people vulnerable to drought impacts (Sen 1981, Hewitt 1983, Watts 1983, Blaikie et al. 1994). Conventional research frameworks have tended to focus on the physical agents causing drought, attributing hazard impacts to natural forces. However, when these research frameworks began to be applied across the many different human settings of the Third World, debates were raised about the specific human factors that interrelate with physical dimensions of the hazard to effect drought impacts (Torry 1979a, Torry 1979b, Hewitt 1983, Oliver-Smith 1986, Emel and Peet 1989, Chiotti and Johnston 1995). These debates point to the importance of articulating social factors which shape how hazards are perceived, how people respond to them and

ultimately the effectiveness of coping strategies. This approach is much different from early studies of hazards which attributed hazard impacts largely to geological and geomorphic processes (Hewitt 1983).

An important concept emerging from the study of drought hazards which can be related to processes of agricultural decision making is the use of "vulnerability" in studying drought impacts. Vulnerability can be defined as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard" (Blaikie et al. 1994). In the case of farmers adjusting to drought impacts, this definition might be applied not only to measure farmers' capacities to anticipate and cope with drought hazards (vis-a-vis farm structure, economic or family constraints associated with their operating environment) but could also be extended to include a measure of the farmers' desire to implement adjustment strategies given other personal goals, motivations and values. Such an approach would outline some of the forces shaping farmer perception of drought and relate these to the farmer's choice of response strategies. Studies of vulnerability certainly demonstrate the importance of studying the decisions of farmers in the context of individual farms, since case studies have revealed such complex patterns of vulnerability that it becomes difficult to describe patterns at regional scales (Liverman 1990, Dow 1992, Meyer et al. 1998).

2.6 Discussion

Research detailing agricultural adjustment in urban settings, the re-structuring and globalization of agricultural economies, and adjustment to drought hazards provides a

rich backdrop toward identifying the human dimensions of agricultural decision-making needed to enhance our understanding of the agricultural systems-climatic change interface. Contributions are made in both the major findings of these research bodies with respect to the choice of adaptive strategies used, and in the methodologies employed to investigate farm-level decision-making. Of the three major research bodies discussed in this section, several common themes may be identified and are summarized in **Tables 2.1 - 2.3**.

One theme common to these studies (**Table 2.1**) is the recognition of the role of social and personal factors in influencing and sometimes commanding the decision process. Studies in each of the three broad geographic subfields are linked in that they demonstrate that personal factors, family considerations and farmers' age and experience all affect farm decisions significantly.

Table 2.1: The role of social and personal factors influencing the decision process.

Examples of contributions from:	Theme #1: Identifying the role of personal and non-economic motives in agricultural decisions.
Urban adjustment literature	<ul style="list-style-type: none"> - adaptation to land pressures depends partly on personal factors (e.g. privacy, status) - strategies involving off-farm work or switching to part-time farming depend largely on individual motives, family life cycles and aspirations
Agricultural restructuring literature	<ul style="list-style-type: none"> - accumulation strategies require the coordination of family interests - decisions to diversify are related to both external forces and those internal to farm families (e.g. family relations, age of children) - some strategies (e.g. switching to part-time farming) are popular among farmers who place high importance on expressive and intrinsic values
Drought hazards literature	<ul style="list-style-type: none"> - adoption of adaptation strategies does not rest with their perceived effectiveness but also with human factors (e.g. farmer's age, drought experience, willingness to change)

A second theme (**Table 2.2**) relates to the way in which a farmer's range of available choices may be constrained or broadened by the farm's wider environment. Studies in each geographic subfield show that the degree to which a farmer has flexibility in their choice of adjustment strategies depends on significant features of the economic and political environment. In assessing the role of on-farm factors (e.g. social, personal, family) it is important to situate the farm with respect to broader economic, political and social forces.

Table 2.2: Research links in the way a farmer's range of choice may be constrained or broadened by the farm's wider environment.

Examples of contributions from:	Theme #2: Understanding how agricultural decisions are influenced and constrained by the social, economic and political environment.
Urban adjustment literature	<ul style="list-style-type: none"> - existence of urban markets allows for diversification and specialty operations not integrated into highly regulated sectors - these diversified enterprises have greater flexibility in responding to change
Agricultural restructuring literature	<ul style="list-style-type: none"> - increased linkages with external capitals, technical and economic factors produce constraints for managing the farm
Drought hazards literature	<ul style="list-style-type: none"> - choice of adaptive strategies highly influenced by the external environment; many farmers "bear the losses" if insurance and compensatory schemes are available while others must make adjustments

The bodies of research presented in this section indicate that another common theme underpinning agricultural decision-making is the importance of farmer perception in the decision process (**Table 2.3**). The bodies of research are linked in that they demonstrate that farmers make many important decisions from information that comes from a series of perceptions as opposed to an objective reality. These perceptions have been found to depend on several factors, including a farmer's information sources, the nature of a farmer's work, the aspects of climate the farm is most sensitive to, perceived threats and opportunities, and future expectations. More broadly, the studies stress the overall importance of perception in affecting the decision process.

Table 2.3: Research links demonstrating the importance of perception in the decision process.

Examples of contributions from:	Theme #3: Locating perception in farmers' decision processes and understanding how it relates to the selection of adaptive strategies.
Urban adjustment literature	<ul style="list-style-type: none"> - perception of the nature and strength of urban pressures (e.g. competing land use pressures) influences land management decisions - responses to pressures from non-farm rural populations often depend on farmers' perceptions of public demands and attitudes
Agricultural restructuring literature	<ul style="list-style-type: none"> - type of specific coping strategies employed are often related to a farmer's perception of his/her wider pathway of farm business development
Drought hazards literature	<ul style="list-style-type: none"> - perception of drought shapes the type of adaptive strategies employed - the farmer's perception is itself influenced by the nature of the operation and its associated climatic sensitivities, farmer's age and drought experience

While the bodies of research discussed in this section deal with a diversity of topics, the common themes related to agricultural decision-making that have emerged from these studies may be applied toward understanding agricultural decisions with respect to climatic change. The way in which urban, agricultural restructuring, drought and climatic change challenges present themselves to farmers is in many ways different, but the means by which the farmer balances these pressures with those of their wider decision-making environment bears similarity. Decisions pertaining to climatic change, like those found in the other three bodies of research discussed, depend on the way in which social and personal factors enter into the farmer's decision process, the way in which the farmer's range of choices may be constrained or broadened by the farm's wider

economic and political environment, and the way in which climatic change is perceived.

Critical knowledge gaps in existing climatic change-agricultural systems research include the narrow treatment of non-climatic forces, particularly the implicit assumptions that climatic influences control human decisions, or the use of approaches which assume that agricultural adjustments will be governed by the "invisible hand" of the market place (Chiotti et al. 1997). These approaches often underemphasize the processes shaping farmers' coping strategies and neglect the social and economic reasons why farmers may be reluctant to implement certain adaptive measures (Chiotti et al. 1997). If the list of possible factors shaping agricultural adjustments to climatic change is broadened to include climatic and societal variables, researchers may be able to investigate the interactions between these variables, and determine ultimately how these relationships may constrain or facilitate responses to climatic change (Chiotti and Johnston 1995).

The use of scenarios in conventional approaches to studying climatic change and agriculture also tends to mask the significance of farmer perception of climatic change in the decision process. Studies of climatic change and agricultural systems would be enhanced by incorporating notions of the perception approach used in other research bodies, where the main objective is to analyze adjustments from the perspective of the decision-frame as it appears to individual farmers, with all of its imperfections (Whyte 1985). This approach to studying perception would help assess how farmers perceive climatic change as a threat or opportunity to their current practices, how they evaluate impacts which are uncertain and not previously experienced, and which may occur over a long time period.

In developing a research methodology for studying climatic change and agricultural decision-making, similarities in the methodologies used by the three bodies of research discussed in this chapter are noteworthy. All three research areas emphasize the importance of studying the farm family or individual farmer as the basic unit in analyzing processes of agricultural change. Studies of agricultural adjustment to urban pressures often utilize questionnaires to measure the value farmers attach to different factors and seek to relate this information to a farmer's socio-personal or family characteristics. Similarly, studies of individual farmer's adjustments to broad forces of agricultural restructuring advocate the use of detailed, open-ended surveys which look at how forces operating within the farm family interact with external pressures. Research into agricultural adjustment to drought often starts by gathering background information about the general characteristics of a farmer's operation and their perceptions of the factors most influencing their farm before inquiring directly about what type of adaptive strategies farmers choose to adopt.

Given the similarities in the types of approaches needed to investigate farm-level decision-making, this study seeks to integrate some of these methodologies to develop a procedure for enhancing our understanding of agricultural adjustment to climatic change. In light of the findings produced by studies of agricultural adjustment to urban, restructuring and drought pressures, some of the key elements to a study of agricultural adjustment to climatic change must include:

- an assessment of how farmers weigh climatic change information vis-a-vis other factors in the decision process;
- greater understanding of how climatic change may be perceived as a threat or opportunity at the farm level;
- a thorough appraisal of the background characteristics of farm enterprises which may be used to distinguish differences in how climatic change is perceived and in the choice of adaptive strategies used across different farms;
- a clear indication of the background and roles of decision-maker(s) on each farm;
- identification of personal factors important to farm decisions (e.g. retirement plans, expectations regarding farm succession);
- identification of the reasons for past, current and future changes to the farm operation (e.g.. production, land management, structural changes) that comes directly from farmers themselves; and,
- analysis of the aspects of weather and climate to which individual farms are most sensitive.

The next chapter outlines how these objectives are built in to an agricultural survey investigating climatic change and agricultural adaptation in the Regional Municipality of Ottawa-Carleton (RMOC). Included is a description of the local agricultural context. This context is an important consideration not only in the development of the survey, but

will also be vital toward interpreting the RMOC survey results later in this paper.

CHAPTER 3: DEVELOPMENT AND ADMINISTRATION OF THE AGRICULTURAL ADAPTATION SURVEY

3.1 Introduction

The previous chapter reviewed three geographic subfields studying agricultural adjustment and developed a set of criteria important to the investigation of agricultural decisions. This chapter builds upon this foundation and outlines the development and application of a farm-level survey designed to provide a better understanding of agricultural adjustment to climatic change in the Regional Municipality of Ottawa-Carleton (RMOC).

The chapter begins by identifying considerations for the overall structure of the survey, followed by an explanation of specific survey questions, organized by section. Next, the selection process for farmer interviews and the interview mechanics are presented. This chapter also includes information about the nature of agriculture in the RMOC, current agro-climatic and biophysical properties of the region, and broad trends in agricultural land use, livestock and crop production. Although this information is presented later in the chapter, the local agricultural context is a very important consideration in survey design and is related back to the development of survey questions in order to show how conditions specific to the local agricultural environment were incorporated into the survey methodology.

3.2 Questionnaire Development: Overall Structure

Given that the objectives of this study relate to understanding agricultural

decisions from the perspective of individual farmers, it was decided that detailed personal interviews with individual farmers and farm families would be an effective way to determine, in a farmer's own words, the bases of their past and current decisions and future plans, and perceptions of climate and climatic change-related information.

Personal interviews rather than mailed-out surveys were used. Although mailed-out questionnaires could be completed at a lower cost, personal interviews were favoured because of the need for considerable detail in the explanation of farm-level decisions.

The survey contains a combination of both closed questions (e.g. those seeking yes/no answers, or rating and ranking schemes) and a number of open-ended questions. This was done purposefully, to allow the researcher the flexibility of being able to compile broad trends from the closed questions very efficiently, but to also be able to explore variations in individual farmer perceptions and gauging some of the factors in farmer decision processes by citing their responses to open-ended questions in considerable detail. This approach of coupling highly structured and open-ended questions within a survey instrument, and the use of personal interviews over mailback questionnaires has been used effectively elsewhere to investigate agriculture-environment relationships (Dagel 1997), and more generally agricultural adjustment to socioeconomic change (Marsden et al. 1989, Ilbery 1991, Bryant and Johnston 1992).

The survey is structured into 7 broad sections (Parts A-G), so that factual or "objective" information such as farm characteristics and land-use may be gathered in addition to but separately from "subjective" information such as a farmer's own expression of motives and attitudes (Ilbery 1985). The survey structure was modified

from a similar survey used to explore agricultural adaptation in Renfrew County, Ontario (Brklacich et al. 1997b). The survey instrument used in the field component of this research is presented in **Appendix A. Table 3.1** presents an overview of the survey structure and questions, and **Section 3.3** summarizes the survey and major assumptions underpinning its design and structure.

Table 3.1: Questionnaire Overview

Part	Title	Questions	Thematic questions
A	Farm Background Information	1 to 6	Farm type, Land area, Production profile, Total sales, Off-farm income.
B	Farm-Level Decision Making	7 to 12	No. of decision makers, Socio-economic profiles, Information sources, Decision making factors, Future viability.
C	Agricultural Context	13 to 14	Recent agricultural changes in E. Ont., Future opportunities & challenges.
D	Recent Farm-Level Changes	15 to 17	Inventory of recent changes to production, management & farm structure, Reasons for & timing of changes.
E	Planned Farm-Level Changes	18	Inventory of planned changes, Reasons for & timing of changes.
F	Weather & Climate	19 to 22	Information sources & relative importance, Sensitivity of farm operations to weather & climate.
G	Climatic Change & Agriculture	23 to 25	Perceived climatic changes & responses, Responses to climatic change scenario, Utility of climatic change information.

3.3 Survey Content

3.3.1 Part A: Background Information

The first section (Part A) is designed to gather background information about farm type, land area, sales, and whether the farmer has any sources of income outside the farm. This basic information was gathered so that it would be possible to develop broad classifications for the purposes of analysis, for instance by distinguishing differences in how climatic change is perceived and in the choice of adaptive strategies used across farms of different types, owner characteristics, or proportion of family income obtained from the farm.

3.3.2 Part B: Farm-Level Decision-Making

Part B of the survey focuses on farm-level decision-making, beginning with an identification of the number and roles of different decision-makers on the farm. For each interview, all persons contributing to decisions on the farm were asked to attend. This was done so that the input of those contributing to important decisions on the farm was not overlooked, since one decision-maker, for example, may have influences and information sources quite different from someone else on the same farm. By emphasizing the individual as the decision-maker, many geographic field studies have tended to neglect the social dimensions of decisions, including concerns of family members (Whyte 1985). Therefore this section of the survey seeks input from all decision-makers on the farm, and also asks questions related to broad family considerations which may or may not affect farm decisions (e.g. retirement plans, age of family members, future viability of the farm and plans for succession). Broadly, Part B

asks decision-makers to rate the relative importance of different factors and information sources influencing farm-level decisions.

It is worth noting here that one objective of this thesis is to explore the role of climate-related information in farm-level decisions vis-a-vis other information. Therefore, an important consideration in designing the survey instrument was to ensure that questions did not focus on climate as a key component of agricultural decisions in the early stages of the interview. Here, the importance of climate-related information versus other forces (e.g. social, economic, political) affecting farm decisions is being established. Therefore, in this part of the survey there were no questions asking farmers to indicate the importance of climate above other factors which may influence their decisions. In questions where farmers were asked to rate the importance of several broad factors influencing farm decisions (of which climatic conditions were part of the list), these factors were placed in random order with the intention of avoiding biases that may result from placing this list in any other particular order.

3.3.3 Part C: Agriculture in General

The next section, Part C, focuses on observations that farmers have about changes happening in the agricultural region broadly, again without asking farmers to address specific climate-related issues so that their importance relative to other broad forces of agricultural change might be established. In doing so, questions were kept open-ended, for example: "In your opinion, what significant changes have occurred in agriculture over the last ten years and describe how these changes have affected agriculture in Eastern Ontario?; What do you see as the main opportunities and challenges facing agriculture

over the next ten years?". This part of the survey helps to indicate aspects of change concerning farmers the most, in addition to identifying changes happening in the broad context of the RMOC region.

3.3.4 Parts D and E: Farm-Level Changes

Parts D and E of the survey deal with past and planned future changes to the farmer's own operation respectively. For past changes, the temporal dimension of 10 years was chosen for a few reasons. This period represents a time frame over which significant changes on the farm could occur, but is not so long as to raise concerns about the accuracy of reasons underpinning decisions. Decision-makers are asked about the nature of past changes to their production and management practices and farm structure, the timing of these changes, and reasons for change. If no change was made, farmers are asked reasons why they made no adjustment to their particular practice. The reasons for this structure are to establish what types of changes are most common to farms in the region, and by exploring the farmer's own reasons for these changes to determine the relative importance of different broad factors (e.g. social, economic, political, environmental) in terms of their degree of influence on farm decisions. In cases where individuals mention more than one reason for change, each reason is recorded. Although reasons for change can sometimes be inferred, only those reasons offered by farmers are recorded because the survey aims to measure farmers' perceptions of their own motivations.

In Part E, farmers are also asked about the types, timing and reasons for changes, this time regarding planned future changes to their operation. For this question a time-

frame of five years was used, since farmers sometimes plan ahead one or two years but rarely more than five (Parry and Carter 1985). Beyond that time the number of variables (economic, political, social) changing and affecting the farm's operating environment may have altered to the extent that it would be unreasonable for a farmer to be able to reasonably forecast their planned changes.

3.3.5 Part F: Weather and Climate

Not until Part F of the survey are farmers asked directly about the importance of weather and climate information to their decisions. Here they are asked to indicate their sources of weather information and the aspects of climate to which their farm is most sensitive. This sort of information is useful in showing where climate currently fits in to their decision processes and suggests the aspects of climate that concern farmers most.

3.3.6 Part G: Climatic Change and Agriculture

The final section, Part G, addresses one of the study's main objectives by asking farmers about their perception of climatic change specifically. Farmers are asked what aspects of climate have changed in their opinion, and whether they have made changes to their operation in response to climatic changes. These responses are important because they may relate to information gathered in previous sections about the reasons underpinning farm decisions. The final section also includes a "scenario" of climatic change. This scenario is not the departure point of the research since important objectives include understanding how climatic change is perceived by farmers and how climate information is weighed relative to other factors important in the decision process. The scenario is used instead to assess how decision-makers would react to information

presented in a manner quite typical of the way climatic change information presents itself to farmers: as a series of potential changes to agro-climatic conditions and yields for crops currently important to farms in the region, but the spatial and temporal distribution of which (occurring over a 20+ year time period) is very uncertain.

While previous sections of the questionnaire helped identify the importance of climate information relative to other factors affecting agricultural decisions, the main objectives of the final part of the survey are to explore how climatic change is perceived and to develop a greater understanding of farm-level adaptive strategies to climatic change. The latter objective is addressed not only through the farmers' indications of their planned adjustments to the climatic change scenario, but also in their assessments of the types of information they would find most helpful for adjusting to climatic change.

3.4 Administration of the Survey

3.4.1 Co-ordination of Interviewers

The pretest and final survey were administered by the primary investigator and a paid research assistant. Prior to the pretest, the two interviewers met to discuss interviewing strategies and ensure standardized methods were employed. The two interviewers also met regularly throughout the period that the final survey was administered (see **Sec. 3.4.3**) to discuss and review progress, and to co-ordinate their interviewing schedules and methods.

3.4.2 Pretest of Survey

A pretest of the survey was completed in early March 1998 by both interviewers

hired to carry out the survey. This was done to assess whether there were any difficulties relating to the interpretation of survey questions and to ensure consistency in the recording of responses by the interviewers. After the pretest was completed the interviewers met to discuss these issues and the survey instrument was deemed satisfactory for the study objectives.

3.4.3 Final Survey

Farmers participating in the agricultural adaptation survey were selected from a list of farms in the RMOC that were members of the Ontario Federation of Agriculture (OFA). OFA membership is mandated by provincial law and therefore the OFA membership list approximates the farm population for the RMOC (and elsewhere in Ontario). The OFA membership list is maintained by the Agricultural Publishing Company (Toronto), and this agency randomly selected 206 farms out of a RMOC population of nearly 1500 farms. This randomly selected subset of RMOC farms had been ordered by postal code by the Agricultural Publishing Company, and therefore it was necessary to re-order the subset to avoid biases that might have been introduced. Given the study objectives and research team resources, a target of 60 personal interviews was established.

Initially, the interviews were to take place in January 1998. However, a severe ice storm over much of Eastern Ontario and Western Quebec led to prolonged disruption of electrical services throughout the region. The rural regions of the RMOC were affected severely and electrical power outages ranging over several weeks created severe hardship. It was both unsafe and professionally unethical to attempt to interview farmers in January

1998.

Recovery from the ice storm was monitored and the contacting of farmers in the RMOC was delayed until 22 February 1998. At that time, the first 100 farmers on the randomly re-ordered subset of 206 farmers were mailed a letter indicating that they had been selected for the agricultural adaptation study (see **Appendix B**). Two weeks after mailing the letter a follow-up telephone call was made to find out if the farmer was interested in participating in the survey, which entailed a personal interview of approximately one hour in length at their farm.

An additional 50 letters were sent out on 12 March 1998 and follow-up calls made before the research target of 60 personal interviews was met. Of the 150 letters that were mailed out, 58 people agreed to participate and were successfully interviewed between 9 March 1998 and 6 April 1998. Two scheduled interviews were rejected, one because the interviewee was no longer actively farming and the other because the subject repeatedly missed scheduled interviews. Another 47 farmers said they were not interested or unable to participate in the survey, sometimes citing that their farms were small operations and therefore they did not wish to participate. These individuals were reminded that all farms were of interest but nonetheless at least 4 of these farmers still elected not to participate. Another 43 could not be reached during the study period. Outdated or invalid addresses and telephone numbers supplied by the Agricultural Publishing Company Farm Database prevented contacting individuals identified in the OFA list in 7 cases. **Table 3.2** provides a summary of participation in the RMOC survey.

Table 3.2: Survey Contacts Summary

Total Number of Farms in RMOC ¹	1455
Random Subset from OFA Membership:	206
Number of Initial Contacts (see Letter in Appendix B):	150
Number of Interviews Completed:	58
Number of Rejections/Incompleted:	49
Number of Non-Contacts	43

¹ From 1996 Census (Statistics Canada 1997)

At the beginning of each interview the decision-maker(s) received an informed consent form which identified that the research was part of a Carleton University and Agriculture and Agri-Food Canada study, and to be used for this thesis. Other conditions regarding participation (e.g. confidentiality, right to withdraw, etc.) were also clarified at this time. The informed consent form is presented in **Appendix C**.

3.5 Agriculture in the Regional Municipality of Ottawa-Carleton

The local agricultural context is an important consideration in both survey design and in the interpretation of survey results. This section reviews the physical setting of agriculture in the RMOC, and broad trends in agricultural land use, livestock and crop production, in an effort to show how the survey was designed to best capture the dynamics of agricultural change in the region.

3.5.1 Physical Setting of Agriculture in the RMOC

The Regional Municipality of Ottawa-Carleton (RMOC) is located in eastern Ontario adjacent to the Ottawa River (**Fig. 3.1**). The range of biophysical and climatic

Figure 3.1: RMO Study Area

resources and the proximity of a major urban centre (Ottawa-Hull) with a population of approximately 1 million make for a very diverse agricultural landscape.

Ottawa-Carleton's agroclimatic resources consist of a frost-free period averaging 142 days and accumulated Corn Heat Units of between 2500-2700 (Huffman and Dumanski 1983). Summer temperatures are quite warm. Mean daily temperatures for June, July and August are in the 18-21 °C range, with average daily maximums in the 24-26 °C range (Environment Canada 1983). The mean number of days with maximum temperatures exceeding 30 °C per growing season is 10, most of which occur in July. The number of days where minimum temperatures drop below 0 °C averages 15 in April and 2 in May, and sometimes below freezing conditions occur in June and September (Environment Canada 1983). In the winter months, the mean number of days with minimum temperatures dropping below -20 °C is 18, often occurring in January and February. The prevailing wind direction for most of the growing season is from the southwest (Environment Canada 1983).

Average annual precipitation is 850 mm (Huffman and Dumanski 1983). About half of the total rainfall occurs in the April-September period, and is highest in July and August, when thunderstorms are most likely to occur (Environment Canada 1983). During the months October through March, mean rainfall measures 210 mm and mean snowfall totals 218 cm. The mean number of days with freezing rain over this period is 15, most often occurring in December and January (Environment Canada 1983).

The total area of the RMOC is approximately 275 800 hectares. Much of the region has productive soil resources, with about 52% of the land base suitable for

sustained field crop production (CLI classes 1-3). About 10% of the land base is highly suitable (Class 1) land for agriculture (Hoffman and Noble 1975). Much of the remaining land base is marginal for sustained agriculture, capable of supporting hay and pasture. Only about 5% of the land base is considered unsuitable for agriculture (CLI class 7) (Hoffman and Noble 1975). Where soil capability limitations do occur, they are often due to excess water, the presence of consolidated bedrock or stoniness, or a combination of adverse soil characteristics such as poor soil structure, low fertility and moisture content. Much of the highly-suitable land is concentrated in the Carleton West, Osgoode and Rideau townships (Hoffman and Noble 1975).

3.5.2 Agricultural Land Use: 1951 to Present

Trends in the total number of farms and total farmland area in the RMOC since 1951 are similar to trends observed for much of southern Ontario (Hay 1992). Most notably the number of farms and total farm area continues to decline, while average farm size is on an upward trend (**Tables 3.3 and 3.4**). Between 1951 and 1996 the number of census farms in the RMOC declined by about 54%, and the total area of farms was reduced by over one-third. Average farm size has fluctuated over the years but continues on an upward trend, increasing from 62 ha in 1951 to 83 ha in 1996 (**Fig. 3.2**).

Table 3.3: Trends in the Number of Census Farms, RMOC and Ontario 1951-1996

Year	Ontario	RMOC
1951	149 920	3 104
1961	121 333	2 277
1971	94 722	2 041
1981	82 448	2 002
1991	68 633	1 606
1996	67 520	1 455
% change 1951-1996	↓ 55%	↓ 54%

Table 3.4: Trends in Total Farmland Area, RMOC and Ontario 1951-1996 (ha)

Year	Ontario	RMOC
1951	8 449 866	191 677
1961	7 518 462	164 497
1971	6 460 025	157 900
1981	6 039 242	143 753
1991	5 451 385	121 039
1996	5 616 860	120 114
% change 1951-1996	↓ 34%	↓ 38%

(sources: Dominion Bureau of Statistics 1953, 1963, OMAF 1971, 1982, 1992, Statistics Canada 1997)

Figure 3.2: Trends in Average Farm Size, RMOC and Ontario

Figure 3.3: Trends in Improved Land, RMOC and Ontario

(sources: Dominion Bureau of Statistics 1953, 1963, OMAF 1971, 1982, 1992, Statistics Canada 1997)

Similar to total farmland area, the amount of improved land in the RMOC has steadily declined since 1951. However, improved land accounted for a rising share of total farmland over the 1951-81 period (**Fig. 3.3**) before dropping slightly in the 1980s and 1990s. The proportion of improved land on farms in the RMOC has followed a path generally similar to that of Ontario except that the proportion of improved land in the RMOC relative to total farm land was considerably greater than that for Ontario in 1951. By 1991 this trend had reversed, as the proportion of improved land in the RMOC was considerably less than that for the province.

3.5.3 Crop Production: 1951 to Present

Hay is the dominant crop in terms of area in production and total crop value in Ottawa-Carleton. Between 1951 and 1981, hay typically accounted for about half the total area in field crop production. More recently the area devoted to hay production has declined while the area used for grain corn and soybeans has increased substantially. The increase in land used for grain corn has increased steadily since 1951, while increases in land used for soybean production did not occur until the early 1990s. The land area used for the production of wheat has consistently been low while the land area used for other cereals (oats, barley, rye, mixed grains) has decreased substantially, from over 31 000 ha in 1951 to about 5 400 ha in 1996 (see **Fig. 3.4**).

Figure 3.4: Trends in Crop Production, 1951-1996 ¹

¹ Note: Data are unavailable for area in wheat production for 1971 and 1981. (sources: Dominion Bureau of Statistics 1953, 1963, OMAF 1971, 1982, 1992, Statistics Canada 1997).

Hay remains the most valuable crop; however, the relative importance of grain corn in terms of total crop value is increasing. The value of the soybean crop also increased considerably between 1981 and 1991, although its total value remains less than that of hay, grain corn, fodder corn and other cereals and mixed grains.

As the value of grain corn and soybean production have risen substantially, so too have their yields. Between 1971 and 1991, grain corn yields increased from about 5000 kg/ha to over 6900 kg/ha, and soybeans increased from just over 1800 kg/ha to over 2400

kg/ha. Over the same period, yields for hay have fluctuated and increased only slightly while those for fodder corn have declined, perhaps explaining in part the shift in production toward grain corn and soybeans.

The most intensive types of field crop production in Ottawa-Carleton are monoculture corn cropping systems, followed by corn rotation systems, and mixed crop (with dairy and/or beef) operations. Less intensive forms of field crop operations include hay and pasture systems (Huffman and Dumanski 1983). A small number of farms (fewer than 10%) produce vegetables, in which sweet corn, tomatoes and squash are the most common products grown. Other specialty crops harvested include potatoes, apples, strawberries and raspberries.

3.5.4 Livestock Production: 1951 to Present

Livestock production in Ottawa-Carleton has traditionally been dominated by dairy and beef production; however, horses, pigs and sheep are also raised on many cash crop-livestock mixed operations (**Fig. 3.5**). Overall, the total number of livestock on farms in Ottawa-Carleton rose slightly from 1951 to 1971, and has since declined.

Figure 3.5: Trends in Livestock Production, 1951-1996 ²

²Note: “Dairy Cattle” includes: cows and heifers kept mainly for milking purposes, over 1 yr. of age. “Beef Cattle” includes: cows and heifers kept mainly for beef, and steers over 1 yr. of age. For 1996, Dairy and Beef totals do not include heifers (information about whether the 12 382 heifers were kept for dairy or beef purposes was unavailable).
(sources: Dominion Bureau of Statistics 1953, 1963, OMAF 1971, 1982, 1992, Statistics Canada 1997).

In the 1950s and 1960s, the number of cattle being used or raised for milking purposes significantly outnumbered the number being raised for beef. From about 1971 onwards the number of dairy cattle dropped significantly to the point where dairy numbers are approximately equal to that of beef. This trend may reflect a number of forces affecting farmers in Ottawa-Carleton, including the desire to shift away from

highly-intensive dairy operations as farmers take on off-farm work and move to part-time operations. However it also reflects the trend towards fewer dairy cattle as production per head increases. The number of beef cattle, quite low in the 1950s and 1960s, increased substantially through the 1970s but by the 1990s began to decrease.

The number of pigs on Ottawa-Carleton farms, exceeding 20 000 in 1951, has diminished steadily so that by 1996 the number of pigs was less than half that of 1951. The number of horses and sheep have fluctuated and remain less than that of pigs.

3.5.5 Summary of Agricultural Trends in the RMOC

Many farms in the RMOC have experienced significant changes over relatively short periods of time. Some of the largest changes may be found in the livestock sector where there has been a shift in emphasis from a sector dominated by dairying to one where dairy and beef production take on roughly equal importance. In terms of crop production, farms in the RMOC have undergone a number of changes. The most significant of changes include a move away from the production of cereals, a substantial increase in grain corn production and the introduction of soybean crops to many farms. Together these changes underscore both the diverse and dynamic nature of agriculture in the RMOC.

3.5.6 Incorporating the Local Agricultural Context into the Adaptation Survey

The agricultural landscape of the RMOC is very diverse, and the variety of farm types and sizes in the region presents a certain challenge when comparing the concerns of one farmer with those of another in the investigation of agricultural decisions. This diversity is reflected in several key characteristics which in some ways act to distinguish

the decision-making process from one farm to another. Distinguishing characteristics which figure most prominently in farm-level decisions in the RMOC include:

- considerable variation in dependence on the farm as a source of family income from one farm to another, due in part to the proximity of the Ottawa-Hull urban area and opportunities for off-farm employment;
- differences in urban pressures (e.g. land values, development pressure, public complaints) which may vary substantially by locale;
- the wide range of farm types in the region, enhanced by the presence of specialty markets existing in the urban area; and,
- a variety of farm sensitivities to climate and weather conditions, also explained in part by the diversity of farm types found in the region.

Since these distinguishing features often affect agricultural decisions (e.g. see **Section 2.3.2**), and since their importance to farmers may vary, it is vital to capture their meaning to each farmer interviewed in order to gain a better understanding of individual farm decisions. In order to obtain this information, specific questions were employed at different parts of the survey. These questions, while undoubtedly having some utility for studies of agricultural adaptation in other contexts, were introduced particularly to address issues relevant to the local agricultural environment.

In order to address the wide variation in dependence on the farm as a source of income, farmers were asked in Part A of the survey (**Appendix A, Question 6**) directly

about whether any family members obtained income from sources off the farm and the proportion of household income coming from the farm itself. They were also asked later in the survey (**Question 9**) to rate the importance of off-farm work availability in terms of its influence on farm-level decisions over the last ten years. Using the results from these questions it is possible to learn whether the farm is the farmer's primary source of livelihood or simply one of several sources of income taken into consideration in their decisions.

Differences in urban pressures were also examined in the survey. Early in the survey (**Question 9**) farmers were asked to rate the significance of non-farm rural population increases to their decision-making, as well as the importance of urban perceptions of agriculture. Later on, when farmers were asked questions of an open-ended nature, for instance those regarding past and planned future changes to their operation, and what they see as future opportunities and challenges in agriculture (**Questions 13-18**), farm responses which made reference to urban pressures were noted and recorded separately.

In order to capture the wide range of farm types in the region, farmers were first asked to describe their farm type (**Question 1**), and were also asked to identify how their agricultural sales from the previous year were derived, in terms of the percentage of their 1997 sales coming from different agricultural commodities (**Question 4**). Since mixed-type farms are common in the RMOC, this question provided a more detailed indication of which products the farmer depends on most for their livelihood.

Given the range of farm types in the region it was anticipated that there would

also be a range in the weather and climate conditions which concerned different farmers. Therefore, in Part F of the survey, farmers were asked which aspects of their farm operation are most sensitive to weather and climate conditions (**Question 21**), and which climatic properties have the greatest influence on decision-making for their farm (**Question 22**). By emphasizing the climatic information the farmer is most sensitive to, a greater understanding of the farmer's perception of climate and climatic change information is also possible, since changes to climate properties most affecting farm operations are often of greater salience to the farmer than those with no direct consequences for the farm's productivity (Whyte 1985).

3.6 Survey Development and Administration: Summary

This chapter has addressed several issues relevant to the development of the agricultural adaptation survey in light of the study objectives. These issues included:

- selecting a survey methodology (a target of 60 personal interviews, about one hour in length) that would provide the level of information required to meet the study objectives but that also took account of research team resources;
- developing a survey design that provided a balance of direct and open-ended questions so that the researcher is able to examine broad trends efficiently but also providing sufficient detail to understand farm-level perceptions and decisions;

- incorporating questions used in other studies of agricultural adjustment (**Chapter 2**) which provide a means of enhancing understanding of agricultural decisions;
- structuring and ordering questions in such a way that farmers' responses about their decision-making environment are not masked or influenced by the survey subject (i.e. climatic change and agricultural adaptation);
- administering the survey in such a way as to avoid unnecessary bias in the process of farmer selection;
- identifying broad agricultural trends in the region in order to be able to assess the extent to which a farmer's planned changes are part of wider trends; and,
- building into the survey design questions which address the unique nature of the local agricultural context, with the aim of identifying important distinguishing features of farm operators' environments which affect decision-making processes.

By incorporating these considerations into the survey structure and administration, the researcher has an instrument which not only reflects conditions relevant to the local agricultural environment but also provides a design suited to the investigation of many aspects of agricultural change.

The next chapter (**Chapter 4**) begins the analysis of farm-level decisions by detailing the background characteristics, socioeconomic structures and information

sources of the farms and respondents included in the survey. The first types of farm-level changes to be investigated are past and recent changes on farms in the RMOC, and these are presented in Chapter 5. In analyzing these changes, reference will be made to the local agricultural environment presented in this chapter, to show how changes on individual farms may be influenced by broad agricultural trends in the region.

CHAPTER 4: CHARACTERISTICS OF RMOC FARMS AND SURVEY RESPONDENTS

4.1 Introduction

This chapter provides an overview of farm enterprises included in this study. It explores:

- a. the extent to which farms differ in terms of a number of enterprise attributes (e.g. type, gross sales, income sources) important to farm-level decisions, and
- b. information sources and factors most affecting farm decisions.

Farmers responding to the survey operate not only a variety of enterprise types but also at a variety of scales. This variety presents a certain challenge when comparing the concerns of one farmer with those of another in the investigation of agricultural decisions. Therefore a useful first step for the analysis is to determine whether any broad similarities in basic farm characteristics important to agricultural decisions (e.g. farm type, gross sales) may be found among different groups of farms. **Table 4.1** shows the range of farm types found in the region and categories of gross sales for farms of each type. This table suggests three groups of farms that may be identified based on farm type and gross sales characteristics:

Table 4.1: Classification of Farm Enterprises**a) Enterprise Types and Gross Farm Sales****1997 Gross Sales:**

Farm Type¹:	< \$50 000	\$50 000 - \$100 000	\$100 000 - \$200 000	> \$200 000	TOTALS
Livestock	9	0	8	15	32
Cash Crop	7	5	1	1	14
Mixed	2	2	1	3	8
Other	3	0	0	1	4
TOTALS	21	7	10	20	58

¹ Livestock and cash crop farms are defined as those with at least 75% of their 1997 agricultural sales coming from that activity. Mixed farms are defined as those where both livestock and cash crop sales are greater than 25% but less than 75%. Similar definitions have been used elsewhere (see Tarrant, 1974).

b) Enterprise Groups

Group No.	Characteristics
G1	Entire survey sample (n=58).
G2	Respondents with gross sales exceeding \$100 000 and which are predominantly (% sales greater than 50%) livestock operations (n=27).
G3	All farms with gross sales less than \$100 000 (n=28).

Livestock farms with relatively high levels of farm sales in 1997 (i.e. sales in excess of \$100,000) are a readily identifiable subgroup within the entire sample (Group 1) and comprise Group 2 (G2) in this study. G2 farms include enterprises where more than 75% of 1997 farm sales are derived from livestock products as well as mixed farms that have more than 50% of their sales tied to livestock products. The majority of the 27

farms in the G2 category are dairy enterprises, and overall G2 represents a relatively homogeneous subgroup within the respondents included in this study.

About an equal number of farms are included in the lower and higher economic categories (i.e. farm sales not exceeding \$100,000 and exceeding \$100,000 respectively). However no single enterprise type typifies farms within the lower sales category. For this reason, Group 3 (G3) farms are defined on the basis of 1997 sales alone and include all livestock, cash crop, mixed and other enterprises with 1997 sales levels below \$100,000 (n=28). Overall, G3 is not as homogeneous a group as G2.

For three of the farms with gross sales exceeding \$100,000, livestock was not a primary activity and therefore these farms did not fall into the G2/G3 classification. The types of operations held by these farmers (i.e. cash cropping, vegetable, nursery sod) did not compare with the predominantly livestock farmers (G2) and given their high income levels it would be inappropriate to categorize these farms with those in the lower income group (G3). These farms were, however, included in the analysis of the entire group (G1).

The sections which follow provide an analysis of enterprise and survey respondent characteristics for the entire sample (G1), and for Groups G2 and G3 as well. A comparison of findings for G2 and G3 groups provides a basis for exploring differences and similarities in enterprise characteristics and decision structures among the two subsets of farms.

4.2 General Characteristics of RMOC Farms

4.2.1 Farm Size

The average size of RMOC farms included in this study is 157 ha. The majority of farms are in the 51 ha to 150 ha range, however it is important to note that about one-third of the farms are larger than 150 ha (**Fig. 4.1**). The largest farms included in the study exceed 1,000 ha and represent less than 5% of all farms included in the study.

Figure 4.1: Average Farm Size

G2 farms (i.e. livestock farms with 1997 sales above \$100,000) tend to be substantially larger than the G3 farms (i.e. farms with 1997 sales below \$100,000), even though about 60% of the farms in each group are in the 51 ha to 150 ha range. The average size for G2 farms is about 2.5 times larger than for G3 farms. All G2 farms are larger than 50 ha and about 15% exceed 250 ha. This is a strikingly different profile than the G3 farms where farm size ranges up to about 250 ha, and 25% are less than 50 ha in

size.

4.2.2 Off-Farm Income

Farms included in this study tend to be either fully reliant on the farm for income or heavily dependent upon non-farm income sources. About 35% of the farms reported that the farm was their sole source of income and about an equal number of farms indicated that off-farm income accounted for at least 75% of their total household income (Fig. 4.2).

Figure 4.2: Income From Off-Farm Sources

The

G2 and G3 farms are markedly different with respect to reliance on off-farm income. The majority of G2 farms do not derive income from off-farm sources and less than 20% of this group draws in excess of 75% of its total household income from off-farm sources. The G3 group is almost the mirror image of G2 farms, with about 85% of G3 farms reporting that more than half of their total household income comes from non-farm sources and very few G3 farms are totally reliant on farm-based income.

4.2.3 Decision-Makers

Major decisions regarding farm practices are most often made by two individuals but on several farms in the RMOc, three or more individuals are regularly included in the decision making process (**Fig. 4.3**). The G2 farms tend to have more complex decision-making structures compared to G3 farms. Three or more individuals are routinely involved in farm-level decisions on G2 farms, whereas three or more individuals are involved on less than 10% of G3 farms.

Figure 4.3: Number of Decision Makers on RMOc Farms

4.2.4 Farming Experience

The majority of the farming community in the RMOc has considerable farming experience, and in this regard, is typical of many other farming communities. More than half of those actively involved in farm-level decision making had been farming for at least 20 years, with about one-third of the group having more than three decades of experience (**Fig. 4.4**). Similar to the region-wide trend, less than half of the farmers on

Figure 4.4: Farming Experience

G2 and G3 farms have less than 20 years experience. However, the percentage of farmers in the most experienced category (i.e. +31 years) is considerably greater amongst G2 farms compared to G3 farms.

4.3 Comparison of Sample Profile with RMOC Census Data

Care was taken to develop a random sample of the RMOC for this survey (see **Section 3.4.3**) but respondents were able to choose to participate in the project, and therefore an element of self-selection bias may have been introduced into the sample. This section compares selected characteristics of the sample of farms employed in this study (see **Section 4.2**) with data recorded by the 1996 Census of Agriculture (Statistics Canada 1997) in order to assess the extent to which the sample is representative of the RMOC farm population.

Farm size is used here to provide insight into the representativeness of the sample of farms surveyed for this study. There is a two-year gap between the Census data and

the data gathered in the spring 1998 survey, but it is unlikely that changes in farm size over this short time period limit the utility of this comparison. The average farm size of the sample of RMOC farms used in this study was 157 ha, which is considerably larger than the 83 ha average among Census farms.

One possible factor contributing to this difference is that several (at least 4) farmers contacted for interviews declined to participate because they felt that their operations were too small to be of interest (see **Section 3.4.3**). These refusals by farmers with relatively small operations contributed to the larger average farm size found in the survey sample.

Another possible source of bias could be related to the scheduling of interviews, the one hour required to complete the questionnaire, and the availability of time by potential respondents. Forty-three farmers could not be contacted during the study period, and although the reasons for this are not known, it is speculated here that some of these farmers were working off the farm and were therefore more difficult to reach to arrange interviews. Since farmers who depend largely on off-farm work tended to have relatively smaller size, part-time operations (e.g. G3 farmers, see **Sections 4.2.1** and **4.2.2**), this would also help explain the larger farm size found in the survey sample.

Another factor which contributed to the relatively large farm size was the small portion (about 5%) of farms that were very large (i.e. exceeding 1000 ha). The sample size of 58 provides a robust base for studying detailed processes underpinning agricultural decision-making but nevertheless these 'outlier' farms do tend to inflate the average farm size substantially. While the average size of survey farms is larger than the

RMOC Census farms, it is important to note that the majority of farms (57%) fall within the 51 to 150 ha range, and the median farm size is 107 ha. These attributes compare favourably to the Census average farm size of 83 ha. Taking account of the reasons for the larger average farm size found in the survey sample presented above, as well as the methodology employed to reduce bias in the survey selection (see **Section 3.4.3**), it is argued that the sample is reasonably representative of the major types of agriculture in the RMOC. Overall, the evidence suggests that the sample is representative of larger livestock operations and smaller, more diversified operations. However, this study does not capture the full diversity of agriculture in the RMOC. For example, fruit and vegetable operations occur in relatively small numbers in the RMOC (see **Section 3.5.3**) and it appears that this study does not accurately capture the particular interests of this segment of the RMOC agricultural sector. Overall, there is most likely a substantial under representation in the sample of farms with relatively small acreages.

4.4 Overview of Farm-Level Decision Making

4.4.1 Information Sources

Farm-level decision-making is a complex process influenced by several information sources. **Table 4.2** shows that input from family members is the most frequently used information source in both short and long term decisions. Only a small proportion of farmers (less than 20%) did not routinely consult family members. Information sources within the agricultural community, including farm organizations,

Table 4.2: Information Sources Used by RMOC Farmers

Information Source	No. of Farmers Rating Information Source as Important ¹ for Short Term Decisions			No. of Farmers Rating Information Source as Important for Long Term Decisions		
	G1	G2	G3	G1	G2	G3
Family	41	21	19	43	22	20
Other Farmers	19	10	9	15	7	8
Agricultural Trends	20	6	13	23	8	14
Farm Organizations	18	10	8	16	7	9
Gov't Policies	6	3	2	15	7	6
Municipal Officials	10	4	4	9	3	4
Media	10	6	3	8	4	3
Public Trends	9	3	5	10	3	5
Employees	7	3	3	5	3	2
Other	12	5	7	8	5	3

¹ Refers to farmers ranking the source as one of 1st, 2nd or 3rd most important.
Sample size: For G1, n=58; G2, n=27; G3, n=28

agricultural community trends and the input of fellow farmers were also identified as significant influences but nevertheless secondary to the input of family members. Other types of information and sources, including government policies, municipal officials, media, public trends and employees tended to be used to a lesser extent than family and other sources in the agricultural community.

The relative influence of most information sources identified by farmers varies little between the short and long term, with one exception. Government policies were

found to exert considerably greater influence on long term agricultural decisions than on short term (day-to-day or seasonal) decisions.

The types of information sources used by farmers in the two groups are similar. However, G3 farmers are influenced by agricultural community trends to a greater extent than G2 farmers. Several G3 farmers elaborated on this finding, indicating that they are small operators who would sometimes rather follow important farm management and production trends in the wider agricultural community than make such decisions on their own.

4.4.2 Factors Important to Farm Decisions

Survey respondents indicated that management decisions they made over the last 10 years on their farm were informed by several factors (**Table 4.3**). Most prominent in their minds were economic factors, particularly production costs and demand for their products.

Environmental factors, especially climatic and soil conditions, were also of considerable significance to their decision-making. Fewer farmers identified the availability of a water source as being important to their decisions. However, several farmers who rated this factor as unimportant also indicated during interviews that they currently had a reliable on-farm water source, and that a decline in water quantity or quality would cause them to re-evaluate the importance of this resource.

Technological, public, social and other factors depicted in Table 4.3 were often identified as being less important to farm decisions than most of the economic and environmental factors. Of these additional factors, the cost and availability of new

Table 4.3: Important Factors Influencing Farm-Level Decisions

Factor		No. of Farmers Rating Factor as Important ¹		
		G1	G2	G3
ECONOMIC	Production Costs	57	27	27
	Product Demand	55	25	27
	Commodity Costs	45	22	21
	Labour Costs	37	18	17
	Off-farm Work	25	6	17
ENVIRONMENTAL	Climate	54	25	26
	Soils	52	25	24
	Topography	38	14	22
	Water Source	32	15	15
TECHNOLOGY	Tech. Costs	45	24	18
	Tech. Availability	38	19	16
PUBLIC PROGRAMS	Regulations	40	20	18
	Insurance Premiums	28	12	13
	Incentives	23	10	11
SOCIAL	Urban Perceptions	35	21	11
	Rural Population	23	11	10
	Peer Pressure	11	5	6
OTHER		3	2	1

¹ Respondents rating factor as either extremely or moderately important.
Sample size: For G1, n=58; G2, n=27; G3, n=28

technologies, and concern about government regulations, were considered most important.

Several differences in the way the different groups of farmers rate factors affecting their decisions are apparent. G3 farmers place much more emphasis on off-farm work availability than G2 farmers. Several G3 farmers mentioned during interviews that they operated hobby farms which were not self-sufficient and had to depend on other income sources to earn a living. This finding is consistent with the earlier observation that G2 farms tend to be more reliant on farm income than G3 farms (see **Section 4.2.2**).

G2 farmers did not consider topography to be an important factor as often as G3 farmers. G2 farmers are predominately livestock operators, and therefore tend to be less concerned with drainage issues than G3 farmers. G3 farmers, especially cash crop operators, were more apt to locate on level terrain and use artificial land drainage as a means to expand the season over which it is possible to undertake field work.

The cost and availability of new technologies were identified as important factors by slightly more G2 farmers than those in G3. Given that G2 farmers tend to have larger operations than G3 farmers (see **Section 4.2.1**), it is not surprising that G2 farmers consider technological factors an important issue for maintaining or increasing farm efficiency.

G2 farmers also placed more emphasis on urban perceptions of agriculture than farmers in G3. A few of the G2 farmers interviewed felt that livestock industries are increasingly becoming the subject of the public eye, and that in order to continue selling their products they must be concerned with how the public perceives their livestock

management practices.

4.4.3. Future Prospects for Farms

Farm planning may also be influenced by a farmer's perceptions of the future viability of their farm and their own retirement goals. The majority of farmers in the RMOC believe their farms will continue to be viable operations when they retire (**Fig 4.5.1**), and most farmers plan to pass the farm on to a family member (**Fig 4.5.2**).

G2 farmers more often felt that their farms would be viable than G3 farmers. Several G3 farmers felt their farms would not remain viable because they were either located too close to the city and pressured by urban development, or the farm was simply too small and becoming uneconomical to operate.

G2 farmers indicated that they would most likely pass the farm on to children, meaning that the farm would continue as a family operation. G3 farmers did not plan to pass the farm to their children as often as G2 farmers, in part because of their concerns that the operation would not be viable in the long term.

Figure 4.5.1: Farm Viability at Retirement

Figure 4.5.2: Person(s) Expected to Take Over Farm

4.5 Summary

Farming in the RMOC comprises a wide range of enterprise types ranging from relatively small-scale hobby farms to extensive, heavily capitalized livestock operations.

The livestock operations with 1997 farm sales above \$100,000 (G2 farms) are predominantly dairy operations. Average farm size is about 220 ha, most are highly reliant on the farm for income, and are routinely managed by 3 or more persons with over 20 years experience in an agricultural setting. Decision makers on these enterprises draw on a wide array of information sources, with family members and other information routinely available in the agricultural community being consulted most frequently. Economic pressures, especially production costs and demand, have had the greatest bearing on recent farm-level decisions. However it is also important to note environmental conditions, the availability and cost of new technologies and urban-based perceptions of agriculture are also factored into recent decisions. The majority of G2 farmers believed their enterprise would continue to be viable after their retirement and that a family member would eventually take over the farm.

The profile of farms with sales below \$100,000 in 1997 (G3 farms) was considerably different than G2 farms. Average farm size was below 100 ha and no farms in this group exceeded 250 ha. Most of the G3 farms derived more than half of their income from sources off the farm. Very few of the G3 farms had more than two persons involved in decision-making, and G3 farmers tended to have less farming experience than G2 farmers. Similar to G2 farmers, G3 farmers consulted multiple information sources, and economic and environmental factors played a larger role in recent decisions than any

other group of factors. The G3 farmers, especially the cash crop operators, placed somewhat greater emphasis on topography than G2 farmers but were less influenced by new technologies. The G3 farmers were less optimistic about the future prospects for their farms, often citing that their farms were too small to be viable over the long term and that urban pressures would make it difficult to remain in farming.

The next chapter (**Chapter 5**) provides an analysis of recent changes on all RMOF farms included in this study (Group 1), and RMOF farmers' perceptions of changes occurring in the wider Eastern Ontario agricultural region. It details not only the nature of recent changes but also reasons given by farmers for making these adjustments. **Chapter 6** adds to the analysis of farm-level change by assessing similarities and differences in recent and planned future changes between farm groups G2 and G3. It is anticipated that differences in the types and reasons for change offered by survey respondents between the two groups will relate closely to differences in enterprise characteristics and decision-making structures presented in this chapter.

**CHAPTER 5:
AGRICULTURAL CHANGE IN THE REGIONAL
MUNICIPALITY OF OTTAWA-CARLETON (1987-2003):
A REGIONAL PERSPECTIVE**

5.1 Introduction

This chapter reports on and analyzes recent changes to agriculture in the RMOC as a region. The assessment begins by establishing the context in which farm-level changes have been made during the 1987-1997 period from a farmers' perspective. Following this assessment, the next three subsections systematically review recent changes to agricultural production, farm management and farm structure, and the reasons underpinning these changes. An analysis of farmers' plans for changes over the short- to medium- term (i.e. five years) is provided later in the chapter.

The focus of this chapter is agricultural change occurring on RMOC farms and changes in the wider Eastern Ontario agricultural region as reported by survey respondents. Hence, the analysis in Chapter 5 considers all respondents to the RMOC survey (i.e. Group G1) with no attempt to disaggregate findings below this regional level. The regional perspective provided in Chapter 5 provides a broader context for examining differences and similarities between intensive, highly capitalized livestock operations (G2 farms) and smaller scale, more diversified forms of agriculture (G3 farms) (see **Chapter 6**).

5.2 Establishing the Context for Recent Changes to Agriculture

Agricultural change does not occur in isolation. Many factors originating at

different scales may create the need for change and also sometimes constrain the range of possible adjustments. In some cases, individual farms and farmers will not be able to influence the forces prompting change and therefore responses are typically confined to positioning themselves within the context of these external forces. Conditions which are more local in origin, however, may present a different set of constraints and opportunities as individual farms may be able to exert greater influence over the source or cause of change, thereby widening the possible range of responses. It would certainly be overly simplistic to divide changes into: (a) top-down changes over which farms exert little influence and therefore must react; and, (b) farm-level changes over which greater influence and control can be exerted. It is important, however, to recognize the myriad of forces which ultimately underpin agricultural change (examined in the following subsections), and that different types of farms will in all likelihood have differential capacity to perceive and respond to changing conditions (see **Chapter 6**).

5.2.1 The Eastern Ontario Context

RMOC farmers reported several important changes had affected agriculture at the regional scale over the previous ten years. Recent agricultural trends in Eastern Ontario, as identified by survey respondents (**Table 5.1**), are to a large extent similar to trend changes that have been observed throughout Ontario agriculture (see **Section 3.5**). These changes have been driven largely by the need to improve farm efficiency and by improvements in agricultural technology which in turn have resulted in fewer but larger farm operations. The price-cost squeeze which results from input costs rising more quickly than returns, and the globalization of agricultural economies contributing to

Table 5.1: Reported Changes to Agriculture in Eastern Ontario

Type of Change	No. of Farms Reporting Change
Fewer farmers, increased farm size	22
Increased efficiency	22
Increase in technology	22
Higher input costs / lower returns	13
Greater conservation / reduced tillage use	13
Change to farm type in area	11
Trade	8
Higher cost of land	6
Increased use of chemical spraying	6
Increased urbanization	5
Greater pressures from rural population	5
Climatic changes	5

G1 sample size: n=58

enhanced opportunities for international trade are also significant factors that have stimulated recent changes to the farm sector in Eastern Ontario.

Economic and technological changes have clearly been the most common forms of agricultural adjustment in Eastern Ontario, but it is also important to note that significant social and environmental changes have also occurred. Conservation tillage, often accompanied by a greater reliance on agricultural pesticides, has become more common in Eastern Ontario in recent years. Ottawa and its surrounding suburban cities, as well as other urban centres in the region, have influenced agriculture through changing

land values, food markets and public pressures, but these influences were identified to a much lesser extent than technological and economic forces generally. Overall, agriculture in Eastern Ontario has been responding to a complex set of forces over the past ten years and significant changes to the region's agricultural landscape have occurred.

5.2.2 The RMOC Context

The adage “the only constant is change” applies to RMOC farmers. Frequent changes to production, farm management and farm structure characterize the last 10-year period in RMOC agriculture (**Table 5.2**).

Table 5.2: Overview of Recent Farm-Level Changes

Type of Change	No. of Farms Reporting Change
Production Changes - Crops	43
- Livestock	42
- Other agricultural commodities	10
Management Changes - Land	46
- Crops	44
- Livestock	38
- Labour	36
- Crop insurance	12
Farm Structure Changes - Capital investment	53
- Land area	41

G1 sample size: n=58

The most common farm-level changes in the RMOC have included increased capital investments, expansion of the land area farmed and expansion of crop and livestock production operations. These changes were to a large extent driven by economic motives and aimed to expand the economic potential of individual farm operations and improve economic efficiency. Social and environmental reasons also stimulated farm-level changes within the RMOC, but to a much lesser extent than economic and technological factors. The reasons for change for specific agricultural activities are analyzed in more detail below.

5.3 Changes to Agricultural Production on RMOC Farms: 1987-97

5.3.1 Crop Production Changes

The vast majority of farms (approximately 75%) in the RMOC implemented changes to crop production over the last ten years (**Fig. 5.1**). For the minority of farms that did not undertake crop production changes, the main reasons for maintaining status quo included satisfaction with existing production systems, inherent limitations of the farm and a lack of time to implement change.

Expanding the cropland base was clearly the most common change to crop production, and occurred on over 75% of the farms that had instituted changes to crop production systems. Other common changes to crop production included switching to alternative crop types and using newer, higher-yielding crop varieties. Preferred new crops often included soybeans and survey respondents also made frequent changes to their grain corn varieties.

Figure 5.1: Crop Production Changes

Changes to Crop Production:		No Change to Crop Production	
No. farms reporting change	43	No. farms reporting no change	15
Common types of change (No. of times made ¹):		Common reasons for no change (No. of times given ¹):	
Increased acreage	35	Tradition/still works	6
Switch crop type	10	Farm limitations	2
Switch crop variety	10	No time	2

General Reasons for Change:

Most Common Reasons for Change:

Economic	
More efficient	14
Product price/demand	10
Expand operation	9
Environmental	
Soil quality	7
Climate/weather	5
Pests/weeds	1

¹ “No. of times made” and “No. of times given” refer to the number of changes made among farms reporting change, rather than the number of farms making changes. One farm may report several changes and reasons for change, each of which were recorded. This terminology is used throughout this paper.
G1 sample size: n=58

Economic reasons, especially efforts to improve efficiency and to respond to changes in product prices and demand, were the dominant reasons for implementing crop production changes. Environmental reasons, most often related to adjusting to available soil and climatic resources, were also important but considerably less so than economic reasons that eventually contributed to a change in crop production. Technological and social issues were not important in shaping crop production decisions on RMO farms in the 1987-97 period.

5.3.2 Livestock Production Changes

Changes to livestock production systems were very common, as only eight of the farms carrying livestock reported no change to their livestock production over the 1987-1997 period (**Fig. 5.2**). The majority of changes to livestock systems were limited to adjusting herd size, with slightly more increasing herd size than decreasing herd size. More drastic changes to livestock production systems, such as changes in the type of livestock being raised, were seldom implemented. These changes involve greater cost to the farmer because they often require significant changes to farm infrastructure and management as opposed to the expansion of existing infrastructure as livestock herds increase.

The reasons for increasing herd sizes were primarily economic, often related to expanding the economic potential of individual operations and increasing efficiency. However, herd size was also sometimes reduced for reasons of economic efficiency, coupled with social factors. Some farms which experienced changes in family structure, such as the retirement of a family member over the 1987-1997 period, cut

Figure 5.2: Livestock Production Changes

Livestock Production Changes:		No Change to Livestock Prod.:	
No. farms reporting change	42	No. farms reporting no change	8
Common types of change (No. of times made):		Common reasons for no change (No. of times given):	
Increase number of head	25	Tradition/still works	4
Decrease number of head	19	Farm limitations	1
Change livestock type	9	Can't afford labour	1

General Reasons for Change:

Most Common Reasons for Change:

Economic	
Expand operation	11
Increase production	10
More efficient	10
Social	
Change in family structure	4
Less off-farm work	2
Off-farm work conflict	1

G1 sample size: n=58

back the scale of their livestock activities in response to changes in available family labour, reducing the livestock herd but increasing efficiency given available labour resources. Political factors such as instability in dairy quotas also prompted change on some occasions. However, the primary reasons for change to livestock production systems in the RMOC were economic in nature.

5.3.3 Production Changes to Other Agricultural Commodities

Production of agricultural commodities outside of traditional crop and livestock products occurred on fewer than 30% of RMOC farms surveyed. However, the majority of farms engaging in the production of these other commodities did adjust their respective production systems over the 1987-1997 period. Changes typically involved increasing or decreasing the level of activity associated with specialty operations (e.g. maple syrup, farm tours, nursery operations) (**Fig. 5.3**).

Reasons for adjusting specialty product activities were primarily economic. Changes were often made to cut labour costs, and sometimes in order to take advantage of perceived opportunities in specialty products not grown at the time. Because specialty product operations are often smaller scale than traditional crop and livestock production systems, are not the farm's primary activity, and are not integrated into regulated market sectors, they are sometimes more flexible to change in response to perceived new opportunities than other types of agricultural production.

Figure 5.3: Specialty Production Changes

Specialty Production Changes:		No Change to Specialty Prod.:	
No. farms reporting change	10	No. farms reporting no change	6
Common types of change (No. of times made):		Common reasons for no change (No. of times given):	
Decrease maple operation	2	Can't afford labour	1
Increase tour operation	2	Unknown	5
Increase lumber operation	1		

General Reasons for Change:

Most Common Reasons for Change:

Economic	
Decrease labour costs	2
More opp. in other activity	2
Increase production	1
Environmental	
Climate/weather	2
Other	0

G1 sample size: n=58

5.4 Changes to Agricultural Management on RMOF Farms: 1987-1997

5.4.1 Land Management Changes

Most RMOF farmers surveyed (79%) made changes to their land management practices over the 1987-1997 period (**Fig. 5.4**). Several changes were often reported on individual farms. A small minority of farms did not adjust their land management over the 10-year period, largely because they deemed the land to be already fully improved. They felt that little would be gained by adjusting the farm's current land management. However, where survey respondents perceived an opportunity to improve land, it is clear that the majority were active in making changes.

Many farmers added tile drainage to their farms, since draining excess water often allowed them the opportunity to work on fields earlier in the season. The utility of tile draining varies significantly from farm to farm and even on different parts of individual farms depending on the topography of the land and the extent to which water tends to pool or drain naturally. Therefore the number of changes made depended significantly on the farm's existing physical features. Other common land management changes made by RMOF farmers were to change tillage practices, sometimes to minimum- or no-till methods, and to clear more land where available.

Unlike many other types of change, land management changes were spurred equally by economic and environmental motives. Important environmental reasons for change included the desire to improve the drainage of the fields, and to improve soil quality, often accomplished through changes to tillage practices and the installation of tile drainage. However, reasons for changing land management

Figure 5.4: Land Management Changes

Changes to Land Mgt.:		No Change to Land Mgt.:	
No. farms reporting change	46	No. farms reporting no change	12
Common types of change (No. of times made):		Common reasons for no change (No. of times given):	
Increase tile drainage	31	Farm already fully improved	9
Change tillage practices	16	Tradition/still works	2
Clear land	8	Farm limitations	1

General Reasons for Change:

Most Common Reasons for Change:

Economic	
More efficient	13
To increase yields	13
To increase production	7
Environmental	
Drainage	17
Soil quality	16
Erosion	3

G1 sample size: n=58

demonstrate the difficulty in distinguishing the motivations for changing agricultural practices. For instance, the environmental motives for change such as improving soil quality and drainage were in many ways linked to economic motives, since such improvements often led to increases in crop yields and total production.

5.4.2 Crop Management Changes

Changes to crop management were made frequently on RMOC farms, and a wide variety of changes were reported with no one type of change dominating (**Fig. 5.5**). Less than 25% of farms did not alter their crop management over the study period, largely because these farmers were satisfied with their current approach and felt little need to change tradition.

For the majority of farmers, however, changes entailed adjusting or slightly refining existing systems in an attempt to improve the efficiency of crop management. For instance, gradual increases in fertilizer use and modifications to herbicides were among the common changes made every few years. These modifications tended to be adjustments rather than sudden, full-scale changes. The need for precision in this area was emphasized by farmers who employed a crop or soil consultant to conduct tests before changing their crop management. The risks of crop damage or poor crop performance associated with sub-optimal chemical applications tended to support conservative adjustments over longer time periods rather than more radical shifts in crop management.

As with many other types of change, crop management adjustments were driven largely by economic forces, especially the desire to improve the efficiency of

Figure 5.5: Crop Management Changes

Changes to Crop Mgt.:		No Change to Crop Mgt.:	
No. farms reporting change	44	No. farms reporting no change	14
Common types of change (No. of times made):		Common reasons for no change (No. of times given):	
Increase fertilizer use	14	Tradition/still works	8
Change herbicides	12	No time	1
Crop consultant / soil test	10	No additional land available	1

General Reasons for Change:

Most Common Reasons for Change:

Economic	
More efficient	25
To increase production	11
To increase yields	9
Environmental	
Soil quality	13
Pests/weeds	5
Climate/weather	1

G1 sample size: n=58

production. This was particularly the case among farmers who increased their level of fertilizer use. However, certain other types of crop management changes were motivated largely by environmental reasons. These included changes to herbicides, which were often made in order to respond to the emergence of new types of pests or disease, or because of increasing pest resistance to current herbicides. Some farmers hired crop consultants and then decreased fertilizer levels or adopted precision fertilizer application because of concerns for soil quality, which was the dominant environmental reason for changing crop management.

5.4.3 Livestock Management Changes

Livestock management changes occurred routinely among those farms producing livestock (**Fig. 5.6**). Fewer than 25% of the farms with livestock did not change their management practices over the study period, largely because of a desire to follow a tradition that was felt to have worked for many years.

Similar to crop management changes, many changes to livestock involved making slight adjustments to management practices every few years. The majority of changes involved changing the genetics or breed of livestock, as well as alterations to feed rations, including the introduction of computer feeding methods on some farms.

More than any other type of change, adjustments to livestock management were made overwhelmingly for economic reasons. Most prominent in the minds of RMOC livestock farmers was the need to improve the quality of their livestock products for the market. In order to compete these farmers were also very concerned with increasing both the total production from their livestock and overall efficiency.

Figure 5.6: Livestock Management Changes

Changes to Livestock Mgt.:		No Change to Livestock Mgt.:	
No. farms reporting change	37	No. farms reporting no change	12
Common types of change (No. of times made):		Common reasons for no change (No. of times given):	
Genetics / breed	26	Tradition/still works	6
Change to feed rations	22	Change has little potential	2
Adopted computer feeding	4	Unknown	4

General Reasons for Change:

Most Common Reasons for Change:

Economic	
To improve product quality	23
To increase production	15
More efficient	15
Social	
Personal challenge	2
Public pressure	1

G1 sample size: n=58

Other reasons seldom produced change to livestock management, particularly environmental reasons, which were never mentioned by RMOC survey respondents.

5.4.4 Labour Management Changes

Changes to farm labour were also a common feature of the majority of RMOC farms over the 1987-1997 period (**Fig. 5.7**). However, some farms did not undertake significant labour changes, often because the farm was traditionally worked by family members and there was little need for outside help. Sometimes maintaining the tradition of family labour was more important to these farmers than economic factors including the cost of hiring workers.

Among the farmers who did make labour changes, the most common change was to increase the level of hired labour on the farm. Sometimes this involved hiring full-time staff as an operation expanded, but it also involved taking on seasonal workers at particularly busy times of the year (e.g. harvest season, major land improvements). Another important type of change, however, was the tendency of some farmers to manage and adjust their level of on-farm versus off-farm labour, increasing the amount of work done off the farm in some years and lowering it in others.

While reasons for hiring outside help or increasing personal labour on the farm were often related to economic needs such as a desire to expand the operation and increase its efficiency, labour management changes were also significantly affected by social factors. For instance, the availability of off-farm work often influenced the amount of time a farmer would spend working on the farm as opposed to working

Figure 5.7: Labour Management Changes

Changes to Labour Mgt.:		No Change to Labour Mgt.:	
No. farms reporting change	36	No. farms reporting no change	19
Common types of change (No. of times made):		Common reasons for no change (No. of times given):	
Increase hired labour	14	Tradition/still works	11
Decrease off-farm work	8	Can't afford labour	1
Increase off-farm work	5	Unknown	7

General Reasons for Change:

Most Common Reasons for Change:

Economic	
More efficient	8
Expand operation	4
More opp. in other activity	4
Social	
Change in family structure	12
Less off-farm work	3
Injury / health / unable to work	1

G1 sample size: n=58

elsewhere. If off-farm work opportunities declined, the farmer often had to concentrate more on on-farm activities in order to earn a living. But the most important social factor in terms of its influence on labour management decisions related to changes in family structure. As farm family members aged, retired or passed away, significant changes were made to labour management. Sometimes these changes could be anticipated and planned (e.g. children maturing and expressing an interest in working on the farm), while other changes necessitated rather sudden and unexpected changes (e.g. death of a working family member). These patterns were described in the context of the “farm family life cycle” (Gasson 1988, Marsden et al. 1989, Pile 1990, Moran et al. 1993), and clearly exert considerable influence on labour management decisions in the RMOC.

5.4.5 Management Changes to Crop Insurance

Crop insurance was the only aspect of agricultural management that seldom changed on RMOC farms between 1987 and 1997 (**Fig. 5.8**). Many survey respondents did not carry crop insurance during this period, either because they felt the tradition of bearing crop losses rather than paying insurance premiums worked for them in most years, or because of a previous bad experience with insurance that caused them to lose money. A few farmers felt that even if crop insurance would assist them in some years, they simply could not afford the cost of purchasing insurance.

Of the few farmers who did change their crop insurance, increases and decreases in the level of insurance occurred equally. Similar to those not carrying

Figure 5.8: Crop Insurance Changes

Changes to Crop Insurance:		No Change to Crop Insurance	
No. farms reporting change	12	No. farms reporting no change	32
Common types of change (No. of times made):		Common reasons for no change (No. of times given):	
Increase coverage	6	Tradition/still works	18
Decrease coverage	6	Previous bad experience	7
		Can't afford cost involved	3

General Reasons for Change:

Most Common Reasons for Change:

Economic	
More efficient	2
Former claims not satisfied	2
Diversify / reduce risk	1
Logistical	
Changed nature of operation / crops grown	2

G1 sample size: n=58

insurance during the study period, some of those farmers decreasing the level of insurance did so because of bad experiences with insurance companies when they lost money or when their claims were not satisfied.

For a few farmers, increasing the level of insurance made their operations more efficient by cutting losses in some years and reducing the overall risk of losses from damaged or low crops. Sometimes purchases of crop insurance were also prompted by logistical reasons, including the introduction of new crops to a farm which previously had little need for insurance.

5.5 Changes to Farm Structure on RMOC Farms: 1987-1997

5.5.1 Changes to Land Area

Changes to the land area farmed were a prominent feature of agricultural change in the RMOC over the 1987-1997 period (**Fig. 5.9**). Only in cases where individual farmers felt satisfied that their land base was fully improved, or where no additional land was available within reasonable proximity to their current land base, did farmers continue to farm the same land area.

Farm size increased far more often than it decreased, and this increase in size is consistent with trends occurring in the wider agricultural region and the rest of the province (see **Section 3.5.2**). However, as farms expanded it became more difficult to find quality farmland adjacent to existing properties. This was particularly the case in the more urbanized areas where farmers have had to vie for property with many other competing land uses. Some farmers have had to make the choice of either purchasing

Figure 5.9: Land Area Changes

Changes to Land Area:		No Change to Land Area	
No. farms reporting change	41	No. farms reporting no change	17
Common types of change (No. of times made):		Common reasons for no change (No. of times given):	
Increase land area	36	Tradition/still works	6
Decrease land area	5	Farm already fully improved	3
Increase proportion owned	4	No additional land available	3

General Reasons for Change:

Most Common Reasons for Change:

Economic	
Expand operation	25
To increase production	4
More efficient	4
Logistical	
New source for purchase	8
Changed nature of operation	3
Lost supplier	1

G1 sample size: n=58

land several kilometres from their current land base or cease the expansion of their land area altogether. Nonetheless, many farmers have opted to continue expanding the land base in spite of high land costs and farm fragmentation.

The reasons why many farmers have expanded their land area under these circumstances were largely economic, and like many other changes were related to the desire to expand the operation in order to increase its economic potential. Logistical reasons for change were also noteworthy, however, and these often included changes in the nature of production activities which provoked a change in the land area needed for the farm, or the opening up of a new opportunity to purchase land. These logistical reasons for change highlight the difficulty many farmers in the RMOC have had in purchasing land suitable for farming, reasonably close to their current properties and not subject to considerable urban pressures.

5.5.2 Capital Investment Changes

Changes to capital investment were the most common type of change reported on RMOC farms (91% of farms surveyed). In fact many farms added to their capital investments on a yearly or semi-yearly basis. The few farmers who did not change their capital investment tended to do so either because they felt their current system satisfies their needs or because they were about to retire from farming and therefore had little desire to invest more money in the farm (**Fig. 5.10**).

Changes to capital investment almost always involved increasing technology or infrastructure investments. This included the addition of new equipment and updating or repairs for older equipment on a regular basis. The addition of buildings,

Figure 5.10: Capital Investment Changes

Changes to Investment:		No Change to Investment	
No. farms reporting change	53	No. farms reporting no change	5
Common types of change (No. of times made):		Common reasons for no change (No. of times given):	
Increase technology	49	Tradition/still works	2
Increase infrastructure	42	About to retire/sell farm	2
Increase quota	15	Can't afford cost involved	1

General Reasons for Change:

Most Common Reasons for Change:

Economic	
Expand operation	29
More efficient	24
To increase production	12
Technological	
Upkeep of equipment	33
More expertise	4

G1 sample size: n=58

storage space and livestock handling areas was also consistent with the expansion of farm operations. Many of those farms carrying livestock purchased additional dairy quota which allowed these farmers the opportunity to sell larger volumes of dairy products.

The reasons for capital investment changes focused almost exclusively on economic and technological issues. Expansion of the scale of operation coupled with increased efficiency were two important goals for the majority of farmers adding to their capital investments. Many commented that although it was difficult to keep up with the latest technology and make regular equipment purchases while the price of agricultural commodities remained static, these purchases and additions were a necessary part of remaining competitive in the industry. While weary of the effects of rising input costs on farm budgets, they believed that a farmer whose equipment became “out-of-date” would soon become less efficient than other farmers in the region. Therefore, investments in equipment were necessary both to expand the amount of work that could be done on the operation and to keep older equipment operating efficiently. Social and environmental issues were seldom a factor in capital investment decisions.

5.6 Plans for Farm-level Changes over the Short- to Medium-Term on RMOF Farms: 1998-2003

RMOF survey respondents were asked to indicate any planned changes they have for their farm in the short- and medium term future (i.e. next 5 years), in an effort to explore whether the types and motives for future change were similar to

those of recent decisions. A second objective was to explore what types of changes farmers actively plan over the short- and medium-term, as opposed to those changes that tend to be more reactive in nature (e.g. changes resulting from unforeseen family illness or extreme weather events).

Most farmers indicated that they did plan to make changes to their operation over the next five years (**Fig. 5.11**). Some mentioned, however, that it was difficult to state for certain any changes they would make beyond the next 1-2 years because of high levels of change in the industry, particularly with respect to changing market opportunities and new technologies. One common thread of many of the farmers' planned future changes is that they often relate to the overall goal of expanding farm operations. In particular, the number of farmers planning to add infrastructure, increase herd sizes and purchase more land as it becomes available suggests that the existing trends of increasing land area and capitalization of farm operations will continue.

The motivations for planned future changes are also strikingly similar to those for many recent changes on RMOF farms. Economic issues, such as the need to expand operations, increase production and efficiency remain a driving force for agricultural change. However, social, environmental and technological issues are also considered in future changes. An important social dimension of agricultural planning is changing family structure, including the aging and pending retirement of family members. While family considerations (e.g. age, ability of certain family members to work) was not directly identified as a cause of the majority of recent changes, the

Figure 5.11: Planned Future (5-Year) Changes

Planned Changes:		No Planned Changes	
No. farms reporting change	46	No. farms reporting no change	11
Common types of change (No. of times made):		Common reasons for no change (No. of times given):	
Add infrastructure	20	Can't afford cost involved	2
Increase livestock herd	7	About to retire/sell farm	1
Buy more land	6	Unknown	8

General Reasons for Change:

Most Common Reasons for Change:

Economic	
Expand operation	22
To increase production	11
More efficient	10
Social	
Change in family structure	7
Advice of neighbours	1
Not able to find quality labour	1

G1 sample size: n=58

farmers' mention of these issues for future changes suggests that they are cognizant of family considerations in their short- and medium-term planning. Sometimes changes which can be forecast with some degree of certainty, such as changes to family structure, are a more readily identifiable influence on future plans than those that cannot be reliably predicted (e.g. changes in the technological or political environment in which agriculture operates).

5.7 Summary

RMOC survey respondents' farms were characterized by high levels of change in many different areas. The most common changes have been to the farm structure, particularly through increasing capital outlays in equipment and infrastructure. Changes to the farmers' land, crop, livestock and labour management, and crop and livestock production, were also very common.

While survey respondents reported a wide variety in the types of changes made over the 1987-1997 period, several important similarities exist in the reasons for these changes. Most were spurred by the need to increase farm size and improve efficiency, trends which survey respondents identified were occurring throughout the wider agricultural region. RMOC survey respondents' planned short- and medium-term future changes show considerable similarity to the types of changes they have made in the recent past, expressing the need for continued farm enterprise expansion and improvements in overall efficiency (**Table 5.3**).

A notable difference between recent and planned future changes is found in

Table 5.3 Summary of Characteristics of Recent and Planned Future Changes

Attributes of Change	Recent Changes (1987-1997)	Planned Future Changes (next 5 years)
Frequency	- Very frequent changes	- Planned changes very common - Similar activity level to recent changes
Type	- Expanding operations through capital investments and improvements to land area - Frequent change to farm production, management and structure	- Expansion of land area, herd sizes and addition of infrastructure
Motivation	- Economic motives dominate: expansion of economic potential, improvements in production and efficiency	- Need to expand operations and economic potential - Social reasons for change take on greater importance (e.g. changes in family structure)

the farmers' suggestions that foreseeable changes in family structure (e.g. aging) are an important factor in their future plans. However, economic motives, particularly those related to farm expansion, remain a dominant driving force for agricultural decisions. These economic trends have clearly exerted considerable influence on most types of agricultural change occurring in the recent past and planned for the short-term future.

The importance of economic motives relative to other influences varied depending on the type of decision being made. For instance, decisions related to livestock production and management appeared to be influenced almost exclusively

by economic concerns, but for land and crop management decisions, environmental issues such as soil quality took on considerable importance. Many motivations for change were interrelated (e.g. the desire to add tile drainage may be motivated by the environmental goal of improving soil quality and the economic goal of increasing field crop production), but these findings demonstrate that specific types of agricultural decisions were influenced by their own distinct set of motivations. Different types of decisions are therefore not always subject to the same set of constraints, a feature of agricultural planning that must be recognized if farm-level adjustments are to be understood.

Not only are agricultural decisions subject to different sets of influences, but the objectives and aspirations of individual farmers can also exert considerable influence on farm-level decisions. In an effort to establish the context of the broad forces affecting agricultural change in the RMOC, this chapter did not explicitly address these differences in farm enterprise characteristics affecting agricultural decisions. With the context of agricultural change established, the next chapter (**Chapter 6**) investigates the meaning of different enterprise and decision-making structures to farm-level change, by comparing agricultural decisions on large-scale, highly capitalized livestock operations (G2 farms) with those providing lower levels of farm income and tending to operate at smaller scales (G3).

CHAPTER 6: COMPARATIVE ASSESSMENT OF RECENT AGRICULTURAL CHANGE ON HIGHLY CAPITALIZED LIVESTOCK FARMS (G2) AND LOWER INCOME (G3) FARMS

6.1 Introduction

The previous chapter provided regional scale analyses of agricultural change in the RMOC. The analyses were based upon responses by 58 RMOC farms (G1) to a field study conducted in March 1998, which considered changes made in the 1987-97 period as well as changes planned for 1998-2003. This chapter further develops the analyses of agricultural change by examining the extent to which types of change and motivations for change are associated with the two major types of farm enterprises identified for the RMOC. A comparison of changes occurring on heavily-capitalized livestock operations (G2 farms) versus a range of farms with lower levels of farm income (G3) will be used to help identify the significance of basic farm enterprise characteristics to processes of agricultural change.

In this comparative assessment of recent farm-level changes on G2 and G3 farms, the analyses and discussion are disaggregated into two major sections (see **Table 6.1**).

Section 6.2 focuses on the types of agricultural changes that were implemented on both G2 and G3 farms. For these farm-level adjustments, there were no apparent differences between the two farm groups. This does not necessarily suggest that the two groups shared similar decision processes with respect to these aspects of farm-level change, but rather that the types of changes implemented were ultimately similar. The analyses in Section 6.2 commence with brief descriptions of the changes implemented

Table 6.1: Overview of Recent Farm Level Changes on Highly-Capitalized Livestock (G2) & Lower Income (G3) Farms in the RMOC

Major Category of Change	Similar Changes on G2 & G3 Farms	Different Changes on G2 & G3 farms
Agricultural Production	<ul style="list-style-type: none"> • Other agricultural commodities (Sec 6.2.1) 	<ul style="list-style-type: none"> • Crops (Sec 6.3.1) • Livestock (Sec 6.3.2)
Farm Management	<ul style="list-style-type: none"> • Crops (Sec.6.2.2) • Crop Insurance (Sec 6.2.3) 	<ul style="list-style-type: none"> • Land (Sec 6.3.3) • Livestock (Sec 6.3.4) • Labour (Sec 6.3.5)
Farm Structure	<ul style="list-style-type: none"> • Land Area (Sec 6.2.4) 	<ul style="list-style-type: none"> • Capital Investment (Sec 6.3.6)

over the 1987-97 period, and then proceed to an assessment of reasons motivating these changes. This structure was selected as it will highlight the extent to which the two farm groups are or are not motivated by similar factors.

Section 6.3 reviews and assesses types of agricultural change that, to a large extent, were distinctly different on G2 and G3 farms. The analyses carefully document differences across the two types of farms, highlighting differences in the nature and pace of recent changes, reasons prompting these changes, plans for near-term (five-year) changes and perceptions of changes occurring within a broader agricultural context.

6.2 A Comparative Assessment of Recent Farm-Level Changes Common to G2 and G3 Farms

6.2.1 Other Agricultural Commodities and Specialty Products

Few farmers surveyed in the RMOC engaged in the production of specialty products over the 1987-1997 period. Heavily-capitalized livestock operations and lower-income farms were similar in this regard, and only very small numbers of farms in groups G2 and G3 reported changes to this aspect of agricultural production (**Table 6.2**).

For a small group of farmers, however, the production of other commodities was recognized as an opportunity to experiment with and potentially benefit from production targeted at specialized markets beyond those traditionally tied to agriculture. As a result, the motivations for these changes for both G2 and G3 farms were primarily economic. Because these operations are by their very nature activities which have not been established in the wider agricultural region, farmers engaging in specialty production must often treat these activities as experiments initially, relying heavily on their own judgement and individual expertise in a specialized area of production. Therefore many of the changes involved implementing activities where a new market opportunity was perceived, and sometimes cutting back or eliminating activities for which input costs (e.g. labour costs) were found to exceed returns.

Table 6.2: Recent Changes Common on G2 and G3 Farms: Other Agricultural Commodities

a) Number of Farms Changing Other Agricultural Commodities Production

Changes to Other Commodities Production	G2	G3
No. farms reporting change	5	4
No. farms reporting no change	4	2
Not applicable (i.e. other commodities never produced)	18	22

b) Reasons for Not Changing Other Agricultural Commodities Production

Common Reasons for No Change (No. of times given)	G2	G3
Cost of labour	0	1

c) Other Commodities Production Changes

Type of Change (No. of times made)	G2	G3
Decrease maple syrup operation	1	1
Increase tour/education operation	2	0
Increase maple syrup operation	0	1
Increase lumber operation	0	1
Decrease nursery/shrub operation	0	1
Increase sweet corn operation	1	0

d) Reasons for Other Commodities Production Changes

Common Reasons for Change (No. of times given)	G2	G3
Decrease labour costs	1	1
More opportunity in other activity	2	0
Climate/weather	1	1
Increase production	0	1
Product price / consumer demand	1	0
More efficient	1	0
Less off-farm work available	0	1
Desire to educate the public	1	0

Sample size: G2, n=27; G3, n=28

While G2 and G3 farms were similar in terms of the number of farmers engaged in specialty production and the economic reasons for change, the types of activities carried out were quite diverse. The range of specialty commodities produced reflects both the interests of farmers, and resources unique to certain farms in the region. Some farms contained woodland areas suited to the production of lumber products or maple syrup activities, while others possessed natural features and aesthetic qualities which made them attractive places for members of the public interested in agriculture and farm-based recreation. The wide range and small frequency of specialty activities makes it difficult to distinguish any distinct patterns in the types of production engaged on G2 and G3 farms, however these farms remain similar with respect to both the level of change to these activities and in the motives for adjusting specialty production.

6.2.2 Crop Management

Crop management is one major type of agricultural activity that has evolved significantly over the 1987-1997 study period. G2 and G3 farmers alike were particularly active in changing fertilizer and herbicide types and application methods over this time (**Table 6.3**).

G3 farmers tend to rely on cash crops as an important source of income more than G2 farmers who depend primarily on their livestock activities. However, these groups were strikingly similar in that changes to crop management among farmers in both groups occurred on a roughly equal basis. It is clear that although G2 farmers may not have depended on income from crops to the extent that G3 farmers did, they shared many of the same concerns that these farmers had relating to improving the overall efficiency

Table 6.3: Recent Changes Common on G2 and G3 Farms: Crop Management**a) Number of Farms Changing Crop Management**

Changes to Crop Management	G2	G3
No. farms reporting change	22	19
No. farms reporting no change	5	9

b) Reasons for Not Changing Crop Management

Common Reasons for No Change (No. of times given)	G2	G3
Tradition / still works	2	6
No time	0	1
No additional land available	1	0

c) Crop Management Changes

Type of Change (No. of times made)	G2	G3
Increase fertilizer use	4	10
Change herbicides	7	5
Hire crop consultant / soil test	5	3
Started using round bales	2	6
Precision fertilizing and spraying	3	3

d) Reasons for Crop Management Changes

Common Reasons for Change (No. of times given)	G2	G3
More efficient	14	10
Soil quality	7	5
To increase production	3	8
To increase yields	3	6
To decrease labour costs	2	5
Pests / weeds	3	2

Sample size: G2, n=27; G3, n=28

of their crop management systems. An important objective for both has been to achieve greater precision in the application of fertilizers and herbicides. Many hired professional crop consultants who conducted soil tests, and some adopted precision application systems in order to increase crop production and at the same time eliminate those applications found to be wasteful. Thus the reasons for crop management changes on both G2 and G3 farms tended to be economic and environmental in nature. By increasing the precision of fertilizer and herbicide applications, G2 and G3 farmers were able to improve the effectiveness of their crop management through increasing crop yields and economic efficiency generally, but also addressing environmental concerns including soil quality and the presence of pests and weeds. Even for G2 farmers, regardless of whether crops were grown for market or for feed on their own operation, the efficiency of crop management systems was clearly an important issue and was demonstrated by the regularity with which farmers updated their crop management methods. In these respects, crop management continues to evolve along a similar path on many G2 and G3 farms.

6.2.3 Crop Insurance

Crop insurance was one aspect of farm management that changed little over the study period for both G2 and G3 farms. In fact, very few farmers in either group carried crop insurance between the years 1987 and 1997 (**Table 6.4**), and these farmers shared very similar sets of reasons for not carrying this insurance.

A common feeling among farmers in both groups was that insurance was simply too expensive to be of benefit, regardless of their operation scale and financial resources.

Table 6.4: Recent Changes Common on G2 and G3 Farms: Crop Insurance**a) Number of Farms Changing Crop Insurance**

Changes to Crop Insurance	G2	G3
No. farms reporting change	7	4
No. farms reporting no change	17	13

b) Reasons for Not Changing Crop Insurance

Common Reasons for No Change (No. of times given)	G2	G3
Tradition / still works	8	8
Previous bad experience	4	3
Can't afford cost involved	1	2

c) Crop Insurance Changes

Type of Change (No. of times made)	G2	G3
Increase coverage	2	3
Decrease coverage	5	1

d) Reasons for Crop Insurance Changes

Common Reasons for Change (No. of times given)	G2	G3
More efficient	1	1
Former claims not satisfied	1	1
Diversify / reduce risk	1	0
Economic inputs exceed outputs	1	0
Changed nature of operation / crops grown	1	0
Climate / weather	0	1

Sample size: G2, n=27; G3, n=28

Instead they felt satisfied with the tradition of managing through difficult seasons with their own resources, at least to a greater extent than they were willing to encumber the cost of insurance coverage. Others had experiences with crop insurance prior to 1987 which they estimated to bring more costs than returns, and therefore were not interested in purchasing any insurance during the RMOC survey study period. Although slightly more G2 farmers carried insurance than G3 farmers, the majority of farmers in both groups did not carry insurance and many of those who did had taken steps to reduce their level of coverage. The reasons for these changes related simply to the fact that crop insurance has not made economic sense to most farmers in groups G2 and G3.

6.2.4 Land Area

Farmers in both G2 and G3 were very active in making changes to their farms' land area over the 1987-1997 period, particularly those changes involving expanding the land base of their operations. This trend was shared not only by farmers in the two groups of farms but also in much of the wider agricultural region (see **Chapter 4**).

G2 and G3 farms were similar with respect to the level of change to their farms' land area, and also in the types of changes made and the reasons for these changes (**Table 6.5**). Both groups were primarily motivated by a desire to expand their operation in order to increase economic potential. However, logistical reasons for change, such as the opening of a new opportunity to purchase land, were also important to farmers in both groups. Very seldom did farmers in either G2 or G3 decrease their land area by selling off land or renting it to others. Although these farms may differ substantially in a

Table 6.5: Recent Changes Common on G2 and G3 Farms: Land Area**a) Number of Farms Changing Land Area**

Changes to Land Area	G2	G3
No. farms reporting change	20	18
No. farms reporting no change	7	10

b) Reasons for Not Changing Land Area

Common Reasons for No Change (No. of times given)	G2	G3
Tradition / still works	2	4
Nature of farm (already fully improved)	0	3
No additional land available	2	1

c) Land Area Changes

Type of Change (No. of times made)	G2	G3
Increased land area	17	15
Decreased land area	2	3
Increased proportion owned	2	1

d) Reasons for Land Area Changes

Common Reasons for Change (No. of times given)	G2	G3
Expand operation	11	11
New source for purchase	4	4
Change in family structure	2	4
To increase production	3	1
More efficient	3	1
Changed nature of operation	1	2

Sample size: G2, n=27; G3, n=28

number of enterprise attributes, it is clear that the majority of farmers in both groups see expansion of the farm's land base as a prerequisite to economic growth for their own operations. The fact that these changes were common to both the RMOC farms surveyed and the wider region demonstrate that the expansion of land area remains vital to the economic survival of farmers participating in most types of agriculture currently practised.

6.3 A Comparative Assessment of Recent Farm-Level Changes which Differentiate G2 and G3 Farms

6.3.1 Crop Production

While the majority of farmers in both groups G2 and G3 made changes to their crop production systems over the 1987-97 period, the two groups reported differences in their crop production adjustments in several key areas. One important difference was that G2 farmers were more active in making changes to their crop production systems than G3 farmers. Only five G2 farmers did not make changes to their crop production over the study period, while twice as many G3 farmers did not adjust crop production activities (**Table 6.6**).

A review of the reasons underpinning decisions to either change or not change crop production provides insight into the different adaptation strategies employed by G2 and G3 farms. G2 farms tended to be more concerned with economic issues, in particular the need to increase efficiency, than G3 operators. By increasing the land area devoted to crop production, many G2 farmers felt that increased crop production would allow them to support larger livestock herds, and thereby lead to greater economies of scale. By

Table 6.6: Recent Changes Which Differentiate G2 and G3 Farms: Crop Production Changes

a) Number of Farms Changing Crop Production

Changes to Crop Production	G2	G3
No. farms reporting change	22	18
No. farms reporting no change	5	10

b) Reasons for Not Changing Crop Production Systems

Common Reasons for No Change	G2	G3
Tradition/still works	3	3
Farm limitations	0	2
No time	0	2

c) Crop Production Changes

Type of Change (No. of times made)	G2	G3
Increase crop acreage	20	13
Switch crop type	3	5
Switch crop variety	4	4
Decrease crop acreage	2	2
Introduce cropping systems	0	2
Cease cropping	0	2

d) Reasons for Crop Production Changes

Common Reasons for Change (No. of times given)	G2	G3
More efficient	11	2
Product price / demand	4	5
Expand operation	5	4

Sample size: G2, n=27; G3, n=28

contrast, only two G3 farmers cited efficiency as a reason to change their crop production systems. These farmers were more concerned with changes in consumer demand and the price for their crops. Rather than focusing on increasing the land area devoted to crops as many G2 farmers did, G3 farmers often made more substantive changes, including the adoption of new crops in an attempt to adjust to changing markets.

The nature of the farm enterprises appears to have considerable influence on the sorts of crop production changes implemented over the last 10 years. G2 farms are livestock operations which tend to be larger than G3 farms, and considerable economic benefits were derived by G2 farmers who were able to expand their feed crop production. In many instances, on-site production of feed crops internalizes production costs and reduces the need to purchase more expensive livestock feed from off-farm sources. These G2 farmers most often stated that efficiency was the dominant motivation for their changes. G3 farms, on the other hand, have either no livestock operation or relatively small scale livestock operations. Cash cropping is often more important on G3 farms and therefore changes in the price of cash crops on the market are often of more consequence to these farmers' livelihoods. Because these farmers operate at a smaller scale and are greatly influenced by market fluctuations for cash crops, the G3 operators are more likely to change the types of crops grown from year-to-year. In summary, while G2 farmers tended to make a greater number of changes to crop production systems than G3 farmers, these changes were quite narrowly focused on the goal of improving the farm's overall efficiency. G3 farmers made fewer changes but when changes were made they were done for a wider range of reasons than G2 farmers.

6.3.2 Livestock Production

Differences in livestock production changes over the 1987-97 period were very similar to those for crop production changes between G2 and G3 farms. Once again, changes to livestock production activities were a prominent feature of farms in both groups; however, the types of changes being made differed greatly. While livestock herd sizes continue to expand on the majority of G2 farms, many G3 farmers have reduced or only maintained their livestock herd numbers (**Table 6.7**). G3 farmers were more active in changing the type of livestock being raised than G2 operators.

The reasons for changing livestock production activities also differed substantially, and relate strongly to differences in enterprise characteristics for the two groups of farms. Large-scale G2 operators were often motivated by a desire to expand their operation, increase production and improve efficiency in order to boost the economic potential of their livestock production systems. Unlike G2 operators, few G3 farmers made changes to their herd for reasons of expanding their operation or increasing production and efficiency. Instead, G3 farmers were swayed more by changes in consumer demand for particular livestock products and by their perception of new opportunities emerging in other livestock activities. Because these farms typically operate at a smaller scale than G2 farms, changes in the type of livestock being raised may be made in order to take advantage of new market opportunities. These changes are often very difficult, but remain more attainable for G3 farmers than G2 farmers who

Table 6.7: Recent Changes Which Differentiate G2 and G3 Farms: Livestock Production Changes

a) Number of Farms Changing Livestock Production

Changes to Livestock Production	G2	G3
No. farms reporting change	21	20
No. farms reporting no change	6	2

b) Reasons for Not Changing Crop Production Systems

Common Reasons for No Change (No. of times given)	G2	G3
Tradition/still works	3	1
Farm limitations	1	0
Cost of labour	0	1

c) Livestock Production Changes

Type of Change (No. of times made)	G2	G3
Increase number of head	15	10
Decrease number of head	6	12
Change livestock type	2	7

d) Reasons for Livestock Production Changes

Common Reasons for Change (No. of times given)	G2	G3
Expand operation	11	3
Increase production	10	2
More efficient	10	2
Product price / consumer demand	1	9
More opportunity in other activity	3	6
Change in family structure	3	1
Less off-farm work	0	2
Off-farm work conflict	0	1

Sample size: G2, n=27; G3, n=28

have considerably more money and inputs invested in their existing livestock systems. In this way, G3 farmers tend to be more capable of responding to changes in consumer demand quickly. Conversely, if demand for a G2 farmer's livestock products lowers, increasing the herd size and attempting to derive economic benefits from increased efficiency often remains a more viable strategy than a wholesale change to the type of livestock being raised. Dairy quota purchases are another major factor promoting stability in the type of livestock being raised by G2 farmers, since the quota offers a supply management system designed to guarantee farmers reasonable returns on dairy products (Bryant et al., 1997). These differences among RMOC farmers offer one example of the extent to which basic enterprise characteristics, including farm scale and investments, play out in agricultural decisions.

Certain social factors, particularly the availability of off-farm work, also affected the decisions of G3 farmers more than for G2 farmers. Since livestock production often involves highly labour-intensive activities, it becomes difficult to maintain production if the level of off-farm work increases. Most G2 farmers work on their operations full-time, so that the issue of off-farm work availability seldom concerns them. G3 farmers, however, derive significant portions of their family income from off-farm employment (see **Chapter 4**), and if the level of off-farm work changes because of a job loss or new job opportunity, it becomes necessary to make changes to their allocation of time and personal labour on the farm. While never mentioned by G2 farmers, declines in off-farm work availability, and conflicts between work on and off the farm, were identified by some G3 farmers as a strong motivating factor for changes to their livestock production

systems.

6.3.3 Land Management

Changes to land management were a regular feature of both G2 and G3 farms in the 1987-97 period. However, these changes were more common on G2 farms (89%), than G3 farms (71%) (**Table 6.8**).

Land management changes most often involved the installation of tile drainage. Sometimes farmers also switched to minimum tillage practices as a means of improving their land management. Both of these types of changes occurred with greater frequency on G2 farms.

An important feature of land management changes was that they were often implemented in order to improve the farm's efficiency. Some farmers mentioned economic efficiency as a reason for invoking these changes directly, while others recognized their motivations as being environmental in nature (e.g. to improve drainage, soil quality), but ultimately tied to the overall goal of making the farm a more efficient operation. G2 operators differed from those in G3 in that they were more often motivated by a desire to improve the farm's efficiency, and changed land management practices on a more regular basis than G3 farmers. As with many other types of change discussed, investments designed to improve the efficiency of the farm, such as the addition of tile drainage to boost productivity of soils with excess water, often bring greater returns to the G2 farmers since they operate at a larger scale than the majority of G3 farmers. Therefore G2 farmers tended to be more active in changing their land management activities.

Table 6.8: Recent Changes Which Differentiate G2 and G3 Farms: Land Management Changes

a) Number of Farms Changing Land Management

Changes to Land Management	G2	G3
No. farms reporting change	24	20
No. farms reporting no change	3	8

b) Reasons for Not Changing Land Management

Common Reasons for No Change (No. of times given)	G2	G3
Farm already fully improved	3	6
Tradition / still works	0	1
Farm limitations	0	1

c) Land Management Changes

Type of Change (No. of times made)	G2	G3
Increase tile drainage	17	13
Change tillage practices	10	6
Clear land	5	3

d) Reasons for Land Management Changes

Common Reasons for Change (No. of times given)	G2	G3
Drainage	10	7
Soil quality	10	6
More efficient	8	5
To increase yields	6	6
To increase production	3	4

Sample size: G2, n=27; G3, n=28

6.3.4 Livestock Management

Many of the livestock management activities of G2 and G3 farmers involved altering the genetics of their livestock breed in order to try to produce better quality products for consumer markets. However, significant differences are found in terms of other management changes G2 farmers made to their livestock over the 1987-1997 period, and in some of their motivations for change when compared with the lower income G3 farmers.

G2 farmers were much more active than G3 farmers in changing the contents of their livestock feed rations, in an attempt to gain more productivity from their cattle and improve the overall efficiency of their livestock operation (**Table 6.9**). Some G2 farmers also adopted computer feeding methods in order to further enhance their operation's efficiency. While G2 and G3 farmers were motivated equally by a desire to improve the quality of their products for consumers, G2 farmers were motivated to a greater extent by a desire to increase production levels and efficiency than G3 farmers. This emphasis on efficiency explains the higher level of change to livestock management among G2 farmers, coupled with the fact that all farmers in G2 depend on livestock activities as their primary source of income. The scale of G2 farmers' operations often motivates them to place high priority on efficiency in their livestock management practices. For instance, slight improvements in the nutrient content of feed grains sometimes translate in to highly positive effects on the total production of large scale (e.g. several hundred head) livestock operations, but the returns for smaller scale livestock activities may not warrant the costs associated with researching and changing the content or supplier of existing feed rations.

Table 6.9: Recent Changes Which Differentiate G2 and G3 Farms: Livestock Management Changes

a) Number of Farms Changing Livestock Management

Changes to Crop Production	G2	G3
No. farms reporting change	21	16
No. farms reporting no change	5	6

b) Reasons for Not Changing Livestock Management

Common Reasons for No Change (No. of times given)	G2	G3
Tradition / still works	3	3
Change has little economic potential	0	1

c) Livestock Management Changes

Type of Change (No. of times made)	G2	G3
Genetics / breed	14	12
Change to feed rations	14	8
Adopted computer feeding methods	4	0

d) Reasons for Livestock Management Changes

Common Reasons for Change (No. of times given)	G2	G3
To improve product quality	12	11
More efficient	11	4
To increase production	12	2
Product price / consumer demand	4	4
To decrease labour costs	6	0
Expand operation	3	0

Sample size: G2, n=27; G3, n=28

Overall, the higher level of change and the number of reasons prompting change to livestock management on G2 farms illustrate that improvements in efficiency and total production are often an even stronger motivating force for change on large scale livestock operations.

6.3.5 Labour Management

Substantial changes to labour management were featured on many RMOC farms during the 1987-1997 period, and differences in these changes among G2 and G3 farms illustrate the importance of certain farm enterprise characteristics to agricultural decisions. Although many farms continued to expand, both in the sense of increasing land area and total production, labour inputs have tended to fluctuate rather than increasing with farm outputs. These changes in labour levels on RMOC farms have resulted from the interchange of several different forces affecting farm-level decisions.

One important difference between G2 and G3 farms is that the operators of the large scale livestock (G2) operations changed their labour management less frequently than the lower income operators (**Table 6.10**). Livestock production (esp. dairying) tends to be a highly labour-intensive activity and the majority of G2 operators have always worked on their operations full-time. G3 operators, on the other hand, often do not work on their farm full time and therefore must supplement their farm income with off-farm work. Accordingly, these farmers were more active in changing the levels of off-farm work than G2 farmers. The availability of jobs off the farm tends to be much more important to these farm families, who depend on off-farm work for a greater portion of their income than G2 operators (see **Sec. 4.2.2**).

Table 6.10: Recent Changes Which Differentiate G2 and G3 Farms: Labour Management Changes

a) Number of Farms Changing Labour Management

Changes to Labour Management	G2	G3
No. farms reporting change	15	20
No. farms reporting no change	11	6

b) Reasons for Not Changing Labour Management

Common Reasons for No Change (No. of times given)	G2	G3
Tradition / still works	6	4
Can't afford to increase labour	1	0

c) Labour Management Changes

Type of Change (No. of times made)	G2	G3
Increased hired labour	6	7
Decreased off-farm work	2	6
Hired more contract workers / specialists	4	1
Increased family labour on farm	3	2
Increased off-farm work	1	3

d) Reasons for Labour Management Changes

Common Reasons for Change (No. of times given)	G2	G3
Change in family structure	5	7
More efficient	6	2
Expand operation	1	3
More opportunity in other activity	1	2
Changed nature of operation / crops grown	0	3
Less off-farm work	1	2

Sample size: G2, n=27; G3, n=28

When G2 farmers made labour changes this was often to increase the farm's efficiency, while G3 farmers were motivated by economic and social factors other than farm efficiency alone. These included changes in family structure (e.g. aging, death or retirement of family members), changes in off-farm work levels, or changes in the nature of the operation because of a perceived new opportunity. These findings suggest that as opportunities changed, G3 farmers were more likely to switch the nature of the operation and make related labour adjustments. In fact, labour management was the only aspect of farm-level change that changed more often on G3 farms than G2 farms. The smaller scale of these operations offered one advantage in that G3 farms were often capable of responding to changes in opportunities more quickly than large scale livestock operations.

6.3.6 Capital Investment

Capital investment changes were prevalent on both G2 and G3 farms over the 1987-1997 period. However, these farms were distinguished by both the types of investments made and some of the motivations for these investments. These differences relate closely with the overall scale of G2 and G3 operations.

Technology investments were common among both groups of farms and typically involved the addition of new agricultural equipment every few years, or maintenance and repairs of older machinery (**Table 6.11**). G2 farmers, however, made many more additions to farm infrastructure than G3 farmers, investments which were crucial when farming larger pieces of land and expanding at a rate more quickly than most G3 operators. While both groups of farmers were concerned with maintaining efficiency

Table 6.11: Recent Changes Which Differentiate G2 and G3 Farms: Capital Investment Changes

a) Number of Farms Changing Capital Investment

Changes to Capital Investment	G2	G3
No. farms reporting change	26	24
No. farms reporting no change	1	4

b) Reasons for Not Changing Capital Investment

Common Reasons for No Change (No. of times given)	G2	G3
Tradition / still works	0	2
About to retire / sell farm	1	1
Can't afford cost involved	0	1

c) Capital Investment Changes

Type of Change (No. of times made)	G2	G3
Increased technology investments	20	23
Increased infrastructure investments	27	15
Increased dairy quota	15	0

d) Reasons for Capital Investment Changes

Common Reasons for Change (No. of times given)	G2	G3
Expand operation	19	10
Upkeep of equipment	15	14
More efficient	11	12
To increase production	11	1

Sample size: G2, n=27; G3, n=28

and the general upkeep of their equipment, it was G2 farmers in fact who expressed much stronger motivations for expanding their operation and increasing production. Keeping up with emerging agricultural technologies and equipment was clearly an important issue for farms at both G2 and G3 scales, although investments in infrastructure designed to further increase production capacity (e.g. addition of storage buildings, livestock barns, manure pits) were more prominent among G2 farmers than those in G3. Additionally, the higher sales levels of G2 farmers sometimes offered a cash flow which could be utilized to support large investments in farm infrastructure. Increases in the purchases of dairy quota also happened frequently on G2 farms, while never happening on G3 farms. This was expected since G2 farms are larger, predominantly dairy operations. While regular technology investments were crucial to the success of both G2 and G3 farms, it appears that in some years G2 farmers were able to take advantage of their operation scale by utilizing its cash flow, and in this way were more capable of expanding both infrastructure and quota purchases than G3 farmers.

6.3.7 Planned Short- and Medium-Term Future Changes: 1998-2003

The short term plans of large scale livestock operators and farmers with lower farm sales levels display very different trends. Although few farmers in either group were comfortable discussing farm plans beyond a three or four-year window, it is clear that the decisions of G2 and G3 operators will continue to take on different paths in several key areas.

In their short term future plans the G2 livestock operators continue to place emphasis on their desire to expand their operations, and many more of these operators

planned additions to their farm's infrastructure than G3 farmers (**Table 6.12**). Some also planned to increase the size of their livestock herd and to purchase more land. This suggests that, where possible, the larger-scale G2 farms will continue to expand, increasing in area while many of the smaller-scale G3 operations will remain substantially smaller. Although both groups of farmers expressed a desire to expand their operation's economic potential, G2 farmers have planned more changes in pursuit of this objective. This higher level of change on G2 farms was also a feature of recent farm-level changes (see **Sec. 6.3.1** through **6.3.6**). It appears that an important strategy for many G2 farmers rests with a continued expansion of the farm land base and production in order to manage rising input costs. As with many past changes, G3 farmers continue to focus less on expansion of their land base. Having to survive at a scale significantly smaller than most G2 farmers, these G3 operators must deploy a range of strategies that take into consideration the limits of their existing farm land base. While these G3 farmers did not indicate that they had future plans as often as their G2 counterparts, one of the biggest strengths of G3 farmers' recent agricultural adjustments has been their capability to respond quickly to changes in agricultural markets, an ability which will likely remain vital to the viability of many G3 farms in the short and medium-term future.

Table 6.12: Comparison of Planned Future Changes on G2 and G3 Farms in the RMOC (1998-2003)

a) Number of Farms Planning Changes

Farms Planning Change	G2	G3
No. farms reporting change	24	21
No. farms reporting no change	2	7

b) Reasons for No Planned Future Changes

Common Reasons for No Change (No. of times given)	G2	G3
Can't afford cost involved	0	1
About to retire / sell farm	0	1

c) Planned Future Changes

Type of Change (No. of times planned)	G2	G3
Add infrastructure	13	7
Increase livestock herd	5	2
Add equipment / technology	2	4
Buy more land	5	0

d) Reasons for Planned Future Changes

Common Reasons for Change (No. of times given)	G2	G3
Expand operation	11	10
To increase production	6	5
More efficient	7	3
Change in family structure	7	4

Sample size: G2, n=27; G3, n=28

6.3.8 Perception of Change Occurring in the Eastern Ontario Agricultural Region

G2 and G3 farms are also differentiated by the types of changes farmers in each group reported had occurred in the Eastern Ontario agricultural region over the ten-year period. Observations about some of the dominant changes were shared by farmers in both groups, in particular the trend toward fewer farmers, increased farm size and increased technology (**Table 6.13**). However, other types of change were often reported to a differing extent among G2 and G3 farmers. For example, more G2 farmers noted increases in farm efficiency than G3 operators, and these farmers were also more cognizant of the higher costs of land when defining what they described as significant changes to agriculture in the region. G3 farmers, on the other hand, more often observed changes in conservation and tillage methods, increases in the use of chemical sprays, urbanization and rural population pressures, and changes to the climate than G2 farmers. These differences would seem to suggest that differences in the perception of changes occurring throughout the wider agricultural region relate closely to the farm structures and interests of G2 and G3 operators. The G2 operators were more aware of increases in efficiency and the rising cost of land, and an important focus of many of these farmers' agricultural activities involved expanding their land base and increasing the scale of production. G3 farmers, however, were more aware of changes to tillage, chemical use and conservation generally, and this may reflect the fact that some of these farmers depended on cash crops to a greater extent than the predominantly livestock producers found in G2. In addition, G3 farmers were often not as dependent on the farm as a source of family income, and sometimes displayed more interest in social and environmental

Table 6.13: Comparison of Agricultural Changes in Eastern Ontario, As Reported by G2 and G3 Farmers

Type of Change	G2	G3
Fewer farmers, increased farm size	11	10
Increased efficiency	12	8
Increase in technology	10	9
Higher input costs / lower returns	5	8
Greater conservation / reduced tillage use	4	8
Change to farm type in area	5	5
Trade	5	3
Higher cost of land	5	1
Increased use of chemical spraying	1	5
Increased urbanization	1	4
Greater pressures from rural population	1	4
Climatic changes	0	5

Sample size: G2, n=27; G3, n=28

changes than those related more directly to the farm's economic efficiency and production.

6.4 Summary

This chapter has analyzed similarities and differences in agricultural adjustment among heavily-capitalized livestock operations and farms with lower levels of agricultural sales. While this analysis was presented individually for many types of farm-level change, several common themes are found in these adjustments across the different

types of change. **Table 6.14** summarizes the differences and similarities in agricultural adjustment occurring on G2 and G3 farms.

Differences in the types of change and reasons for change were found to often relate closely to differences in the nature of G2 and G3 operations and the decision-making structures on these farms (see **Section 4.4**). G2 farmers reported a greater number of changes overall, and more reasons prompting change, reflecting the more complex decision-making structure found on G2 farms. While economic motives were the most common reason for changes for both groups, they were an even stronger force for G2 farmers. These farmers tended to be particularly concerned with expanding the farm operation and improving efficiency, factors essential for the success of the heavily capitalized livestock operations found in G2.

G3 operators' changes were broadly similar to those of G2 except that sometimes these changes involved decreasing input levels (e.g. number of livestock, labour) rather than increasing them in order to maintain farm efficiency. For these operators, expansion was sometimes not the best path for farm efficiency; in fact due to their farm limitations it was often not an option. While economic motives remained the dominant reason for changes, G3 farmers tended to be influenced by a wider range of motives than G2 farmers in their decisions. For certain types of decisions, including those related to crop production, labour management and future plans, environmental and social motives encouraged changes on G3 farms more often than for G2 farms.

These findings do not suggest that the types of change and motivations for change are universal to farms in each group. Rather, they demonstrate that agricultural decisions

Table 6.14: Summary of Characteristics of Change on G2 and G3 Farms

Attributes of Change	G2	G3
Frequency	<ul style="list-style-type: none"> • Very high: Few farms report inactivity in farm production, management or farm structure 	<ul style="list-style-type: none"> • High level of change but less than that of G2 farms
Type	<ul style="list-style-type: none"> • Changes common for most aspects of farming except for management of crop insurance and specialty production • Changes typically involve expansion of scale of activity • Changes to operation type or livestock type are difficult to achieve at this scale 	<ul style="list-style-type: none"> • Higher level of change for labour management • Changes involve both expansion and reduction in scale of activity (e.g. labour and livestock levels) • Some farmers are able to change the nature of the operation and livestock type to respond quickly to changing opportunities
Motivation	<ul style="list-style-type: none"> • Focused mainly on expanding the operation and its economic potential, improving farm efficiency 	<ul style="list-style-type: none"> • Efficiency also important, but incorporating a wider range of additional motives (e.g. social and environmental)

are often complex, being influenced by a wide range of physical, economic and social forces. While these decisions are undoubtedly the product of individuals and their farm families faced with a very specific set of circumstances, this chapter has demonstrated that basic differences in farm characteristics, including type, scale and income, have exerted considerable influence on agricultural decisions in the RMO.

CHAPTER 7: RMOC SURVEY RESPONDENTS' PERCEPTION AND ADJUSTMENT TO CLIMATIC CHANGE: A REGIONAL PERSPECTIVE

7.1 Introduction

Chapters 5 and 6 established the context of agricultural decision making in the RMOC by examining agricultural adjustments and the motivations for these adjustments in relation to a broad range of influences (e.g. economic, technological, social, environmental). Now that some of these influences have been identified, Chapter 7 explicitly addresses RMOC farmers' perceptions and responses to climatic change in an effort to identify farm-level adaptive strategies, and to explore the role of climatic information vis-a-vis other forces affecting agricultural change.

The nature of farmers' responses to past and potential future climatic changes are affected by several important characteristics of both RMOC farmers and their enterprises. These characteristics are addressed in separate sections of this chapter (**Table 7.1**).

Table 7.1: Factors Affecting Adjustment to Climatic Change on RMOC Farms

Section	Factor
7.2	Sources of Weather Information
7.3	Farm Sensitivities to Weather and Climate
7.4	Perceptions of Climatic Changes

This structure was adopted so that reasons for farm-level responses (analyzed in **Section 7.5**) may be examined in light of the farmers' own indication of their information sources, perception of climatic changes, and sensitivities to climate, which ultimately affect the

choice of adaptive strategies employed. After the farmers' adaptive strategies are analyzed, the utility of different types of information that could be used to assist farmers adapting to climatic change is evaluated from the perspective of farmers themselves. The respondents' evaluations will help identify areas where RMOC farmers feel particularly vulnerable to climatic change and suggest areas for which the farming community is already quite capable of adapting.

In an effort to establish broad trends in climatic change perception and response in the region, this chapter provides an overview among all RMOC farms surveyed (G1). Some of the factors included in Table 7.1 differ substantially by farm enterprise type, and for this reason, the next chapter (**Chapter 8**) provides a comparative assessment of climatic change perception and response between highly-capitalized livestock farms (G2) and lower income farms (G3) in the RMOC. Highlighting some of the similarities and differences across RMOC farms provides a basis for understanding how farmers may be differentially affected by climatic change, and this G2-G3 comparison is addressed following the regional perspective of climatic change perception and response provided in this chapter.

7.2 RMOC Farmers' Sources of Weather Information

The majority of RMOC survey respondents use several sources for obtaining weather information (**Table 7.2**). Radio and television forecasts are by far the most common weather sources used, with other sources used on fewer than half of the

Table 7.2: Sources of Weather Information

Source	No. of Farms Using Source	Types of Decisions Most Often Used For (No. of Farms):
Radio	47	cropping/seeding (29), harvesting (28)
Television	44	cropping/seeding (28), harvesting (26)
Phone Service	29	harvesting (24), cropping/seeding (16)
Newspaper	14	cropping/seeding (8), harvesting (8)
Farm Paper	14	cropping/seeding (6), harvesting (4)
Almanac	8	other ¹ (7), harvesting (2)
World Wide Web	2	cropping/seeding (1), harvesting (1)
Other Sources	15	harvesting (8), cropping/seeding (6)

¹ Refers to use in decisions other than those involving cropping/seeding, harvesting, livestock or land management.

G1 sample size: n=58

RMOC farms surveyed. For many farmers, the timeliness of weather forecasts is very important for their day-to-day decisions. Radio and television offer a distinct advantage over some sources (e.g. newspapers, farm papers, almanac) in this regard because they can be consulted on a regular basis (e.g. several times per day) for more current forecasts than other media. Also, radio and television are more accessible to most RMOC farmers

than sources such as the world wide web. Radio is perhaps the most accessible of all media used for weather information since it can be monitored in barns or in the tractor while working fields.

The information obtained from radio and television forecasts is used in a wide range of farm decisions. Most farmers use these forecasts for decisions related to seeding and other cropping decisions, as well as during harvest time.

A phone-in weather information service is used by half of the RMOC farmers surveyed, but is often used in a different fashion than radio and television sources. This service is used primarily at harvest time, particularly for rain forecasts during haying. Some farmers mentioned that it is used several times a day during this season because it tends to be more accurate than radio and television sources, and sometimes delivers a forecast more local to their area. However, some stopped using the phone-in service once a fee was introduced for its use. Although the phone service could be consulted for regular updates of weather information, the cost associated with its use made it less accessible to some RMOC farmers than radio and television sources.

An important additional source mentioned by some farmers was the use of their own experience in judging the weather, often by visual inspection and previous experience with weather patterns. This approach was mentioned most often by farmers with extensive farming experience. Few of these farmers relied exclusively on their own judgement of the weather, instead balancing their observations with forecasts obtained from media sources.

7.3 RMOF Farm Sensitivities to Weather and Climate

7.3.1 Critical Periods for Reliable Weather Information

During certain times of the year, access to reliable weather information is critical for many farm livelihoods. The times in which this information is most important varies depending on both farm characteristics and agro-climatic properties unique to a particular region. In the RMOF, the majority of survey respondents identify that May is the beginning of a critical period for having reliable weather information (**Table 7.3**).

Table 7.3: Critical Months for Reliable Weather Information (No. of Farms Identifying)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	3	1	13	43	52	50	44	32	26	15	2

G1 sample size: n=58

The end of this critical period is less well-defined, varying from farm to farm with October being a critical month for about half of survey respondents' farms. This May-October period is most critical because it captures the times at which agricultural activities common to the region (see **Sec. 7.3.2**) are most vulnerable to changing weather conditions. Having reliable information in the months of November and April is considered critical by a small number of farmers, much fewer than for other months in the growing season. Fewer farmers grow crops in these months because of the considerably higher risk of frost or freezing temperatures occurring in April and November than in months in the middle of the growing season (see **Sec. 3.5.1**). Winter months are seldom a

critical period for weather information, except for a few farmers with specialty operations (e.g. maple syrup).

7.3.2 Aspects of RMOC Farms Most Sensitive to Weather Conditions

RMOC farmers’ identification of the critical months for reliable weather information is closely tied with the timing of the activities they perceive to be most sensitive to weather on their own operations. These farmers identified that their crop and livestock quality, productivity and management were all affected by weather conditions (Table 7.4). Crops tended to be much more sensitive to weather conditions in the region than livestock. In particular, the hay crop was identified by an overwhelming majority

Table 7.4: Aspects of Farm Most Sensitive to Weather Conditions

Aspect of Farm Operation:	No. of Farms Reporting:
Hay	39
Crops (generally)	13
Crops - quality	9
Livestock - productivity	8
Crops - productivity	7
Crops - management	4
Other	3

G1 sample size: n=58

of survey respondents as the most sensitive aspect of their farms to weather conditions, for several reasons. First, the quality of the hay harvest depends on having a period of several days in succession without rain. If hay becomes dampened by rainfall the quality of the crop deteriorates significantly. Another reason is that hay is one of the most common crops produced in the region (see Sec. 3.5.3). Although other crops were

sometimes mentioned these were often not considered as sensitive as hay and were not grown on as many farms in the RMOC.

7.3.3 Climate Properties Influencing Farm Decisions

Precipitation levels are the most significant climate property in terms of their influence on farm decisions in the RMOC (**Table 7.5**). The amount of rainfall was

Table 7.5: Climate Properties Influencing Farm Decisions

Climate Property:	No. of Farms Reporting:
Precipitation (amount)	37
Precipitation (timing of)	25
Sun/heat (amount)	20
Wind	8
Sun/heat (timing of)	5
Other	9

G1 sample size: n=58

considered by many farmers an important factor because of its relationship with the development and maturation of many popular field crops. Close to one-half of the RMOC farmers surveyed also distinguished the timing of precipitation as a crucial factor, for several reasons. Precipitation at critical periods such as crop seeding and harvest times can affect crop quality (see **Sec. 7.3.2**), and the pattern of precipitation throughout the growing season is also important, since extended dry periods during the season can damage both the quality and productivity of many field crops grown in the RMOC.

The amount of sunlight and heat was considered of secondary importance to precipitation, but still significant to agricultural decisions on close to one-half of the

farms. Some farmers related the amount of heat to the productivity of corn crops in particular. Wind was another factor identified of secondary importance, since it can affect activities such as chemical spraying and the drying of harvested crops.

7.4 Recent Climatic Change Perception

7.4.1 Overview of Climatic Change Perception

The vast majority of survey respondents (81%) believed the climate had changed in their area over the last 20 years. Most of these farmers identified changes to temperature, precipitation, extreme events and weather predictability over this period, and an overview of the types of changes reported is presented in **Table 7.6**. Changes to other agro-climatic properties such as Corn Heat Units (CHUs) and the number of frost-free days were not mentioned as frequently, in part because some farmers had no opinion on whether they had changed.

Very few farmers surveyed (12%) believed the climate had not changed in their area. They often noted year-to-year changes in weather patterns, but felt that these changes were not part of any long term trend, citing the cyclical nature of climate. Another small group of farmers referred to the difficulty of separating year-to-year changes from long term trends and indicated that they could not say for certain whether or not the climate had changed in their area.

Table 7.6: Overview of Climatic Change Perception and Common Types of Change

Has climate changed in your area in the last 20 years?		Type of Change (No. of Farms Reporting)	
	G1	Change to:	G1
Yes	47	Temperature	45
		Precipitation	40
		Extreme events	37
		Weather predictability	35
		Heat Units	28
		Frost-free days	25
		Other Climate Properties	22
No	7		
Not Sure	4		

G1 sample size: n=58

7.4.2 Perceived Temperature Changes

Increased temperatures were widely reported by survey respondents, especially in the winter months (**Table 7.7**). For many, these winter temperature increases were felt to have been significant enough to raise average yearly temperatures in the RMOC. While no farmers suggested a lowering of average temperatures, several perceived a decrease in the summer months. In fact, opinion was divided between increased and decreased temperatures during the summer. It is clear that while many farmers believe average temperatures are rising, much of this temperature increase is perceived to occur during the winter months.

Table 7.7: Perceived Changes to Temperature

Change:	No. of Farms Reporting:
Average temperature - Increase	17
Average temperature - Decrease	0
Summer temperature - Increase	7
Summer temperature - Decrease	6
Winter temperature - Increase	14
Winter temperature - Decrease	1
Temperature becoming less predictable	4
Other changes	3
No change to temperature	11
No opinion	2

G1 sample size: n=58

7.4.3 Perceived Precipitation Changes

The majority of survey respondents also believed precipitation had changed in their area over the last 20 years (**Table 7.8**). However, a wider range exists in the types of changes reported for precipitation. The most common observation was a decrease in

Table 7.8: Perceived Changes to Precipitation

Change:	No. of Farms Reporting:
Total precipitation- increase	12
Total precipitation - decrease	5
Timing - more evenly dispersed	1
Timing - less evenly dispersed (more erratic)	12
Winter snow - decrease	13
Other changes	4
No change to precipitation	16
No opinion	2

G1 sample size: n=58

winter snowfall. Many farmers associated the drop in snowfall levels with increased winter temperatures (see **Section 7.4.2**), resulting instead in increased amounts of winter rain, freezing rain and ice (see **Section 7.4.4**).

Slightly more farmers observed increased precipitation levels than decreases, but a common observation was that precipitation was becoming more erratic, making rainfall patterns less predictable. A few farmers commented that this made it difficult to plan certain farm activities, particularly harvesting. They observed a tendency for large amounts of rain to fall at one time, and then to be followed by extended dry periods.

Some farmers also mentioned a trend toward increased local variation in rainfall patterns. When these farmers reported changes to precipitation, they suggested that changes were sometimes confined to their immediate area, and cited different precipitation patterns on farms only a few kilometres away. This may help account for the range in perceptions of the types of changes reported by farmers across the region. These highly-localized rainfall patterns are significant because they make it difficult for farmers to rely on rainfall forecasts provided at the regional scale or higher.

7.4.4 Perceived Changes to Extreme Events

Changes to extreme events were the third most common type of change reported by RMOC survey respondents. There was little consensus among farmers about the types of changes occurring, except that events have generally been occurring more frequently and with greater severity over the last 20 years (**Table 7.9**).

With regards to changes to specific types of events, increases in the number and severity of dry events (e.g. summer drought) were the most common changes reported.

Table 7.9 Perceived Changes to Extreme Events

General Changes:	No. of Farms Reporting:
Events generally - more frequent	10
Events generally - less frequent	1
Events generally - more severe	5
Events generally - less severe	0
No change to extreme events	18
Changes to Specific Events ¹:	No. of Farms Reporting:
Dry events - more severe	8
Ice storms - more severe	8
Dry events - more frequent	7
Wet events - more severe	7
Hail - more frequent	7
Ice storms - more frequent	6

¹ Only those changes most often reported are included.

G1 sample size: n=58

However, a wide range of changes were observed. These included increases in the severity and frequency of ice storms, often associated with increased winter temperatures. The increased temperatures may result in the melting of snowfall or freezing rain, but subsequent cooling causes the snowmelt to freeze and sometimes produce ice hazards. The RMOC respondents' perception of these ice storms is likely to have been influenced by the severe ice storm which impacted the region in the two to three-month period before surveys were conducted, but the extent to which this affected their responses is not known (see **Section 3.4.3**). Some respondents believed that the ice storm was part of a trend toward increased extreme events, while others felt it was an anomaly or freak occurrence, and still others believed that extreme events of such magnitude are rare, but nonetheless a feature of the current climate.

The range in changes reported provides little evidence that certain types of extreme events are becoming more prominent in the minds of RMOC survey respondents than others. But regardless of the type of events reported, an important conclusion among RMOC farmers surveyed is that these events are increasing, in terms of both their frequency and severity.

7.4.5 Perceived Changes to Weather Predictability

The majority of farmers also believed that the weather in their area had become less predictable over the last 20 years (**Table 7.10**). Many related this trend to their

Table 7.10: Perceived Changes to Weather Predictability

Change:	No. of Farms Reporting:
Weather becoming more predictable	2
Weather becoming less predictable	30
No change to weather predictability	19
No opinion	4

G1 sample size: n=58

observations about changing precipitation patterns, sometimes mentioning a tendency for weather to occur in small “pockets” with considerable local variation. Others reported more fluctuation and extremes for other climate properties, including temperature and heat units. For some, the changes observed to weather predictability have affected the way they use weather forecasts on the farm. These farmers held little confidence using forecasts in spite of possible improvements in forecasting methods, largely because of their belief that weather itself is becoming less predictable.

A minority of farmers (approximately one-third) believed weather predictability had not changed in their area. Some were careful to point out that this did not mean weather conditions were similar from year to year. Rather, they felt that the weather has been consistently unpredictable in their area, and observed nothing to suggest that this would change. Very few farmers felt weather conditions were becoming more predictable.

7.4.6 Perceived Changes to Heat Units

Changes to heat units were reported by a minority of farmers, much fewer than the number reporting temperature changes (**Table 7.11**). While temperature increases

Table 7.11: Perceived Changes to Heat Units

Change:	No. of Farms Reporting:
Increased Heat Units	21
Decreased Heat Units	1
Other changes	3
No change to Heat Units	22
No opinion	8

G1 sample size: n=58

were observed most often in winter (see **Section 7.4.2**), heat units are only recorded during the growing season. Some farmers mentioned that they did not consciously follow heat units, and fewer farmers had an opinion on whether heat units had changed than temperature.

Among those farmers reporting changes to heat units, there is a consensus that heat units are increasing. For some this has provided an opportunity to change crop

cultivars to higher-yielding varieties. However, some farmers cautioned that despite the average increase in heat units, there remain extreme years when heat units can be abnormally low. This has considerable implications for crop production since some farmers choose not to adopt higher CHU variety corn and take on lower, more conservative varieties to protect against the possibility of low CHU years despite the overall increase.

7.4.7 Perceived Changes to Frost-Free Days

Changes in the timing and amount of frost-free days were reported on fewer than half of the RMOC farms surveyed (**Table 7.12**). However, of those reporting change, a

Table 7.12: Perceived Changes to Frost-Free Days

Change:	No. of Farms Reporting:
Increase in number of frost-free days	19
Decrease in number of frost-free days	2
Arrive earlier in season	4
Finish later in season	4
No change to frost-free days	28
No opinion	5

G1 sample size: n=58

large majority believe the number of Frost-Free Days (FFDs) during the growing season have increased. Some of these farmers were able to recall very specific changes to dates in the spring in which they could expect the frost-free period to begin, and extensions of the date in which they may expect the first fall frost.

7.5 Adjustment to Climatic Changes

7.5.1 Adjustment to Recent Changes

While a large majority of farmers perceived climatic changes to have occurred in their area over the last 20 years, only about half of these farmers made adjustments to their operation in response to the climatic changes they identified (**Fig. 7.1**).

Figure 7.1: Recent Climatic Change Perception and Response

(a) Recent Climatic Change Perception

(b) Adjustment to Recent Climatic Change ¹

¹ Among survey respondents who had perceived climatic changes to have occurred in their area within the last 20 years (n=47).

There are a number of reasons why these farmers perceived climatic changes but did not make a response at the farm level. The most prominent reason for many was simply that their farm was not sensitive enough to the changes they identified to warrant any changes to their current system (**Table 7.13**). For other farmers, however, a change was desired

Table 7.13: Adjustments to Recent Climatic Changes ¹

Change/Reasons	
No. of Farms Reporting Adjustments	24
Common Types of Adjustments (No. of times made):	
Switch crop types/varieties	5
Harvesting/planting times	5
Harvesting/planting techniques	5
Livestock management	4
Irrigation/drainage	2
Common Reasons for Adjustments (No. of times given):	
More productive	11
Spread risks	7
Minimize weather-related damages	6
More efficient	4
Access new markets	0
No. of Farms Reporting No Adjustment	23
Common Reasons for No Adjustment (No of times given):	
Farm not sensitive enough to changes	13
Cannot afford cost involved	4
Cannot afford risk involved	2
Stand to benefit as is	0

¹ Among survey respondents who had perceived climatic changes to have occurred in their area in the last 20 years (n=47).

but could not be implemented because they could not afford the cost or risk associated with making the change. Together, these reasons for no adjustment demonstrate that changes in climate must be balanced with other factors, particularly the economic and social cost of change to the farmer, before changes to farm systems are implemented. These costs are sometimes readily-identifiable (e.g. the purchase price of a new piece of equipment) while others are measured in terms of perceived risks (e.g. associated with trying a new crop variety).

When changes were made in response to past climatic changes, they most often involved changes to crop production and management. Crop varieties were adjusted and sometimes crop types changed in order to increase the productivity of existing cropping systems. This productivity was also enhanced by changing planting or harvesting times and techniques due to changes in climate. For instance, some farmers were able to take advantage of extended frost-free periods by harvesting later in the season, thereby improving total production.

Changes made in response to past climatic changes were not always made simply to improve farm productivity. Rather, many were made in reaction to damaging weather effects (e.g. severe storms) and were designed to recover production levels and spread risks rather than simply improving on production levels previously achieved. Farmers who felt that the climate had changed producing heavier rains early in the growing season sometimes delayed planting times and installed tile drainage in order to minimize risks associated with heavy rains damaging their particular crops. Similarly, some changed harvesting times and methods (e.g. wrapping bales) in order to minimize rain damage later in the season.

In summary, recent climatic changes have not always resulted in adjustments at the farm level. When adjustments were made, these were sometimes done to take advantage of new opportunities associated with a changed climate. However, the number of farmers adjusting with the aim of benefitting from climatic changes only slightly exceeded the number of farmers making changes to recover from damages they associated with perceived climatic changes. For many RMOF farmers, recent climatic

changes have been just one of many forces affecting their decision-making, and opportunities associated with changes in the climate have often been counterbalanced by its damaging effects.

7.5.2 Adjustment to Future Climatic Change Scenario

In addition to responding to past climatic changes, farmers were asked how they would respond to a future climatic change scenario. The scenario is described in **Appendix A, Question 24**. It includes substantial increases in frost-free season length, growing degree days, and precipitation. These changes are expected to have significant effects on crop development, and therefore the scenario also suggests a series of yield increases and reduced maturation times for corn, oats, wheat and soybean crops. In this way, the scenario was presented to survey respondents in a manner quite typical of how climatic change information appears to farmers, as a series of possible changes to agro-climatic properties and yields for crops currently important to the region, but the temporal distribution of which (occurring over the next 20+ years) is very uncertain.

While only one-half of survey respondents made adjustments due to past climatic changes, an overwhelming majority (88%) would plan adjustments to the future climate scenario (**Fig. 7.2**). Only one farmer felt that their operation was not sensitive enough to

Figure 7.2: Comparison of Response to Recent and Future Climatic Changes

(a) Adjustment to Recent Climatic Change ¹

(b) Adjustment to Future Scenario

¹ Among survey respondents who had perceived climatic changes to have occurred in their area within the last 20 years (n=47).

the changes to warrant a change to their operation (**Table 7.14**), reflecting that the climatic changes included in the future scenario are often of greater magnitude than those perceived by survey respondents in the recent past. Unlike past changes, the main reason a few farmers did not adjust to the future scenario is that they felt that they stand to benefit from climatic change without changing their operation. This suggests that the future scenario presents a climate regime in many ways more favorable to agricultural activities than previous climatic changes experienced. The majority of farmers plan to switch crop types and varieties in response to the future scenario. Some farmers would plan to adopt several new types of crops, while others would adjust varieties of their

Table 7.14: Comparison of Adjustments to Recent Perceived Climatic Changes ¹ and Future Scenario ²

Change/Reasons	Recent Climatic Changes	Future Climate Scenario
No. of Farms Reporting Adjustments	24	51
Common Types of Adjustments (No. of times made):		
Switch crop types/varieties	5	59
Harvesting/planting times	5	10
Harvesting/planting techniques	5	1
Livestock management	4	5
Irrigation/drainage	2	5
Common Reasons for Adjustments (No. of times given):		
More productive	11	62
Spread risks	7	5
Minimize weather-related damages	6	3
More efficient	4	16
Access new markets	0	5
No. of Farms Reporting No Adjustment	23	7
Common Reasons for No Adjustment (No of times given):		
Farm not sensitive enough to changes	13	1
Cannot afford cost involved	4	0
Cannot afford risk involved	2	1
Stand to benefit as is	0	3

¹ Among survey respondents who had perceived climatic changes to have occurred in their area in the last 20 years (n=47).

² Among all survey respondents (n=58). For a description of the future climate scenario, see **Appendix A**, Q. 24.

current crops in order to take advantage of the increased heat units associated with the climatic change scenario.

Some farmers also plan to change harvesting and planting times under the scenario, but very few plan to change their harvesting and planting techniques. Changes to these techniques were more popular for past climatic changes, reflecting that these changes are sometimes more reactive in nature than consciously planned. For instance, in response to past climatic changes, some farmers began wrapping hay following an experience where heavy rains damaged the crop the previous year. Another explanation why fewer farmers plan to change harvesting techniques for the future scenario despite the heavier precipitation regime is that most farmers have already adapted their harvesting techniques (i.e. most now wrap their hay) to the point that there is little that can be done to improve this aspect of crop management.

Reasons for adjustments to the future scenario and past climatic changes differed in a few ways. Farmers often made adjustments in response to recent climatic changes in order to minimize damages resulting from the perceived new climatic conditions, but this was rarely a reason for changes under the future scenario. Again, this suggests that the future scenario is perceived to offer conditions more favorable to agricultural activities than the current climatic regime.

Another difference is that farmers sometimes plan to make changes for the future scenario in order to access new markets, but this was never mentioned as a reason for change for past climatic changes. For some farmers, effects of the future scenario on agricultural markets were prominent in their minds when deciding how to adjust to the

new climate regime. While many planned to expand production of the crops experiencing the largest yield increases under the new scenario (e.g. corn, soybeans), others believed that if these crops were to experience large yield increases that the number of farmers growing them would increase, diminishing their value on the market. Therefore these farmers would choose to start growing crops that showed modest yield increases but which they felt would not be produced by the majority of farmers (e.g. oats and wheat), assuming favorable market conditions.

Although adjustments to the future scenario were prompted by a variety of factors, it is clear that economic motives including the marketability of products, crop productivity and efficiency are very prominent in the minds of these decision-makers. In this respect, adjustments to the future scenario are very similar to those for past climatic changes.

7.6 Crucial Information for Adjusting to Climatic Change

7.6.1 Overview

In addition to indicating the adjustments they would make to a climatic change scenario, RMOC survey respondents were asked to assess the extent to which a range of information would help farmers in the region adjust to future climatic changes. The types of information farmers were asked to rate included climatic change impacts on agricultural activities, farm-level adaptation options, and climatic change forecasts at different scales.

While farmers felt that many types of climatic change information would be

helpful, they expressed distinct preferences for certain types of information. These farmers cautioned against extensive research being done in all areas. Rather, they felt that it would be prudent to target climatic change research to a few select areas that would enhance their capacity to understand and respond to climatic change.

7.6.2 Climatic Change Forecasts

RMOC farmers' rating of the utility of climatic change forecasts demonstrates the importance of the scale at which these forecasts are delivered. While approximately one-third of farmers felt that sub-provincial forecasts (i.e. at the regional level) would be a crucial type of information for adjusting to future changes in climate, very few felt that forecast information would be crucial at broader scales (e.g. provincial, national) (**Fig. 7.3**). The small group of farmers who felt national level forecasts would be crucial mentioned that they would use the forecasts to monitor how climatic change might affect competing producers in different parts of the country (especially western Canada) in order to estimate the effects of climatic change on agricultural markets. Some would also use forecasts at the national or provincial scales to estimate how they would be affected by prevailing weather systems moving in from the west and affecting farmers in the RMOC. However, the number of farmers who would consider forecasts at these scales to be crucial for adjusting to climatic change are in the minority. Given the difference in farmers' ratings of forecasts across different scales, it is clear that the scale of these forecasts is very important to farmers. Some suggested the need for forecasts at scales even lower than the sub-provincial level, given considerable local variation in weather patterns.

Figure 7.3: Number of Farmers Rating Forecast Information as Crucial for Adjustment to Future Climatic Change:

7.6.3 Climatic Change Impacts on Agricultural Activities

Few farmers rate information about the impact of climatic changes on current agricultural activities as crucial to their adjustment to climatic change (**Fig. 7.4**). Of those expressing concern about climatic change related impacts, many are concerned about the impact of warming temperatures on agricultural pests and diseases, and about 25% of farmers felt that information about this aspect of livestock and crop management would be crucial. A few of these farmers were particularly sensitive to this aspect of farm management because of previous experiences, where extended hot periods had significant effects on the number and types of pests on their farm. Few farmers would

Figure 7.4: Number of Farmers Rating Climatic Change Impacts Information as Crucial for Adjustment to Future Climatic Change

consider information about impacts on other agricultural activities to be crucial. While most believe that information about how climatic change might affect their current activities is helpful, many farmers in the RMOC feel that their own experience would be more important in assessing the impacts of changed weather patterns on various farm activities.

7.6.4 Information on Adaptation Options

Information about adaptation options for adjusting to climatic change is considered the most important type of information among those discussed (Fig. 7.5). The type of information considered most crucial by farmers is information on marketing programs designed to take advantage of new agricultural opportunities arising from

Figure 7.5: Number of Farmers Rating Information About Adaptation Options as Crucial for Adjustment to Future Climatic Change

climatic change. Information about new crop varieties possible under a changed climate is considered slightly less important. Many farmers commented that information about the latest developments in crop varieties and genetics is readily available from commercial seed companies, so there is little need to duplicate this area of research. Farmers expressed similar feelings about information on technological responses to climatic change, since machinery manufacturers provide farmers with a wealth of information about new technologies and equipment. One other area that farmers feel would be important is information about the kinds of programs and subsidies to expect that would assist farmers coping with climatic change. Given a recent history of declines in the amount of subsidies available however, many farmers surveyed were pessimistic

about the kind of subsidies to expect.

7.7 Summary

This chapter has examined a wide range of topics concerning survey respondents' perceptions and responses to both past and potential future climatic changes. Several important themes emerge which help to explain how changes in climatic conditions affect decisions on RMOC survey respondents' farms. These include the ways in which individual farmers' sources of weather information and basic farm characteristics, including current sensitivities to climate, all influence how climatic changes are perceived and responses implemented.

Many farms in the RMOC rely on radio and television as primary sources of weather information, but some farmers also use their own experience in evaluating possible changes to weather conditions. Survey respondents farms are also very similar in that, for many of them, the most sensitive aspect of the farm to weather conditions is crop harvesting, particularly that of hay. Because of the need for adequate amounts of rainfall during the growing season and the need for a dry period lasting several days at harvest time, survey respondents felt that the amount and timing of precipitation were two climate properties exerting the most influence on their decisions. Due in part to this sensitivity, many survey respondents were aware of rainfall patterns (including very localized patterns) and past changes to the precipitation regime. The majority felt precipitation patterns had changed in the last 20 years and reported a wide range in the types of changes occurring.

Another theme emerging from this chapter is the importance of the degree of climatic changes experienced before adjustments at the farm level are undertaken. While a large majority of farmers perceived recent climatic changes to have occurred, only about half of these farmers made any sort of adjustment in response to these changes. For the future climatic change scenario, however, a large majority indicated they would plan several adjustments, most often including the adoption of new crop types and varieties. Differences in the level of response to past changes and the future scenario, while in part a result of the differing nature of the changes, also show that changes to agro-climatic properties must reach a certain threshold, measured against a number of economic and social costs to the farmer, before any significant change to the farm system is warranted. Many farmers believed their farm was simply not sensitive enough to the past climatic changes they described to provoke a response. While some adjustments would undoubtedly result in marginal improvements in production or efficiency, the cost of the adjustment would prohibit change (e.g. building new storage space, purchasing new harvesting equipment). Even when farmers felt a change was warranted, some farmers were unable to implement the change because of its cost or the level of risk associated with that activity. These findings demonstrate that adjustment to climatic change does not simply entail making adjustments best suited to the new climatic regime, but rather requires a balancing of the opportunities and risks associated with the changed climate with other factors. This paper proposes that much can be learned about the nature of these other factors by close examination of the reasons for past and planned future changes on the farm independent of climatic change (see **Chapter 5**).

RMOC survey respondents' evaluation of the utility of different types of information for adjusting to climatic change reveals important points about which factors concern farmers most about future climatic change, and possible strengths and weaknesses in the farming community's current capacity to cope with climatic change. The type of information RMOC farmers feel is most crucial for their adjustment is information about marketing programs to take advantage of new opportunities associated with climatic change. The fact that this type of information is considered most crucial suggests that some farmers are not so much concerned with specific changes to crop yields, seeding dates or other agricultural activities which may be affected by climatic change, but most importantly they want to know what kind of market will be available for commodities they produce under a future climate. Although many farmers were pessimistic about the types of programs and subsidies to expect for adjusting to climatic change, this information is also considered more crucial than many other kinds of information that could be made available. The preference for these types of information highlights the fact that many farmers feel the success of their livelihoods depends more on the economic and political environment in which agriculture operates than changes and improvements in many on-farm activities.

The farmers' evaluation of different types of information also reveals aspects of agriculture and climatic change to which the farming community is already quite capable of adapting. For instance, some survey respondents believe that information about new crop varieties possible under a changed climate would be of little help since seed companies currently provide farmers with information about crop varieties which may be

grown in the region. Many also feel that information about adaptation options involving technological responses would not be critical for their adjustment to climatic change since equipment manufacturers keep farmers up to date with recent technologies. Therefore, for certain activities the agricultural community appears inherently capable of adapting to climatic change, while for other activities its access to information is more restricted. An evaluation of those areas for which the agricultural community already has access to information is an important step before prescribing specific research programs designed to help farmers adjust to climatic change.

This chapter has provided a regional perspective by identifying broad trends in RMOF farm sensitivities, perceptions and responses to climatic changes, both past and future. This does not suggest that RMOF farmers are a homogeneous group, likely to be affected similarly by climatic change. Rather, the chapter has revealed a mosaic of perceptions of past climatic changes, plans for adjustments to climatic change, and sensitivities to weather that are sometimes unique to individual farms. Therefore, the next chapter provides a comparative assessment of climatic change perception and response between highly capitalized livestock (G2) farms and lower-income (G3) farms, in an effort to explore how farms in the RMOF may be differentially affected by climatic change.

CHAPTER 8: COMPARATIVE ASSESSMENT OF CLIMATIC CHANGE PERCEPTION AND RESPONSE ON HIGHLY CAPITALIZED LIVESTOCK (G2) AND LOWER INCOME (G3) FARMS

8.1 Introduction

Chapter 7 provided a regional perspective of perception and response to recent climatic changes and a future climatic change scenario for all RMOC farmers surveyed. This analysis helped establish the context in which farm-level adjustments to climatic changes are made, and in so doing has suggested that decisions regarding the types of adjustments made are influenced by a complex mix of factors, some of which are potentially unique to individual farms. Clearly, farmers in the RMOC are not a homogeneous group and are likely to be affected by, and to react to, climatic changes in different ways. This chapter expands on the previous analysis by comparing perceptions of and responses to climatic change by highly-capitalized livestock (G2) farms and lower income (G3) farms. This chapter aims to distinguish the extent to which farms in the RMOC may be differentially affected by climatic change.

In some respects, perceptions and responses to climatic changes identified by G2 and G3 farmers are very similar. These similarities help illustrate aspects of climatic change which concern both groups of farmers, and in this sense present challenges which are most universal to the agricultural community adapting to climatic change. However, there are also rather subtle, and sometimes more pronounced, differences in the way in which climatic changes are perceived and the way in which different farmers are capable of responding. These differences are important because they suggest that the most

effective means of responding to climatic change will tend not to be universal in nature. Rather, they must take account of differences in farm sensitivities as well as the resources and abilities of different types of farms responding to climatic change.

8.2 Comparative Assessment of RMOC Farmers' Sources of Weather Information

The highly-capitalized livestock farmers (G2) and those with lower income operations (G3) used similar sources of weather information (**Table 8.1**). The primary sources for farmers in both groups consist of radio and television. Radio was a slightly more popular source among G2 farmers, while television and the phone-in weather information service were more popular among G3 farmers. Reasons for these differences are not known, although it is possible that the popularity of radio sources among G2 farmers rests with its easier accessibility while working full-time on the fields (e.g. tractor radio) or in farm buildings.

G2 farms are predominantly livestock operations, and it is clear that many G2 farmers use weather information for harvesting and seeding of their feed crops. Weather information was also used mainly for cropping decisions on G3 farms. This similarity is not surprising since the majority of farmers in the RMOC considered their cropping practices to be more sensitive to weather than livestock production or management (see **Section 7.3.2**).

Table 8.1: Sources of Weather Information: G2 and G3 Farms

Source:	No. of Farms Using Source:		Type of Decision Most Often Used For (No. of farms):	
	G2	G3	G2	G3
Radio	24	21	harvesting (15)	cropping/seeding (13)
Television	18	24	harvesting (12)	cropping/seeding (15)
Phone Service	12	17	harvesting (11)	harvesting (13)
Newspaper	7	7	cropping/seeding (5)	harvesting (4)
Farm Paper	7	5	cropping/seeding (3)	cropping/seeding, livestock mgt. (2)
Almanac	3	4	harvesting (2)	other ¹ (5)
World Wide Web	2	0	cropping/seeding, harvesting (1)	N/A
Other Sources	4	9	cropping/seeding (2)	harvesting (6)

¹ Refers to use in decisions other than those involving cropping/seeding, harvesting, livestock or land management.

Sample size: G2, n=27; G3, n=28

8.3 Comparative Assessment of RMOC Farm Sensitivities to Weather and Climate

One of the major differences between the two subsets of farms is farm type, with G2 farms being predominantly livestock operations and G3 farmers operating a wider range of enterprise types and often more diversified forms of agriculture. Because of these differences, one might expect farmers in the two groups to identify different sensitivities to the current climate. However, the two groups identified sensitivities that

are very much alike (**Table 8.2**).

Both groups felt that the May-October period was most critical for having reliable weather information. The only difference between the two subsets of farmers in this regard was that a very small number of G3 farmers felt that winter months (i.e. December through February) were a critical period, while no G2 farmers felt this way. This difference probably reflects those G3 farmers with specialty operations such as maple syrup which are affected to a greater extent by winter weather conditions than other types of agriculture commonly found in the RMOC.

Hay crops were identified as the most common sensitive activity by G2 and G3 farmers, and this is especially important given that hay crops continue to be the dominant crop produced in the RMOC (see **Sec. 3.5.3**).

Both groups of farmers felt that the amount and timing of precipitation were climate properties exerting the greatest influence on their decisions. In light of the fact that the quality of hay crops can be diminished significantly by rainfall at harvest time (see **Section 7.3.2**), and that farmers in both groups identified hay as their most important sensitivity, it follows that they are most concerned with the precipitation levels and timing. G2 and G3 farmers were also similar in their identification of other climate properties influencing farm decisions (i.e. amount of sun and heat).

The findings presented in this section suggest that the activities most sensitive to climate are shared by farmers in both groups, even though the basic characteristics of G2 and G3 farms are different. Many G3 farmers produce hay crops for sale to larger livestock operators, while G2 farmers often do not sell their hay crop but rather use it as

Table 8.2: RMOF Farm Sensitivities to Weather and Climate: G2 and G3 Farms**8.2 (a) Critical Months for Reliable Weather Information**

Critical Months for Reliable Weather Information (No. of Farms Identifying):												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
G2	0	0	0	5	24	24	24	20	17	15	7	0
G3	3	3	1	7	17	27	25	22	13	10	7	2

8.2 (b) Aspects of Farm Most Sensitive to Weather Conditions

Aspect of Farm Most Sensitive to Weather (No. of Farms Reporting):		
Aspect of Farm Operation:	G2	G3
Hay	17	21
Crops (generally)	12	0
Crops - quality	3	4
Livestock - productivity	2	6
Crops - productivity	3	4
Crops - management	2	1
Other	0	3

8.2 (c) Climate Properties Influencing Farm Decisions

Climate Properties Most Influencing Farm Decisions (No. of Farms Reporting):		
Climate Property:	G2	G3
Precipitation - amount	16	20
Precipitation - timing	10	12
Sun/heat - amount	10	8
Wind	3	4
Sun/heat - timing	3	2
Other	3	6

Sample size: G2, n=27; G3, n=28

an input for their own livestock production systems. G2 operators often do not obtain an income directly from the sale of hay as a cash crop, but seasonal variations in climate over the recent past have sometimes significantly improved or diminished the quality of their feed, thereby affecting the overall efficiency of their livestock systems. Thus the sensitivity of hay crops may be just as important to G2 farmers as it is for many G3 farmers producing hay for sale on agricultural markets. Those likely to be most affected by changes in the productivity of hay crops, however, are the G3 farmers who produce hay as their primary source of income. Four farmers in this group depended on the sale of hay crops for more than 50% of their 1997 agricultural sales.

8.4 Comparative Assessment of Recent Climatic Change Perception

8.4.1 Overview

G2 and G3 farms were very similar with respect to their observations about the level of climatic changes occurring over the last 20 years. In fact, both groups felt that temperature and precipitation changes were most common, followed by changes to weather predictability and extreme events. The only notable difference in terms of the types of changes reported was that G3 farmers tended to report more changes to “other climate properties” than G2 farmers (**Table 8.3**). Most prominent here were observed changes to wind patterns and strength, properties which may affect farmers who depend on cash crops more significantly than the livestock operators. Wind sometimes affects the precision of crop and herbicide spraying activities on their farms, and these farmers

Table 8.3: Overview of Climatic Change Perception on G2 and G3 Farms

Has climate changed in your area in the last 20 years?			Type of Change (No. of Farms Reporting)		
	G2	G3	Change to:	G2	G3
Yes	23	21	Temperature	23	19
			Precipitation	19	18
			Extreme Events	17	17
			Weather Predictability	17	18
			Heat Units	14	14
			Frost-Free Days	12	13
			Other Climate Properties	6	14
No	2	5			
Not Sure	2	2			

Sample size: G2, n=27; G3, n=28

were more cognizant of the effects of changed wind patterns. Some farmers affirmed this idea by suggesting that they really only notice changes to those climate properties directly affecting their operation.

Although the number of G2 and G3 farms reporting changes to specific climate properties (e.g. temperature, precipitation, extreme events) were very similar, sometimes these farmers differed in their perceptions of the nature of changes to these properties. The sections which follow provide a more detailed comparison of the types of changes reported for each climate property across G2 and G3 farms.

8.4.2 Perceived Temperature Changes

G2 and G3 farmers' perceptions of temperature changes were quite similar, as those reporting change felt that temperatures were increasing on the average (**Table 8.4**).

Table 8.4: Temperature Changes Reported on G2 and G3 Farms

Change (No. of Farms Reporting)	G2	G3
Average temperature - increase	8	7
Average temperature - decrease	0	0
Summer temperature - increase	2	3
Summer temperature - decrease	2	3
Winter temperature - increase	9	3
Winter temperature - decrease	0	1
Temperature becoming less predictable	3	1
Other changes	2	0
No change to temperature	4	7
No opinion	0	2

Sample size: G2, n=27; G3, n=28

However, many more G2 farmers believed winter temperatures had increased compared to those in G3. These G3 farmers seldom offered opinions on whether winter temperatures had changed, but did feel that yearly average temperatures had increased as often as G2 farmers.

8.4.3 Perceived Precipitation Changes

G2 and G3 farms both reported a wide range of changes to precipitation in their area over the last 20 years (**Table 8.5**). Since precipitation levels have tended to exert the most influence of any climate properties on farm-level decisions in the RMOC (see **Sections 7.3.2** and **7.3.3**), G2 and G3 farmers alike paid particular attention to any trends or changes they observed in precipitation levels and the timing of rainfall.

A slight difference in the perceptions of change among the two groups is that more G2 farmers reported decreases in winter snowfall. This difference makes sense

Table 8.5: Precipitation Changes Reported on G2 and G3 Farms

Change (No. of Farms Reporting)	G2	G3
Total precipitation- increase	6	5
Total precipitation - decrease	3	2
Timing - more evenly dispersed	0	1
Timing - less evenly dispersed (more erratic)	6	6
Winter snow - decrease	8	4
Other changes	0	3
No change to precipitation	7	9
No opinion	1	1

Sample size: G2, n=27; G3, n=28

given the number of G2 farmers who believed winter temperatures have been on the rise in their area (see **Section 8.4.2**), tending to produce more rain as opposed to snowfall.

8.4.4 Perceived Changes to Extreme Events

Some farmers provided considerable detail about changes involving specific kinds of storms in their area. Given the range of storms reported on, it is difficult to compare the responses of G2 and G3 farmers with respect to specific storm types. However, G2 and G3 farmers reporting these changes concurred that storms were generally increasing, in terms of both frequency and intensity (**Table 8.6**).

Table 8.6: Changes to Extreme Events, as Reported on G2 and G3 Farms

General Changes (No. of Farms Reporting)	G2	G3
Events generally - more frequent	4	4
Events generally - less frequent	0	0
Events generally - more severe	1	1
Events generally - less severe	0	0
No change to extreme events	8	10
Changes to Specific Events ¹ (No. of Farms Reporting)	G2	G3
Dry events - more severe	3	2
Ice storms - more severe	5	2
Dry events - more frequent	4	3
Wet events - more severe	2	3
Hail - more frequent	4	1
Ice storms - more frequent	2	3

¹ Only those changes most often identified are included.

Sample size: G2, n=27; G3, n=28

8.4.5 Perceived Changes to Weather Predictability

Most farmers in each group felt that weather predictability had changed over the 20 year study period. Of those reporting changes, opinion was sharply divided among both G2 and G3 farmers, with some feeling that weather had in fact become more unpredictable while others disagreed (**Table 8.7**).

Table 8.7: Changes to Weather Predictability, as Reported on G2 and G3 Farms

Change (No. of Farms Reporting)	G2	G3
Weather becoming more predictable	2	0
Weather becoming less predictable	14	13
No change to weather predictability	9	8
No opinion	1	2

Sample size: G2, n=27; G3, n=28

8.4.6 Perceived Changes to Heat Units

Recent changes to Corn Heat Units (CHUs) were reported by fewer than half of the RMOC farmers surveyed. Farmers who did report changes tended to believe that heat units were increasing (**Table 8.8**). One difference between G2 and G3 farmers was that fewer G3 farmers had an opinion on whether heat units had changed. Some of these farmers mentioned that they are smaller operators who felt little need to keep track of heat units, and a few were also unfamiliar with the CHU measure.

Table 8.8: Changes to Heat Units, as Reported on G2 and G3 Farms

Change (No. of Farms Reporting)	G2	G3
Increased Heat Units	11	7
Decreased Heat Units	1	0
Other changes	1	1
No change to Heat Units	12	9
No opinion	1	5

Sample size: G2, n=27; G3, n=28

8.4.7 Perceived Changes to Frost-Free Days

Few farmers in either group were confident that the number of frost-free days were increasing, and fewer still believed that they had decreased (**Table 8.9**). This is not to say that RMOC farmers have not been cognizant of the frost-free season, for the length and timing of the season are very important to the cropping practices of farmers in both G2 and G3. Rather, many farmers in each group noted year-to-year changes in frost-free season length, but did not feel that these changes were part of a long-term trend.

Table 8.9: Changes to Frost-Free Days, as Reported on G2 and G3 Farms

Change (No. of Farms Reporting)	G2	G3
Increase in number of frost-free days	9	7
Decrease in number of frost-free days	2	0
Arrive earlier in season	0	1
Finish later in season	3	0
No change to frost-free days	13	13
No opinion	2	2

Sample size: G2, n=27; G3, n=28

8.5 Comparative Assessment of Adjustment to Climatic Change

8.5.1 Recent Climatic Changes

In the RMOC, farm-level adjustments to climatic changes have taken on several forms and so too have the motivations for these changes. The previous chapter demonstrated that whether or not adjustments to climatic changes were initiated depended on the interplay of many factors, including individual farmers' perceptions of climatic changes and their ability or capacity to respond. Although an approximately

equal number of farmers with highly-capitalized livestock operations and lower-income farms perceived climatic changes to have occurred in their area over the last 20 years (23 G2 farms compared with 21 G3 farms), the number of farmers actually making a change in farm practice in response to climatic changes differed substantially. In fact, nearly twice as many G2 farmers were active in adjusting to past climatic changes than G3 farmers (**Table 8.10**).

Adjustments to recent climatic changes typically involved changing crop production and management, and it is in these areas that G2 farmers were much more active than those in G3. These farmers sometimes changed their harvesting times and techniques in order to adapt to past climatic changes. They also changed planting practices and on some occasions changed the varieties of crops grown. The motivations for many of these G2 farmers were to boost the productivity of their crop systems, spread risks and minimize damage to crops associated with recent changes in the climate. The only farmers in this group who did not implement a response were those who felt that their farm was not sensitive to the climatic changes they identified.

While many G3 farmers felt equally sensitive to recent climatic changes, these farmers operate at a smaller scale where it does not always make sense to change production and management practices (e.g. adopting new harvesting techniques requiring the purchase of additional equipment) in order to recover or improve production in response to changes in climate. In fact, some G3 farmers indicated that they could not afford the cost associated with making changes even if these changes might improve

Table 8.10: Recent Adjustments to Climatic Changes Made on G2 and G3 Farms ¹

Change/Reasons	G2	G3
No. of Farms Reporting Adjustments	15	8
Common Types of Adjustments (No. of times made):		
Switch crop types/varieties	3	2
Harvesting/planting times	4	1
Harvesting/planting techniques	5	0
Livestock management	0	3
Irrigation/drainage	0	1
Common Reasons for Adjustments (No. of times given):		
More productive	5	4
Spread risks	4	3
Minimize weather-related damages	4	1
More efficient	2	1
Access new markets	0	0
No. of Farms Reporting No Adjustment	8	13
Common Reasons for No Adjustment (No of times given):		
Farm not sensitive enough to changes	7	4
Cannot afford cost involved	0	3
Cannot afford risk involved	1	0
Stand to benefit as is	0	0

¹ Among survey respondents who had perceived climatic changes to have occurred in their area in the last 20 years (G2: n=23; G3: n=21).

productivity on their farm. Therefore, while many G3 farmers recognized the merit in implementing adjustments to recent climatic changes, some of these lower-income farmers found potential adjustments to be inhibited by their costs.

8.5.2 Adjustment to Future Climatic Change Scenario

Responses to the future climatic change scenario were very different from recent climatic change adjustments in that both G2 and G3 farmers plan to be very active. A large majority of farmers (25 in each group) would plan adjustments, including switching

crop types and varieties and changing planting and harvesting times (**Table 8.11**). Many farmers planned several adjustments. Farmers in each group were motivated mainly by a desire to increase the productivity of their cropping under the new climatic scenario. A longer frost-free season, and higher precipitation levels and heat units were important factors to both groups of farmers in making plans designed to improve crop production.

While the nature of the planned changes among the two subsets of farms are quite similar, G2 farmers planned a greater number of changes. G3 farmers typically felt that they would make one or two changes while many G2 farmers planned several changes, especially those involving switching crop types and varieties, and changing harvesting and planting times. These farmers also expressed a greater number of reasons for making changes, especially those of improving production and efficiency. This finding is consistent not only with reasons for responses to past climatic changes but also for recent adjustments independent of climatic change (see **Section 6.3**). Overall, the higher level of change and number of reasons prompting change may reflect the more complex decision-making structure found on G2 farms.

Table 8.11: Adjustments to Future Climatic Change Scenario on G2 and G3 Farms

Change/Reasons	G2	G3
No. of Farms Reporting Adjustments	25	25
Common Types of Adjustments (No. of times planned ¹):		
Switch crop types/varieties	29	20
Harvesting/planting times	8	0
Harvesting/planting techniques	0	0
Livestock management	2	2
Irrigation/drainage	2	0
Common Reasons for Adjustments (No. of times given ¹):		
More productive	29	18
Spread risks	2	1
Minimize weather-related damages	3	0
More efficient	8	4
Access new markets	1	3
No. of Farms Reporting No Adjustment	2	3
Common Reasons for No Adjustment (No of times given):		
Farm not sensitive enough to changes	0	1
Cannot afford cost involved	0	0
Cannot afford risk involved	0	0
Stand to benefit as is	2	0

¹ Note: The number of adjustments planned and reasons for adjustment sometimes exceed the total number of farms making changes. In some cases, several adjustments and reasons for adjustment were mentioned by individual farmers, and these were all recorded.

Sample size: G2, n=27; G3, n=28

8.6 G2 and G3 Farmers’ Evaluation of Crucial Information for Adjusting to Climatic Change

Groups G2 and G3 are broadly similar in the way they evaluate the utility of different types of information relative to one another for adjusting to climatic change. For example, with respect to climatic change forecasts, both subsets of farmers feel strongly that sub-provincial forecasts would be considerably more helpful than forecasts at provincial or national levels (**Fig. 8.1**). However, some G3 farmers do feel that forecasts at these broader scales would be crucial for farmers’ adjustment to climatic change in the RMOC region. Since these farmers tend to be more dependent on cash

Fig. 8.1: Number of G2 and G3 Farmers Rating Forecast Information as Crucial for Adjustment to Future Climatic Change:

crops for an income than the predominantly livestock farmers in G2, some expressed concern about prevailing weather systems moving in from western Canada and affecting their crops, as well as the impact of climatic change on competing western Canadian crop producers.

G2 and G3 farmers held similar views about the utility of climatic change impacts information for RMOF farms (Fig. 8.2). Both tended to feel that material on how climatic change might affect agricultural pests and diseases, international trade and farm-level economics were the most valuable types of information that could be provided in this area. An important difference is that overall, G3 farmers tended to find this information more crucial than G2 farmers. For example, G3 farmers were much more

Fig. 8.2: Number of G2 and G3 Farmers Rating Climatic Change Impacts Information as Crucial for Adjustment to Future Climatic Change

concerned with impacts on pests and diseases, in part because of their more diversified crop base which introduces the possibility of a wider range of pests than those affecting predominantly livestock operators. It is also not suprising that G2 farmers tended to be less concerned with information about international trade impacts given their more secure “local” markets compared to G3 farmers who often produce cash crops for export.

With respect to climatic change adaptation options, the two subsets of farms provided a similar evaluation in that they agreed that information about marketing programs was most important, followed by information on programs and subsidies, and new crop varieties which would out-perform current varieties given climatic change (**Fig. 8.3**). Here again, however, the two groups of farms differed in that G3 farmers tended to

Fig. 8.3: Number of G2 and G3 Farmers Rating Information About Adaptation Options as Crucial for Adjustment to Future Climatic Change

view this information as being considerably more crucial than most G2 farmers.

In summary, G2 and G3 farmers were very much in agreement about the types of information they considered most critical. However, the subsets of farms consistently differed in that G3 farmers tended to consider information of all types to be more helpful for farm-level adjustment than G2 farmers. This perhaps reflects a difference in how G2 and G3 farmers use available information. G2 farmers are larger operators who often rely more on their own experience in making important decisions, than using agricultural trends in the wider community as a source of information (see **Section 4.4.1**).

Conversely, many G3 farmers have less agricultural experience and therefore might be more inclined to consult outside sources for information when making decisions.

Other reasons why G3 farmers expressed a greater need for different types of information may include the fact that they operate more diversified forms of agriculture than many G2 farmers, who represent a fairly homogeneous group with respect to basic farm characteristics. Some of these G2 farmers may also feel less need for climatic change impacts information because of the security offered by milk quotas designed to guarantee returns, and their more localized markets compared to G3 farmers who produce cash crops which must compete internationally.

8.7 Summary

For both highly-capitalized livestock and lower-income farmers in the RMOC, responses to climatic changes are influenced by their sources of weather information, perception of climatic changes, and farm sensitivities to climatic conditions. Many of

these perceptions and sensitivities are shared, and as such demonstrate areas where the agricultural community as a whole is most vulnerable to climatic changes, as well as those areas where significant opportunities arise from climatic change. For example, farmers in both groups identified that hay crops were the aspect of their farms most sensitive to weather conditions. Changes in the timing and amount of rainfall have sometimes diminished the quality of the hay harvest, and farmers in both groups are therefore very attentive to any changes they observe in precipitation patterns. With respect to potential future climatic changes, farmers in each group are also quick to recognize opportunities to take advantage of extended growing seasons and more favorable cropping conditions generally, by changing crop varieties and sometimes planning to include an additional hay cut. These options are not unique to a select group of farmers but rather present opportunities which are recognized by most farmers in the RMOC region.

The responses of G2 and G3 farmers also show, however, that different types of farms differ in their capacity to adjust to changing conditions. The nature of these adjustments are first influenced by the way in which climatic changes are perceived. Although G2 and G3 farmers were similar in their views about which climatic properties had changed the most, they differed in their perceptions of the nature of some of these changes. Although it is difficult to account for differences in the perception of climatic changes from farm to farm, what is of particular consequence as far as adjustments to climatic change are concerned is the observation by some farmers that they really only notice (and sometimes, respond to) changes to those climatic properties most directly

affecting their operation. Therefore changes to climatic properties not seen to directly affect current on-farm activities are often not monitored.

G2 farmers tended to be more active in responding to both past and potential future climatic changes, and often indicated that they had more reasons for making these changes (e.g. to improve both production and efficiency) than G3 farmers. When G2 farmers did not make changes, it was often because they felt their farms were not sensitive enough to the climatic changes, while for some G3 farmers the cost of implementing adjustments was an issue preventing change.

These differences hold important implications for the way in which different farmers perceive climatic changes as a threat to their current agricultural activities, and in the way they recognize climatic changes as an opportunity for agricultural change. In this sense, they reflect how different types of farms vary in their capability to respond, largely from an economic perspective but from a social one as well. Some G3 farmers did not have the financial resources to make adjustments to recent climatic changes even though they recognized that these adjustments were potentially effective responses to the changed climate. From a social standpoint, some of these farmers are also less experienced than those in G2 and felt that information about climatic change forecasts, impacts and adaptation options for their farm would be crucial for adjusting to climatic change. G2 farmers felt more comfortable balancing this information with their own experience and judgement.

These differences in perceptions and responses emphasize that climatic change has the potential to affect different types of farms in different ways. Farmers seeking

effective means of coping with climatic change must take account of their own enterprise characteristics, goals, and available resources to implement specific kinds of adjustments. This does not mean that these farmers do not share many challenges and opportunities with respect to climatic changes, but rather it shows that decisions to implement changes are influenced by the interplay of several factors (e.g. farm type, perception of climatic changes, ability to take on economic and social costs and risks) which work together to determine whether adjustments are appropriate at the single farm level.

CHAPTER 9: SUMMARY OF RMOC CASE STUDY AND RECOMMENDATIONS FOR ADVANCING CLIMATIC CHANGE AND AGRICULTURAL ADAPTATION RESEARCH

9.1 Research Summary

9.1.1 Research Problem and Purpose

This thesis began by outlining approaches used to investigate relationships between climatic change and agriculture. Traditional approaches modelled the impacts of climatic change on agricultural systems in one direction. Forecasted changes to the physical environment and climatic properties important to agriculture were the usual starting point, and this information was then used to derive impacts on agriculture at different scales.

This thesis argued that in order to understand the implications of climatic change for farmers, it was important to study climatic change from their own mindsets (i.e. perception of climatic changes, capacity to respond, importance of other factors in the decision-making environment) as well as impacts on biophysical properties important to agriculture. Such an approach would recognize that the implications of climatic change for agricultural systems stem from a series of physical and human interactions as opposed to impacts measured in one direction only. This approach would draw attention to the way in which climatic change appears to individual farmers, rather than making assumptions about the nature of farm-level adaptation to climatic change. Hence, the overall purpose of this thesis has been to situate climatic change within the broader context of agricultural decision-making. In order to meet this purpose, four interrelated

objectives were specified: to situate the project within contemporary agriculture-climatic change research and agricultural decision-making; to explore farm-level perceptions of climatic change; to enhance understanding of farm-level adaptive strategies; and to explore the influence of climatic information vis-a-vis other information farmers deemed important to their agricultural decisions.

9.1.2 Research Methods

Geographic subfields which have studied agricultural decisions extensively, and which were most relevant to the RMOC study area, included environmental hazards, globalization of agricultural economies, and agriculture in near-urban settings. Although this represents a diversity of topics, these subfields each address:

- the role of perception in the decision process;
- the role of social and personal factors influencing the decision process; and,
- the way in which a farmer's range of choice may be constrained or broadened by the farm's wider environment.

Because these themes were identified as crucial to understanding agricultural decision-making in several contexts, the review concluded that they would also be an important part of any methodology designed to investigate farm-level decision making as it relates to climatic change.

Several methods for investigating agricultural decision-making were employed within the three subfields. This research showed that broad trends and patterns in agricultural decision-making could be deduced from routinely collected data such as an agricultural census, but a thorough understanding of decision-making processes at the

farm level required interviews with individual farm families. Hence, personal interviews became the foundation for this research.

Studies in other geographic subfields also revealed advantages and disadvantages of quantitative and qualitative approaches to social science research. Many of these studies used a combination of direct, quantitative questions designed to gather information efficiently, with more open-ended questions used to delve into conditions and reasons underpinning perceptions and decision-making. In this context, the research methods were developed by viewing quantitative and qualitative techniques to gathering information as complimentary approaches rather than polar opposites.

Seven sections comprised the final questionnaire. Section A gathered background information about basic farm characteristics (e.g. farm type, size) so that the farms could be classified for further analysis. Influences on farm decisions were investigated in Section B, and these helped identify the extent to which farms differed in terms of basic decision-making structures (e.g. number of decision-makers, information sources). The next section helped establish the local agricultural context by asking farmers about recent changes happening to agriculture in the wider region of eastern Ontario. Once the broad regional trends were established, sections D and E focused on past and planned future changes happening on individual farms, and the reasons for these changes. Because one objective of the research was to situate climatic change relative to other forces affecting agricultural decisions, farmers were not asked directly about the influence of climatic changes until Section F. Here they were asked about their operations' climatic sensitivities and their sources and use of weather information. The final section asked

farmers directly about their adjustments to climatic changes which they perceived to have occurred in the recent past and to a future climatic scenario.

Fifty-eight personal questionnaires were administered in the RMOC between 9 March and 6 April 1998. These were selected on a random basis from the population of approximately 1500 farms in the region. After the surveys were completed, the respondents were classified into three groups. G2 (n=27) represents farms which are predominantly livestock operations, with 1997 gross farm sales exceeding \$100,000. G3 (n=28) represents all farms with gross sales below \$100,000, and G1 is used to denote the entire sample. These classifications were developed to enable comparison of RMOC farms in terms of farm characteristics and farm-level change.

9.2 Major Findings

9.2.1 RMOC Farm Characteristics

Differences in the profile of G2 and G3 farms highlighted the fact that agriculture in the RMOC is very diverse, and emphasized relationships between a number of enterprise characteristics and agricultural decisions. G2 farms included in the RMOC study were large-scale livestock operations, operated by several individuals with considerable farming experience, who believed that their farms will continue to be viable operations in the long term. G3 farms were smaller in size, more likely to be part-time operations with rarely more than two people involved in making decisions, and these farmers were often uncertain about the future viability of their operations. The significance of these enterprise characteristics to agricultural decision-making in the

RMOC became most apparent when differences in the types of changes being made were compared between G2 and G3 farms.

9.2.2 Recent and Planned Changes to Agriculture in the RMOC

High levels of change were a feature of most RMOC farms and it is difficult to characterize farms in the region according to the types of changes being made. This diversity demonstrated the wide range in the goals and motivations of individual farmers, and basic differences in farm enterprise characteristics. Despite this diversity, there were some important conclusions that help to describe processes of agricultural decision-making and change in the RMOC.

Although a wide variety of changes were reported, many of them related to the overall goal of improving farm efficiency. Recent on-farm changes often involved expanding farm size and changes to crop and livestock production, and planned changes over the next 1-5 years often reflected the desire to add infrastructure to current systems.

Economic motivations dominated reasons for past and planned future changes, however, agricultural change in the RMOC was rarely the result of a single factor. Many farmers identified several factors prompting each decision, and in some cases the motivations for change were interrelated. For example, while some farmers described their motivations for adding tile drainage to be environmental in nature (e.g. to improve soil quality), they also identified economic motives (e.g. to increase production). To categorize certain types of decisions as being “economic” in nature and others as being “environmental” would oversimplify the decision process. What is clear is that some types of decisions tended to be influenced by a distinct mix of factors. For example, crop management decisions were closely linked with economic and environmental motives,

while labour management decisions tended to relate strongly with both economic and social factors. These were, however, very broad trends and must be taken together with the goals, motivations, and specific enterprise characteristics of individual farmers if agricultural decisions are to be understood.

The comparative assessments of agricultural change on G2 and G3 farms revealed the importance of enterprise characteristics to agricultural decision-making. Farm type, income and operation scale were found to influence the type of change and motivations for change. On the higher income and larger scale G2 operations, farmers were capable of implementing and planning a greater number of changes than most G3 farmers, and were more often motivated by economic factors (especially farm expansion and efficiency) than G3 farmers. Although efficiency was also a strong motive for G3 farmers, improvements in efficiency were sometimes achieved by cutting back or changing livestock and crop types rather than following the expansionary path which was more popular among G2 operators. G3 farmers often did not have the resources to attempt large capital investments and did not make changes as frequently as G2 farmers. Although economic motives were also the strongest push for G3 farmers, they tended to be influenced by a wider range of additional motives (e.g. social, environmental) than G2 farmers. A major conclusion of this research is that farms may differ quite remarkably in their capacity to respond to change. This thesis identified two types of farms existing in the same agricultural region but with many differences in enterprise characteristics, motivations for change, and adaptive potential. These differences stress the importance of studying the pressures on, and capacities of, individual farmers when examining

processes of agricultural change.

Another important conclusion from the analyses of recent farm-level changes in the RMOC was that few farmers identified environmental factors (including weather and climatic changes) as a motivation for past and planned future changes. This suggests that climatic changes are seldom identified as a primary reason for making adjustments to existing systems. Instead, they represent one of many factors including economic, technological, social and other environmental pressures which must be factored into a broader, more holistic context for understanding agricultural decisions.

9.2.3 Climatic Change Perception and Response

The results of this study suggest that the responses of RMOC farmers to climatic changes are shaped by a number of factors, most importantly:

- farmers' perceptions of climatic changes;
- magnitude of the perceived changes;
- basic farm characteristics (e.g. operation scale, income) which influenced individual farmers' capacities to respond, and,
- farmers' own judgements of factors other than climatic change important to agricultural decisions.

Farmers in the RMOC may experience many different types of climatic changes, but this research indicated that perceptions of climatic change (and sometimes responses to) were tied closely to those aspects of climate which directly affected their operation. In this context, farmers did not consider all properties which ultimately define climate and weather, but rather focused on a subset that was important to their specific farm and

agricultural region. The most common types of climatic change perceived were changes to precipitation patterns, the climate property that most directly affects agricultural activities in the RMOC, in particular hay harvesting. Not surprisingly, changes to precipitation were the most common changes to climate reported over the past 20 years.

Whether a response to these perceived changes was warranted depended on several factors, including the degree of climatic changes experienced. A comparison of responses to the perceived climatic changes identified by RMOC farmers and responses to the future climate scenario indicated that the severity of climatic change was one factor determining whether a farm-level response was warranted. Many respondents perceived past climatic changes, but only about half of these farmers made any adjustment in response to these perceived changes. Reasons for not making adjustments included that their existing systems were not sufficiently sensitive to the changes to warrant any adjustment. The future climate scenario employed in this research depicted a set of agro-climatic conditions which were considerably more favorable for the production of RMOC field crops, without any indication of possible changes to other conditions affecting agriculture. Under these conditions, many farmers suggested on-farm adjustments would be warranted and desirable.

Responses to climatic change were also found to relate to a number of basic farm enterprise characteristics, which help shape farmers' capacities to cope with climatic changes. Comparative assessments of G2 and G3 operations showed how farms of different types, scales and income levels varied in their ability to adjust to perceived changes in climate. While farmers in both subsets of farms recognized particular

opportunities and challenges associated with climatic change (e.g. opportunities to grow new higher-yielding crop varieties), certain adjustments depended largely on farm characteristics and available resources. G2 farmers were better positioned and able to introduce infrastructure investments in response to climatic changes that would expand crop production. G3 farmers also recognized these opportunities, but for many of these farmers the costs of these investments, or limitations associated with their farm, prohibited certain adjustments in the past and discouraged plans for large future investments. This comparative assessment of two types of farming in the RMOc suggested that adjustment strategies must take account of individual farm sensitivities, as well as the capacity of these different farms to implement change, before adaptation options can be evaluated.

Climatic change is of course only one part of the decision-making environment facing RMOc farmers, and this survey has demonstrated that whether adjustments were made to climatic changes depended appreciably on other factors that farmers identified as important motives or pressures in their decisions. A main finding of the research is that farmers seldom viewed climatic change in isolation, but decisions regarding whether change was warranted had to factor in the social, economic and political context in which the farm operated as well as the climatic change context. This underscores the importance of studying the reasons for past and planned future changes on the farm independent of climatic change, if farm-level adaptations to climatic change are to be understood.

9.3 Advancing the Research Field

As research into climatic change and agriculture continues to evolve, the importance of incorporating human dimensions of agricultural decision-making into the research has become more apparent. Farmer decisions related to climatic change were once assumed or derived from the results of crop yield or economic models, and often associated with climatic change scenarios in isolation. These studies provided insight into potential threats and opportunities associated with climatic change, and sometimes identified possible adaptation options. But by making assumptions about farmer behaviour, these studies did not place climatic change within the broader context of the forces affecting agricultural decision-making, including farmer perceptions and their own adaptive capacities.

By situating climatic change within agricultural decision-making on RMOC farms, this paper has identified a number of factors other than climatic change important to farm-level decisions. As identified in the previous section, these included economic, technological, social, environmental, and political factors. The total set of factors influencing farmers, and more importantly the way in which these factors play out against one another, need to be understood so that climatic change is placed within the broader context of agricultural decision-making and adjustment. The way in which these factors interact essentially acts as a filter between the perception of climatic changes and ultimately, responses to climatic change. This study found that, for example, climatic changes may encourage adjustments but taken in the context of economic constraints (e.g. available income) or social plans (e.g. family aging, retirement plans, available time), an

adjustment designed explicitly to take advantage of climatic changes may not be warranted. Investigating reasons for not making adjustments is equally important as understanding why farmers have implemented changes. Overall, this research provides a stronger rationale for broadening the context for research into agriculture and climatic change decisions. Future studies evaluating the meaning of climatic change for farm communities will need to explore further which factors influence and interact within the decision making environments of farmers.

One limitation of this study was that it analyzed decisions on two types of farms in one region to a limited number of climatic change scenarios. A systematic study of agricultural decision-making over a wider set of farm types, including those not captured within the RMOC sample (e.g. specialty livestock, fruit and vegetable operations) in the RMOC and studies in other regions would provide a firmer foundation for understanding agricultural sensitivities to climatic change and coping capacity. This could be expanded into identifying those farm types capable of adjusting to climatic change, versus those most at risk.

Another limitation of the research is that understanding farmers' responses to the future climatic change scenario was somewhat restricted in the sense that farmers were unaware of the social, economic and political environment their farms would be operating in when making future plans based on the scenario. Additionally, the climatic change scenario employed in this study portrayed a more favorable physical environment for agriculture. This is in contrast to perceived climatic changes over the previous 20 years. Survey respondents' recollections of previous changes were often less well-defined. To

extend this research, it is critical that the use of climatic change scenarios be expanded in two ways: (1) to detail not only the nature of changes to agro-climatic properties, but also expressing these changes in terms of potential changes to climatic variability and agricultural risk; and, (2) to define scenarios more broadly, and include estimates of potential climatic changes as well as incorporating the social, economic and political context of agriculture. This second point is crucial since many farmers responding to the climatic change scenario in this study expressed a need to know changes in other conditions (e.g. marketability of new crops) before stating what types of adjustments they would plan to implement under a changed climate.

Farmer participation in the research process was a very important element of the RMOC study, and is warranted in other contexts. Direct farmer involvement will help identify those climate properties most relevant to farming decisions (e.g. changes in ranges, climatic variation or extreme conditions versus changes in yearly average conditions often provided in scenarios of climatic change), and define climatic change issues in an agricultural context that is meaningful to farmers. For example, this study found that many farmers in the RMOC are concerned with information about adaptation options, including marketing programs for new crops that may be grown under an altered climate. Information about new crop varieties was deemed to be less important, as this information is readily available within the agricultural community.

Perhaps the biggest strength of farmer participation in climatic change and agriculture research is that it enables the researcher to move beyond identifying adaptation options, and toward assessing the feasibility of different adjustment strategies

from the perspective of farmers themselves. Ultimately, the forces of global change, including climatic change, are perceived and responded to at the local level. Only through greater involvement of the agricultural community will it be possible to identify response strategies that are economically and socially feasible.

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Appendix A: *AGRICULTURAL ADAPTATION SURVEY*

PART A: BACKGROUND INFORMATION

In this section we are interested in obtaining information regarding general characteristics of your farm operation. This will provide us with an overview of your farm and help us classify your farming operation.

1. Please provide a general description of your farm (ie. farm type).

2. How many years has this farm been in your family? _____ years

3. Farm Size (1997)

	Total () ha () ac	Owned () ha () ac () % Tot
Total Area	_____	_____
Area in Crop	_____	_____
Area in Pasture	_____	_____
Area Not Suitable for Crops	_____	_____
Area Tile Drained	_____	_____

4. Approximately what percentage of your 1997 agricultural sales were derived from:

___ Crops (total)	___ Livestock (total)	Other (specify)
___ Corn	___ Dairy	___ _____
___ Soya Beans	___ Beef	___ _____
___ Wheat, Barley, Oats	___ Hogs	___ _____
___ Hay	___ Poultry	
___ Fruits	___ Other Livestock	
___ Vegetables		
___ Other Crops		

5. Please check the category which best describes your operation's **gross farm sales** for 1997.

- ☐ < \$50,000
- ☐ \$50,000 - \$100,000
- ☐ \$100,000 - \$200,000
- ☐ > \$200,000

6. Do members of your family derive income from work outside of this farm?

☐ Yes ☐ No

If yes, what percentage of your **total household income** is obtained from the farm?

_____ %

PART B: FARM LEVEL DECISION MAKING

*In this section we are interested in learning how decisions are made **on your farm** and what factors influence those decisions.*

7. Please identify the principal decision maker(s) on your farm and provide the requested background information for each decision maker.

	Person 1	Person 2	Person 3	Person 4	Person 5
RELATION (Eg. Father, Daughter, Hired Help etc...)					
ROLE IN DECISION MAKING (Please specify, Eg. primary decision-maker, financial advisor etc...)					
AGE					
SEX					
HIGHEST LEVEL OF EDUCATION (High school, college, univ.)					
YEARS ACTIVELY FARMING					
YEARS AT THIS LOCATION					
FARM ORGANIZATION MEMBER (Please specify)					

8. Please rank in order of importance, which of the following sources influence your:

- (a) short-term (day to day, seasonal) decisions and
- (b) long-term (year to year) decisions.

Rank only those factors which contribute to the decision-making **on your farm**. (1 being most important)

Information Sources/Influences	Rank (Short-Term)	Rank (Long-Term)
Input of family members	_____	_____
Input of employees	_____	_____
Farm organizations/groups	_____	_____
Municipal officials & regulations	_____	_____
Agricultural community trends	_____	_____
Broad public trends	_____	_____
What other farmers do and say	_____	_____
Government policies	_____	_____
Media	_____	_____
Other: Please specify	_____	_____

9. Rate the importance of the following factors in influencing farm management decisions over the last ten years made **on your farm**. Check the appropriate box.

Factor	Importance:				
	Not Important	Slightly	Moderately	Extremely	No Opinion
Demand for products					
Cost of labour					
Soil conditions					
Availability of new technologies					
Increases in non-farm rural pop'n.					
Topography					
Commodity prices					
Urban perception of agriculture					
Insurance premiums					
Farming peer pressure					
Cost of production					
Climatic conditions					
Water source availability					
Cost of new technologies					
Off-farm work availability					
Government regulations					
Government incentives					
Other:					

10. When do you plan to retire from farming?

_____ Year or _____ Years from now.

11. Do you think your farm will be viable after you retire?

_____ Yes _____ No

Please explain.

12. Do you plan to pass on your farm to a family member after retirement?

_____ Yes _____ No

If yes, please indicate his/her/their relationship.

PART C: AGRICULTURE IN GENERAL

In this section we are interested in learning how agriculture has changed and adapted over time.

13. In your opinion, what significant changes have occurred in agriculture over the last ten years and describe how these changes have affected agriculture in Eastern Ontario. Please identify beneficial and adverse changes.

14. What do you see as the main opportunities/challenges facing agriculture over the next ten years?

Opportunities:

Challenges:

PART D: FARM LEVEL CHANGES SINCE 1987

*In this section we are interested in how **your farm operation** has changed since 1987, and in learning about the reasons for these changes. To make sure that all changes are recorded, we will ask you to recall changes to:*

- a) crop and livestock production (eg. crop type, acreage)*
- b) farm management practices (eg. land improvements, fertilizer use)*
- c) farm structure (eg. size, capital investment)*

15. Production Changes: Please identify whether there have been production changes on your farm between 1987 and 1997 with respect to:

a) Crop Production ☐ Yes ☐ No ☐ Not Applicable
(e.g. crop type, acreage)

If yes, identify the changes made and reasons prompting those changes?

Change(s)	Year or Time Period	Reason(s)

If no, please indicate why?

b) Livestock Production ____ Yes ____ No ____ Not Applicable
(e.g. livestock type, number)

If yes, identify the changes made and reasons prompting those changes?

Change(s)	Year or Time Period	Reason(s)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

If no, please indicate why?

c) Other Agricultural ____ Yes ____ No ____ Not Applicable
Commodities
(e.g. specialty products: e.g. maple syrup)

If yes, identify the changes made and reasons prompting those changes?

Change(s)	Year or Time Period	Reason(s)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

If no, please indicate why?

16. Management Changes: Please identify whether there have been management changes on your farm between 1987 and 1997 with respect to:

a) Land Management ____ Yes ____ No ____ Not Applicable
and Improvements
(e.g. tillage, drainage)

If yes, identify the changes made and reasons prompting those changes?

Change(s)	Year or Time Period	Reason(s)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

If no, please indicate why?

b) Crop Management ____ Yes ____ No ____ Not Applicable
(e.g. use of fertilizers, harvesting methods)

If yes, identify the changes made and reasons prompting those changes?

Change(s)	Year or Time Period	Reason(s)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

If no, please indicate why?

c) Livestock Management ____ Yes ____ No ____ Not Applicable
(e.g. feed rations, genetics)

If yes, identify the changes made and reasons prompting those changes?

Change(s)	Year or Time Period	Reason(s)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

If no, please indicate why?

d) Labour ____ Yes ____ No ____ Not Applicable
(e.g. hired labour, off farm work)

If yes, identify the changes made and reasons prompting those changes?

Change(s)	Year or Time Period	Reason(s)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

If no, please indicate why?

e) Crop Insurance ____ Yes ____ No ____ Not Applicable
(e.g. amount and types insured)

If yes, identify the changes made and reasons prompting those changes?

Change(s)	Year or Time Period	Reason(s)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

If no, please indicate why?

17. Farm Structure Changes: Please identify whether there have been changes to your farm structure between 1987 and 1997 with respect to:

a) Land Area ____ Yes ____ No ____ Not Applicable
(e.g. size, ownership, land rental)

If yes, identify the changes made and reasons prompting those changes?

Change(s)	Year or Time Period	Reason(s)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

If no, please indicate why?

b) Capital Investment ____ Yes ____ No ____ Not Applicable
(e.g. equipment, buildings, quota)

If yes, identify the changes made and reasons prompting those changes?

Change(s)	Year or Time Period	Reason(s)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

If no, please indicate why?

PART E: FARM LEVEL CHANGES IN THE NEXT 5 YEARS

*In this section we are interested in how you plan to change **your farm operation** over the medium term.*

18. Please complete the table below indicating the sorts of changes you plan to introduce over the next 5 years and reasons for the planned changes.

[illegible]

PART F: WEATHER AND CLIMATE

*In this section we are interested in the significance of day to day weather and long-term climatic conditions on farm management decisions made on **your farm**.*

19. Sources of Weather Information

Please identify sources you consult for weather information by indicating (with a check) what time period information is used from each source, and how this information is used in decision making.

Source	Daily Use	Weekly Use	Monthly Use	Seasonal Use	If used, how is it used in decision making (eg. cropping decisions, seeding and harvesting)
TV					
Radio					
Paper: General					
Paper: Farm, Local					
Almanac					
Phone service					
Env. Canada Website					
Other(s) _____					

20. During which period(s) is it most critical for you to have reliable weather information? (Check appropriate months)

- ☐ January
- ☐ February
- ☐ March
- ☐ April
- ☐ May
- ☐ June
- ☐ July
- ☐ August
- ☐ September
- ☐ October
- ☐ November
- ☐ December

21. Which aspect(s) of your farm operation is (are) most sensitive to weather and climate conditions?

22. Which climatic property or properties have the greatest influence on decision making for your farm?

PART G: CLIMATE CHANGE AND AGRICULTURE

23. Climate Change Perception

a) Have you noticed climate to be changing **in your area** over the last 20 years?
☐ Yes ☐ No ☐ Not Sure

If yes, identify which of the following climatic properties you believe have changed and describe how they have changed.

Climatic Properties	Change			If Yes, How (Please describe)
	Yes	No	No Opinion	
Precipitation				
Temperature				
Frost free days				
Heat Units				
Predictability				
Other(s): Please Specify				

b. Do you believe extreme climatic conditions (such as droughts, windstorms, floods) in this area have changed over the last 20 years? If so, describe the changes (e.g. more or less frequent, more or less severe, etc...)

c. Have you made changes to your farm operations due to the changes in climatic attributes you have indicated in 23(a) or 23(b)?

___ Yes ___ No

If yes, please describe the changes in your farm operation and explain why?

If no, please describe why not?

25. Please rate how you feel the following types of information (presented as factsheets, short videos, websites) might help Eastern Ontario farmers adjust to global climatic change. Please check appropriate boxes.

1. Climatic Change Forecasts at the:	Rating:				
	No Help	Least Helpful	Somewhat Helpful	Helpful	Crucial
a) national level					
b) provincial level					
c) sub-provincial (e.g. E. Ontario) level					

2. Impacts of Climatic Change On:	Rating:				
	No Help	Least Helpful	Somewhat Helpful	Helpful	Crucial
a) earliest possible seeding dates					
b) crop yields and/or quality					
c) agricultural pests and diseases					
d) livestock production					
e) farm-level economics					
f) international agricultural trade					
g) crop insurance coverage & premiums					

(Question 25 continued....)

3. Agricultural Adaptation Options to Climatic Change such as:	Rating:				
	No Help	Least Helpful	Somewhat Helpful	Helpful	Crucial
a) new crop varieties (e.g. longer season varieties)					
b) opportunities for winter cereals					
c) opportunities for new crops (ie. crops not currently grown in E. Ontario)					
d) irrigation potential					
e) marketing programs to increase public awareness of new agricultural opportunities (e.g. niche marketing)					
f) technological responses to reduce impacts of climatic change					
g) programs & subsidies to ease farm-level adjustments					

26. Other Comments

Please feel free to add other comments concerning agricultural adaptation.

THANK YOU FOR PARTICIPATING IN THIS AGRICULTURAL ADAPTATION SURVEY

Appendix B: Initial Contact Letter

_____, 1998

AGRICULTURAL ADAPTATION SURVEY

Dear _____,

We are contacting you to request your input for a study on agricultural adaptation on Eastern Ontario farms. The study is undertaken by researchers at Carleton University, and receives support from Agriculture and Agri-Food Canada. We are very interested in how the farming community has adapted to changing conditions over the past 10 years and how agriculture might adjust to potential changes in the future, including possible changes in climatic conditions.

Direct contact with farmers is the foundation for the project. We rely upon farmers describing why and how they change their farm operations, rather than trying to derive this information from secondary information sources such as the Agricultural Census of Canada.

Our original plan was to contact farmers in January 1998. But given the extreme hardship caused throughout rural Eastern Ontario by the ice storms, we decided to delay this part of the research and we are hoping that March will be a more suitable time. We will be contacting you by telephone in the month of March to find out if you are interested in participating in the survey, and if appropriate, to schedule a time when we can come to your farm to meet with you and conduct a personal interview. The plan is to personally interview about 60 farmers in the Regional Municipality of Ottawa-Carleton.

If you choose to participate in this project, we would appreciate if the person or persons responsible for making decisions on your farm could attend the interview. It should take no more than one hour to complete the survey. All responses will be anonymous and results will be aggregated to ensure that individuals and individual farms cannot be identified. Project findings will be reported to Agriculture and Agri-Food Canada, and the research results will also be used in an M.A. Thesis and presented in scientific journals. All farmers completing the survey will be able to receive a summary report free-of-charge. The main report will be available on a loan basis from Carleton University.

(please turn over)

Appendix B: Initial Contact Letter (cont'd.)

Please contact us if you have any questions about this project. Otherwise, we will be contacting you by telephone and sincerely hope that you will be able to participate in this Agricultural Adaptation Survey.

Yours sincerely,

Michael Brklacich
Associate Professor
Tel: (613) 520-2600 Ext. 7553
FAX: (613) 520-4301
Email: mbrklac@ccs.carleton.ca

Ben Veenhof
M.A. Student
Tel: (613) 520-2600 Ext. 8120
FAX: (613) 520-4301
Email: bveenhof@chat.carleton.ca

Appendix C: Informed Consent Form

AGRICULTURAL ADAPTATION SURVEY - INFORMED CONSENT FORM -

Informed Consent provides a mechanism to ensure that all contributors to this project are aware of the project's purpose and expectations regarding their participation. Please review the enclosed information and, should you agree to participate, sign and return the Consent Form to the interviewer.

I, _____, agree to participate in the Carleton University study investigating agricultural adaptation to changing conditions (eg. economic, technological, climatic).

I understand that:

- It will take no more than one hour to complete the questionnaire.
- Participation is voluntary and you may choose to not answer all questions and/or withdraw from the interview at any time.
- Confidentiality is ensured because the survey is completed anonymously.
- Analyses based on data collected from the survey will be aggregated to ensure individuals or individual farms cannot be identified.
- The researchers will prepare a Project Report for Agriculture and Agri-Food Canada. The information will also be incorporated into a M.A. Thesis at Carleton University and used in scientific publications.
- A summary report of the project's findings will be made available to all participants upon request.

Signature

Date

PLEASE COMPLETE AND RETURN TO THE INTERVIEWER

(Please turn over)

Appendix C: Informed Consent Form (cont'd.)

**AGRICULTURAL ADAPTATION SURVEY
- SUMMARY REPORT -**

Please complete the information below if you wish to receive a summary report free-of-charge.

Name: _____

Address: _____

Postal Code: _____