



The South Saskatchewan River Basin Drought Response Study
Phase I Report: Findings of a Preliminary Survey

Prepared for the Government of Canada's
Climate Change Impacts and Adaptation Program
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Abstract

This document summarizes the results of the first phase of a multi-phase project aimed at improving our understanding of the drought-proofing behaviours exhibited by farmers and ranchers in the South Saskatchewan River Basin. As this research follows the droughts of 2001 and 2002, a secondary objective is to assess the extent to which those events may be linked to changes in farming and ranching practices and water-use. The information yielded by this research will be helpful in assessing current levels of drought preparedness, but will also assist in better understanding the vulnerability of agriculture in the basin in the context of anticipated changes in the region's climate.

The results suggest that a majority of the measures which have been adopted by producers are probably being used because they carry with them coincident benefits such as reducing production costs or enhancing productivity, or are measures that are relatively inexpensive or demand a small time commitment. Respondents displayed an appreciation for drought and understood that the probability of drought becoming more frequent in the future will likely increase, but the perceived risks associated with drought do not appear to be sufficiently high to prompt widespread adoption of a large number of measures aimed specifically at better insulating farming and ranching operations from the risks associated with drought. Consistent with previous research on similar questions, financial considerations appear to represent a significant barrier to the adoption of drought-proofing measures, particularly those that do not carry with them coincident benefits.

(I) Introduction

Western Canadian agriculturalists are not unfamiliar with drought or with the consequences associated with drought. For instance, the droughts of the 1930s, which led to massive out-migration and unprecedented changes in land use and farming practices, still figure prominently in the collective consciousness and popular culture of the region. And while the region has suffered through additional droughts since the 1930s, the droughts of 2001/2002 have been shown to be noteworthy for several reasons. Based on analyses conducted by Richards and Burrige (2006) and Bonsal and Regier (2006), the droughts that marked the dawn of the new millennium have been shown, on several dimensions, to be the most severe for the past several decades, and amongst the most severe on record at some locations in Western Canada.

But the droughts of 2001 and 2002 are noteworthy for other reasons. Not only do these events offer researchers an opportunity to assess drought preparedness, but because many climate change models suggest that the region will likely become warmer and drier, and that the frequency, extent (temporal and spatial) and severity of drought is likely to increase over time as a result of global climate change (see for example, Hengeveld, 2000), these recent droughts offer a window on the future. By learning more about how farmers and ranchers responded (or did not respond) to these droughts, we can develop a better understanding of the vulnerability of agriculture in the region to drought.

This document reports on the first phase of a drought-response study that has focused on the drought-proofing behaviour of farm operators located mainly in the Alberta portion of the South Saskatchewan River Basin. The broader research project, of which the work reported here is a part, has been structured around three objectives:

1. To document the extent to which a battery of relatively well known drought-proofing measures are being used by farmers and ranchers in the South Saskatchewan River Basin.
2. To identify barriers and constraints to the adoption of drought-proofing measures.
3. To use the empirical findings to assess current levels of drought preparedness and to discuss the potential vulnerability of agriculture in the region in the context of future climatic conditions which are expected to be characterized for more frequent and severe droughts.

The findings summarized here come from the first phase of this research and have been derived from questionnaires completed by 29 respondents. The next two phases of the work will comprise administering our questionnaire to a larger sample of respondents, thereby generating a larger number of cases so that a range of inferential procedures can be applied to the data, and then conducting a series of case study interviews to complement and expand upon the findings derived from the survey data.

This report is organized as follows. The next section places adaptation in research in the context of the broader field of climate change. It is intended to set the theoretical context for this study. Following that discussion we move to a description of the steps undertaken to collect our empirical data and then present a characterization the basic attributes of our respondents and their operations. Section four of the report summarizes the information collected regarding the adoption of a battery of drought-proofing measures. These measures have been organized into six broad categories: household water use, lawn and gardening practices, soil moisture management, cropping and range management practices, livestock management and operational aspects of the farm business itself. Section five summarizes respondents' views on the risk of drought and their self-assessed the level of preparedness. Section six focuses on the information sources used by our respondents and the relative importance attached to various information sources. In the final section we present our conclusions.

(II) Adaptation Research in Context

For much of the last three decades climate change impact assessment research has been dominated by the scenario approach (Parry, 1988). Such studies begin with the specification of several possible climatic futures, typically involving projected departures from mean conditions. In the early stages of this work Atmospheric General Circulation Models (AGCMs) are most often used for scenario development (Gates, 1987), although some studies employed historical or spatial analogues (Rosenberg *et al.*, 1993). More recently, scenario developers have largely turned to coupled models which link ocean circulation models to atmospheric circulation models. However generated, the climatic

scenarios are then superimposed upon a study area, and the effects projected for whatever climate-sensitive system is under investigation.

By and large, the first generation of studies were preoccupied with assessing first-order impacts only. This involved an assessment of the consequences of possible changes in climatic conditions (often with respect to average conditions) on what Carter *et al.* (1994) called an “exposure unit”. This general framework was refined, and an increasing number of investigators began to consider not only first-order impacts of climate change, but higher-order ones too (Parry and Carter, 1988). Thus emerged the “cascading impact approach” (Chiotti and Johnston, 1995), as output from one modelling exercise is used as input to the next, and so on. Some investigations, such as the one by Bergthórsson *et al.* (1988) which assessed the impact of climate change first on grass yield in Iceland and then on dairy production, involved only two orders of impacts. Other studies are considerably more ambitious. For example, in a study focussing on Saskatchewan, Williams *et al.* (1988) traced the impacts of crop-yield changes through to farm-level expenditures, farm income and ultimately provincial GDP.

Further analytical sophistication was added to the assessment of cascading impacts by tracking effects within the agricultural sector to other sectors of the economy. Described by Parry and Carter (1988) as the integrated approach, input-output analysis (I-O) is sometimes used for studies of this type. This technique, which was developed by regional scientists to trace the consequences of change in one or more sectors of a regional economy, was used by Arthur and Van Kooten (1991) in their study of possible impacts of climate change in the three Canadian prairie provinces. The integrated approach was subsequently extended with the introduction of analytical frameworks providing for the evaluation of climate change impacts in one region *vis-à-vis* climate change impacts in other regions (Rosenzweig and Parry, 1994). This development recognized that regional economies do not operate in isolation, but are linked in various ways through a global-scale systems of production, distribution, exchange and consumption (see, for example, Bryant and Johnston, 1992). The way in which a change agent or exposure unit in one region might respond to climate change is influenced by the way in which their counterparts in other regions also respond. For example, imagine that the climate in a region shifts such that at some point in the future it is possible to grow corn, when in the past it was not possible to do so. A producer’s decision to grow corn will be influenced not only by the prevailing climatic conditions, but more importantly by whether or not corn enjoys a comparative advantage over other crops, which is governed not only by site and regionally specific production conditions but also by the supply of and demand for corn generally in the marketplace.

The Business as Usual Assumption

The early studies generally conceptualized climate change impact assessment in terms of a simple, one-way relationship between an exposure unit or change agent and one or more attributes of the climatic regime. Impact assessments using this simple-impact approach were grounded on the “assumption of direct cause and effect where a climatic event (e.g., a short-term variation of temperature) operating on an exposure unit (e.g., a

human activity) may have an impact or effect” (Parry and Carter, 1988). Many of these studies adopted a ‘business as usual’ position, in that it was assumed the future structure of the system under consideration would be broadly similar to the baseline year. However, in assuming the structure of any given system would remain static over time, a fundamental flaw was embedded in such work. Simply put, the majority of these investigations failed to accommodate the possibility that systems under consideration might adapt to changing climatic conditions in order to avoid the negative consequences of climatic change or to exploit new opportunities (see, for example, Mendelsohn *et al.*, 1994). The point at issue is not that researchers made wrong assumptions about decision-making behaviour, but rather that decision-making behaviour was not considered at all.

By the late 1980s this criticism had been internalized by an increasing number of impact assessment researchers (Crosson, 1993). As observed by Reilly *et al.* (1996) most impact studies conducted since about 1990 have considered some technological options for adapting to climate change (see, for example, Rosenzweig and Parry, 1994). Typically such studies run two sets of analyses. First, impact evaluations are conducted for as many climate scenarios as are specified, but assuming that no adaptation will be undertaken. Then, a second set of assessments are run, this time incorporating various assumptions concerning the adaptability of the system under examination. The first step in this research design represents the control scenarios, whereas the second run can be considered transitional scenarios. In adopting this conceptual framework, researchers can theoretically identify the worst possible outcome versus the best possible outcome, as well as a range of possible adaptive strategies.

Used this way, adaptation research is a positive heuristic. It seeks to identify which of a range of theoretically possible adaptive options are likely to reduce the negative effects of climate change, or offer the chance of taking advantage of new opportunities. However, a majority of studies employing this approach has omitted any consideration of the likelihood that a given adaptive mechanism, or a range of mechanisms, will actually be adopted. In other words, as Smithers and Smit (1997, p. 173) observe, “there has been relatively little attention focussed directly on the process of adaptation to environmental change”. In focussing on process as opposed to outcome, an approach which is consistent with the definition of adaptation to climate change offered by Burton (1992), researchers begin to ask about the various cultural, perceptual, institutional and other factors and circumstances, operating across a range of geographic scales, that will influence the chances that any given adaptive strategy will be adopted (Johnston and Chiotti, 2000). In order to address these concerns, an additional role for adaptation research can be defined (see, for example, Smit, 1993; Smit *et al.*, 1999; Smit *et al.*, 2000). This approach involves reference to the characteristics of systems that make them more or less vulnerable to climate change, and which in turn affect the capacity of any given system to adjust to the consequences of climate change. By focussing on the “ecological properties” of systems (Smithers and Smit, 1997), the research question shifts from which adaptive strategies are possible to which are probable, seeking to identify those attributes of systems that constrain adaptive capacity. More recently, researchers have further conceptualized the notion of adaptation research. Smit and Skinner (2002), for instance, draw a helpful distinction between the characteristics of adaptive measures (e.g, intent,

timing, etc.) as opposed to the various forms adaptive responses can take (e.g, adoption of new technologies vs adjusting cultural practices).

Various authors have developed lists of key attributes to be used in this approach to adaptation research (see, for example, Smit, 1993; Sprengers *et al.*, 1994), but there appears to be agreement on three characteristics in particular, namely sensitivity, adaptability, and vulnerability.

Briefly, sensitivity analysis, which was a central feature of the “risk-hazard” model developed by Burton *et al.* (1978), is undertaken to determine which particular aspect or aspects of climate a system is especially responsive to. Some systems may be particularly sensitive to a change in average conditions (e.g., average precipitation) while other systems may be particularly sensitive to an increase in the duration, frequency or magnitude of extreme events such as drought. In addressing this question, researchers are able to build knowledge about those aspects of the climatic regime to which systems will actually need to adjust.

Adaptability can be thought of in terms of the flexibility or the amount of “manoeuvrability” that exists in a system (Smit, 1993). The amount of flexibility in a socio-economic system can be constrained by exogenous variables such as the institutional arrangements that surround resource use decisions (Ivy, 2001; IPCC Working Group II, 2007), or by the internal structure of the system. For instance, it can be argued that systems displaying a high degree of homogeneity, such as a highly specialized farming system, may possess less flexibility and hence display less adaptability as compared with a smaller-scale, more diversified systems. Herein lays a curious conundrum, because in socio-economic systems as in ecosystems, there is a negative relationship between diversity and efficiency.

Vulnerability can be defined as the “degree to which a system, or part of a system, may react adversely to the occurrence of a hazardous event” (Timmerman, 1981) and as been observed by instance Smit (1993), among others, vulnerability is closely related to two ecological properties of systems in particular: stability and resilience. According to Burton (1992), stability refers to the “steadfastness” of a system, while resilience relates to the “elasticity” of a system. As Smit (1993, p. 24) explains: “a farming system which produces a consistent yield over time through resistance to impact or quick recuperative power is stable, while an agricultural system which can sustain itself despite large fluctuations in yields or prices etc. is resilient”. To illustrate, producers who manage through substantial swings in commodity prices without any extramural support display resilience, whereas producers who remain in business on the basis of income support programmes, crop insurance, and even ad hoc programmes can be described in terms of stability.

The concepts of sensitivity and adaptability can be combined to create a picture of a system’s overall or general vulnerability to climate change. As noted by Smit *et al.* (1999), the Summary for Policy Makers developed from the Second Assessment Report of IPCC (1995) defined the most vulnerable systems as those displaying the greatest

sensitivity to climatic change, combined with the least adaptability. We find this conceptualization repeated in the contributions of the IPCC's Working Group II to both the Third and Fourth Assessment Reports.

(III) Data Collection and Characteristics of the Respondents

Data Collection

The empirical data summarized in this report were collected using a survey questionnaire. The questionnaire, which is contained in Appendix A, was available on-line and in hard-copy form. The core of the survey asks respondents which of 40 drought-proofing measures, organized into six broad categories, they have adopted. For those applicable measures that had not been adopted, respondents were asked to indicate why the measures had not been adopted. The survey also contained questions soliciting each respondent's views on the risk of drought, their level of preparedness, the role of government programmes, information sources used, and the extent to which the recent droughts had stimulated farm diversification or, if applicable, the decision to work off the farm. Finally, basic information about the each respondent and their respective operations was also collected.

The questionnaire was developed in several stages. First, information on drought-proofing measures was collected from a wide range of sources. Various provincial and US state government agencies were especially helpful in this regard, as were extension units at several of the US land-grant universities. Once collected and refined, the measures were then organized into broad categories. A draft of the measures was then circulated for comment and further refinement. Saskatchewan Agriculture, Alberta Agriculture, Food and Rural Development and Agri-food and Agriculture Canada provided invaluable assistance during this stage of the work. The final list of measures used is shown in Table 1.

The initial intent was to administer the questionnaire on-line. After converting the paper-copy version of the questionnaire to a computer-based format, it was piloted and further refined based on the feedback received. Then in the summer of 2006, an initial mailing of 3,200 postcards was made to farm addresses using Canada Post's bulk mailing service. The post cards described the nature of the study, how the information collected will be used, and provided a set of directions for accessing and completing the on-line survey. The first mail-out was followed up by a second one.

Administering the questionnaire on-line yielded discouraging results, and so the decision was made to circulate the survey in hard-copy form as well. To that end, display space was secured at Lethbridge's annual agricultural trade fair and exhibition ("Ag Expo"). The booth was staffed by two senior undergraduate students for the entire event. Potential respondents had the opportunity to complete a survey on-site, take one home and mail it in later, complete the on-line version at one of two workstations, or take a postcard with instructions for completing the on-line version at a later time.

The data summarized in this report were derived from 29 respondents representing 28 separate agricultural operations. Although the empirical findings are interesting, and while the operations and operators represented in the sample appear to be broadly representative of the general populations of which they are a part, care must be taken in the interpretation of the findings. Specifically, because the number of cases on which information was collected is so small, it was not possible to conduct inferential tests on the data and so the likelihood that findings reported for our sample can be generalized to population could not be determined.

Attributes of Respondents and Their Operations

As shown in Table 2 three-quarters of the respondents were male, about one-third reported their age to be between 35 and 65, and just over half the sample had attended a post-secondary institution. Those responding to the survey were experienced and well positioned to provide valid responses to the questions posed; all but 3 of the respondents were in management positions in their respective operations. Additionally, only two respondents reported having fewer than 10 years experience in the industry, and the average number of years of farming experience for the group overall was just over 30. Eleven respondents told us they had been farming for 35 years or more.

| Category | Measures |
|---------------------------------------|---|
| Household | (1) Low-flow showerheads; (2) Ultra-low flush toilets; (3) Dual-flush toilets; (4) Composting toilet system; (5) Gray water system; (6) Front-load washer; (7) Water meter; (8) Expand household water supplier or tie into municipal water system. |
| Lawn and Garden | (1) Timers on sprinklers; (2) Xeriscaping; (3) Drought-tolerant plants; (4) Rainwater collection. |
| Conserving or Enhancing Soil Moisture | (1) Conservation tillage; (2) Zero or minimum tillage; (3) Cultivate along land contours; (4) Sculpt stubble to trap snow; (5) Chemical fallowing; (6) Litter cover of at least 30%; (7) Shelter belts between fields; (8) Cultivate at 90 degrees to prevailing wind; (9) Build soil organic matter. |
| Crop Production and Range Management | (1) Return seeded pasture to native grasses; (2) Plant cropland to forage; (3) Plant drought-tolerant crops; (4) Plant drought-tolerant cultivars; (5) Plant winter cereals; (6) Change crop rotation to disrupt pest cycles; (7) Precision farming (GPS technology) |
| Livestock Production | (1) Emergency feed supply; (2) Arrange for emergency pasture; (3) Rotational grazing; (4) Reduce stocking rates; (5) Shade or shelter for livestock; (6) Increase storage capacity of dugouts; (7) Cull older livestock. |
| Farm Business Management | (1) Set up contingency fund; (2) Diversify crop and/or livestock mix; (3) Establish farm-based business; (4) Purchase crop insurance; (5) Obtain off-farm work |

Based on recent reports from the 2006 Census of Agriculture, our sample of respondents appears to be generally representative of the general population, although two features stand out as being distinctive. First, only two of our respondents were female, whereas the most recent census of agriculture found that approximately 27% of census farms are operated by women. Secondly, nearly one-third of our respondents reported having earned at least one university degree and, as reported above, more than half the sample reported some sort of post-secondary education. The latter attribute of the sample may well be explained by the method of questionnaire delivery.

The attributes of the farming operations represented in the sample are summarized in Table 3. The operations on which data were collected were almost all family run, in one manner or another. Owner-operated operations and family partnerships accounted for three-quarters of the cases in the sample, and only 2 operations were non-family owned.

| Attribute | Number | Percentage |
|---|--------|------------|
| Age (valid responses = 26) | | |
| < 35 years | 4 | 13.8 |
| 35 to 44 | 6 | 20.7 |
| 45 to 54 | 8 | 27.6 |
| 55 to 64 | 4 | 13.8 |
| > 64 years | 4 | 13.8 |
| Education (valid responses = 29) | | |
| Elementary School | 4 | 13.8 |
| High School | 6 | 20.7 |
| College or Technical Institute | 7 | 24.1 |
| University | 9 | 31.0 |
| Gender (valid responses = 24) | | |
| Male | 22 | 75.9 |
| Female | 2 | 6.9 |
| Years Farming (valid responses = 28) | | |
| 15 or fewer | 4 | 14.3 |
| 16 to 25 | 6 | 21.4 |
| 26 to 35 | 10 | 35.8 |
| More than 35 | 8 | 28.6 |

The range of farm types represented in the group is consistent with what one would expect in southern Alberta, although two gaps in the sample should be noted. First, most of the beef operations were cow-calf producers, which means that feedlot operations are under-represented. Second, operations producing specialty crops, particularly for small, niche markets, are similarly under-represented.

Table 3 also presents two measures relating to scale of operation; total farm size and total capital value. Here, the sample would appear to be consistent with two general trends in

Canadian agriculture; farms are growing in size and becoming increasingly heavily capitalized.

| Table 3: Selected Attributes of the Respondents' Operations | | |
|---|--------|------------|
| Attribute | Number | Percentage |
| Tenure | | |
| Owner Operated | 17 | 60.7 |
| Family Partnership | 4 | 14.3 |
| Family Corporation | 5 | 17.9 |
| Other Ownership Arrangement | 2 | 7.1 |
| Farm Type | | |
| Dairy | 1 | 3.6 |
| Beef | 9 | 32.1 |
| Wheat | 4 | 14.3 |
| Other Grains, Oil Seeds and Other Field Crops | 5 | 17.9 |
| Other Combination | 9 | 32.1 |
| Size of Operation | | |
| Under 500 Acres | 2 | 7.2 |
| 500 to 999 Acres | 7 | 25.1 |
| 1,000 to 1,999 Acres | 7 | 25.1 |
| 2,000 to 2,999 Acres | 4 | 14.4 |
| 3,000 Acres and Over | 8 | 28.6 |
| Total Capital Value | | |
| < \$500,000 | 11 | 44.0 |
| \$500,000 to \$1,499,999 | 5 | 20.0 |
| > \$1,499,999 | 9 | 36.0 |
| Irrigation Reported | | |
| Yes | 12 | 42.9 |
| No | 16 | 57.1 |

(IV) Adoption of Drought-proofing Measures

The purpose of this section is to report on the central objective of the research, namely to document the adoption of a range of drought-proofing measures amongst a sample of farmers and ranchers. The questionnaire asked respondents about 40 distinct measures organized into six broad categories. It should be noted that while many of the measures listed in the survey carry some benefit in terms of reducing the risk associated with drought, there are often other good reasons for adopting many of the measures. Referring to the adaptation typology developed by Smit and Skinner (2002), relatively few of the measures that were adopted appear to have been adopted with the specific or planned intention of adapting to predicted changes in climate. Just because a measure has been adopted, it cannot be concluded that the adoption is a drought response, or that the adoption represents a response to the increased risk of drought.

Indoor Household Water Conservation

With the exception of water meters, which allow a household to monitor its water use, perhaps with the view to installing water conserving technologies, the measures in this category comprise technologies that can be adopted in order to reduce the overall volume of water used by a household. The technologies range from relatively inexpensive ones, such as low-flow showerheads which can be purchased for under \$10 and installed in minutes, to more expensive appliances such as front-load washing machines which range in price to from around \$1,000 to about \$2,000.

As shown in Table 4, the lowest cost, least effort measure – low-flow showerheads – was found to be the most widely adopted measure. The next most popular measures, in descending order of adoption, were establishment of a new water supply, the purchase of front-load washing machines and the installation of low-flush toilets. Of the respondents reporting they had established a new water supply, about half had taken the opportunity to tie into a municipal water system, while the balance augmented on-farm water.

| Drought-proofing Measure | Respondents Reporting Adoption | | Respondents Who Have Not Adopted Measure | | Reason Most Frequently Mentioned For Not Adopting Measure |
|----------------------------|--------------------------------|------|--|------|---|
| | # | % | # | % | |
| Low-flow Showerheads | 19 | 67.9 | 9 | 32.1 | Unaware of measure |
| Low-flush Toilet | 11 | 39.3 | 17 | 60.7 | Cost |
| Dual-flush Toilet | 5 | 17.2 | 23 | 79.3 | Unaware of measure |
| Composting Toilet | 0 | 0 | 28 | 100 | Cost |
| Gray Water System | 4 | 14.3 | 24 | 85.7 | Unaware of measure |
| Front-load Washing Machine | 9 | 33.3 | 18 | 66.7 | Cost |
| Water Meter | 1 | 3.4 | 28 | 96.6 | Unnecessary |
| Establish New Water Supply | 14 | 51.9 | 13 | 48.1 | Insufficient responses |

Turning our attention to the final column, it is noted that cost was the most frequently mentioned reason for non-adoption for three of the measures, while lack of knowledge was the most frequently mentioned reason for non-adoption for three other measures.

Outdoor Household Water Conservation

Measures in this category consist of technologies that provide for the conservation of water used in landscaping and gardening. With the possible exception of xeriscaping, these “low-tech” measures are inexpensive and can be implemented with relatively little effort.

As shown in Table 5, only one of the measures identified in the questionnaire -- planting drought-tolerant plants – was found to have been adopted by more than half the respondents. Collecting rainwater, a practice that was well-known to the region’s first European settlers was the next most popular measure, having been adopted by 44% of respondents. The relatively low rates of adoption of timers on sprinklers and xeriscaping were, respectively, accounted for by our respondents on the basis of system incompatibility and knowledge. The explanation the low level of adoption of xeriscaping makes sense given that this practice is relatively new even in urban areas, but the explanation for the low level of adoption of timers on sprinklers is a little curious. It is acknowledged that very expensive in-ground sprinkler systems can be installed, but a number of quite inexpensive “end-of-the-hose” timers are also readily available.

| Drought-proofing Measure | Respondents Reporting Adoption | | Respondents Who Have Not Adopted Measure | | Reason Most Frequently Mentioned For Not Adopting Measure |
|-------------------------------------|--------------------------------|------|--|------|---|
| | # | % | # | % | |
| Timers on Garden Sprinklers | 4 | 14.8 | 23 | 85.2 | System incompatibility |
| Xeriscaping | 5 | 18.5 | 22 | 81.5 | Unaware of measure |
| Planting of Drought-tolerant Plants | 17 | 63.0 | 10 | 37.0 | Unaware of measure |
| Collection of Rainwater | 12 | 44.4 | 15 | 55.6 | Insufficient responses |

Conserving or Enhancing Soil Moisture Holding Capacity

Some of the drought-proofing measures contained in this category (see Table 6) are designed to conserve soil moisture (e.g., chemical fallowing), while others are used to enhance the soil’s moisture-holding capacity (e.g., building up organic matter). The measures consist of both technologies (e.g., chemical fallowing) as well as cultural practices (e.g., stubble sculpting), and most have been promoted by agricultural extension agencies for decades.

It is encouraging that five of the nine measures listed in this category were adopted by more than half of the sample and that one measure, building soil organic matter, is being used by 80% of respondents. However, it should not be assumed that reducing the

vulnerability to drought is the principal motivator underlying the pattern of adoption observed here. Each one of the measures employed for 50% or more of the respondents also reduce production costs or enhance productivity. By contrast, the less-widely adopted measures hold less obvious or immediate benefits vis-à-vis cost containment or enhanced productivity, and in the case of several practices (most notably cultivating along land contours and shelter belts) are seen by many producers as adding to their operating costs.

The findings reported in this section are consistent with two earlier studies of the water conserving practices of Southern Alberta irrigation farmers (Kromm, 1991; Johnston et al., 2001). In both of those studies the authors' reported that irrigators tended to adopt measures that conserved soil moisture or used irrigation water more judiciously for reasons other than a concern for conserving soil moisture or irrigation water.

| Drought-proofing Measure | Respondents Reporting Adoption | | Respondents Who Have Not Adopted Measure | | Reason(s) Most Frequently Mentioned For Not Adopting Measure |
|---|--------------------------------|------|--|------|--|
| | # | % | # | % | |
| Conservation Tillage | 16 | 61.5 | 10 | 38.5 | Cost |
| Cultivating Along Land Contours | 3 | 12.5 | 21 | 87.5 | Insufficient responses |
| Zero (Minimum) Tillage | 15 | 55.6 | 12 | 44.4 | Cost |
| Stubble Sculpting | 6 | 23.1 | 20 | 76.9 | System incompatibility Unaware of measure |
| Chemical Fallow | 15 | 60.0 | 10 | 40.0 | Insufficient responses |
| Litter Layer of 30% | 16 | 61.5 | 10 | 38.5 | Insufficient responses |
| Shelter Belts | 8 | 32.0 | 17 | 68.0 | Insufficient responses |
| Cultivate at Right Angle to Prevailing Wind | 9 | 34.6 | 17 | 65.4 | Cost |
| Build Soil Organic Matter | 21 | 80.8 | 5 | 19.2 | Insufficient responses |

Cropping and Range Management

The drought-proofing options summarized in Table 7 relate to crop and range management. All are well known and with the exception of returning seeded pasture to native grasses, not especially controversial.

Only one measure, planting cropland to forages, was adopted by more than half the respondents, but of the remaining measures, all but three have been adopted by at least 40% of the sample. GPS-based technologies which allow producers to more closely monitor yields and optimize fertilizer application have been adopted by just over a third of the sample, but because this is a relatively new technology, the rate of adoption should increase in the future. The relative unpopularity of winter cereals, adopted by about one-quarter of respondents, is consistent with view held by many producers that fall-planted crops produce lower yields due to winter kill, and the absolute unpopularity reclaiming native pasture is almost certainly a reflection of the radical nature of this option. Finally, it is noted that for all but on measure, cost was the most frequently mention reason by the non-adopters.

| Drought-proofing Measure | Respondents Reporting Adoption | | Respondents Who Have Not Adopted Measure | | Reason(s) Most Frequently Mentioned For Not Adopting Measure |
|---|--------------------------------|------|--|-------|--|
| | # | % | # | % | |
| Return Seeded Pasture to Native Grasses | 0 | 0 | 26 | 100.0 | Cost |
| Plant Cropland to Forages | 16 | 59.3 | 11 | 40.7 | Cost |
| Plant Drought-tolerant Crops | 13 | 48.1 | 14 | 51.9 | Cost |
| Plant Drought-tolerant Cultivars | 11 | 42.3 | 15 | 57.7 | Cost |
| Plant Winter Cereals | 7 | 25.9 | 20 | 69.0 | Cost |
| Change Crop Rotation to Interrupt Pest Cycles | 11 | 40.7 | 16 | 59.3 | Insufficient responses |
| GPS-based Precision Farming | 10 | 37.0 | 17 | 63.0 | Cost |

Livestock Production

The measures contained in this category were amongst the most widely adopted of any of the measures considered in the survey (Table 8). This is not especially surprising since most will be seen by many producers simply as good farming and ranching practices, and for most of the measures a strong financial incentive exists for their adoption. Additionally, there is, especially within the ranching community, a strong ethic that emphasizes animal health and welfare. The authors of this report would suggest that we see this ethic reflected, at least in part, in the pattern of adoption summarized here.

The relatively small number of producers who reported having arranged for emergency pasture was a surprising finding. Upon close examination of those cases, however, it was discovered that the cost was a major impediment to implementing this measure. Further, several respondents commented that it was simply not possible to obtain emergency pasture and that reducing stocking rates, culling vulnerable animals and establishing an emergency feed supply were more cost-effective measures.

| Drought-proofing Measure | Respondents Reporting Adoption | | Respondents Who Have Not Adopted Measure | | Reason(s) Most Frequently Mentioned For Not Adopting Measure |
|---------------------------------|--------------------------------|------|--|------|--|
| | # | % | # | % | |
| Emergency Feed Supply | 17 | 85.0 | 3 | 15.0 | Insufficient responses |
| Arrange for Emergency Pasture | 3 | 14.3 | 18 | 85.7 | Cost |
| Rotational Grazing System | 12 | 60.0 | 8 | 40.0 | Insufficient responses |
| Increase Capacity of Dugouts | 13 | 61.9 | 8 | 38.1 | Insufficient responses |
| Reduce Stocking Rates | 12 | 60.0 | 8 | 40.0 | Insufficient responses |
| Provide Shelter/Shade | 15 | 75.0 | 5 | 25.0 | Insufficient responses |
| Cull Vulnerable (Older) Animals | 15 | 71.4 | 6 | 28.6 | Insufficient responses |

| Drought-proofing Measure | Respondents Reporting Adoption | | Respondents Who Have Not Adopted Measure | | Reason(s) Most Frequently Mentioned For Not Adopting Measure |
|------------------------------|--------------------------------|------|--|------|--|
| | # | % | # | % | |
| Contingency Fund | 9 | 34.6 | 17 | 65.4 | Cost Insufficient cash-flow |
| Diversify Crop/Livestock Mix | 15 | 55.6 | 12 | 44.4 | Insufficient responses |
| Farm-based Business | 7 | 25.9 | 20 | 74.1 | Insufficient responses |
| Crop Insurance | 17 | 65.4 | 9 | 34.6 | Cost |
| Work Off Farm | 12 | 44.4 | 15 | 55.6 | Farm is too demanding |

Farm-business Measures

The drought-proofing strategies considered in this section (see Table 9) relate to measures that producers can adopt in an effort to mitigate the financial impacts of a drought on either the business operation or the household. As with many of the measures considered in other sections, each can be adopted for reasons that are unrelated to reducing the risks associated with drought. To illustrate, of those respondents who told us they had taken steps to diversify their crop and/or livestock mix, just over 20% indicated that recent droughts had influenced their decision, and of those respondents who reported off-farm work, only a quarter indicated that the recent droughts had influenced that decision.

Adoption of Drought-proofing Measures in the Context of the 2001/2002 Droughts

One of the central foci of our study was to see if we could identify impediments or barriers to the adoption of drought-proofing measures. Based on the information presented above, it might be suggested that for many producers the costs associated with a given technology or practice plays a significant role in the adoption decision. But this is really a superficial analysis because it is not just cost that is at issue, but rather cost associated with a given measure weighed against the perception of the risk of drought.

Consequently, the question we would like to address in this section concerns the extent to which the droughts of 2001 and 2002 factored into decisions concerning the adoption of drought-proofing measures. First, we summarize the data collected in question 24 in the questionnaire which asked respondents about the role that recent droughts played in two key decisions (*viz.* the decision to diversify and the decision to seek off-farm work), then we summarize what we learned concerning the year in which various measures were adopted.

Turning our attention to the first question, of the 15 respondents who indicated they had engaged in diversification, less than a quarter indicated they had done so as a response to drought. It seems reasonable to suggest that a substantial majority of those who had diversified their crop and/or livestock mix had done so for reasons other than those related to the risk of drought. Similar findings emerge when we examine the question of off-farm work. As shown in Table 9, just under half our respondents reported working off the farm. However, of that number, about a quarter indicated their decision was linked to the droughts of 2001 and 2002. These findings do not support the conclusion that drought is not a motivating factor in the decision of some respondents to diversify their operations or seek off-farm work, however, it should be noted that this is the case for only a minority of respondents.

Table 10 summarizes our findings concerning the year in which various measures were adopted. We will begin this discussion by explaining how the table was developed. First, in the second column, information is provided on the total number of possible adoptions for each drought-proofing category. To arrive at this number we multiplied the number of

measures in each category by the number of applicable cases. The third column lists the total number of actual adoptions reported, while the fourth column identifies the number of adoption for which the year-of-adoption information was provided by respondents. The final six columns disaggregate the adoptions into three time periods. Specification of the first time period – since 2001 – is obvious, while the second one – between 1987 and 2001 – captures the period between the 1987 drought and the most recent ones. The third time period is more or less a “catch all” category.

After taking into account that not all drought-proofing measures were applicable to all cases, the total number of possible adoptions was determined to be 1,090. Of this number, 437 adoptions of drought-proofing measures were reported, representing 40.1% of the total number of possible adoptions. Year-of-adoption information was collected on 264 adopted measures (60.4% of all adoptions) and as indicated above, this information has been categorized into three time periods.

| Drought-proofing Category | Adoptions | | Adoptions For Which Year-of-Adoption Reported | Adoptions Since 2001 | | Adoptions Between 1987 and 2000 | | Adoptions Before 1987 | |
|---------------------------|----------------|---------------------|---|----------------------|------|---------------------------------|------|-----------------------|------|
| | Total Possible | Number of Adoptions | | # | % | # | % | # | % |
| Indoor Household Measures | 232 | 63 | 52 | 23 | 43.4 | 19 | 36.8 | 10 | 19.0 |
| Outdoor Household Measure | 116 | 38 | 20 | 4 | 20.0 | 6 | 30.0 | 10 | 50.0 |
| Soil Moisture Management | 252 | 109 | 70 | 3 | 4.3 | 31 | 44.3 | 36 | 51.4 |
| Crop and Range Management | 196 | 68 | 36 | 11 | 30.6 | 8 | 22.2 | 17 | 47.2 |
| Livestock Management | 154 | 87 | 59 | 7 | 11.9 | 17 | 28.8 | 35 | 59.3 |
| Farm Business Management | 140 | 72 | 27 | 4 | 14.8 | 6 | 22.2 | 17 | 63.0 |

Organizing the data this way, it appears that the droughts of 2001 and 2002 did not play a substantial role in encouraging the wide-spread adoption of drought-proofing measures. Of the 264 adoptions for which we have year-of-adoption information, only 20% were adopted post 2001, and presumably only a subset of those adoptions were in direct

response to the droughts. By contrast, nearly half (47.3%) of all the adoptions for which year-of-adoption information was gathered were adopted prior to 1987.

Two possible explanations can be advanced to account for this finding. First, it could be that previous experience with drought, dating in some cases to the 1930s, had already stimulated the adoption of a sufficient battery of drought-proofing measures in the view of many decision makers. Second, it could be that the risk of drought is not seen to be sufficiently high to warrant the adoption of measures that seem rather “heroic” to many producers. We attempt to shed some light on these questions in the following section.

(V) Respondent Views on the Risk of Drought and Their Self-assessed Level of Preparedness

In order to shed some light on our respondents’ views on the risk of drought and to gain a sense of their self-assessed level of drought preparedness, we posed a series of statements toward the latter part of the questionnaire and asked participants to respond on a 5-point Lykert scale. In response to the first statement “The recent droughts were abnormal events for my area”, nearly half the respondents expressed either disagreement or strong disagreement. We then posed a statement focusing on the future: “My area will experience an increasing number of droughts in the future”. Consistent with the response to first statement, 44% of the study participants indicated that they agreed or strongly agreed with the statement. We then expressed the same idea about the future, but in the reverse: “The likelihood that drought will become more frequent in my area in the future is low”. Although only about a third of participants agreed or strongly agreed with this statement, the findings from all three questions point in the same direction. A substantial number of respondents in our study appear to understand that drought is not an abnormal phenomena in the region and a substantial number believe that there is an increased chance that drought will become more frequent in the future. Whether or not human activity is responsible for a changing climate, bringing with it an increased chance of drought is another question, however. Nearly 60% (57.7%) of respondents indicated they disagreed or strongly disagreed with the following statement: “Claims that climate may already be changing, and that we are responsible, are overblown.”

Our questions dealing with respondents’ self-assessed level of drought preparedness yielded somewhat contradictory results which should be followed up on in future research. To illustrate, more than 80% of respondents agreed or strongly agreed with the statement: “I have a good understanding of what I can do to reduce the risks associated with drought”. But on the other hand, just over half of the respondents (55.5%) agreed or strongly agreed with the statement: “My measures to reduce adverse drought effects were successful”. One possible interpretation of the response patterns to these two questions is that a substantial number of respondents feel they have learned from their handling of the last droughts, which in retrospect may have been less than successful.

(VI) Information Sources

Researchers have long understood that decision makers rely on a variety of information sources as part of the decision making process (Rogers, 2003). It is also widely recognized that decision makers assign different levels of importance for those various sources and evaluate various information formats differently. Developing a better appreciation of the people and agencies that farm operators use and trust for their information is an important ingredient in any attempt to influence drought-proofing behaviours. The results of our analysis of information sources are presented in two tables (Tables 11 and 12).

To gain an insight into the importance respondents attach to various information sources, we asked participants to rate a set of information sources on a 4-point ascending scale, ranging from “not very important”, which was assigned a value of 1, to “extremely valuable”, which received a score of 4. For each information source, the weighted scores were then summed across all respondents. To arrive at a single, aggregate index, the total possible score was determined (i.e, what the aggregate score would be for an information source if every respondent rated it a “4”) and then the actual sum of the rankings was expressed as a proportion of the possible total. An identical procedure was followed with respect to the question on the value respondents derived from information presented in various formats (e.g., on-farm demonstrations vs workshops).

| Information Source | Importance Rating | Information Source | Importance Rating |
|--|-------------------|---|-------------------|
| Friends and Neighbours | 0.67 | Agriculture and Agri-food Canada | 0.56 |
| Olds College or the Uof A Agr. Faculty | 0.65 | County or MD Agricultural “Fieldman” | 0.53 |
| Print Media | 0.62 | Producer or Commodity Groups | 0.51 |
| Electronic Media | 0.59 | Alberta Environmental Protection | 0.50 |
| Company (Sales) Representatives | 0.57 | Alberta Environmentally Sustainable Agriculture Program | 0.41 |

In the table above we summarize our findings on the relative importance respondents attached to various sources of information. Based on these results it seems that relatively more importance is attached to friends and neighbours and post-secondary institutions,

while relatively less importance is attached to public agencies and producer groups. The media and company representatives occupy the middle of the distribution.

The high level of importance attached to friends and neighbours is consistent with the literature on the diffusion of innovations (see, for example, Rogers, 2003), and so is not surprising. The relatively high rating attached to post-secondary institutions may be a function of the fact that about half our sample had attended a post-secondary institution. That relatively less importance is attached to government agencies and programs may be a function of the general political climate in southern Alberta, a phenomenon that has been documented elsewhere. For instance, in a study examining the weather information needs and preferences amongst a small sample of southern Alberta farmers, Johnston *et al.* (1994) found a high level of distrust surrounding information provided by public agencies, especially those attached to the Federal Government. In contrast, private broadcasters were ranked amongst the most trusted sources of weather information.

In Table 12 we summarize the results for the question we asked about how much value respondents derive from various information formats. Not surprisingly, respondents value face-to-face meetings with extension agents and on-farm demonstrations the highest. This underscores the ongoing importance that rural populations place on interpersonal relationships, agrees with diffusion theory, and is consistent with the finding reported above concerning the importance that respondents' attach to friends and neighbours.

| Information Source | Importance Rating | Information Source | Importance Rating |
|--|-------------------|--|-------------------|
| Face-to-face Meeting With MD/County "Fieldman" | 0.64 | Workshops and Short Courses | 0.54 |
| On-farm Demonstrations | 0.64 | Internet | 0.49 |
| Materials (pamphlets and CD's) From Gov't Agencies | 0.58 | Alberta Agriculture's "Ropin' the Web" website | 0.41 |

The relatively low ranking of the internet in general and the "Ropin' the Web" website maintained by Alberta Agriculture, Food and Rural Development in particular, are noteworthy. This finding may be a function of a lack of familiarity with the technology, especially amongst the older members of the sample. On the other hand, 80% of respondents told us they use a computer for record keeping, and so are clearly computer-literate, nearly two-thirds reported searching for agriculturally-related information on the internet, and almost half reported using the internet specifically to search for information about drought-proofing measures. Consequently, although there appears to be considerable use of the internet, including sites dedicated to agriculture, perhaps the level of satisfaction could be higher.

(VII) Conclusion

Based on the analysis presented here a number of conclusions can be drawn. First, there is a widespread appreciation that drought is a relatively common event in the region and a good understanding that drought may become more frequent in the future. The notion that the increased probability of drought is linked to human-induced global climate change is an idea that seems to enjoy somewhat less support amongst farmers and ranchers in the study area. There is also a certain confidence amongst the respondents to our survey that they are well prepared for drought and have put in place a range of strategies to cope with drought that are both necessary and sufficient. Given that the droughts of 2001 and 2002 were amongst the worst on record since the 1930s and the region did not undergo the massive adjustments in terms of land-use change that it did then, there may well be a basis for optimism. On the other hand, the financial losses caused by those droughts did necessitate intervention by both the Alberta and Saskatchewan governments in the form of drought-response packages. It remains to be seen, however, whether or not that sort of support can be sustained in the future in the event of more frequent droughts. It is worth noting in light of these comments that about a third of our respondents indicated that drought programs do play an important role in how they prepare for drought.

Secondly, we found that about half of the measures that had been adopted (and for which we had year-of-adoption information) were adopted before the 1987 drought, and that the vast majority of measures adopted offered producers obvious benefits in terms of lowering production costs and/or enhancing productivity. Measures specifically designed to reduce risks associated with drought were less widely adopted, especially if those measures did not also offer coincident benefits in terms of cost reduction or productivity gains. Consequently, the droughts of 2001 and 2002 appear not to have stimulated widespread change in farming and water-use practices, and many of the adoptions documented in this study may not have been taken up with the express purpose of reducing the risks associated with drought.

Third, the analysis of barriers to adoption suggests that financial considerations are prominent and quite probably preeminent in the adoption decision. This is hardly surprising as it is consistent with previous work on similar questions. For example, in their 1998 study of nearly 200 southern Alberta irrigation farmers, Johnston *et al.* (2001) report that half of their respondents identified budgetary constraints as amongst the most important reasons for not adopting more water conserving measures than were being employed at the time. Although the constraint analysis found that financial considerations are a major barrier to the adoption of drought-proofing measures for many producers, these barriers, while difficult, are not insurmountable.

Fourth and finally, some observers may be disappointed by the finding that of the just over 1,000 drought-proofing measures that could have possibly been adopted by the participants in our study, only 40% of the total number of measures were actually taken up. Alternatively, this result underscores the fact that there is considerable room for further adjustment in the system and hence a basis for optimism. Financial constraints can be overcome, but it will require political will and a well formulated plan were accessible

information is delivered by trusted and respected sources, and complemented by policy instruments that directly address producers' financial constraints.

In the introduction we indicated that this document represents a report on the first phase of a multi-phase project. Based on the insights gained from this pilot survey, our questionnaire will be adjusted and re-administered. Additionally, the two lead authors, Johnston and Cuthbert, will be commencing a series of case study interviews with a subset of respondents representing a variety of production systems. Finally, discussions are underway with the City of Lethbridge Manager of Environmental Services to survey a sample of city households regarding their indoor and outdoor water use. The hope is to then conduct a rural-urban comparison on water conservation, extending the work described here.

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APPENDIX A

The South Saskatchewan Basin Drought Response Study

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Drought Response Study: Introduction

- The farming and ranching sectors in western Canada were hit especially hard by the droughts of 2001, 2002 and in some places, 2003.
- There is good reason to believe that in the future, droughts of similar or even greater severity may occur more frequently
- Consequently, we need to be as well prepared as possible.

- The purpose of this survey is to gather information from farmers and ranchers so we can understand how producers prepared for and responded to these droughts.
- The information you provide, which will be combined with responses received from many other producers, will be used enhance our drought preparedness.
- Your responses will be treated in strictest confidence.

- None of the information you provide will be used for purposes other than this research project, and no information will be shared in any way at all.
- The survey has been approved by the Human Subject Research Committee at The University of Lethbridge. It meets the standards set out in the Tri-Council Policy Statement entitled "*Ethical Conduct for Research Involving Human Subjects*".

**Questions can be directed to Dr. Tom Johnston
at the address above.**

If you do not operate a farm as defined by Statistics Canada, please do not complete this survey.

Please answer only those questions that are relevant to your operation. You are free to skip any question you don't wish to answer. By completing this questionnaire, you are indicating that you consent to participating in this study.

1) How many years have you been farming? _____

2) Are you currently in a managerial position? No
 Yes

3) If you answered YES to the previous question, how many years? _____

4) Which of the following categories best describes your operation?
 Owner Operated
 Family Partnership
 Non-Family Partnership
 Family Corporation
 Non-Family Corporation
 Other (Specify) _____

5) Please tell us about your farm. Use the measure you are most comfortable using.

| | Acres | Hectares | 1/4 Sections |
|--------------------------------|--------------|-----------------|---------------------|
| Total size of operation | | | |
| Area Owned | | | |
| Area Leased or Rented | | | |

6) Are you an irrigator? No
 Yes

If you answered Yes, Please complete the following two questions.

7) Total area under irrigation in **2006**. (Please specify measurement unit)? _____

8) Please indicate the area irrigated by each of the following systems:

Central Pivot _____
Solid Set _____
Side Roll _____
Flood _____

9) What is your Postal Code? _____

10) In which town do you grocery shop most of the time? _____

11) In what Township and Range is your home farm located?

TWP: _____
Range: _____
Meridian: _____

For questions on this section, please provide information about the **2006** production year.

12) Land use. Again, use whatever measure you prefer.

| | Acres | Hectares | 1/4 Sections |
|-----------------|-------|----------|--------------|
| Land in crops | | | |
| Summer-fallow | | | |
| Seeded forages | | | |
| Natural pasture | | | |
| All other land | | | |

13) How would you describe your operation? (E.g. dairy farm, feedlot, cow-calf, etc.) _____

14) Crop production - Please list the top five crops grown in **2006**, along with the seeded area.

| | 1 | 2 | 3 | 4 | 5 |
|--------------|---|---|---|---|---|
| Crop | | | | | |
| Acres | | | | | |
| Hectares | | | | | |
| 1/4 Sections | | | | | |

15) Livestock - Please provide information on livestock on hand as of December 31, 2006. If you can't remember exact numbers, then approximate counts are fine.

| | Total Number | | Total Number |
|-------------------------------|---------------------|-----------------------------|---------------------|
| Dairy Cows | | Laying Hens | |
| All other dairy Cattle | | Broilers and Rosters | |
| Beef Cows: breeding | | All other hens and chickens | |
| Replacements: calves/ heifers | | Total number of turkeys | |
| Pigs | | All other poultry | |
| Sows and gilts for breeding | | All sheep and lambs | |
| Growers and finishers | | All goats | |
| All other pigs | | Horses | |
| | | Other Livestock | |

16) If you are a feedlot operator, please indicate the total number of pens on your operation(s). _____

- The next series of questions relate to the adoption of what are called drought-proofing measures.
- The measures relate to both your farm/ranch as well as to your household.
- Drought proofing refers to actions that can be taken and technologies that can be used to reduce the risk associated with drought.
- Drought-proofing measures range from using less water more efficiently, to conserving soil moisture, to taking action that allows you and your operation to "ride out" a drought.

- Below is a list of measures that can be used to reduce indoor household water consumption.
- Please indicate the year in which the measure was adopted. If still currently in use.
- For those you are not using, please identify the relevant factors/considerations from the list of possible reasons given.

| | IF YES | | IF NO (please identify all that apply, but circle most important reason) | | | | |
|------------------------------------|---|--------------|--|--------------------------|--------------------------|----------------------------------|------------------------|
| | Adopted | Year Adopted | Risk of drought is low | Too Costly | Unaware of the measure | Cannot use with existing systems | Other – please specify |
| Low-flow showerheads | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Ultra-low flush toilets | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Dual flush toilets | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Composting toilet system | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Gray water system ¹ | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Front load clothes washing machine | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Water meter | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |

1. Gray water system Household waste water is filtered and stored to be used for irrigation.

- Below is a list of measures that can be used to reduce Outdoor household water consumption.
- Please indicate the year in which the measure was adopted. If still in use.
- For those that you are not using, please identify the relevant factors/considerations from the list of possible reasons given in columns 3 to 7.

| | IF YES | | IF NO (please identify all that apply, but circle most important reason) | | | | |
|---|---|--------------|--|--------------------------|--------------------------|----------------------------------|------------------------|
| | Adopted | Year Adopted | Risk of drought is low | Too Costly | Unaware of the measure | Cannot use with existing systems | Other – please specify |
| Timers on sprinklers | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Xeriscaping ¹ | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Plant drought tolerant plants | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Collect rainwater | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Dig well, dig/expand dugout, hook up to municipal water | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |

1. Xeriscaping is a landscape design philosophy which uses techniques to reduce the amount of water used in the irrigation of a landscape. This involves using low water or drought tolerant plants, efficient irrigation techniques, and the use of mulch and appropriate soils.

| | The most common time of day watering occurs | Type of sprinkler system | Frequency of watering. Daily or Weekly | Typical length of watering (hours) |
|-----------------|---|--------------------------|--|------------------------------------|
| Lawn Watering | | | | |
| Garden Watering | | | | |

Below is a list of measures that can be adopted to conserve soil moisture or enhance the moisture holding capacity of your soil.

- Please indicate the year in which the measure was adopted. If still currently in use.
- For those that you are not using, please identify the relevant factors/considerations from the list of possible reasons given in columns 3 to 7.

| | IF YES | | IF NO (please identify all that apply, but circle most important reason) | | | | |
|--|---|--------------|--|--------------------------|--------------------------|----------------------------------|------------------------|
| | Adopted | Year Adopted | Risk of drought is low | Too Costly | Unaware of the measure | Cannot use with existing systems | Other – please specify |
| Conservation tillage ¹ | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Cultivate along land contours | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Zero or minimal tillage ² | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Sculpt stubble to trap snow | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Chemical fallow | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Leave a litter cover of 30% | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Field shelter belts | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Cultivate at right 90 degrees to prevailing wind | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Build/ maintain soil organic matter | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Other | | | | | | | |

1. Conservation tillage: A practice involving crop residue management designed to reduce soil erosion and to maintain or enhance soil moisture.

2. Zero or minimal tillage: A practice whereby the seeds are planted directly into the seedbed, which has not been tilled since harvest of the last crop.

Below is a partial list of things that can be done within cropping and range management systems in order to reduce the impact of a drought.

- Please indicate the year in which the measure was adopted. If still currently in use.
- For those that you are not using, please identify the relevant factors/considerations from the list of possible reasons given in columns 3 to 7.

| | IF YES | | IF NO (please identify all that apply, but circle most important reason) | | | | |
|--|---|--------------|--|--------------------------|--------------------------|----------------------------------|------------------------|
| | Adopted | Year Adopted | Risk of drought is low | Too Costly | Unaware of the measure | Cannot use with existing systems | Other – please specify |
| Return seeded pastures to native grasses | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Plant cropland to forage | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Plant drought tolerant crops | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Plant drought tolerant cultivars (i.e. variety of particular crops) | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Plant winter cereals | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Change cropping rotation to interrupt “pest” cycles | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Use precision farming techniques (GPS) to optimize chemical applications | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Other | | | | | | | |

Below is a partial list of things that can be done within livestock management systems in order to reduce the impact of a drought.

- Please indicate the year in which the measure was adopted. If still currently in use.
- For those that you are not using, please identify the relevant factors/considerations from the list of possible reasons given in columns 3 to 7.

| | IF YES | | IF NO (please identify all that apply, but circle most important reason) | | | | |
|--|---|--------------|--|--------------------------|--------------------------|----------------------------------|------------------------|
| | Adopted | Year Adopted | Risk of drought is low | Too Costly | Unaware of the measure | Cannot use with existing systems | Other – please specify |
| Established emergency feed supply | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Made arrangements for emergency pasture | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Instituted a rotational grazing system | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Increases storage capacity of dugouts | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Reduced stocking rates | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Provide shade or shelter for livestock | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Culled older (more vulnerable) livestock | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Other | | | | | | | |

This is the last table in this sequence! Contained below is a partial list of things that can be done from a farm business management perspective in order to reduce the impact of drought.

- Please indicate the year in which the measure was adopted. If still currently in use.
- For those that you are not using, please identify the relevant factors/considerations from the list of possible reasons given in columns 3 to 7.

| | IF YES | | IF NO (please identify all that apply, but circle most important reason) | | | | |
|---|---|--------------|--|--------------------------|--------------------------|----------------------------------|------------------------|
| | Adopted | Year Adopted | Risk of drought is low | Too Costly | Unaware of the measure | Cannot use with existing systems | Other – please specify |
| Setup contingency fund | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Pay careful attention to drought alerts | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Diversify crop/livestock mix | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Farm-based business (e.g. B&B) | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Purchase crop insurance | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Work off the farm | <input type="checkbox"/> No <input type="checkbox"/> Yes | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Other | | | | | | | |

24) If you engaged in either farm diversification or cultivated an additional household income stream, please respond to the following statements. If not, please ignore this section.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree | No opinion |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| The recent droughts influenced my farm diversification decision. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| The recent droughts influenced the decision to obtain off-farm work | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

25) Could you please provide details on your farm diversification decision?

26) The following are some general questions relating to your views on drought and its impact.

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree | No opinion |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| The recent droughts were abnormal events for my area. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Government drought relief plays an important role in how I think about preparing for future droughts. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| My area will experience an increasing number of droughts in the future. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Information from the government on drought proofing is easy to find/obtain. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Information from the government on drought proofing is clear and easy to understand. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree | No opinion |
| The likelihood that drought will become more frequent in my area in the future is low. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I have a good understanding of what I can do to reduce the risks associated with drought. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| If we have another drought, the government will put in place a drought relief package to compensate producers for losses. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Expanding irrigation capacity is a good way to reduce agriculture's vulnerability to drought. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Claims that climate may already be changing, and that we are responsible, are overblown. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| My measures to reduce adverse drought effects were successful. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

27) If you scored agree or strongly agree on the last question of the previous page, please tell us how you define the effectiveness of the drought-proofing measures you use.

28) Of the following agencies or organizations, please indicate the importance you attach to each in terms of the information and advice they offer.

| | No opinion | Not very important | Important | Very important | Extremely important |
|---|--------------------------|---------------------------|--------------------------|--------------------------|----------------------------|
| The Alberta Environmentally Sustainable Agriculture (AESAs) Program | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Alberta Environmental Protection | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Cows and Fish (Alberta Riparian Habitat Management Society) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Your county or MD agricultural fieldman | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Your local Agricultural Research Association/Group | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | No opinion | Not very important | Important | Very important | Extremely important |
| Producer or Commodity Associations | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Prairie Farm Rehabilitation Administration (PFRA) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Agriculture and Agri-Food Canada (AAFC) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Chemical representatives | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Post-secondary institutions (such as Olds College or the University of Alberta Ag. Faculty) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | No opinion | Not very important | Important | Very important | Extremely important |
| Broadcast Media (TV and Radio) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Print media (newspapers and magazines) E.g. Western Producer and Grand News | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

29) We know that farmers and ranchers rely on a variety of types or forms of information on new techniques and technologies. Please use the scale below to rate how valuable to you each of the following is.

| | No opinion | Not very valuable | Valuable | Very valuable | Extremely valuable |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Alberta Agriculture, Food and Rural Development's "Ropin' the Web" web site | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| The Internet in general | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Printed material and other resources (e.g., CDs) produced by government agencies | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Workshops, short courses and presentations | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| On-farm demonstration sites | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Face to face meetings with your County or MD fieldman | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Agricultural exhibitions, fairs and trade shows | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Friends and neighbours | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Private consultants | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

30) Please respond to the following questions with a yes or no answer. Over the last five years, have you...

| | Yes | No | | Yes | No |
|---|--------------------------|--------------------------|--|--------------------------|--------------------------|
| Used a computer to keep farm records | <input type="checkbox"/> | <input type="checkbox"/> | Taken an agricultural-related on-line course | <input type="checkbox"/> | <input type="checkbox"/> |
| Used the Internet to look for agricultural-related information | <input type="checkbox"/> | <input type="checkbox"/> | Used a piece of computer-based decision-support software | <input type="checkbox"/> | <input type="checkbox"/> |
| Attended a producer organization meeting | <input type="checkbox"/> | <input type="checkbox"/> | Consulted your local agricultural fieldman about a problem | <input type="checkbox"/> | <input type="checkbox"/> |
| Obtained print or other material from Alberta Agriculture, Food and Rural Development | <input type="checkbox"/> | <input type="checkbox"/> | Obtained print material from Prairie Farm Rehabilitation Administration (PFRA) or Agriculture and Agri-Food Canada | <input type="checkbox"/> | <input type="checkbox"/> |
| Purposely sought information about drought-proofing measures | <input type="checkbox"/> | <input type="checkbox"/> | Looked for information on new agricultural practices and emerging trends in farm magazines | <input type="checkbox"/> | <input type="checkbox"/> |
| Taken an agricultural-related short course or participated in a workshop | <input type="checkbox"/> | <input type="checkbox"/> | Print media (i.e. Western Producer) | <input type="checkbox"/> | <input type="checkbox"/> |
| | | | Used a private agricultural consultant | <input type="checkbox"/> | <input type="checkbox"/> |

31) Please identify up to five sources that you have found helpful over the last five years for information on drought aid and proofing.

1. _____ 2. _____ 3. _____
 4. _____ 5. _____

32) Are you male or female?

Male
Female

33) Which of the following age categories do you fit into?

34 years or younger
35 to 44
45 to 54
55 to 64
65 to 74
75 years or older

34) What is the highest level of education you have successfully completed?

Grade 8 or less
High School
Post-secondary (College)
Post-secondary (University)

35) Which of the following categories does your operation fall into in terms of total capital value? Please remember that all information we collect will be held in the strictest of confidence.

less than \$50,000
\$50,000 to \$99,000
\$100,000 to \$199,000
\$200,000 to \$349,000
\$350,000 to \$499,000
\$500,000 to \$999,999
\$1,000,000 to \$1,499,999
\$1,500,000 to \$1,999,999
\$2,000,000 and over

36) Now, it's your turn. Please provide any comments you might like to share with us.

Please don't forget to include the consent form when you return this questionnaire.

Thank you for your time!