AN AGROCLIMATIC RISK ASSESSMENT OF CROP PRODUCTION ON THE CANADIAN PRAIRIES

BY

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ABSTRACT

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An agroclimatic risk assessment for agricultural production across the Canadian prairie provinces has been assembled to address challenges related to frost, heat units, and moisture. Based on 30 years of daily climate data from 1971 though 2000 from 230 climate stations, the assessment provides a series of risk maps depicting the likelihood to achieve certain thresholds of frost dates or durations, heat unit accumulations, growing season rainfall, crop water demand (CWD), and crop water deficits. Maps for each parameter provide a spatial representation of 50%, 25%, and 10% risks and the coefficient of variation. Results related to the thermal attributes of the agroclimate suggest a limited area with sufficient heat units to sustain grain corn (*Zea mays*); mostly restricted to southern Manitoba and southern Alberta. Potato (*Solanum tuberosum*) is also limited due to an inadequate tuber bulking period in all but the southern prairies. Canola (*Brassica napus*), wheat (*Triticum aestivum*), and most forages have few thermal limitations though risk of frost exists for all crops with more variability in frost dates in spring than fall. Moisture is a limitation to production throughout the prairies. Wheat has the lowest risk of moisture deficits followed by corn and then by forages. The probability of stress for all crops increases from east to west and from south to north. Southeastern Alberta and southwestern Saskatchewan are most likely to sustain severe moisture stress while central Alberta and eastern Manitoba are least likely.

To investigate temporal trends in corn heat units (CHU), growing season rainfall, CWD, and moisture deficit for grain corn, an 80-year subset of daily climate data was analyzed. Over this period, average CHU have increased by 0.46 CHU yr^{-1}. An increase of 0.38 mm yr^{-1} in growing season precipitation combined with a decrease of 0.50 mm yr^{-1} in CWD resulted in an overall decrease in moisture deficit of 0.32 mm yr^{-1}. Though spatial variability was evident, these findings show a general trend towards a warmer climate with less water stress. This quantification of agroclimatic risk will assist with adaptation to some of the vulnerabilities related to climate.

ACKNOWLEDGEMENTS

It began in 2003 when a colleague, Bruce Murray, says “Why don’t you go get your Masters?” Since I had no reason why not, I was soon meeting with Paul Bullock, my soon-to-be advisor, charting out this project. Around the same time, while sharing my thoughts of doing a thesis, Loraine Bailey, of the Manitoba Corn Growers Association, offered support on behalf of MCGA. Next came the endorsement of my boss at Manitoba Agriculture, Don Dixon who allowed me to work part time so that I could spend the rest of my time in academia. Somehow along this journey, my wife, Angella also encouraged and tolerated my indulgence. To all of these individuals, for their contributions in one way or another, I am grateful.

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LIST OF ABBREVIATIONS

AWHC	Available water holding capacity
BMT	Biometeorological time
CHU	Corn heat unit/Crop heat unit
CU	Consumptive use factor
CV	Coefficient of variation
CWD	Crop water demand
D_B	Bulk density
DTM	Days to maturity
E_L	Latent evaporation
ET	Evapotranspiration
ET_0	Reference evapotranspiration
EX	Excess moisture
FFD	Frost free days
FFF	First fall frost
GCM	General Circulation model
GDD	Growing degree day
GIS	Geographic information system
HCM	Heat maturity constant
I	Infiltration
JD	Julian Date
LSF	Last spring frost
m	Rank
masl	Meters above sea level
MCHU	Modified corn heat unit
P	Probability
P-Day	Physiological day
q	Risk
Q_0	Solar energy - top of atmosphere (cal cm^{-2})
SLC	Soil Landscapes of Canada
SMW	Soil moisture withdrawal
T	Return period
T_{MAX}	Maximum temperature
T_{MIN}	Minimum temperature
WUE	Water use efficiency

1. INTRODUCTION

While the world experiences staggering population growth combined with an enhanced tendency to consume, a shrinking land and water resource combined with increased climate variability present some tremendous challenges for agriculture in the 21st century. As these changes occur, strategies must be developed to assure that crop production remains sustainable. One method of achieving this is to ensure that crops and cropping practices are optimized and suited to their climate. While agricultural production is inherently associated with a certain degree of risk, the knowledge and management of these risks is the key to avoiding failure.

Agrometeorological and agroclimatological information are meant to improve and/or protect the primary agricultural production factors such as yield, quality, and income while at the same time protecting the agricultural resource base from degradation (Stigter 2007). Achieving maximum net return in a sustainable manner has always been the mission of the farmer; however a new generation of agribusiness has forced primary agricultural production to function at much larger scales, with higher risks and smaller margins. Increased input costs and a heightened awareness of environmental sensitivities have compelled producers to manage their production practices more strictly than ever before. The result is a farm production system that must consider the natural resources and risks that are present - both the assets and the liabilities. Making the most of the available resources as well as acknowledging and planning for the risks that exist can ensure sustainability into the future. From the point of view of a producer, whose goal is to be successful at farming in the long-term, there is motivation to apply new knowledge to achieve sustained productivity and profitability. Preserving the natural resources surrounding a farming operation will contribute to this long-term sustainability as well as to the well-being of the society as a whole.

The Canadian prairies are situated at the northern fringes of the agricultural production zone within the Great Plains of North America. The region consists of approximately 30 million hectares of crop land that lie between 49° and 59°N and 95° and 120°W. Most of the region is made up of Brown, Dark Brown, and Black Chernozemic soils which originally supported the short, mixed, and tall-grass prairie. As agriculture developed, the native grasses were gradually replaced with cropland. While the soil resource is relatively constant over time, the weather is subject to remarkable variability, making the weather the most challenging and unpredictable aspect of agriculture. In summer, local continental air masses are dominant with decreasing rainfall from east to west. In winter, cold polar air masses are most common. This results in a wide annual temperature range with short hot summers and cold winters. The harsh conditions create a unique set of challenges for agriculture. Specifically, the length of the summer frost-free period and the duration of the growing season present the risk that crops may be injured prematurely by frost in late spring or in early fall. Warmer season crops require ample heat throughout the growing season to enable them to reach physiological maturity and be harvested before the onset of winter. Moisture is also a major constraint to the productivity of crops. Agriculture within the prairie region often experiences moisture deficits where frequently, the amount of water available to the crop during the growing season is less than the water demand during that period. This results in moisture stress as a major yield limitation (Raddatz et al. 1994). While drought is a concern, excess moisture can also be problematic. Heavy spring rains and wet soils can delay spring planting while standing water in a field may inhibit plant development or kill the crop altogether.

The agroclimate can be defined as the combined influences of climatic elements that enable the success of a particular crop. These elements include thermal attributes, moisture characteristic, and a combination thereof. The characterization of the agroclimate can provide an indication of whether, and to what extent the climate of a location will be hospitable to a crop consistently enough to make the attempted production of the crop worth while. An indication of whether this agroclimate has changed over the 20^{th} century can provide a valuable resource for agriculture in order to adapt to these possible changes.

To describe the climate of a region, practitioners often refer to average conditions based on the mean weather taken from a suitable length of record. While an average or "normal" provides a very general representation of the climate, it does not provide information about the variability from the mean or the range of conditions that could be expected to occur from one year to the next.

Operationally, it is never the average conditions but rather the variation and extremes that cause the most extensive damage and loss.

There is always a high degree of uncertainty in climatology. Due to the complexity of the atmosphere and the multitude of teleconnections, an effective way to make predictions in climatology is with probability. Recent climate records reveal the relative frequency of an event, from which we can infer the likelihood of the event occurring in a given year or the frequency that the event might occur within a certain length of time. Since agricultural producers must deal with year to year variability in the weather, it is imperative that information about the climate and the associated risk be quantified and available as a planning tool. By examining the behaviour of past weather, we might be able to infer what the climate of the near future has in store. We may also discover which aspects and to what extent the climate has been changing in the past century.

The first objective of the analyses presented in the following chapters is to provide a current assessment of agroclimatic risk related to three main components of agricultural production in western Canada: frost, heat units, and moisture. The second objective of this thesis is to determine if significant temporal trends have occurred within these three components over the course of the 20th century. As crop production is largely limited by a combination of temperature and moisture, these factors have been addressed separately but in consideration of one's effect on the other.

The first chapter evaluates the risk of spring and fall frost dates along with the frost-free period to provide the likelihood of frost occurrences on certain dates. The second chapter continues to focus on thermal characteristics but expands the investigation to the accumulation of growing season heat units that contribute to the growth and development of canola, corn, potato, and forage crops. In addition, the second chapter contains an investigation of temporal trends in heat units to determine whether the thermal climate has changed over the 20th century. The third major section of this thesis focuses on the supply, demand, and deficits of water for crops, as well how these variables have changed over time. These three sets of parameters related to frost, heat units, and moisture provide an overall characterization of some of the main components of the prairie agricultural climate. Each chapter has some similarity in its approach to characterizing each set of attributes of the agroclimate; however the methods of each section build upon those of the preceding chapter. For example, the dates of spring and fall frosts affect the length of the growing season, which may contribute to either an increase or a decrease in the number of heat units that accumulate during the growing season. Or the amount of water that is required by a crop is a function of the stage of development and vigour of a crop, as well as the amount of energy available for evapotranspiration. All of these factors are related to temperature. Therefore, just as a crop is affected by a multitude of inputs, an assessment of the agroclimatic risk cannot consider the influence of just one factor without considering several factors in combination. In this analysis, every attempt has been made to provide a realistic representation of the agricultural climate together with the risks that this climate brings to the commercial production of crops on the prairies.

The dissemination of agrometeorological information is dependent upon the continuum of knowledge transfer from basic understanding to practical applications (Weiss et al. 1999). Knowledge of agroclimatic risk can assist producers in identifying how it corresponds with the coping range of their operation. If there are substantial risks that would exceed the risk capacity of the operation, a producer may consider implementing adjustments and adaptations designed to decrease their vulnerability. If implementing these techniques is not feasible, then it may necessary to revaluate the system as a whole. As producers begin to implement adaptation strategies, their risk is lowered along with the variability in production and hence, variability in income, can be minimized.

The focus of this research is not climate change per se; however it is important to acknowledge that climates have always been in flux. This has required continuous adaptation to various degrees on the part of those who depend on the climate to ensure continued productivity or to take advantage of new opportunities that may present themselves. The current climate as it relates to agriculture has undoubtedly changed. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007) has reported numerous observed changes throughout the latter part of the 20th century related to increased air temperatures, heat waves, heavy precipitation events, and areas affected by drought. Through comparisons with paleoclimatic data, the current warming is classified as unusual at least compared to the previous 1300 years causing a large amount of uncertainty as to the total consequences these changes may bring.

The development of an agroclimatic evaluation is not a novel idea; in fact, there have been several similar assessments done over parts of the prairies over the years (Sly and Coligado 1974; Dunlop 1981; Sly 1982; Dumanski 1988; Ash et al. 1992; Ash et al. 1993). There have also been assessments of the possible agricultural climate of the future under various climate change scenarios (McGinn et al. 1999; McGinn and Shepherd 2003). Of utmost importance for current adaptation and risk management, is the need to update past assessments to reflect the contemporary climate trends that appear. This can provide a way of bridging the gap between the current climate and what may be the climate characteristics of the future. While producers must consider the long-term sustainability of their farming operations by looking to the future, they must also operate within the constraints of the present agroclimate.

The quality of findings of any analysis is unquestionably reliant upon the quality of the input to the analysis. In this case, historic climate data is the main input. A principal assumption with such an investigation is that variations and trends in the climate dataset are almost entirely of meteorological origin. In other words, the dataset is virtually free of errors or other external factors that would bias the data to produce erroneous conclusions. Unfortunately, there is likely a degree of influence from non-climatic factors, making the dataset inhomogeneous. Over the span of record for most weather stations, there are a number of factors that can compromise the integrity of the time series. As technology and methods have evolved, old equipment and procedures have been replaced with newer ones with a general shift towards automation where the replacement of human observers to automated stations may introduce some shifts. Other sources of error include changes in weather station environments or exposure, such as the relocation of a station or the encroachment of vegetation or structures, instrument malfunctions or substitutions, and observing practices, such as time of observation (Peterson et al. 1998). Another potential source of data inhomogeneities is the effect of urbanization or the so called "urban heat island effect". DeGaetano and Allen (2002) while examining extreme temperatures found that urbanization exerted a strong influence on temperature trends in the United States between 1960 and 1996 with the greatest warming occurring at urban stations. There have been several methods that have been developed to isolate inhomogeneous climate datasets as well as other techniques used to homogenize a dataset (Metcalfe et al. 1996; Mekis and Hogg 1999). These methods and procedures are beyond the scope of this paper. The dataset used in this study has not been adjusted to account for possible inhomogeneities. The author has assumed that these discrepancies in the data would have minimal effect on the final output of the analysis.

2. RISK OF FROST ON THE CANADIAN PRAIRIES

2.1 Abstract

To assess the risk of freezing temperatures on the Canadian prairies, 30 years of daily climate data from 230 weather stations were examined for dates of last spring frost, first fall frost, and duration of frost-free days at air temperatures of 0°C and -2.2°C. The data showed a normal distribution thus allowing probability analyses and the determination of frost risks of 50%, 25% and 10%. Maps were produced to demonstrate the spatial distribution of the variables. The number of frost-free days above 0°C on the prairies is between 65 and 141 at 50% risk with most of the southern prairies above 100 days. At 25% and 10% risk, most of the southern prairies receive at least 90 days and 80 days respectively. The number of days above -2.2°C generally exceeds 130 at 50% risk throughout most of the agricultural area. Shorter frost free periods were mostly found towards the northern fringes of the agricultural region. Coefficients of variation of the frost dates were consistently higher for spring frosts than for fall frosts indicating more variability in spring frost dates. Greater variability reduces the accuracy of prediction from a probability analysis. These maps can be used as an effective planning tool to account for the agroclimatic risk related to crop production.

2.2 Introduction

Frost is one of the most devastating weather events to diminish agricultural productivity. An untimely frost event can result in substantial crop losses and reductions in crop quality (Hayter 1978). Unfortunately, frost during the growing season is a constant threat throughout the northern latitudes.

The overall length of the growing season is largely determined by the length of the frost free season. The frost free season or frost free days (FFD) are determined by the numbers of days between the last spring frost (LSF) and the first fall frost (FFF). Long-term forecasting of spring or fall frost dates is not possible with any degree of accuracy nor may the length of the frost free season be predicted for a given year. Therefore, climatological techniques are often used to analyze recent spring and fall frost occurrences to provide an indication of the probability of a freezing event at various dates throughout the growing season based on past observations. For the agricultural regions of the Canadian prairie provinces, an assessment of the risk of freezing temperatures has been compiled based on 30 years of daily weather observations. The results have been mapped to provide a decision support and planning tool for agricultural production. This information can be applied to planning and risk management.

When past weather conditions are used as a basis for current probabilistic forecasts, there is often a danger that past conditions may not appropriately represent the current climate. In particular, some previous studies have observed changes in frost trends over the past century. For example, air temperatures appear to have increased throughout the late winter and early spring more so than at other times of the year (Bootsma 1994; Zhou et al. 2001; Walther et al. 2002). Fewer late spring frosts would be expected to reduce the risk of frost injury during the early stages of crop development. Bootsma (1994) reported significantly earlier LSF and later FFF over a 100 year period at three stations in western Canada. Cutforth et al. (2004) found that temporal changes in frost dates across the Canadian prairies varied by location and were quite regionally dependent, however general trends showed an average annual increase in FFD of 0.26 days yr^{-1} between 1910 and 1997. Results from 1940 to 1997 showed a sharper increase in FFD at a rate of 0.31 days yr^{-1}. Both time frames also showed more pronounced trends towards an earlier LSF compared with a later FFF. In the northeastern United States, Cooter and LeDuc (1995) found that the start of the frost free period has advanced by 11 days since the 1950's. In 1967, Longley observed increases in average minimum temperatures in Alberta from pre-1950's to post-1950's making it undesirable to combine the two time periods. Increases in the length of the frost free season were as high as two weeks to one month. Considering that frost dates have been changing over time, updated knowledge of frost risk is important to reflect recent climatic trends. Analyses that do not include recent data but rather include data from too far in the past run the risk of not being representative of contemporary conditions and, therefore, may have poor representation of current risk.

Frost risk analyses have been performed in the past by other investigators (Longley 1967; Sly and Coligado 1974; Dunlop 1981; Ash 1991). Most of the results no longer reflect current conditions and many of the analyses do not address the entire prairie agricultural region but rather only cover individual provinces. For these reasons, an update of frost risk on the Canadian prairies was deemed essential to assist agricultural producers with their management of risk.

A freezing or frost event is normally defined as a minimum recorded temperature of 0.0°C measured from the standard Stephenson screen height. When dealing with frost, a confounding factor is that air temperature measured in a Stephenson screen can be several degrees different than the air temperature nearer to the ground or at the crop canopy (Cutforth et al. 2004). Hayter (1978) found that the minimum temperatures between May and October at grass height were on average 4.5°C cooler than those measured at screen height. Therefore, the type and height of the crop will influence the extent of the air temperature discrepancy between that recorded and that of the canopy. For example, the foliage of a crop at the seedling stage will be at its maximum vertical distance from the height of the temperature recording while the height of a tall crop may actually be greater than the height of standard air temperature measurements.

The extent of actual frost damage to a crop will depend on several factors. Specifically, the species, stage, and hardening of the crop, the soil type and soil moisture, the actual air temperature, the duration of freezing, and the rapidity with which freezing takes place are all important (Badaruddin and Meyer 2001). A drop in air temperature of short duration will cause less damage than a prolonged period at the same temperature. When the air temperature drops to 0.0°C, cereal and other crops may not sustain damage. Rather, damage or total loss is more common when minimum temperatures reach -2.2°C, often referred to as a killing frost (Hayter 1978). Hume and Jackson (1981) found that most death occurred at -3.0°C in the early stages of soybean growth; however freezing tolerance increased when seedlings were exposed to low temperatures beforehand. Calder et al. (1965) found that alfalfa seedlings that had undergone a 48-hour hardening at 2.0°C could survive to minimum temperatures of -4.5°C while non-hardened plants could only survive to -3.5°C. Meyer and Badaruddin (2001) evaluated the freezing tolerance of ten seedling legume species after three days of hardening. They found the low temperatures that killed 50% of seedlings for one hour of exposure for the ten species ranged from -3.3°C to -7.4°C. Badaruddin and Meyer (2001) found that unhardened seedling survival averaged from 2% to 40% less than that of hardened legume seedlings that were exposed to temperatures between -4.0°C and -8.0°C. These results show that seedling damage will increase with the speed that the temperature drops to the killing temperature. In general, temperature drops in the spring occur gradually over a two or three-day period in the Great Plains enabling some hardening to occur (Meyer and Badaruddin 2001). Since most historic daily climate data does not provide hourly temperature values but rather a single minimum temperature value per day, there is no way to determine the duration of low air temperatures nor the rates of cooling from historic data. Therefore, we cannot differentiate between the various behaviours of frost or the actual crop damage that would be most likely to result.

Frost can be spatially variable, therefore extrapolation of a frost event should be used with caution as topography, elevation, landscape, and proximity to other features such as water bodies will alter the extent and severity of areas affected by freezing temperatures. The spatial variation of a frost will depend largely on the type of frost event. For example, a radiation frost often occurs on calm clear nights when the escape of terrestrial radiation is unimpeded. The occurrence of radiation frosts tend to be sporadic and localized over the landscape, often present or most severe in lower areas into which cold air can drain. In contrast, advection frosts are caused by large-scale cold air masses that will affect a region relatively uniformly. Conditions created during an advection frost can often allow unobstructed radiation flux from the soil, causing both types of frosts to occur concurrently or simultaneously.

A major difference between radiation and advection frosts is the vertical profile of temperature that commonly occurs during the frost event. During radiation frosts, temperature inversions normally develop (Hayter 1978) while the winds associated with an advection frost will cause mixing of the air, creating a more uniform vertical temperature profile. Spring and fall frosts are generally of the radiative type (Rosenberg and Myers 1962). This causes concerns about the representativeness of a meteorological station given the spatial variability associated with radiation frosts. This is particularly the case if meteorological stations are not representative of their surroundings or where a low density of weather stations within a heterogeneous region does not adequately portray the spatial character of frost risk that actually exists over the landscape. A weather station that is situated within a microclimate is unfavourable to such analyses since in completing the analysis, we must assume that each weather station somewhat adequately represents its greater surroundings. Stations located near urban centers, water bodies, or at an unrepresentative elevation can all be problematic in their depiction of their surrounding region.

2.3 Methods

Daily climate archives collected by Atmospheric Environment Services of Environment Canada and acquired from the Eastern Cereal and Oilseeds Research Centre of Agriculture and Agri-Food Canada were analyzed for this assessment. A 30-year period of analysis using daily climate data from 1971 through 2000 was selected consistent with recommendations of the World Meteorological Organization (World Meteorological Organization 1983) and the Meteorological Service of Canada (Allsopp and Morris 2004). A dataset drawn from stations in operation prior to 1971 would increase the spatial density of climate stations across the provinces but would not be expected to detect the most recent frost trends, particularly from climate stations that may have been discontinued several decades ago. Retaining these datasets would ignore any changes in frost dates that have occurred in recent years.

The dataset has been quality controlled and data gaps have been filled. In using the dataset for this climatic assessment, an assumption was made that each station would adequately represent its surrounding area and that differences in observations between stations are due to their regional climate rather than local-scale or non-climatic features. Some of these local properties affecting the data may include topographical differences, lake effect, urban heat island effect, or different observational procedures. Therefore, the siting, the history, and the individual elements of each station were not considered in this analysis. This could introduce the potential for some outliers from stations that may not actually be representative of their respective regions.

A subset of minimum daily temperature values from March through November for all available climate stations were extracted from the larger dataset. Any stations having fewer than 20 full seasons of data were removed from the dataset leaving a total of 230 stations; 60 stations in Alberta, 93 in Saskatchewan, and 77 in Manitoba. Figure 2.1 shows the locations of each climate station included in the analysis. For each location and each year, the dates of the last spring freezing events and the first fall freezing events were tabulated for temperatures of 0.0°C to represent a light frost and -2.2°C to represent a killing frost. LSF 0.0°C and LSF -2.2°C were considered the last day each spring prior to July 15 with a recorded temperature of 0.0°C and -2.2°C or less, respectively. The FFF 0.0°C and FFF -2.2°C were the first occurrences of freezing at each minimum temperature after July 15 of each year. FFD 0.0°C and FFD -2.2°C are the number of days between LSF and FFF each year at the two temperature thresholds.

A given set of observations that follow a normal or Gaussian distribution enable numerous valuable elements to be derived from the data, in particular the probably with which the event is expected to occur. Since both the dates of first and last frost are independent and random events, they, as well as the number of frost free days are expected to be normally distributed. To confirm that each

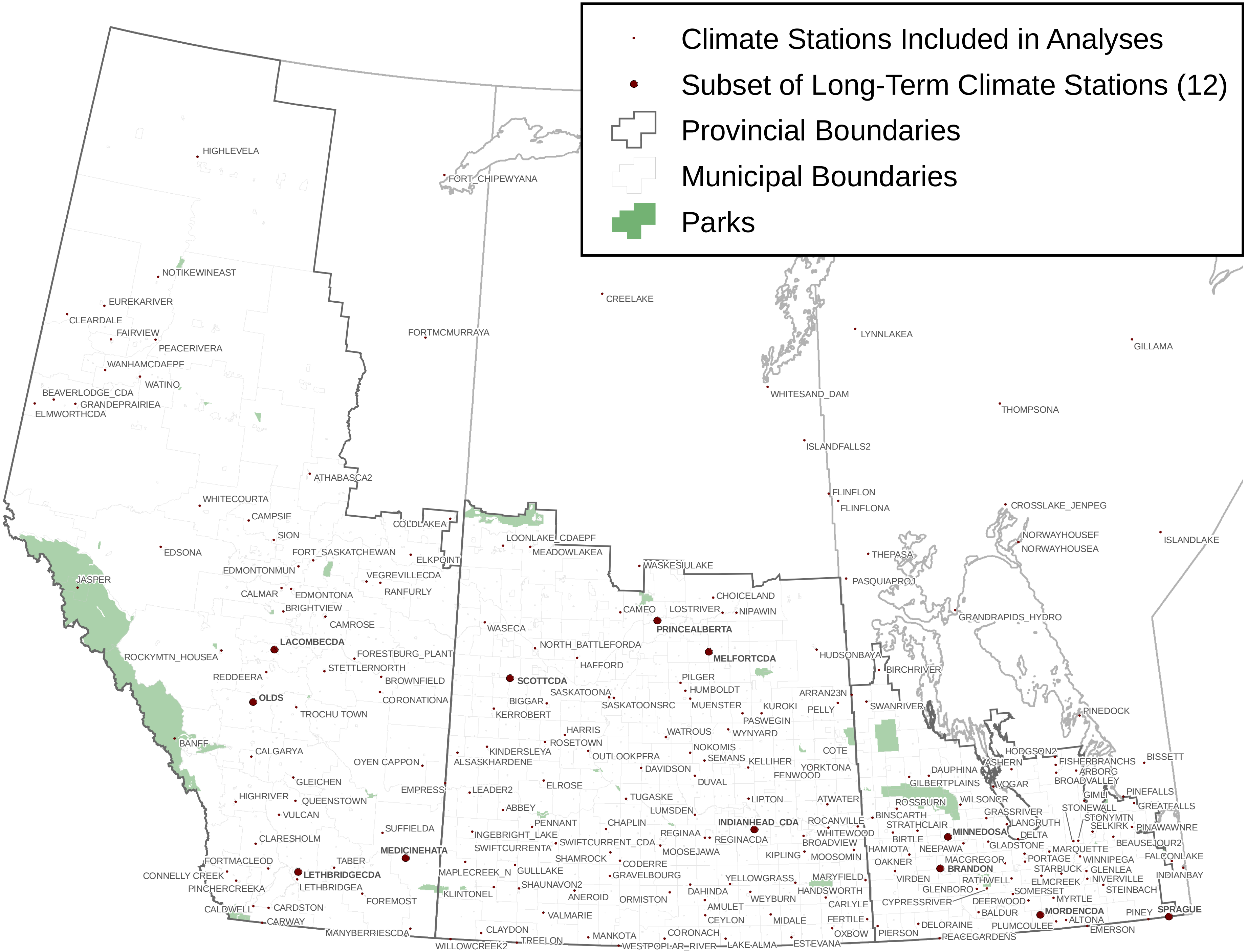

Figure 2.1 Locations of climate stations included in the analyses

parameter could be fit to a normal distribution, subsets of stations were evaluated using the Shapiro-Wilk test where the W statistic approaches one for normally distributed data (Shapiro and Wilk 1965). In nearly all cases, the W statistic was larger than 0.927, indicating a *P*-value greater than 0.05, confirming the three parameters to be normally distributed.

From each set of climatological station data, the mean, the standard deviation, the upper and lower quartiles, and the upper and lower deciles were determined for LSF, FFF, and FFD at minimum temperatures of 0.0°C and -2.2°C. The mean value, which in a normal distribution will correspond with the median and the mode, indicates the 50% probability of an event to occur. Since the area under the normal curve is one ($0 \leq P(A) \leq 1$), the probability of event (A) not happening (q) is $1 - p(A)$, therefore 50% probability is equivalent to 50% risk. The quartiles refer to 25% and 75% probability values or inversely 75% and 25% risk levels, respectively. The deciles refer to 10% and 90% probability or 90% and 10% risk. According to the qualitative description provided by the Intergovernmental Panel on Climate Change (2007), an event with a probability >90% is *very likely* and one with a probability <10% is *very unlikely* to occur. One half of the observations would be expected to occur within the interquartile range (25-75%) and 80% of the observations would be expected to fall between the interdecile range (10-90%). For LSF, each risk level represents the risk that frost will occur on or after the date indicated. For FFF, the risk represents whether frost will occur on or before the date indicated. The risk of FFD provides an indication of the probability that the FFD will exceed the value provided.

Probability and risk may also be expressed as a return period (T). For less common events, T can be used as a convenient indicator of whether an event of certain magnitude is likely to occur once within so many years. For example, an event with a 50% probability (0.5) can be transformed into a return period by T = 1/P which equals two years, or an expected recurrence interval of once every two years. An event with a probability of 10% would be expected to only occur once in 10 years. Return period does not suggest that the event of certain magnitude will occur on regular intervals such as every 10 years or that the event will not occur until 9 years after the previous occurrence of the event. Instead, return period should be considered over the long term, such as several decades or centuries depending on the likelihood and nature of the event.

As a measure of the degree of variability from year to year at each location, the coefficient of variation (CV) was calculated as a function of the standard deviation and the mean of each sample. A larger CV indicates that there is a wider fluctuation in conditions at a climate station. Year to year variability is perhaps the most important indicator of risk since this inconsistency reduces the predictability of any parameter. If a certain weather parameter is consistent from one year to the next, planning is much more straightforward as opposed to planning for events that fluctuate a great deal every year. Conditions that resemble the mean with little year to year variation bring less risk since abnormal events are less common. Those that greatly deviate from normal conditions make adaptation more difficult.

Final results were tabulated and the LSF, FFF, and FFD at risks of 50%, 25%, and 10% and their associated CV were plotted onto a base map of the prairies using ArcGIS/ArcInfo (Environmental Systems Research Institute Inc. 2006). Each parameter was interpolated using an inverse distance weighted technique to provide a continuous surface over the entire area.

2.4 Results and Discussion

2.4.1 Last Spring Frost

Areas with the earliest mean date of LSF 0.0°C occur mainly along the southern borders of the three provinces (Figure 2.2). In southern Alberta, this area spans between Lethbridge and Medicine Hat, extending south to the United States border. In Saskatchewan, the southwest corner has the earliest LSF 0.0°C dates around Estevan followed by the surrounding stations to the east towards Manitoba and to the northwest to Moose Jaw and Swift Current. In Manitoba, the earliest average LSF dates occur in the Morden, Altona, and Emerson area in the south-central part of the province. These areas all have similar dates of LSF 0.0°C ranging from May 16 to May 20 (Appendix II). Most of the remaining portions of the prairies range in dates of LSF 0.0°C between May 20 and May 25. Areas with LSF dates later than May 25 are generally located towards the northern fringes of the agricultural area with the exception of some pockets in the south. Most notable is the large area of southwestern Saskatchewan with the latest LSF 0.0°C date of June 14 at Klintonel, Saskatchewan. Spring frost dates also become later moving west towards the Rocky Mountains in Alberta and moving east towards the Ontario border in southern Manitoba. The results of 25% (Figure 2.3) and 10% risk (Figure 2.4) of LSF 0.0°C have similar geographical distributions across the prairies to the 50% risk map; however the earliest dates range from May 15 to May 25 at 25% risk and from May 20 to May 30 at 10% risk.

The earliest dates of LSF -2.2°C (Figure 2.6) occur mainly in a large portion of southern Alberta and in a few small pockets to the north where the dates range from April 25 to May 4. Most other areas of the prairies range in dates of LSF -2.2°C from May 5 to May 14. At 25% risk (Figure 2.7), the earliest dates also occur in southern Alberta where they range from May 3 to May 8. At 10% risk (Figure 2.8), these areas range from May 10 to May 15. Much of southern Alberta, south of Drumheller extending into Saskatchewan towards Saskatoon and North Battleford, southeastern Saskatchewan, and south-central Manitoba mostly range in dates of LSF -2.2°C from May 10 to May 15 at 25% risk and May 15 to May 20 at 10% risk.

Certain regional differences are apparent from assessing the variability in dates of LSF 0.0°C by means of the CV (Figure 2.5). The areas with the lowest year to year variability indicated by the smallest CV occur in southern Manitoba and range from 5.0% to 6.0%. Regions with CV between 6.0% and 7.0% occur in the Grande Prairie region of northern Alberta, the region south of Edmonton, the Estevan area of southeastern Saskatchewan, and much of southern Manitoba. Areas with the highest CV for LSF 0.0°C and therefore the highest year to year variability are most prominent in southwestern Saskatchewan around Klintonel,

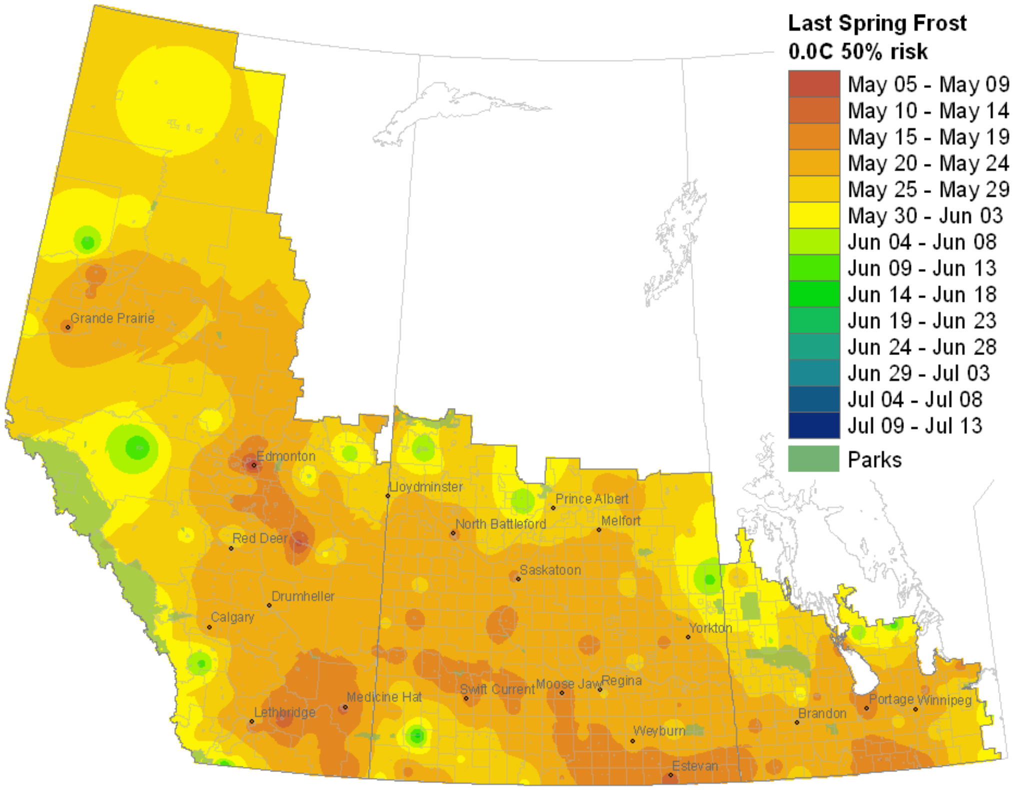

Figure 2.2 Date of last spring frost of 0.0°C at 50% risk

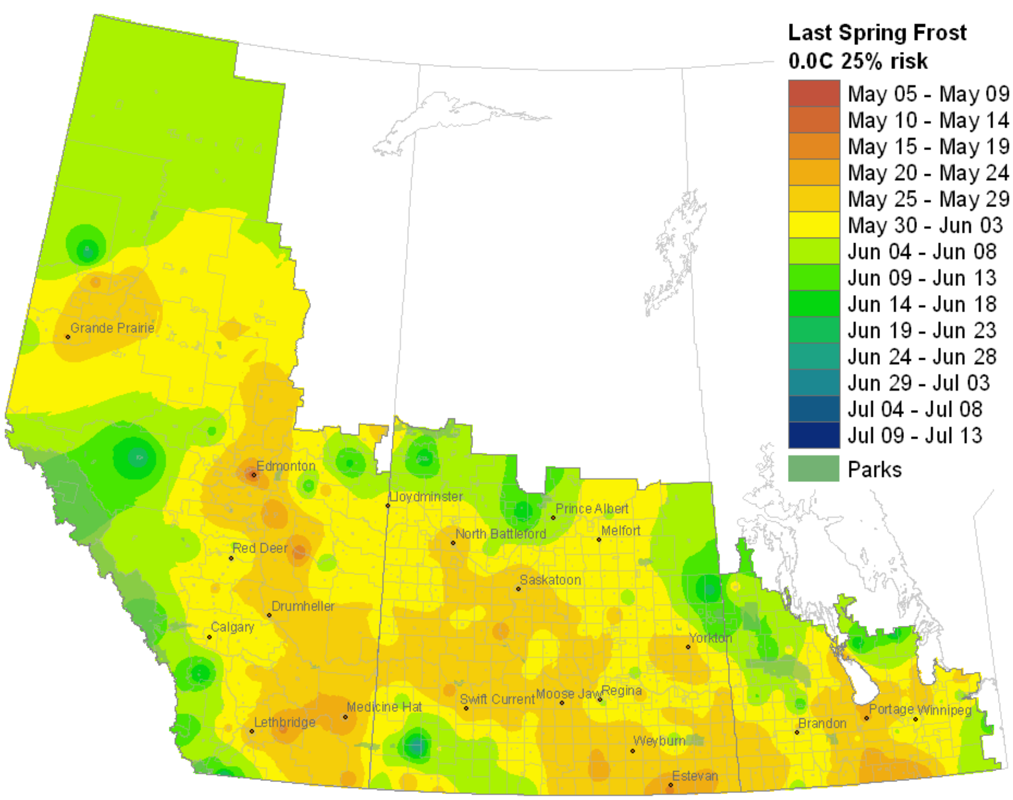

Figure 2.3 Date of last spring frost of 0.0°C at 25% risk

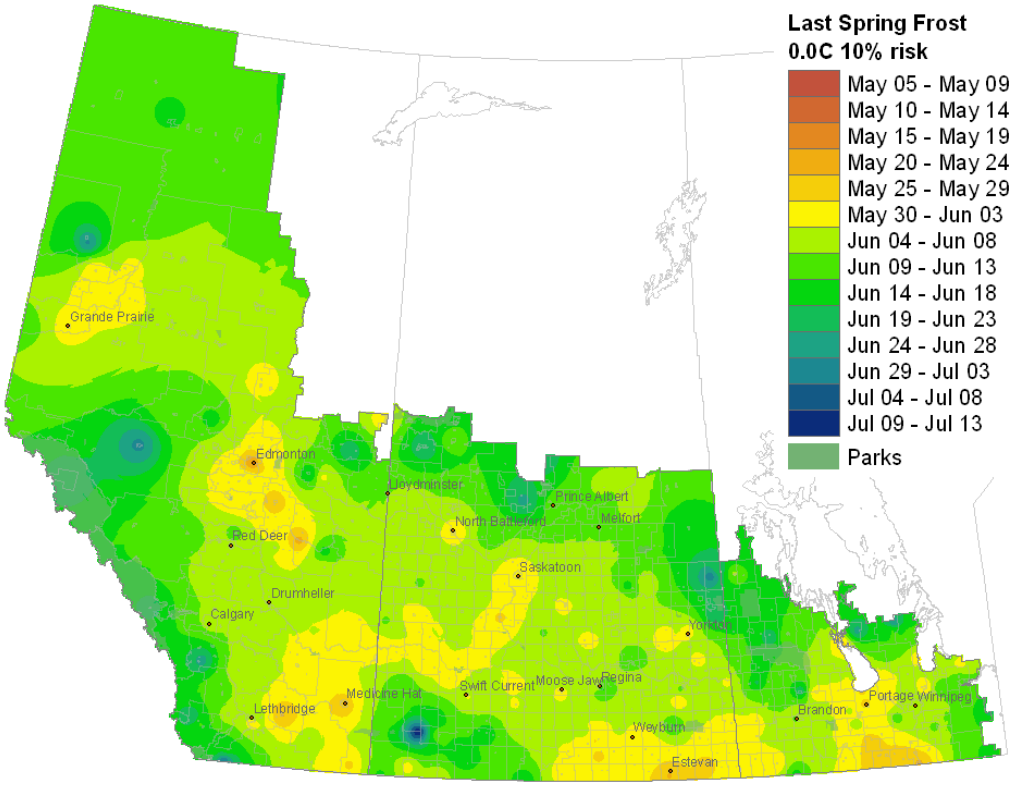

Figure 2.4 Date of last spring frost of 0.0°C at 10% risk

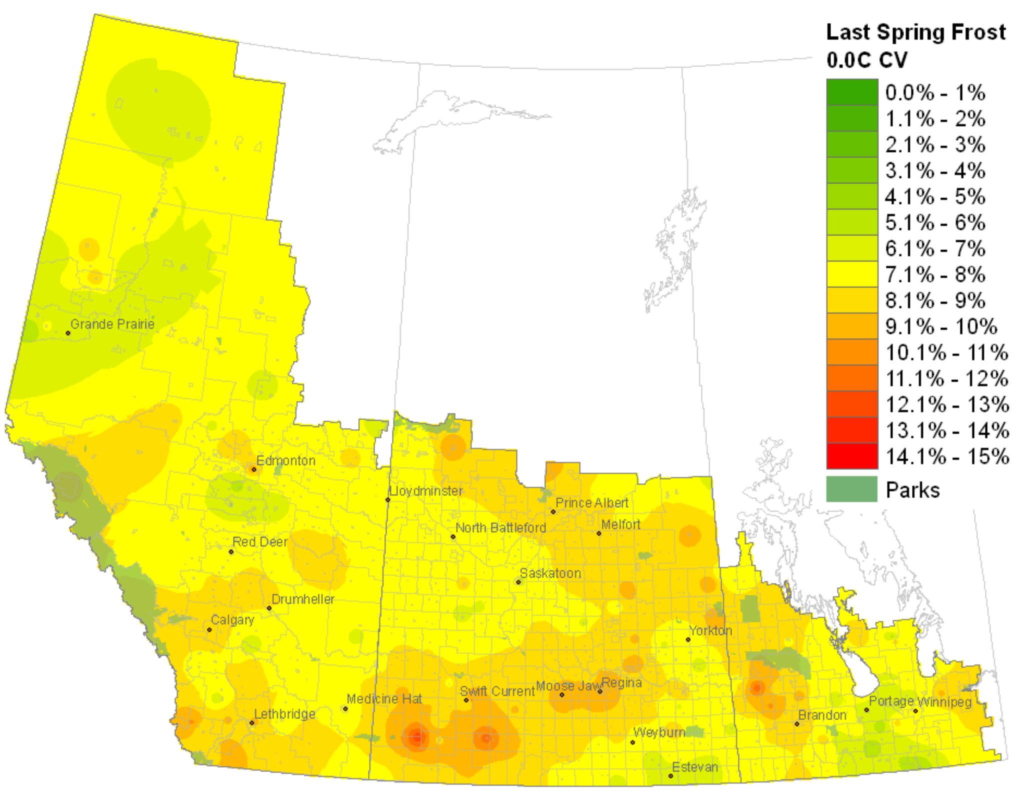

Figure 2.5 Coefficient of variation of date of last spring frost of 0.0°C

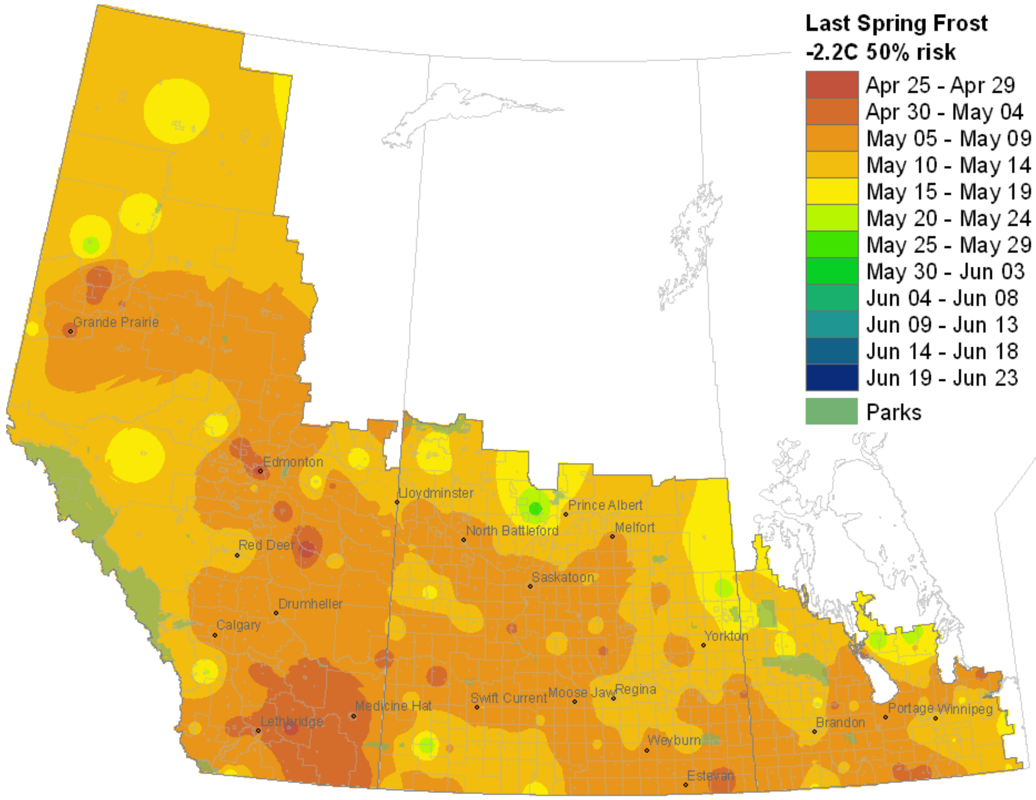

Figure 2.6 Date of last spring frost of -2.2°C at 50% risk

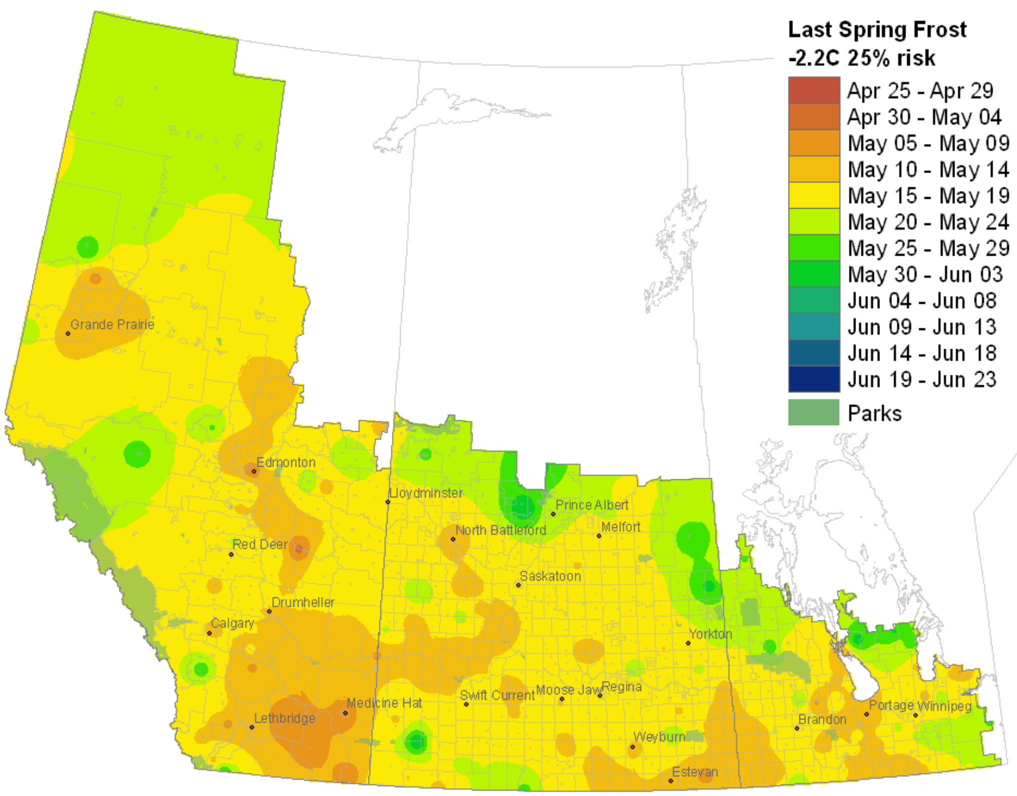

Figure 2.7 Date of last spring frost of -2.2°C at 25% risk

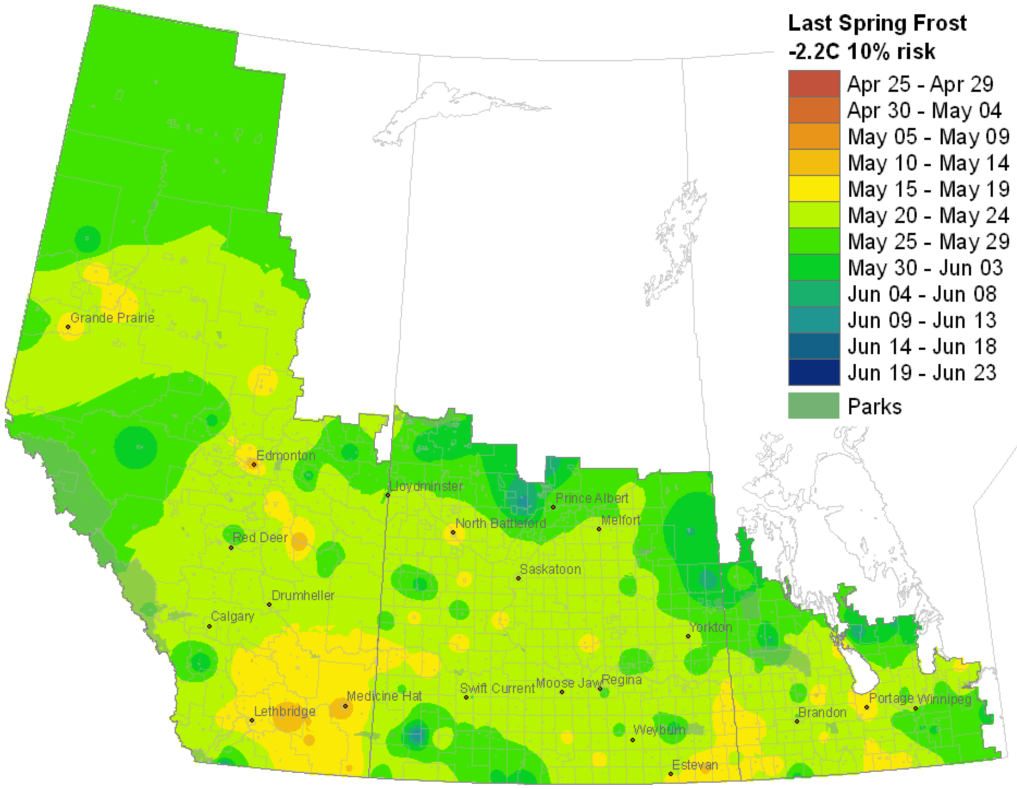

Figure 2.8 Date of last spring frost of -2.2°C at 10% risk

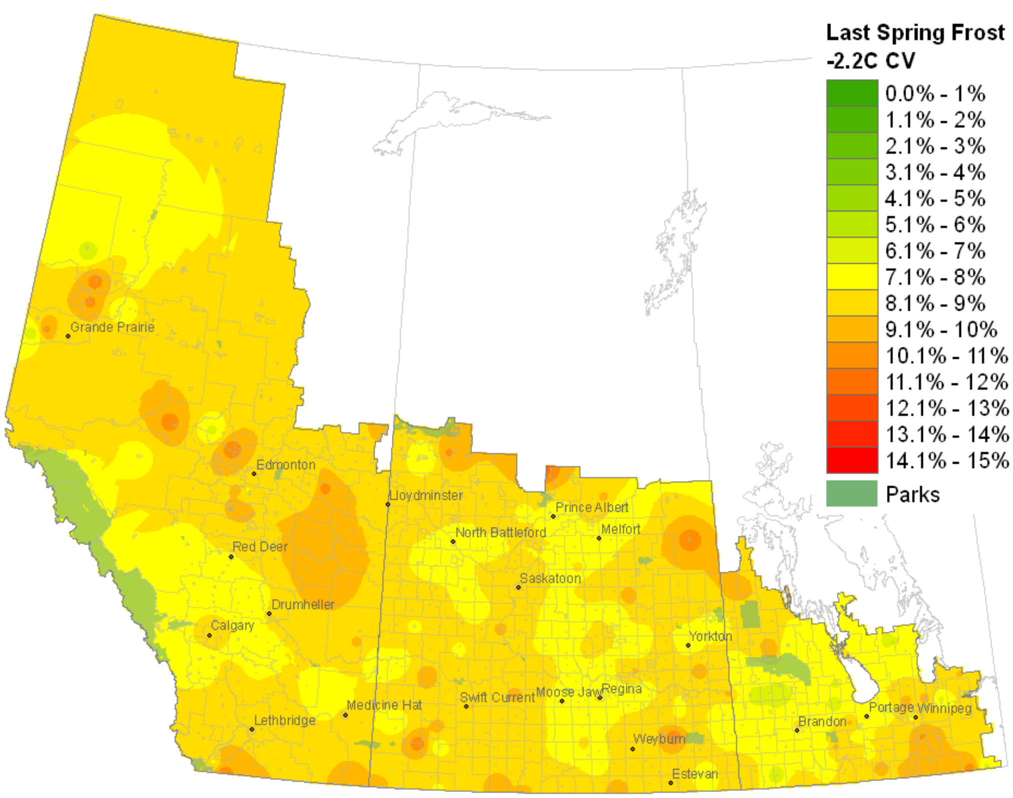

Figure 2.9 Coefficient of variability of date of last spring frost of -2.2°C

Aneroid, and Swift Current. In Manitoba, the areas northwest of Brandon around Birtle and Hamiota also have high CV's. In southwest Alberta, the stations at Connelly Creek and Cardson recorded the highest CV's in the province. All of these areas recorded CV's above 10%.

There were few similarities in the geographical distribution of CV's between the LSF 0.0°C and LSF -2.2°C. A noteworthy difference is the increase in CV of LSF -2.2°C (Figure 2.9) in some of the areas that had the lowest CV of LSF 0.0°C. In particular, the region south of Portage la Prairie in Manitoba and the regions around Grande Prairie and south of Edmonton in Alberta went from having some of the lowest CV's for LSF 0.0°C to some of the highest CV's for LSF -2.2°C. Alternatively, some areas with higher CV's for LSF 0.0°C recorded among the lowest CV's for LSF -2.2°C. Some of these areas include the Birtle and Hamiota area of western Manitoba and the region between Moose Jaw and Regina, Saskatchewan. CV's of LSF -2.2°C were slightly higher than for LSF 0.0°C for most stations though fewer regional differences were observed between stations. While the CV's of most LSF 0.0°C ranged between 5.0% and 11.0%, the CV's for most LSF -2.2°C were between 6.0% and 10.0%.

2.4.2 First Fall Frost

The locations with the latest mean date of FFF 0.0°C appear most consistently in southern Manitoba and through parts of southern Alberta (Figure 2.10). The dates of 50% risk of FFF 0.0°C in these areas occur generally between September 20 and September 26. The dates of 25% risk range from September 13 to September 19 (Figure 2.11) while the dates of 10% risk are between September 8 and September 15 (Figure 2.12). The latest mean dates of FFF 0.0°C in Saskatchewan are between September 18 and September 20 occurring in the southeast part of the province near Estevan. The 50% risk dates of FFF 0°C for most of the remainder of Manitoba fall between September 6 and September 19. Most of the Saskatchewan dates range between September 1 and September 16. Much of Alberta falls between September 7 and September 19 with the exception of some northern areas with dates of FFF 0.0°C occurring in late August.

The relative geographical distribution of FFF -2.2°C (Figure 2.14) is very similar to that of FFF 0.0°C (Figure 2.10). The areas with the latest date of FFF -2.2°C, located within Manitoba and Alberta range from October 1 to October 9 at 50% risk. At 25% risk, these areas range in dates of FFF -2.2°C from September 24 to October 1 (Figure 2.15) and from September 18 to 24 at the 10% risk (Figure 2.16). Most of the remaining area of the prairies ranges in mean date of FFF -2.2°C from September 16 to September 30 and from September 9 to September 23 at the 25% risk.

The CV's for FFF of both 0.0°C and -2.2°C are much lower and less spatially variable than the CV's for LSF. The CV's range from 2.4% to 7.7% and 2.7% to 7.2% for FFF 0.0°C (Figure 2.13) and FFF -2.2°C (Figure 2.17), respectively. Areas with the lowest CV for FFF 0.0°C occur primarily in Manitoba. For FFF -2.2°C, the lowest CV's are in parts of Manitoba and roughly the western half of Saskatchewan. Locations with higher CV's are spread out and appear more isolated, suggesting no apparent geographic trends.

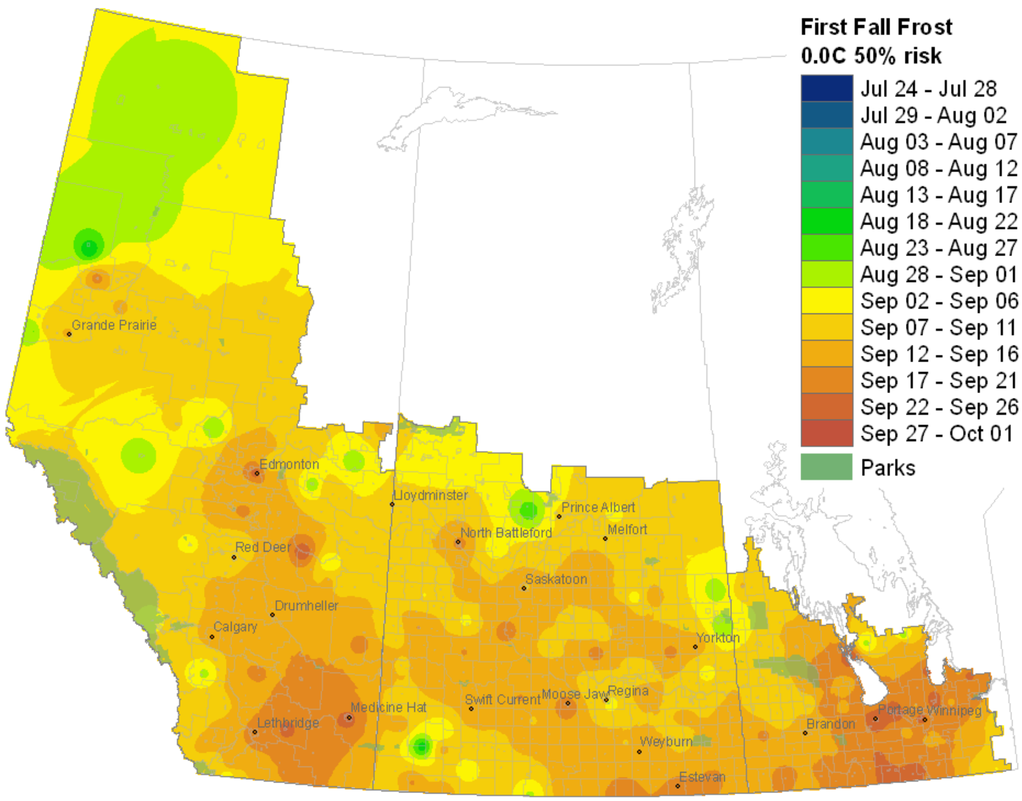

Figure 2.10 Date of first fall frost of 0.0°C at 50% risk

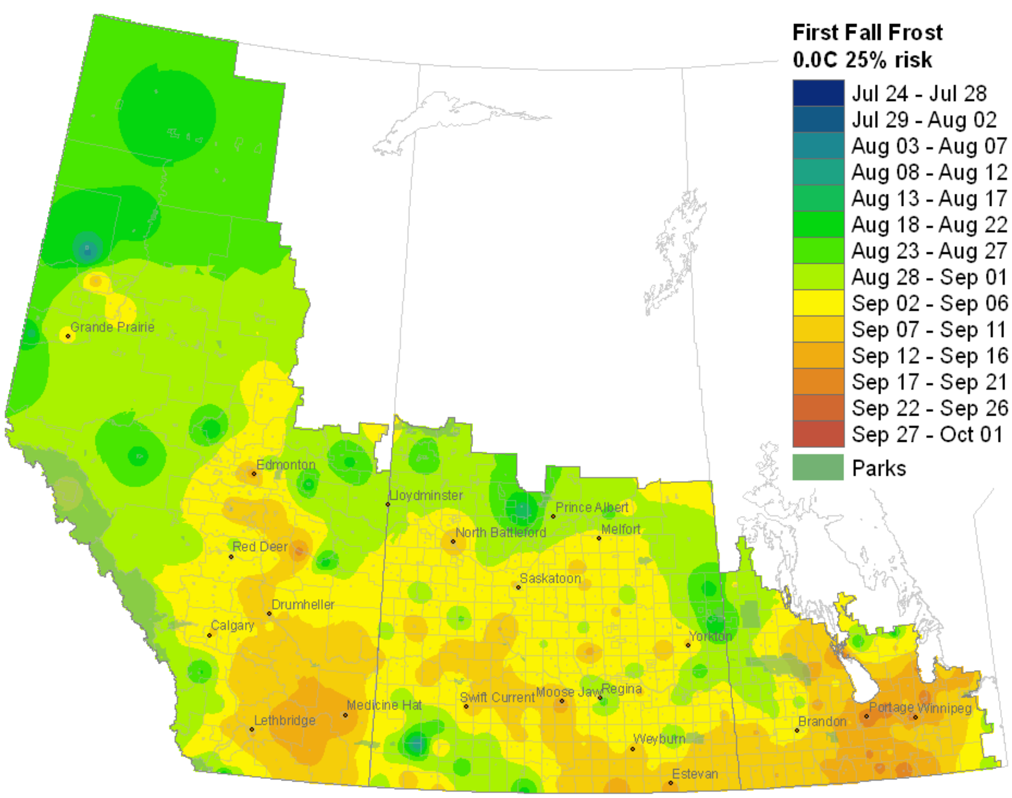

Figure 2.11 Date of first fall frost of 0.0°C at 25% risk

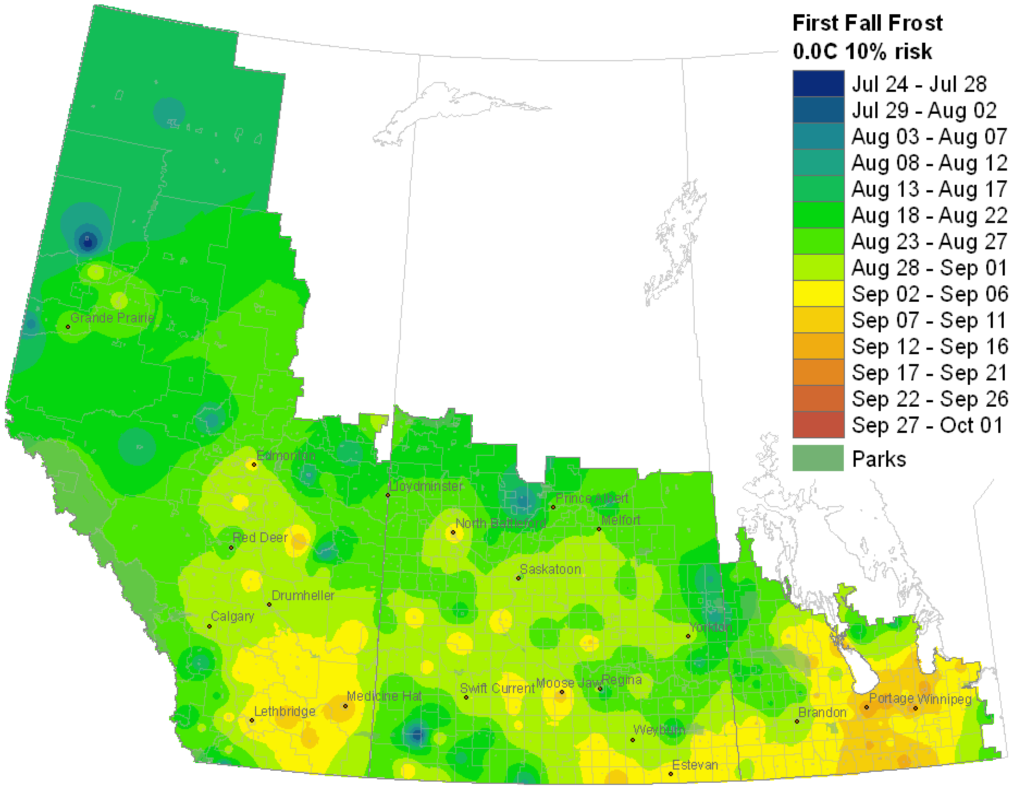

Figure 2.12 Date of first fall frost of 0.0°C at 10% risk

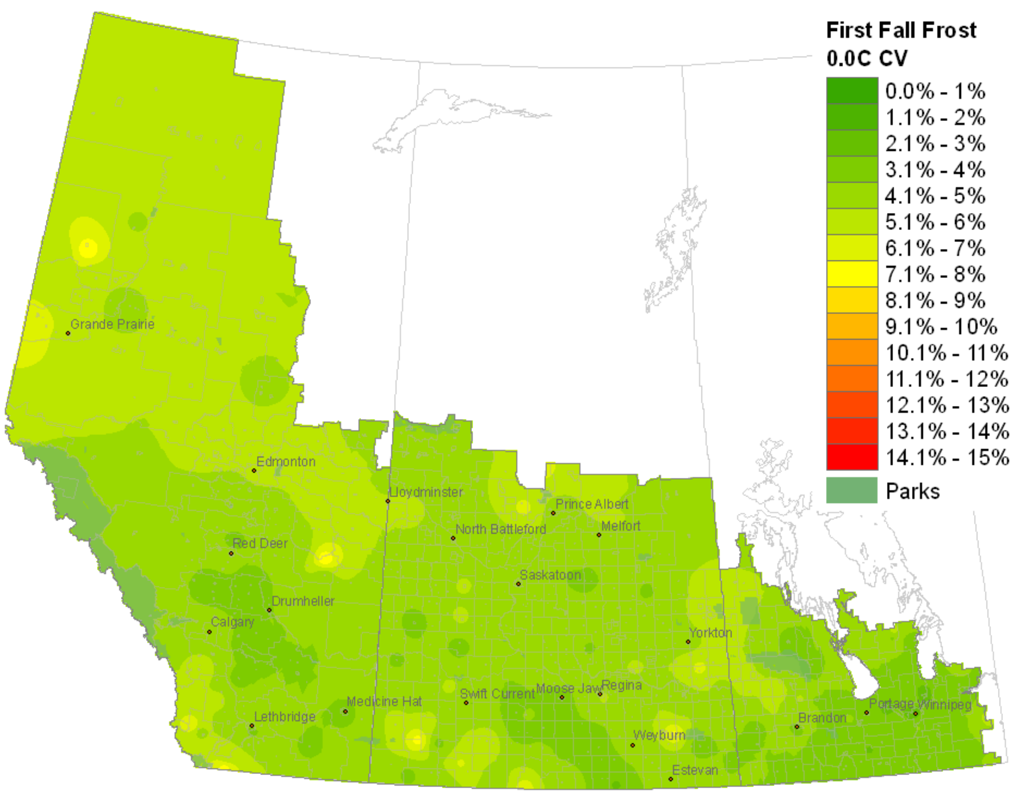

Figure 2.13 Coefficient of variability of date of first fall frost of 0.0°C

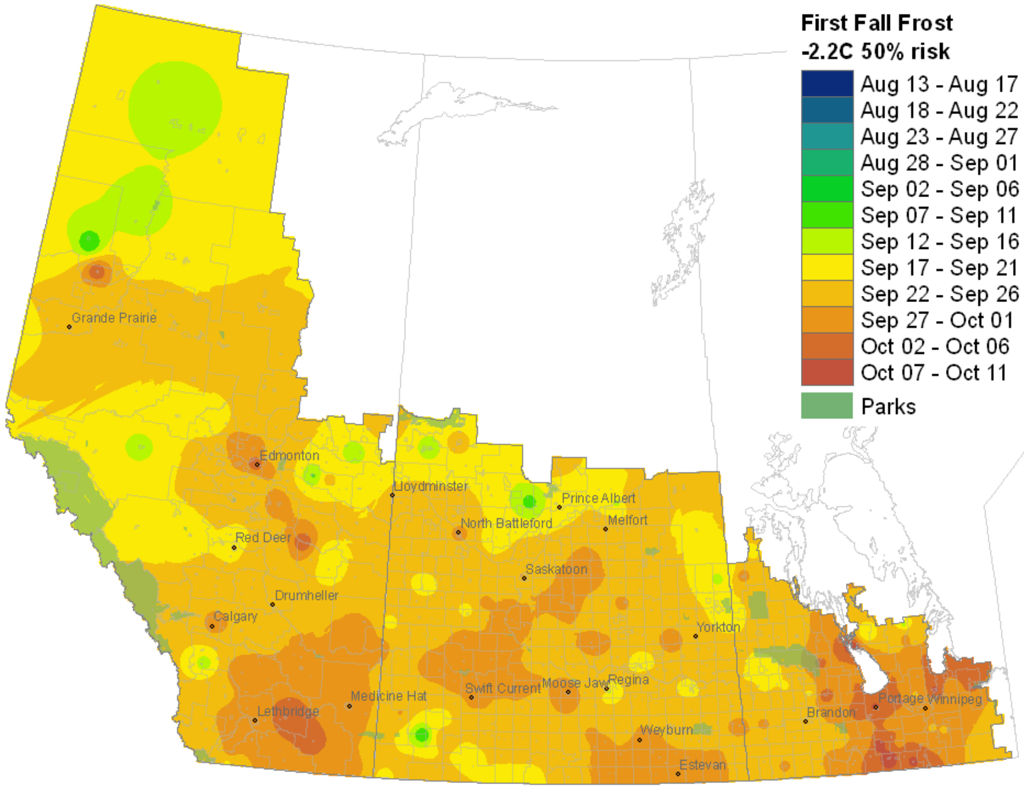

Figure 2.14 Date of first fall frost of -2.2°C at 50% risk

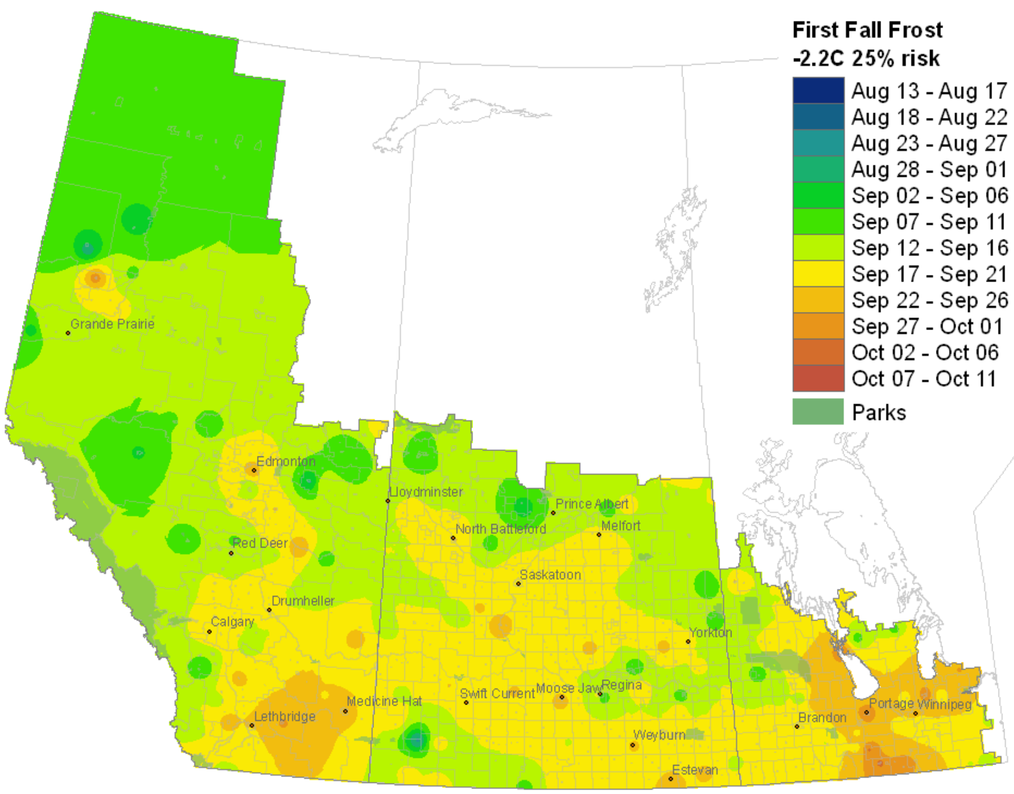

Figure 2.15 Date of first fall frost of -2.2°C at 25% risk

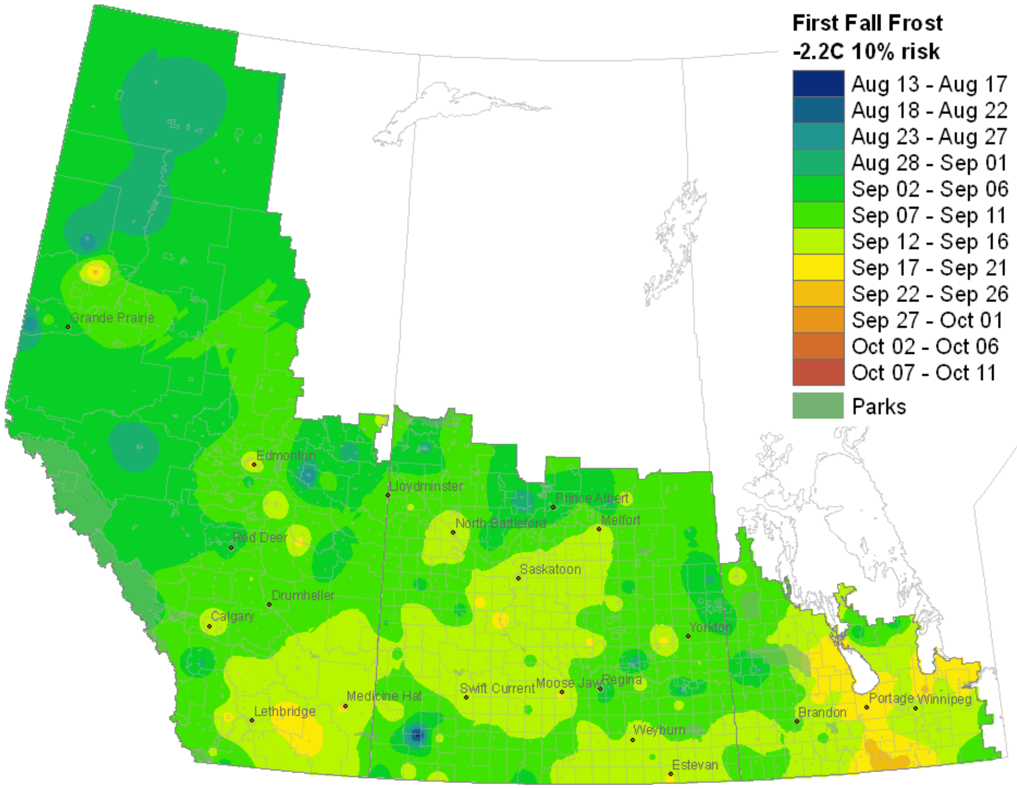

Figure 2.16 Date of first fall frost of -2.2°C at 10% risk

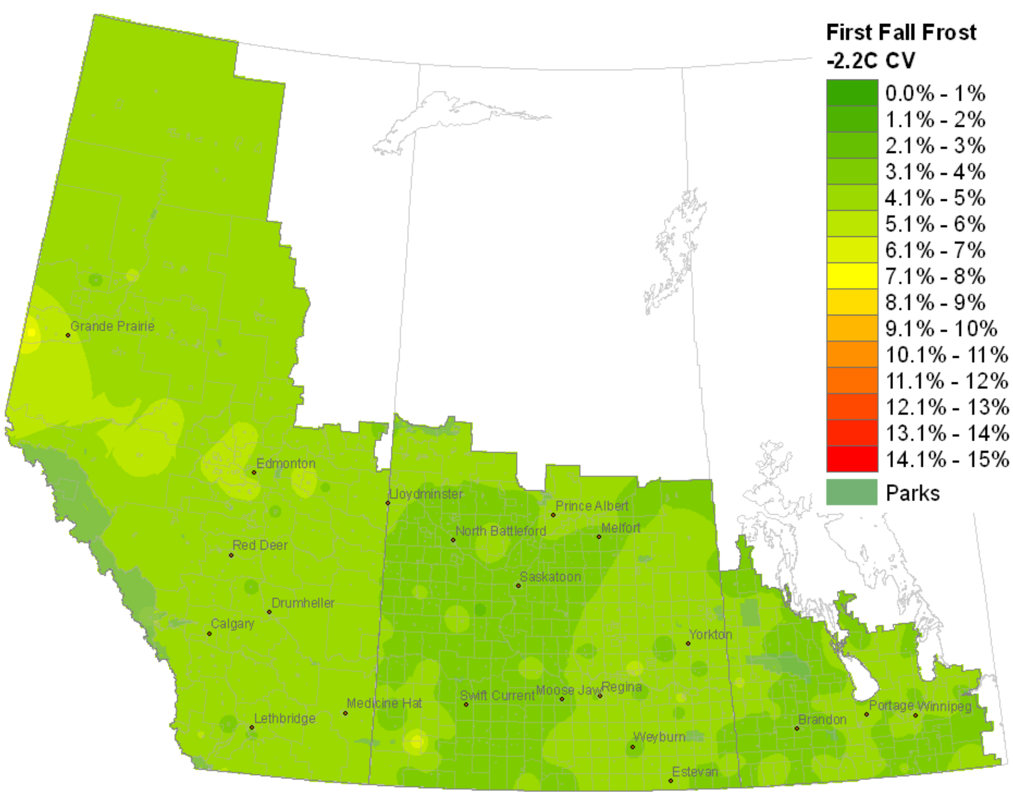

Figure 2.17 Coefficient of variability of date of first fall frost of -2.2°C

2.4.3 Frost-Free Days

The average number of FFD 0.0°C throughout the agricultural region of the prairies ranges from 65 to 141 (Figure 2.18). Areas with the longest frost-free periods are primarily located in Alberta from Edmonton through Camrose and from Taber to Medicine Hat, in south-central Manitoba, and around Estevan in Saskatchewan. These areas average over 125 FFD 0.0°C per season. At 25% risk, these areas range in FFD 0.0°C from 114 to 126 (Figure 2.19) and from 104 to 115 at the 10% risk (Figure 2.20). Most areas of the prairies, particularly regions to the south experience more than 100 FFD in 1 out of 2 years. Areas with short frost-free durations appear mainly towards the northern borders of the agricultural region with the exception of certain localized stations at higher elevations. Some of these stations include Klintonel in southern Saskatchewan (elevation: 1070 masl), Carway in southern Alberta (elevation: 1359 masl), and Edson in central Alberta (elevation: 922 masl).

The average number of days between the last spring and first fall frosts of -2.2°C range from 105 to 161 (Figure 2.22). Areas with the greatest number of days are generally in the southern regions with the exception of some outliers. Most notable is the station at Fairview Alberta, with 158 days above -2.2°C compared with some of its nearest neighbours such as Wanham with 144, Eureka River with 106, Peace River with 132, and Cleardale with 126. These trends can also be observed for FFD 0.0°C as well as both last spring frosts and first fall frost occurrences. With similar elevations at all stations, there is no obvious explanation for this discrepancy other than some abnormality in the location of the climate station. At 50% risk, most areas of the prairies receive more than 130 FFD -2.2°C per season. The geographic patterns are similar to those of FFD 0.0°C with the same noticeable outliers that have shorter frost-free periods than their surroundings. At 25% risk, the number of days above -2.2°C ranges from 88 to 150 (Figure 2.23). At 10% risk, the number of FFD -2.2°C is between 74 and 140 (Figure 2.24).

A consideration when dealing with frost analyses is the potential of warming due to a large human population located near a climate station or the so called "urban heat island effect". This additional heat source would be expected to increase surrounding air temperatures and therefore prolong the length of the frost free periods near large cities. A cursory review of the spatial patterns in the data to evaluate how the non-urban climate stations compare to those near large urban centres shows little difference. Of the large centres, Edmonton is the only location that shows a noticeable difference from surrounding rural stations. Fortunately, climate stations near all other large cities appear to behave similarly to surrounding stations within their respective regions.

The CV's for FFD 0.0°C are the most spatially variable of all frost parameters observed (Figure 2.21). The CV's for most stations are between 8% and 30% with some locations exceeding 30%. For FFD -2.2°C (Figure 2.25), the CV's range from 7% to 23% with most values falling between 9% and 14%. Among the locations with the highest CV's, particularly for FFD 0.0°C, are Klintonel and Cameo, Saskatchewan and Eureka River and Carway, Alberta.

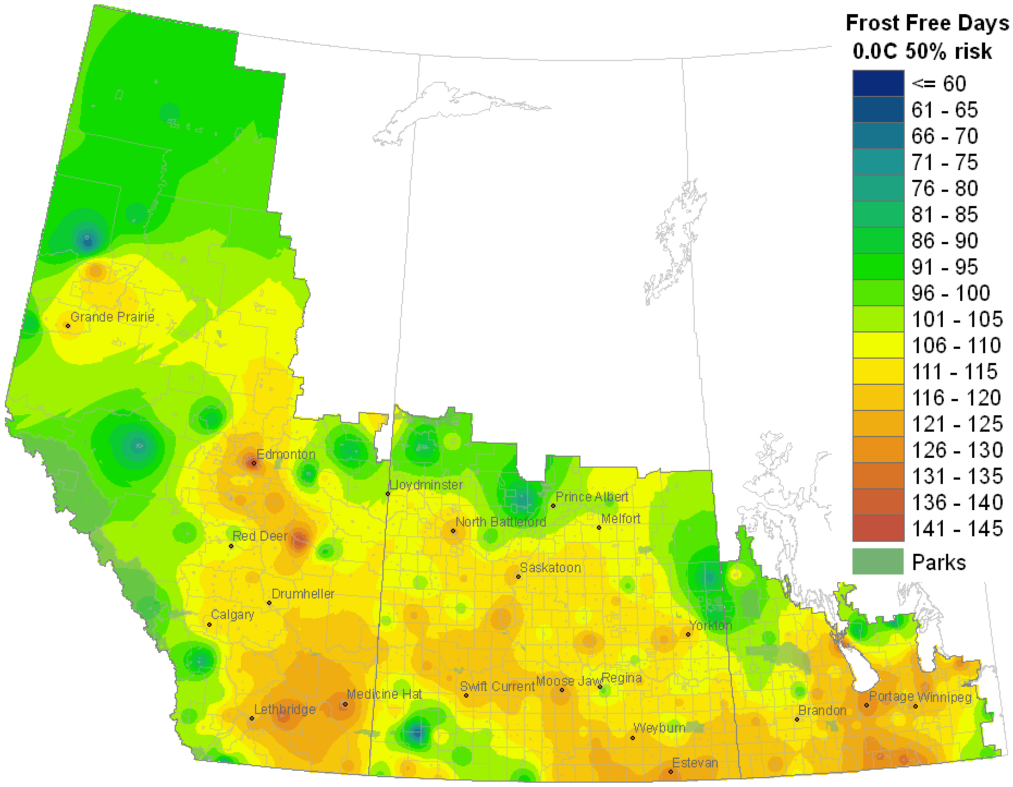

Figure 2.18 Number of frost-free days above 0.0°C at 50% risk

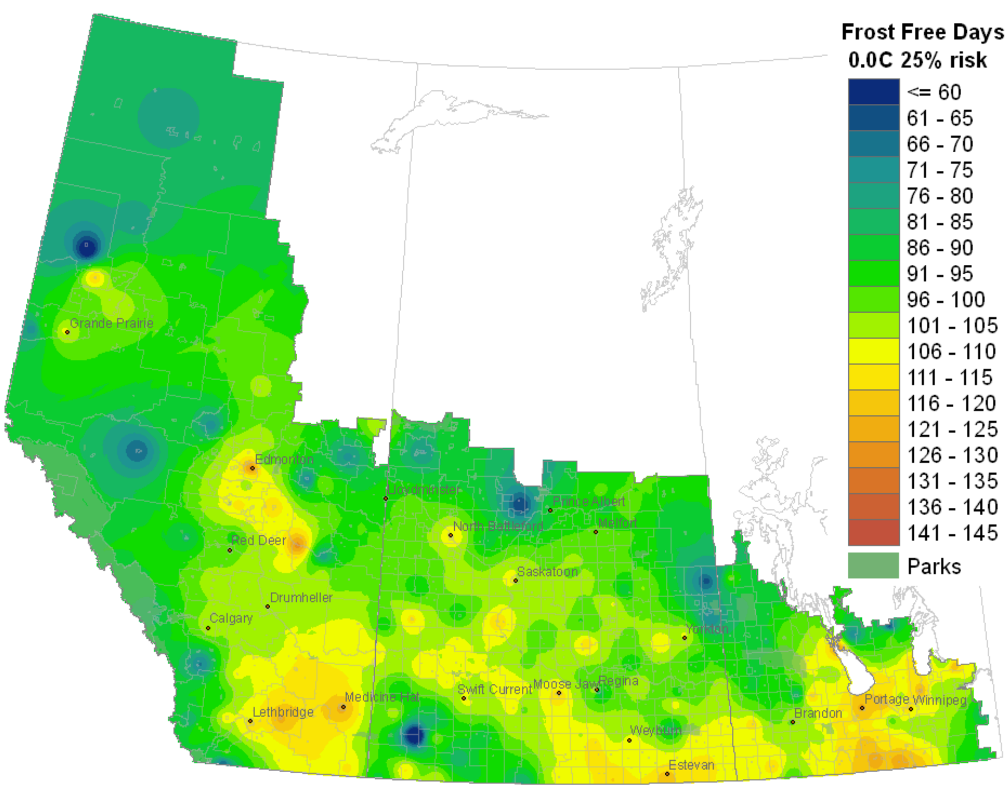

Figure 2.19 Number of frost-free days above 0.0°C at 25% risk

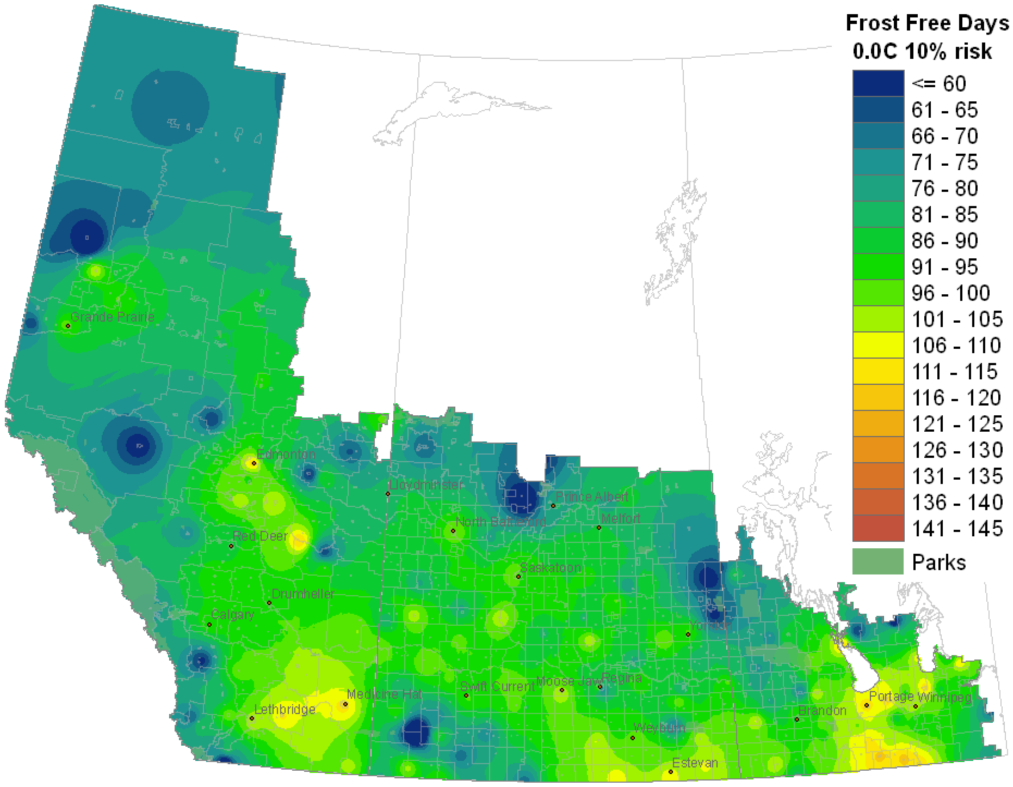

Figure 2.20 Number of frost-free days above 0.0°C at 10% risk

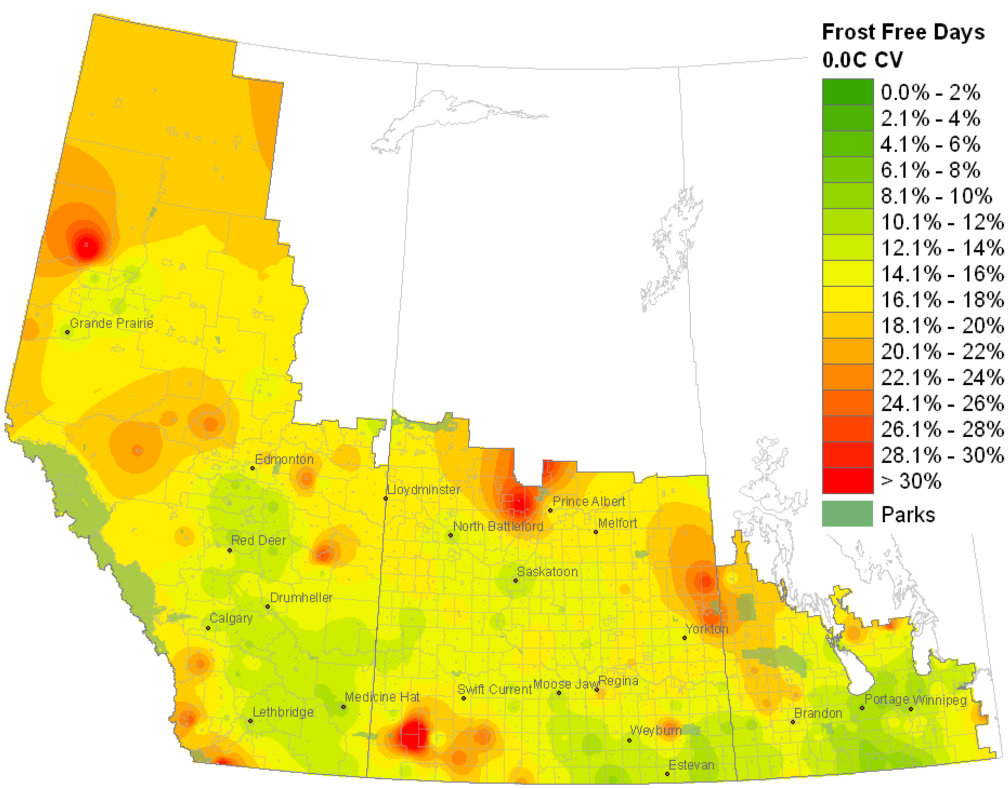

Figure 2.21 Coefficient of variability of frost-free days above 0.0°C

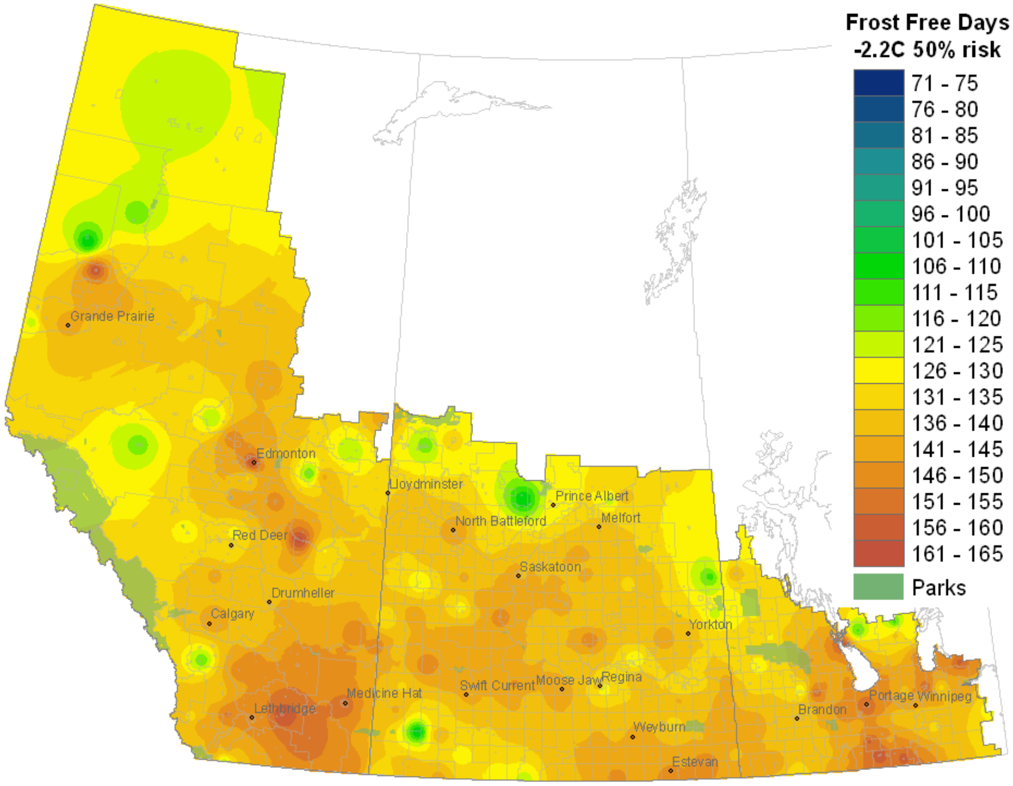

Figure 2.22 Number of frost-free days above -2.2°C at 50% risk

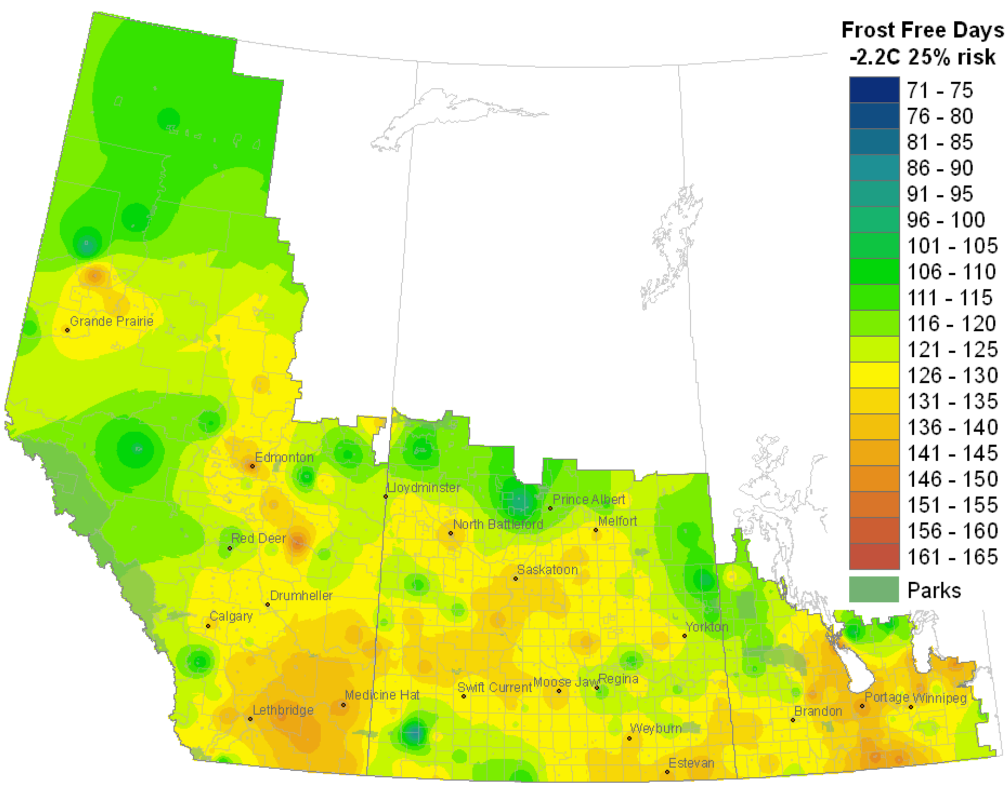

Figure 2.23 Number of frost-free days above -2.2°C at 25% risk

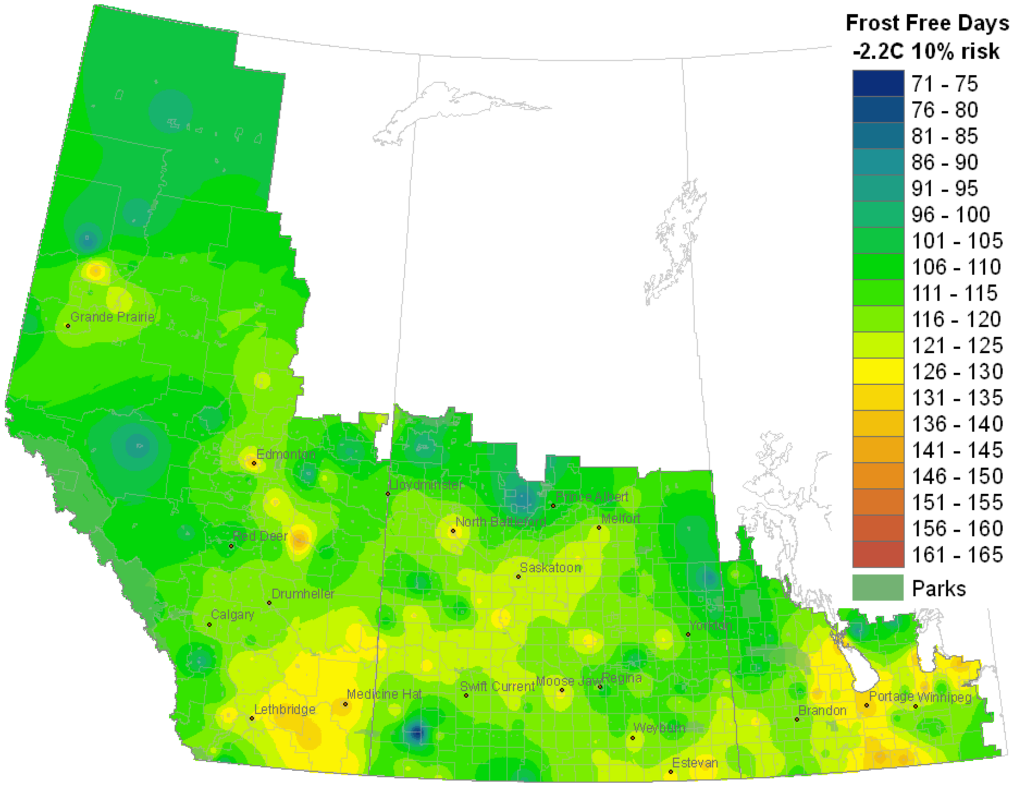

Figure 2.24 Number of frost-free days above -2.2°C at 10% risk

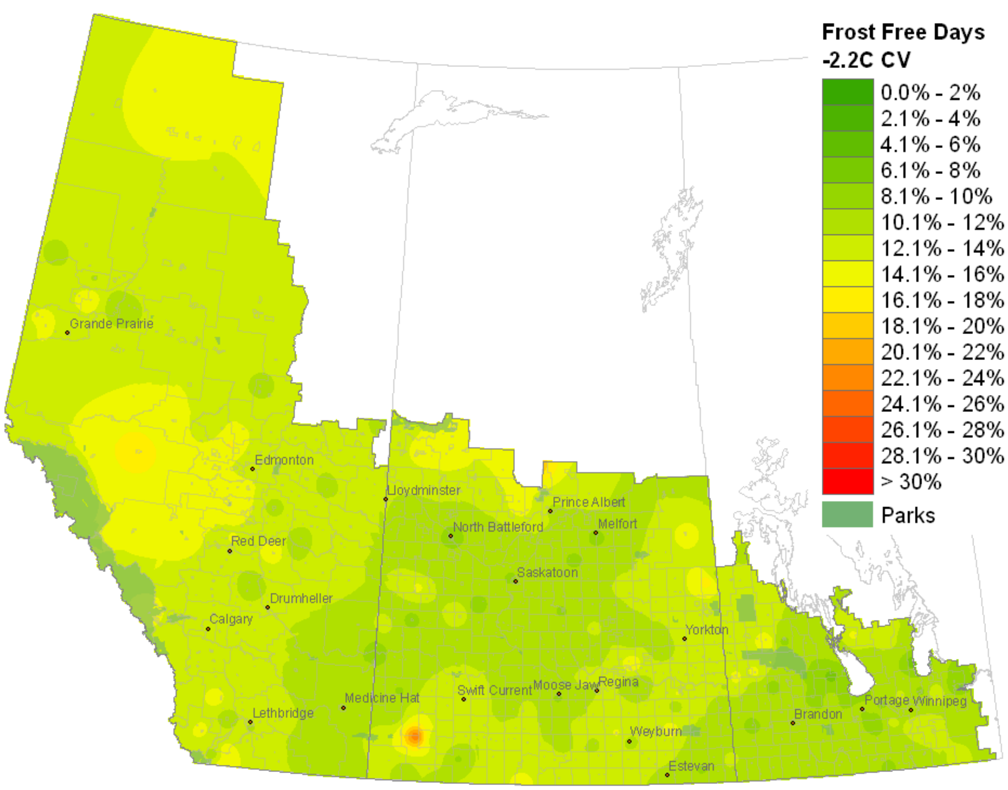

Figure 2.25 Coefficient of variability of frost-free days above -2.2°C

Areas with the lowest CV's generally occur in the regions to the south with the longest durations of frost free seasons, both at temperatures of 0.0°C and -2.2°C. This would suggest that the warmer areas, those with the longest growing seasons tend to have more consistency in annual frost free days. Such a difference can likely be explained by the nature of frost. Locations that are typically warmer will experience air temperatures well above freezing with little risk of dropping below the critical temperature. Cooler areas will experience lower air temperatures closer to freezing and may be more likely to reach freezing temperatures during normal diurnal temperature fluctuations. As frost date is measured as a single event, a momentary drop in temperature can shorten a frost-free season considerably. A single station could experience a brief freezing several days or even weeks before or after other stations in a region.

2.5 Summary and Conclusions

The maps and associated tables present an agroclimatic assessment of LSF, FFF, and FFD at both 0.0°C and -2.2°C for several levels of risk based on the period of 1971 through 2000. Certain areas of the prairies are severely limited for crop production by the length of their growing season. Seedling damage due to a late spring frost or late season damage due to an early fall frost can have detrimental effects on crop yield and quality. An assessment of the risk of frost can assist with planning and decision making. Knowledge of the length of the frost-free period can be the first step in assessing the suitability of crops for a region. The extent of risk that is acceptable within a system will determine the level of probability that is most appropriate to use.

Interpretation of the risk maps should be used with caution as local variability will always be present. The density of weather stations does not allow representation at the small scale or farm level but is intended to provide a regional assessment of the climate as it relates to frost. While a weather station is meant to represent a general area, certain features will diminish the correlation between the climate of a particular location and one or more nearby weather stations a certain distance away. Particularly with a single event such as the occurrence of frost, a subtle difference in microclimate can have profound effect on LSF, FFF, and FFD. Since temperature and frost are strongly influenced by elevation and topography, these factors should be considered when evaluating the risk of frost.

The CV, a function of the standard deviation and the mean represents the relative magnitude of variation about the mean, providing a useful indication of the degree of inconsistency from year to year and hence, the reliability of prediction. The CV's for LSF are consistently much higher than the CV's for FFF. This would indicate a superior level of predictability for FFF since the fall frost dates are not nearly as variable as spring frost dates. This is common to both the 0.0°C and the -2.2°C frosts. Greater predictability of FFF can be particularly useful for assessing the likelihood that a particular crop will reach maturity prior to a killing frost. Delayed spring planting will often increase the risk that a crop will not reach maturity. An indication of the likely growing season length combined with an estimate of heat during that period can serve as an effective indicator of the likelihood that a crop will reach physiological maturity and be harvestable prior to the season's end.

Agroclimatic information is important for any sort of agricultural risk management. Frost damage is a major concern for prairie agriculture and must be considered in any planning process. Knowledge of the risk of frost is a key piece of agroclimatic information, one that can be incorporated into more complex agroclimatic indicators such as heat units and moisture requirements for crop production. These factors can then be applied towards the reduction of overall agroclimatic risk.

3. THE THERMAL AGROCLIMATE OF THE CANADIAN PRAIRIES

3.1 Abstract

The thermal limitations to crop production on the Canadian prairies reinforce the need for an accurate and current risk assessment for growing season heat units. This paper presents a quantification of the thermal agroclimate related to the accumulation of growing degree days (GDD), corn heat units (CHU), and physiological days (P-Days) for the production of canola (*Brassica napus*), corn (*Zea mays*), potato (*Solanum tuberosum*), and forages at risks of 50%, 25%, and 10%. Annual accumulations of CHU between 1921 and 2000 were further assessed at 12 climate stations to detect whether temporal trends exist. The production of canola, based strictly on GDD would be severely restricted in some northern parts of the prairies though factors such as day length are not considered. Grain corn would only receive adequate CHU at 10% risk in selected locations in south-central Manitoba, southern Saskatchewan, and in southern Alberta. These same regions would offer sufficient P-Days to achieve adequate potato yields by providing a longer tuber bulking stage. At 25% risk, most parts of the prairies could sustain two forage harvests. Warmer parts of the prairies are likely to allow three harvests. Over the past 80 years, the trends in CHU show an increase at an average rate of 0.46 CHU yr^{-1}. A gradual shift towards greater accumulations of CHU could enable the further expansion of warm season crops like grain corn.

3.2 Introduction

The productivity of a crop is largely dependent upon temperature. Temperature is the single most important factor contributing to plant response (Edey 1977). Particularly with warm season crops such as corn (*Zea mays*) and soybean (*Glycine max*), relatively long warm growing seasons are necessary to achieve high yields (Bootsma et al. 1999). The Canadian prairies are known for relatively short summers and harsh winters. Inadequate heat during the growing season can result in delays to phenological development, potentially resulting in a crop being damaged or killed by fall frost prior to reaching physiological maturity.

Each crop has a unique set of temperature response thresholds and rates of development within their environment. There are various heat unit systems that are used as methods of quantifying the rate of development of a crop based on the accumulation of useful heat. Each crop must be treated differently due to individual physiological differences that result in unique growth and development properties. According to Shaykewich (1995), phenological studies can be used for assessing whether a crop can be grown commercially in a particular area or as a guide for developing crop varieties to certain regions. Assessing the suitability of a crop to an area is especially relevant on the Canadian prairies where temperature often limits the type of crops that can be consistently grown. The amount of heat that a specific crop requires during the growing season is referred to as that heat maturity constant (HMC) (Edey 1977). A comparison of the probable heat units for a region and the HMC of a certain cultivar can be an effective means of assessing risk.

To evaluate the thermal constraints of the agricultural climate of the Canadian prairies, a review of past climate records has been completed by performing daily then seasonal tabulations of heat units for all available climate stations over a series of years. The seasonal totals are compiled beginning at a modelled planting date through to the end of the growth period for certain crops. The purpose of the analysis is to assess the probability of achieving various thermal targets related to growing degree days (GDD) for canola (*Brassica napus*), forages (e.g., *Medicago sativa, Phleum pratense, Bromus inermis*), and other crops, corn heat units (CHU) for warmer season crops such as grain corn (*Zea mays*) and soybeans (*Glycine max*), and physiological days (P-Days) for potatoes (*Solanum tuberosum*). The result is a quantification of the thermal climate for crop production. This provides a set of indicators of risk that can be used to assess the thermal limitations and potential of a region for the viability of various crops. If there is little or no change in agro-climatic variables over time, a suitable length of past station records can provide a reliable indication of the probability distribution that could be expected over the next decade or more (Bootsma 1994). While there is often a temptation to project any observed trends further into the future, this would not be recommended as rates of change can vary and climatic trends of various temporal durations may occur.

A subsequent analysis looks at the change in the seasonal accumulation of heat units over time to detect trends that may exist. This information is particularly relevant for the production of longer-season crops such as corn and soybeans that can benefit from longer and warmer growing seasons. The production potential of these crops is closely linked to the amount of heat the crop receives (Bootsma et al. 1999). A warmer climate on the Canadian prairies would enable more diverse cropping systems which are often limited by relatively short growing seasons (McGinn and Shepherd 2003). As future climate scenarios predict higher temperatures and increases in seasonal accumulations of GDD (McGinn and Shepherd 2003; Intergovernmental Panel on Climate Change 2007), it is important to realize the extent of the changes that have already occurred. In a review of 100 years of maximum and minimum air temperature in Canada, Skinner and Gullet (1993) found significant warming trends. The adjustments in agricultural practices in response to these thermal trends can demonstrate the level of adaptation that has taken place and help to identify the vulnerabilities that may exist.

3.2.1 Heat Units

There are certain weaknesses that are common to most heat unit systems. One limitation is that plants respond differently to their environment depending on the stage of development (Suomi and Newman 1960). Therefore using a single set of threshold temperatures may not be sufficient through all development stages of the crop. Another limitation is the representative quality of temperature records and the occurrence of microclimates (Suomi and Newman 1960). While the height of the crop canopy changes as the crop grows, the standard height of the temperature recording sensor remains constant, and is most commonly at a level well above the developing crop. Furthermore, night time temperatures are normally cooler at the crop or ground level than those recorded at the standard height of temperature sensors. During the day, temperatures are normally higher at crop or ground level (Hayter 1978). These temperature differences can be amplified by several factors including soil moisture, radiation, and soil temperature. Ehrler et al. (1978) found that the temperature of a water-stressed wheat canopy could be as much as 4°C higher than the air temperature above. A canopy that was well supplied with water was usually cooler than the ambient air temperature. Increased solar radiation and release of sensible heat will result in higher temperatures at the soil or canopy than the air above (Shaykewich 1995).

While temperature is the primary driver of crop development, other factors can also influence the rate of development of a plant. For example, low soil fertility will often decelerate crop growth. High soil nitrogen content supports heavy stem growth delaying maturity while high soil phosphorus tends to hasten maturity (Edey 1977). Lower plant populations in the field will often result in the crop maturing slightly earlier than higher plant populations. Soil texture and moisture will affect soil temperature, which will in turn influence early crop development. Soil temperature is influenced by soil moisture, residue cover, tillage, and soil characteristics such as drainage, slope, texture, color, and organic matter. Depth of seeding will also expose seeds to higher or lower soil temperatures affecting rate of emergence, either hastening or extending the early development stages (Edey 1977). Sandy soils tend to warm earlier than clay soils and dry soils will warm faster than wet and poorly drained soils. Later in the season, low soil moisture can hasten maturity or may even kill the plant if the moisture deficit is extreme and prolonged.

The influence of the length of days and nights on crop development is well recognized. However, most phenological models do not consider these factors but are strictly based on temperature. Robertson (1968) introduced the concept of the biometeorological time scale (BMT), a method to relate temperature and photoperiod to the phenology of cereals. In developing this concept, Robertson stressed that the mathematical function that defines crop development should integrate the influence of day and night temperatures and photoperiod over short phenological stages within which the physiological response is relatively uniform. The model consists of three quadratic terms to define the effect of photoperiod, maximum air temperature (T_{MAX}), and minimum air temperature (T_{MIN}). Robertson found that the BMT method provides a superior approach to explaining the development of wheat based on tests carried out across Canada and in Argentina. Given the range of environmental conditions under which the model was evaluated, the BMT scale is considered an ideal model to be used on the Canadian prairies given the vastness of the geographic area that the region encompasses.

3.2.1.1 Growing Degree Days for Canola. The GDD system operates on the premise that plants have a physiological baseline temperature which is the minimum temperature whereby plant development is able to take place. Growth cabinet experiments done by Morrison et al. (1989) found that the average baseline temperature through the entire development of canola (*Brassica napus* cv. Westar) was 4.77°C, similar to the standard and more practical baseline temperature of 5.0°C used for many crop species. Plants that were grown in average growth cabinet temperatures of 10.0°C and 13.5°C with diurnal ranges of 5.0°C to 15.0°C and 8.5°C to 18.5˚C respectively were found to have fewer expanded leaves than plants grown in higher cabinet temperatures. Experiments with cabinet temperatures greater than 25°C resulted in sterile plants. Verification work in Manitoba comparing the growth cabinet findings to field observations showed agreement between phenological development and responses to temperature using GDD (Morrison et al. 1989). Based on data from 10 sites between 1984 and 1986, an average of 576 GDD were found to correspond with the period between seeding and flowering and 1157 GDD were needed to reach physiological maturity. Using a regression equation describing the percent development to physiological maturity per day as a function of temperature, the relationship was found to be the strongest towards the later stages of crop development and less accurate during the early and mid phases of crop growth. The authors suggested that during the early stages, soil temperature and moisture may play a more important role than air temperature in phenological development. The time from seeding to emergence was predicted most consistently using calendar days rather than GDD. Despite the discrepancy between development stages, the authors note that GDD would be sufficient to predict maturity and the suitability of an environment for the growth of canola.

Subsequent work by Wilson (2002) investigated the effects of temperature on phenological development of canola using P-Days. Results from 8 test sites during the 1999 and 2000 growing seasons showed the P-Day system using base, optimal, and maximum temperatures of 5°C, 17°C, and 30°C respectively was superior to GDD. This method shows promise for future phenological studies involving canola.

3.2.1.2 Corn Heat Units. Corn heat units (CHU), also referred to as crop heat units, are used to define the relationship between temperature and the development of corn hybrids and to classify the suitability of certain hybrids to be grown in different regions (Brown 1969; Smith et al. 1982). Developed by Brown (1969), the concept was first used in Ontario and is now widely used across Canada. While the actual rate of development is influenced by photoperiod, soil moisture, soil fertility, and plant population, temperature remains the main factor for the development of corn as cool temperatures will delay progress to maturity and warmer temperatures will hasten this process (Coelho and Dale 1980; Brown and Bootsma 1993; Bootsma and Brown 1995). As corn production on the prairies is often limited by heat, the CHU index evaluates the potential of having the corn crop reach physiological maturity within the growing season.

The CHU system is considered an improvement over most other heat unit systems (such as GDD) in that the CHU method considers daytime temperatures separately from night time temperatures by using the daily maximum and minimum temperatures separately. In addition, the CHU equation is non-linear. The equation incorporates a daytime base temperature of 10°C below which the CHU ceases to accumulate. The optimum daytime temperature value of 30°C represents the point where CHU will accumulate at the greatest rate. Beyond 30°C, this rate begins to decrease to reflect the detrimental effects of very high temperatures. Night time or minimum daily temperatures have a base of 4.4°C which is considered the minimum temperature for development.

Despite its widespread use in Canada, the corn heat unit system has been subject to some criticism. Major et al. (1983) studied the heat unit requirements of different hybrids at several locations across Canada to determine whether different corn hybrids have varying CHU requirements in different climates. The authors observed that the most suitable units of measurement, the ones with the lowest coefficient of variability between hybrids and locations, were not consistent between stages of development. According to Plett (1992) and Dwyer et al. (1999), an ideal index should estimate a constant number of heat units to reach a specific development stage for a given genotype regardless of weather conditions. From planting to emergence, Major et al. (1983) found that calendar days had the lowest variability while GDD with a base temperature of 8.0˚C was best suited for both emergence to anthesis and for anthesis to 45% ear moisture, or ripe. Nielson et al. (2002) found that planting date had a major effect on development. They observed that the duration from planting to silking decreased by 14 days and silking to maturity decreased by about 5 days when the corn crop was planted one month later than normal. In addition to temperature, Baron et al. (1975) reported that latitude had a significant influence on corn maturity.

Smith et al. (1982) investigated the applicability of CHU ratings to the different climatic conditions in the Atlantic provinces. Their results showed that an additional 160 CHU were required to bring corn to maturity at one of the locations in comparison with the other areas. This was attributed to the differences in the distribution of accumulated CHU over the season, differences in daily T_{MAX} and T_{MIN} extremes, and the effect of higher wind speeds causing less discrepancy between measured air temperature and plant temperature. In Manitoba, Cutforth and Shaykewich (1989) observed that the duration from planting to emergence was predominantly influenced by soil temperature while air temperature had the most effect on the duration from emergence to stem elongation. The soil environment is particularly important from germination through to the six-leaf stage while the growing point remains below the soil surface (Swan et al. 1987; Shaykewich 1995). Calendar days were found to be the best indicator from stem elongation to silking but less effective than thermal units from planting to emergence, emergence to stem elongation, and emergence to silking. In addition to using GDD base 10°C and CHU as units of accumulated air temperature, Cutforth and Shaykewich (1989) also experimented with using a modified corn heat unit system (MCHU) with adjusted minimum and maximum temperature response thresholds of 7°C and 15°C respectively. The MCHU and GDD base 10°C were more reliable estimators of the duration of emergence to silking than CHU. They also found that the number of CHU required for a crop to reach a given stage increased with the number of calendar days. This would suggest that cooler growing seasons or cooler climates would require a greater number of CHU to complete the same amount of development than would be required in a warmer environment. Plett (1992) went on to evaluate GDD base

10°C, CHU, and MCHU and found CHU to have the lowest coefficient of variability to the point of 30% kernel moisture.

Shaykewich (1995) argued that the response curve within the CHU equation, which considers the maximum increase in rate of CHU accumulation to be just above the daytime base temperature of 10°C, does not accurately reflect the actual crop response. A more suitable representation would be a curve with a sigmoidal shaped increase whereby the rate of accumulation occurs very slowly just above the lower threshold and gradually increases with temperature. A response curve of this shape would show the most rapid increase in the rate of development to be midway between the minimum and optimum daytime temperatures.

Despite the need for more work to be done in phenological modeling (Shaykewich 1995), the CHU remains the standard by which regions and corn hybrids are rated for their suitability to one another. When a new hybrid is introduced, a CHU rating is assigned, which must be compared to an area's CHU potential to assess whether the hybrid is appropriate for the region. For grain corn grown in the warmer parts of the Canadian prairies, the CHU ratings range from 2050 to 2600 with most hybrids rated between 2200 and 2400 (Manitoba Agriculture, Food and Rural Initiatives & Manitoba Seed Growers' Association 2007). Acknowledging the limitations of this method, it is still very important to be able to assess whether a location has a strong likelihood of a corn hybrid reaching maturity.

3.2.1.3 P-Days for Potato. P-Days are used as a heat unit for the growth and development of potatoes (Sands et al. 1979). Potatoes are a cool-climate crop (Raddatz et al. 1996); therefore the P-Day algorithm is a useful measure of heat because it considers minimum, optimum, and maximum temperatures of 7°C, 21°C, and 30°C respectively. Temperatures below the minimum and above the maximum are not considered to contribute to plant growth while temperatures near the optimum will accumulate P-Days at the greatest rate. Generally, P-Days begin to accumulate at planting date and continue until the first fall frost results in the termination of the growing season at some point during the tuber bulking stage. A premature frost will cause reductions in yield; therefore a longer tuber bulking stage will generally result in higher yields (Raddatz et al. 1996).

Within the First-generation Prairie Agrometeorological Model (Raddatz 1989), the development of potatoes is estimated to correspond with the accumulation of P-Days where 0 to 160 represents planting to emergence, 160 to 330 is the vegetative growth stage, 330 to 440 is tuber initiation, and from 440 to first fall frost is the tuber bulking stage. Some variation to this relationship was reported by Raddatz et al. (1996) where test plots in Carberry, Manitoba showed average emergence of Russet Burbank and Shepody potato varieties at 195 P-Days in 1994 and at 130 P-Days in 1995. These differences in P-Days to emergence suggested that better prediction of fractional leaf area and phenology could be accomplished by commencing the accumulation of P-Days from the date of 50% emergence rather than from the planting date (Shaykewich et al. 1998).

3.2.1.4 Growing Degree Days for Forages. Forage crops include legumes such as alfalfa (*Medicago sativa*) and clover (*Trifolium spp.*) and grasses such as timothy (*Phleum pratense*) and bromegrass (*Bromus inermis*). Though each plant type has its own unique characteristics related to temperature response, this analysis does not differentiate between the responses of various species of forages. Rather, many of the characteristics of alfalfa are considered to apply to most common forage species grown in western Canada.

Under non moisture limited growing conditions, temperature is the most significant factor to influence the rate of development of forages (Bootsma 1984). Optimum temperatures for foliage growth of alfalfa range between 15°C and 30°C, minimum temperatures range from 8°C to 10°C, and maximum temperatures from 35°C to 40°C (Dubé 1981). A baseline temperature of 5°C is commonly used to calculate growing degree days for general plant growth, including the development of forage crops. However, under soil water supply limitations, growth is closely related to water supply. During energy supply limitations, growth is related to solar irradiance (Wallis et al. 1983).

Perennial forage crops are different than annual crops in that harvest often occurs more than once during the growing season. Alfalfa is generally first cut around the 10% bloom stage (Krogman and Hobbs 1965) and allowed to re-grow for subsequent cuts. According to Selirio and Brown (1979), alfalfa flowers appear and harvest would commence at approximately 550 GDD from the start of growth in spring. The second and third cuts would occur at 550 GDD intervals thereafter at roughly 1100 and 1650 GDD since spring. While a growing season with more than 1650 GDD could potentially support three harvests, Bootsma and Suzuki (1985) describe a fall critical harvest period whereby alfalfa must be left to gain hardiness for winter survival. This period of approximately 6 weeks in duration would start around the date when 450 GDD remain in autumn prior to the first killing frost. Therefore, when assessing the climate of a region for alfalfa production, a single cut plus an adequate fall hardening period would require roughly (550 + 450) 1000 GDD, two cuts would require (1100 + 450) 1550 GDD, and three cuts would require approximately (1650 + 450) 2100 GDD before the first killing frost in fall. Harvesting in fall without allowing the adequate hardening would likely jeopardize the forage crop of the subsequent season. The extend of hardening would depend on the crop since different cultivars of alfalfa possess different levels of tolerance to freezing temperatures depending on their genetic traits (Kanneganti et al. 1998).

3.2.2 Seeding Date

The date of the start of the growth period for a specific crop will influence the crops rate of development and will determine the timing of certain stages of development. This can have a profound impact on the point of the onset of moisture stress or damage by adverse weather conditions either in spring, during the growing season, or late season events such as a killing frost in fall. Depending on the stage of crop development, various types of stresses will affect final yield and quality (Bootsma and DeJong 1988). Seeding dates vary by year, by crop, and by location due to the influence of numerous factors, both climatic and cultural.

In the current analysis, the intention is to assess the potential suitability of a crop within a certain area, therefore selection of the optimum planting date and generally the earliest possible date of seeding is desirable. This enables a simulated crop to benefit from the maximum possible growing season length as determined only by the constraints of climate. Crops that require a long growing season must normally be planted early in the season to increase the likelihood of reaching physiological maturity before fall frost in addition to allowing some time for field-drying (Gupta 1985). In temperate climates, earlier seeding is advantageous as it will usually result in higher yield and quality (Selirio and Brown 1972; Helms et al., 1990; Blaylock, 1995). Planting dates beyond the optimal period will result in lower yield and quality or may preclude harvest of a mature crop altogether. In northern Wisconsin, Laurier et al. (1999) found that seeding within the first two weeks beyond the optimum seeding dates reduced final yields in corn by 0.2% to 1.7% day^{-1}. Seeding beyond two weeks past the optimum date reduced yield by up to 3.8% day^{-1}. Planting date response will vary among years and locations depending on the variability in the growing season weather (Saseendran et al. 2005). A later seeding date for warm-season crops may reduce the risk of spring frost damage but will increase the risk of exposure to fall frost (Halvorson et al. 1995).

True seeding dates from past seasons are difficult to determine on a consistent basis due to a number of issues related to geography, averaging techniques, and subjectivity in reporting. With the spring seeding period spread out over several weeks, and considering that some crops may be planted before others, the limitations on time and equipment must be considered. Seeding that occurs later in spring, well past the time when weather and soil conditions allow, can often be attributed to factors such as scheduling of people and equipment and the capacity of the equipment rather than climatic restraints. Normally, the earliest seeded crops are those that are best adapted to spring conditions such as cooler soil temperature and frost. Another factor is the value of the crop. If a crop is more valuable and favours early seeding, this will take priority over the lower valued crops which will be seeded later as time and resources permit. These factors tend to cause additional complications when it comes to estimating seeding date, particularly for multiple crops.

Previous agrometeorological assessments have drawn upon seeding dates based on various methods. These methods include; using a fixed seeding date for every year, using available seeding date records, or deriving specific plantings dates based on actual weather and soil parameters. Each option will be discussed.

3.2.2.1 Fixed Seeding Date. The fixed seeding date has been used in several past agrometeorological analyses where the authors have used the same date for all locations and years (Sly 1982; DeJong et al. 1984). This is the simplest method for modelling purposes since it does not involve complex calculations nor does it involve compiling individual dates for each crop, year, and location. Some older analyses tend to have used this method having been performed prior to the advent and availability of fast computers with large data storage capabilities. The benefit of a fixed planting date is that the start of the growing season is not affected by observer bias nor are there inconsistencies and influences associated with the reported or actual planting dates.

One of the limitations to fixed planting dates is that is does not reflect the influence of climatic trends on seeding. For example, with spring warming trends that appear to be occurring (Intergovernmental Panel on Climate Change 2007), there is a likelihood that the opportunity for earlier seeding may exist. The fixed planting date would not reflect this change over time. Any crop growth models using fixed planting dates will start crop growth on the same date regardless of the actual field conditions. As a result, this approach could create crop growth scenarios that are physically impossible or that are not optimized for actual weather and field conditions. While this method is attractive in its simplicity, actual farming operations are not scheduled according to calendar periods but rather according to the weather and soil conditions (Baier 1973).

3.2.2.2 Actual Seeding Date. Regional seeding date observations have been gathered and compiled by various organizations. Statistics Canada has produced *Reference Dates of Field Operations* handbook (Statistics Canada 1988) from 1952 until 1988. The dates in this handbook were generated based on surveys of a crop reporting panel consisting of residents from each locality across the prairies. Members of the panel were asked to provide estimates of when certain field operations were general in their farming neighborhood. The published dates were tabulated based on the mode or frequency of mention for each field operation within each crop reporting district. While the handbook provides a single date of when seeding is general, it does not provide an indication of the early seeding dates or the first dates when seeding was possible. Therefore, this indicator does not provide the maximum potential growth period of an area but rather one that commences slightly later.

From 1956 to 1988, the handbook published seeding dates for eight crop districts in Alberta. For Saskatchewan, seeding dates for 19 districts are available from 1952 to 1988. From 1952 to 1976, seeding dates in Manitoba are available for each of 14 crop districts. Following the 1977 census, the divisions in Manitoba were changed and the number of districts was reduced to 12. Over the course of this transition, borders between districts were shifted, causing many locations to be reclassified into new regions. This impacted the tabulated modal date within each new district due to the different geographical and climatic characteristics of the farming operations that fell within this new region. The result was an apparent shift in some seeding dates that was not the result of climatic influences.

One of the advantages to reported seeding dates is that local producers are consulted with the assumption that they have good knowledge of field operations in their immediate area. The disadvantage is that each member of the crop reporting panel would base their reporting on a rough estimate of seeding activities and acreage at a time when they are likely busy with their own farming operations. The resulting data may be prone to a certain amount of subjectivity and bias or simply a lack of research. This information from Statistics Canada is not available past 1988.

Crop insurance organizations also collect seeding date information with a considerable length of record for all insured crops. In this case, dates are tabulated based on reporting by each farmer for each crop that is being insured. These dates could be used effectively in regional simulation models to predict the development of different crops within the appropriate reporting district. A limitation to crop insurance data is that there are only records for the crops that were actually insured in each region for each year. Therefore, if a certain crop has not traditionally been grown within an area, there would be no data. This can be limiting if the purpose of the simulation is to assess the suitability or success of a new crop that has yet to be grown in a locale or that has not been insurable in a district. A limitation to using observed seeding dates is that they may not correspond with the desired date range of the analysis that is to be performed. A long-term analysis requires a consistent source of planting date data for every crop, year, and location. The lack of consistency in collection and tabulation methods as well as poor continuity of geographic regions can produce inconsistencies in planting date records.

Apart from the physical conditions that enable field operations to occur, there are also cultural factors that may influence the timing of spring seeding. These technological and agronomic factors have evolved over history and are expected to continue to change. In an analysis of historic seeding dates since the 1930's at Lethbridge, Alberta, Major et al. (1996) identified five distinct eras where spring field operations were influenced by certain factors. During the 1930's and early 1940's, horses were used to pull tillage and seeding implements.

This period was characterized by early seeding since horses could access moist soils. The 1940's brought the introduction of tractors and heavy equipment for field operations. Seeding dates became later than the previous era and erratic due to frequent delays caused by wet soils which restricted equipment access. Some years required lengthy delays in seeding to allow soils to dry. The late 1950's saw further delays in seeding due the need for additional tillage prior to seeding to control late-germinating wild oats. In the 1960's, advances in herbicides enabled improved weed control. This reduced the requirement for excessive spring tillage and there was less dependency on dry conditions resulting in a noticeable advance in seeding dates. The clustering of seeding dates into distinct eras demonstrates that actual seeding dates are not necessarily governed solely by the weather and soil conditions. The additional factors that have been shown to influence seeding have caused a decoupling of actual seeding date and climate. Furthermore, for an analysis of the agricultural climate, it would be inappropriate to imply the presence of any sort of climatic trends simply on the basis of historic seeding dates that may be partially the result of the cultural practices.

3.2.2.3 Modelled Seeding Date. The above discussion on actual seeding dates reveals that in the absence of cultural and technological influences, the timing of potential seeding operations could be dictated entirely by the weather, the soil, and the characteristics of the crop that is being sown. In particular, soil water content, temperature, precipitation, and snow cover are assumed to be the main factors affecting seeding date (Bootsma and DeJong 1988). Most important are trafficability criteria since equipment access is necessary and often the limiting factor to performing field operations. A soil is generally considered trafficable if a farm machine can operate to satisfactorily perform its function without causing significant soil damage (Hassan and Broughton 1975). Trafficability is a function of the moisture content within the upper layers of the soil with thresholds generally at or near field capacity (Dyer and Baier 1979). Soil moisture content in the lower zones is not considered as important for trafficability (Selirio and Brown 1972).

Rutledge and McHardy (1968) classified trafficability based on soil shear strength. This criterion is greatly influenced by moisture and soil texture, in particular soil plasticity and clay content. As a rule, higher moisture contents are more tolerable for coarse soils than for finer textured soils. Water content thresholds generally range from 80% to 98% of available water holding capacity (AWHC). Texture specific trafficability coefficients were derived by Rotz and Harrigan (2004), which use different upper and lower thresholds depending on the nature of the field operation. According to their analysis, fall field operations can be performed in wetter soil conditions than spring operations. The spring trafficability coefficients in the upper 75 mm of soil measured as percent of field capacity range from 92% for clay loam to 100% for loamy sand. Within the layer from 75 to 150 mm, the thresholds range from 94% to 100% for clay loam and loamy sand respectively. Fall harvest trafficability coefficients are as high as 108% in the upper level for loamy sand. Rotz and Harrigan (2004) also point out that lower coefficients should be used for heavier equipment while higher coefficients could be used for lighter equipment.

Seeding date criteria are generally similar to those for trafficability but with an additional temperature requirement for seeding to take place. In order for a seed to germinate in a reasonable amount of time, soils must experience a certain amount of warming post spring thaw. Excessively cold soils will delay or abort germination or result in slow seedling growth. Soil temperature is quite variable based on its particular soil properties, moisture content, and management practices so it is difficult to accurately estimate soil temperature. Air temperature is normally used as a proxy for that of soil since the temperature of the soil is related to that of the air above. The air temperature can then be used for seeding date criteria. Some models to estimate seeding date require a certain number of days with the daily air temperatures above a certain threshold (Bootsma and DeJong 1988; Bootsma and Brown 1995; Major et al. 1996). Also related to temperature is the risk of frost. While frost tolerance will vary between crop varieties, the risk of spring frost should be considered, especially for more vulnerable crops that are planted early.

Spring trafficability criteria were developed by Selirio and Brown (1972) which consider the top 120 mm of soil and require that the modelled moisture content not exceed 90% of field capacity. Also, daily snowfall must be less than 2.5 cm and the maximum air temperature must exceed 0°C. Using the three parameters for a study site at Guelph, Ontario, they obtained reasonably good agreement between the estimated first trafficable date and the actual first date of field work ($r = 0.91$).

An investigation into seeding date estimates on the Canadian prairies was carried out by Bootsma and DeJong (1988). Based on the reported date when seeding is general for spring wheat produced by Statistics Canada (Statistics Canada 1988), an empirical prediction method was derived. This method considers four criteria and requires that they be met for 10 days, not necessarily consecutively, prior to seeding. The first condition is related to soil moisture. Based on estimates derived from the Versatile Soil Moisture Budget (Baier et al. 1979), the top 5% of the soil profile must not exceed 90% AWHC and the next 7.5% of the profile must not exceed 95% AWHC based on work from Retledge and McHardy (1968) and Selirio and Brown (1972). The temperature condition considers both T_{MAX} and the T_{MIN} such that $\frac{3}{4} T_{MAX} + \frac{1}{4} T_{MIN}$ must exceed 7°C for all of the 10 days. The remaining criteria are that daily precipitation must be less than 2.0 mm and there must be less than 10 mm of snow cover on the ground.

Comparisons of weather-derived seeding date estimates using the method of Bootsma and DeJong (1988) to the dates reported by Statistics Canada by crop district were performed for 25 climate stations across the prairie region representing 19 crop districts. With the exception of two crop districts in Alberta, all correlation coefficients were significant though not considered high. The authors noted one of the limitations was that a single climate station is used to represent an entire crop district. Another factor is that seeding normally takes place over the span of several weeks.

McGinn et al. (1999) found that the method of Bootsma and DeJong (1988) underestimated the seeding dates at Swift Current, Saskatchewan. To improve the accuracy, they adjusted the criteria such that the daily average temperature (½ T_{MAX} + ½ T_{MIN}) must exceed 10°C and soil water in the top two soil zones must be less than 90% AWHC using the Versatile Soil Moisture Budget (Baier et al. 1979). The adjusted air temperature and soil moisture criteria, combined with the same daily precipitation and snow cover criteria as Bootsma and DeJong (1988) were to be met for 10 days for seeding to occur.

Another method of modelling seeding date, proposed by Major et al. (1996), provides a best-fit model of nonlinear relationships through the use of neural networks. Using this technique, the model "learns" the relationships that exist within the dataset by first being "trained" as it is supplied input with known corresponding output. After multiple iterations, a best-fit model is returned with little user control over the final weighting values between variables. In this case, the tested inputs included era (as discussed earlier), Julian Date (JD), daily T_{MAX}, daily T_{MIN}, daily precipitation, available soil water, and daily pan evaporation. Also, many combinations of inputs were used such that averages and temporal shifts were included. The optimal results ($r^2 = 0.92$) were obtained using a total of 17 inputs based on era, JD, T_{MAX}, and soil moisture. Major et al. (1996) found that T_{MIN}, precipitation, and pan evaporation could be ignored with little effect on the final estimates. While this method is considered quite accurate, it is also very complex with numerous inputs and little user control. Further development of this technique could lead to wider use.

For agrometeorological modelling and prediction, it is apparent that modelled seeding dates based on weather-derived parameters are preferable over recorded or fixed seeding dates. Seeding date models vary in their complexity and apparent accuracy but all are based on similar criteria, namely soil moisture and temperature. Model validation is a difficult task due to the fact that the actual seeding date records with which to validate the model output are not necessarily consistent or even accurate. The subjectivity involved and the different methods of gathering seeding date information could have a margin of error that is greater than that of the model itself.

Additional work is needed in the generation of seeding date estimates. As climate prediction models become more sophisticated, realizing the effect of future climate conditions on agriculture will be important for the purposes of adaptation.

3.3 Methods

Daily climate data has been assessed using various heat unit models to evaluate the regional variations as well as the long-term change in thermal potential of the Canadian prairies. The climatic data used in the analysis was obtained through the Eastern Cereal and Oilseed Research Centre of Agriculture and Agri-Food Canada. The data was collected by Atmospheric Environment Services of Environment Canada and has undergone a quality assurance process where all missing data has been filled using values from nearby stations. To detect the possible recent climatic trends related to agricultural parameters, it is important that a suitable period of weather observations be used in the analysis. Records that span too long of a period run the risk of overlooking contemporary climatic trends (Dunlop 1981). For this reason, the World Meteorological Organization recommends that climate normals be updated to the official 30-year period at the end of every decade (World Meteorological Organization 1989). To characterize the current thermal climate of the prairies, daily data from 1971 through 2000 was compiled. Climate stations having less than 20 years of data were excluded from the analyses leaving a total of 230 stations; 60 in Alberta, 93 in Saskatchewan, and 77 in Manitoba (Figure 2.1). The long-term agroclimatic trends using data from 1921 though 2000 from 12 climate stations, four from each province, was also compiled. The stations were selected based on their completeness of record, their spatial distribution, and their distances from large urban centres.

Seeding date to mark the start of each growing season was calculated using a method based on that of McGinn et al. (1999), which considers springtime temperatures, precipitation, and soil moisture. Temperature and precipitation were readily accessible from the historic daily climate database while soil water content had to be derived from an initial run of an updated version of the First-generation Prairie Agrometeorological Model (Raddatz 1989). To begin running the model, the soil water content at the start of the first growing season is required as an initial condition. Soil water for the start of subsequent growing seasons is then calculated through the previous winter based on the value from fall. Since historic soil water content at each location was not known, the model was initialized to start prior to the period of analysis. For the 1971 to 2000 period, the model was initialized in 1961 with an arbitrary soil moisture value of 75% of

AWHC at all stations. A decade was found to be adequate to provide the model with sufficient time for the soil water values to stabilize and not be affected by the initial input values. Through repeated wetting and drying of soils, over time the water content becomes less dependent upon the initial estimate. A sensitivity analysis on a subset of 12 climate stations using initial soil moisture values in 1961 of 50%, 75%, and 100% AWHC yielded identical spring soil moisture values in the spring of 1971 for all stations. To assess the long-term trends in heat units from a subset of climate stations, the model was started at the earliest possible year with available data at each station. For the initial run, wheat was selected as the crop for all years and May 15 was chosen as a fixed seeding date. While May 15 is a rough approximation of seeding date, this date is not expected to have a significant effect on soil moisture during the first few weeks of seed emergence and early crop growth. During this time, an immature crop will not influence the water use amounts to a great extent since the main source of water removal would be through evaporation from the soil surface rather than transpiration from the crop. Planting date will have more influence on moisture once the crop has become established.

Following the initial model run, the daily spring soil moisture contents were applied to the seeding date criteria. Between April 1 and July 31, the AWHC must be less than 90% within the top 5 cm of soil, precipitation must be less than 2.0 mm, and the daily average temperature must exceed 10°C for 10 days though not necessarily consecutively for seeding to occur.

Due to the simplicity of the seeding date model, under certain circumstances, some modelled seeding dates were estimated very late in the growing season, beyond a reasonable date when a producer would plant a crop that would be expected to reach maturity. Retaining these seeding dates in the model would reflect unlikely farming practices. In reality, land that remains unseeded by late spring past the ideal seeding window would likely be hastily seeded despite suboptimal seeding conditions at the risk of there being no crop whatsoever for that year. While field operations in early spring may wait for the ideal field conditions, the urgency associated with late seeding may not permit optimal conditions to occur. As a method to accommodate sub-optimal seeding situations, a cut-off for spring seeding dates was applied using the insurable seeding deadlines for various crops from the provincial crop insurance corporations (Manitoba Agricultural Services Corporation, Canada Saskatchewan Crop Insurance Corporation, and Agricultural Financial Services Corporation of Alberta). The latest seeding deadlines of the three provincial organizations were selected as the cut-off for each crop and applied to all three provinces. For canola, and potatoes, the modelled seeding date for wheat was used with a cut-off at June 20. Corn used the same seeding date but with a cut-off of June 6. If the modelled seeding date occurred after the cut-off date, the seeding date was set to occur on the cut-off date.

To mark the beginning of the growth period for forages, the method used by Selirio and Brown (1979), Dunlop (1981), and Raddatz (1989) was used whereby growth begins following five days with an average temperature above

5°C. The end of the growing season for all crops is triggered either by physiological maturity for crops such as canola, or by the first killing frost of -2.2°C in the fall for crops such as corn, potato, and forage.

To assess the probability of receiving a certain number of heat units during a given season, each data set must first be fitted to a standard normal distribution which compares the observed data distribution to a theoretical Gaussian distribution. A subset of the annual heat unit accumulations was tested for normality using the Shapiro-Wilk test where the W statistic approaches one for a normally distributed sample (Shapiro and Wilk 1965). This method tests the null hypothesis that a sample is from a normally distributed population. Nearly all stations and parameters tested were found to be normally distributed with a P-value greater than 0.05 and a W statistic larger than 0.927. The characteristics of the probability distribution can effectively describe the probability and the variability of occurrences. Whether the distribution is flat, peaked, skewed, or irregular will affect the likelihood of an event of a certain magnitude to occur. Translating this distribution into the probability of occurrence is the key to assessing agroclimatic risk.

For each station, the mean μ (50% probability), the standard deviation σ, the lower and upper quartiles (25% and 75% probability), and the lower and upper deciles (10% and 90% probability) were calculated for GDD for canola, GDD for forage, CHU for corn, and P-Days for potatoes. BMT for wheat was not calculated since the scale does not accumulate beyond 5.0 past physiological maturity. The probability P(A) refers to the likelihood that an event A will occur within a given year while the risk q is the opposite of probability (1 – P(A)) or the likelihood that the event will not occur. An assessment of the risk of heat units indicates the risk of not achieving a certain number of units each year.

The year to year spread or variability in heat units is measured using the coefficient of variation (CV). A high CV (CV≈100%) indicates greater annual fluctuations in conditions and less consistency. Areas with a high CV are at greater risk of receiving abnormal conditions due to increased or more frequent variability about the mean. Areas with a low CV (CV≈0%) are considered relatively consistent from year to year, enabling easier planning due to a higher degree of predictability.

To generate a continuous surface across the agricultural region of the three prairie provinces, risks of annual accumulations of GDD for canola and forage, CHU, and P-Days at each degree of risk as well as CV were interpolated using an inverse distance weighted technique using ArcGIS/ArcInfo GIS software package (Environmental Systems Research Institute Inc. 2006).

To assess the long-term trends in heat units, annual accumulations of CHU were calculated for all available years from 1921 to 2000 at four climate stations in each prairie province. The duration of records at each station ranged from 73 to 80 years. Annual totals were compiled and a least-squares regression function was fitted to each time series to determine the relationship between annual CHU and year. The average annual rate of change over the period of record is described by the slope. A slope value of zero would indicate that there is no trend. A positive slope would indicate an increase in CHU over time while a negative slope would indicate a decrease. A probability level of $P \leq 0.10$ was selected to be considered statistically significant. If the P-value exceeds 0.10, there is no meaningful linear trend.

In dealing with long-term datasets, there is the potential for non-homogeneity in the climatological records. These discrepancies can be brought about through changes in monitoring equipment, location, and exposure of weather stations, automation, urban heat island effects, or by instruments that are malfunctioning or out of calibration. An investigation into the history of each climate station in search of potential non-homogeneities is beyond the scope of this report and has been addressed elsewhere (Mekis and Hogg 1999; Zhang et al. 2000; Vincent et al. 2002). Therefore, we have assumed that each long-term record is acceptably homogeneous for this assessment. Climate stations situated near large urban centres were intentionally left out of the trend analysis to avoid potential warming trends that may emerge as the result of urban influences.

3.4 Results and Discussion

3.4.1 Growing Degree Days for Canola

Areas with the highest average accumulations of GDD from a modelled seeding date to first hard frost appear mainly in southern Manitoba in the Morden, Altona, and Emerson region followed by parts of Alberta around Medicine Hat and Empress (Figure 3.1). Average GDD in these areas ranges between 1650 and 1715. Areas in Saskatchewan with the highest mean GDD, generally those exceeding 1600, occur primarily along the southern border between Elrose and

Estevan extending northwest towards Moose Jaw. Based on work by Morrison et al. (1989), who suggested that 1157 GDD are needed for a canola crop to reach maturity, several regions, particularly in Alberta appear to have inadequate heat for canola production. Nearly all climate stations north of Edmonton and west towards the Rocky Mountains have a mean annual accumulation of GDD below 1157. According to the criteria of Morrison et al. (1989), canola would not be expected to reach maturity in over half of the growing seasons. The fact that canola is grown widely and successfully in northern Alberta suggests that there is some regional bias in the relationship between the accumulation of GDD and the maturity of canola. This could also suggest some limitations of the GDD system, possibly related to the influence of day length. In Saskatchewan, only a few areas towards the northern fringes of the agricultural region as well as the station at Klintonel in the southwest have less than a 50% chance of receiving 1157 GDD or more. Within the agricultural region of Manitoba, GDD at 50% for all stations was greater than 1157. Stations with the lowest mean GDD in the agricultural region of Manitoba were found at Hodgson with 1208 and The Pas with 1219 GDD (Appendix V).

At a 25% risk or 75% probable accumulation of GDD, the areas with the highest values in southern Manitoba, Saskatchewan, and Alberta range from 1450 to 1577 (Figure 3.2). Areas where GDD would not be expected to exceed 1157 in one out of four years (25% risk) extend through much of Alberta with the exception of the southeast, through the northern portion of Saskatchewan, and through parts of northwestern Manitoba. Stations with the highest accumulations of GDD at a 10% risk generally range between 1350 and 1472 (Figure 3.3). Areas that would not be expected to accumulate 1157 GDD in 9 out of 10 years include all of Alberta with the exception of the region extending from Lethbridge through Medicine Hat, north to Empress and south to the United States border. In Saskatchewan, areas to the north of North Battleford, Wynyard, and Yorkton are also not likely to receive 1157 GDD. In Manitoba, this area consists of a larger portion of the northwest, and parts of the north Interlake region.

The CV for annual GDD is relatively consistent across the southern prairies generally ranging from 10% to 13% (Figure 3.4). The one exception is the Klintonel station who's CV is 22.7%. A few stations, mostly in southern Alberta had CV's between 7% and 10%. Generally in Alberta and Saskatchewan, there is a gradual increase in CV from the south to the north.

Despite the limitations on canola related to growing degree days, particularly in the western prairies, canola makes up a significant percentage of the seeded area. In 2006, canola was the third most common crop in Alberta after wheat and barley with 1,646,500 ha. In Saskatchewan, canola was the second largest crop after wheat (excluding areas under summerfallow) with 2,418,900 ha. Within Manitoba canola was also the second largest crop with 922,100 ha (Statistics Canada 2007a). In western Canada, including British Columbia, canola made up 5,013,500 of the seeded hectares. Estimates for 2007 have increased this area by more than 17% due to strong demand and higher prices (Statistics Canada 2007a). Clearly, canola is an important crop that is produced throughout the prairies. Unfortunately, the heat units in areas that are currently on the cooler side

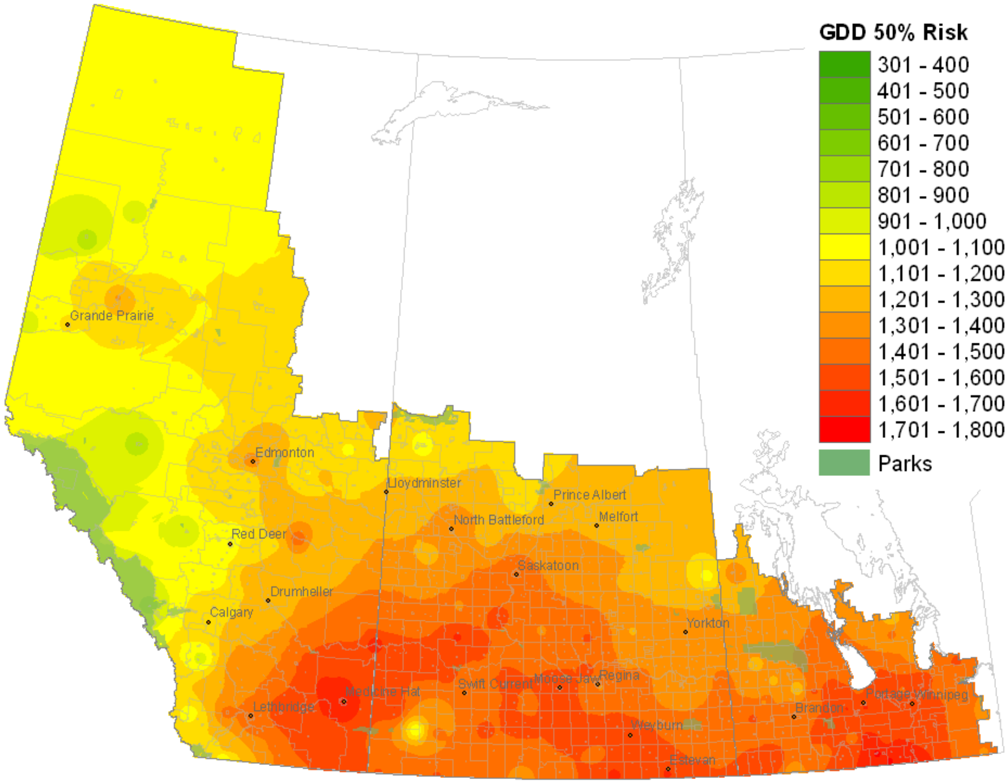

Figure 3.1 Seasonal accumulation of growing degree days for canola at 50% risk

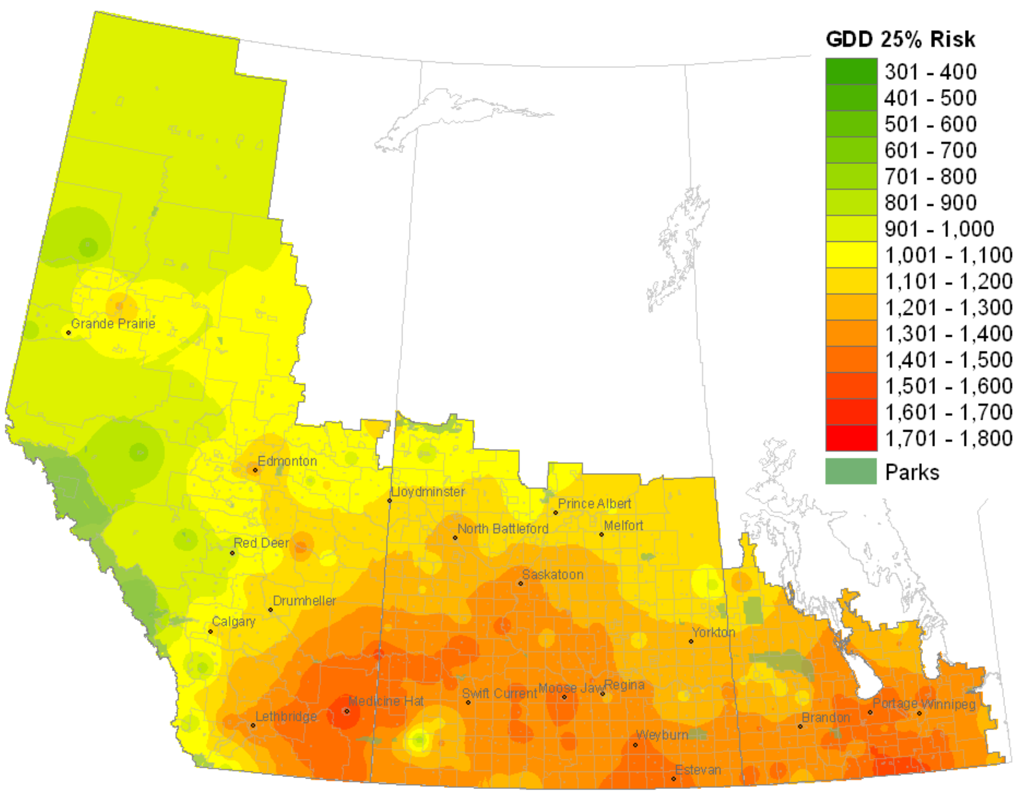

Figure 3.2 Seasonal accumulation of growing degree days for canola at 25% risk

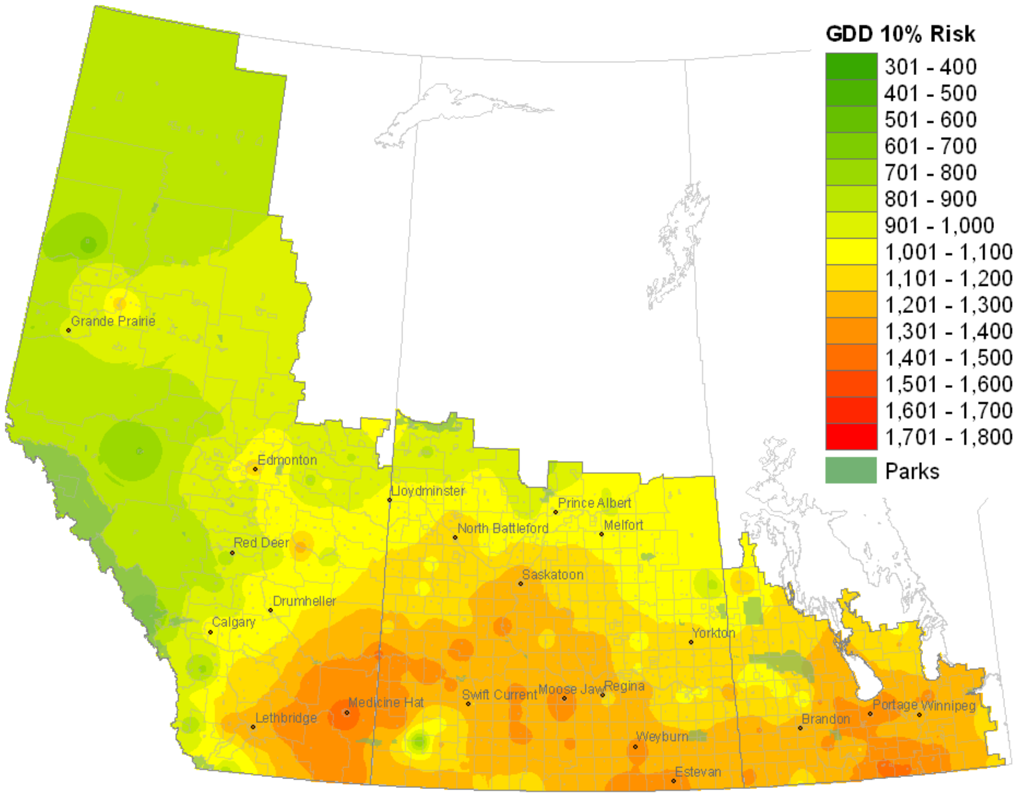

Figure 3.3 Seasonal accumulation of growing degree days for canola at 10% risk

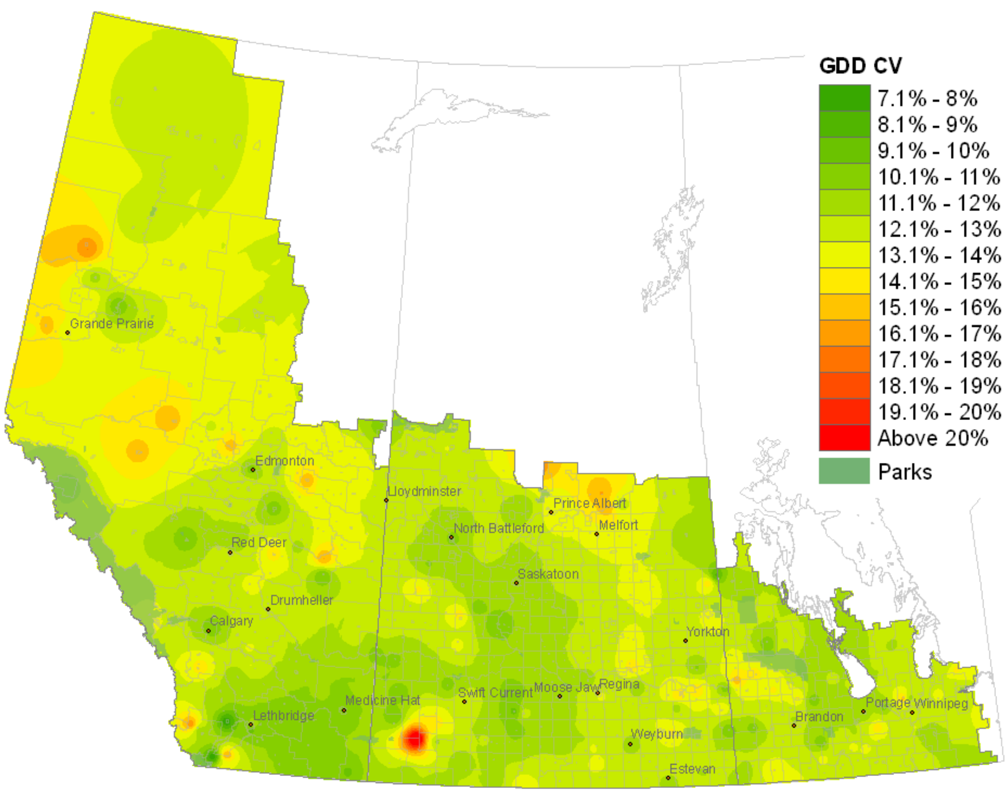

Figure 3.4 Coefficient of variation of growing degree days for canola

of the ideal range for canola, those to the north and the northwest, also have slightly higher CV's. Canola production in these regions comes at a higher risk since abnormal years are more frequent and more likely to result in inadequate accumulations of GDD. However, given the limitations of the GDD system and the actual extent of canola production throughout nearly all parts of the prairies, canola appears to be a well-adapted crop that can be grown throughout most of the agricultural region.

3.4.2 Corn Heat Units

Accumulations of CHU at 50% risk tend to be highest in southern Manitoba and near Medicine Hat Alberta (Figure 3.5). These climate stations range in mean CHU from 2600 and 2750. CHU values ranging from 2500 to 2600 appear in much of southern Manitoba, including Portage la Prairie, Selkirk, and Deloraine, Elrose and Estevan Saskatchewan, and Suffield and Empress Alberta. Most of the remaining climate stations in agricultural Manitoba fall between 2200 and 2500 CHU. In Saskatchewan, there is a general decrease in mean CHU from south to north ranging from 2500 to approximately 1800 around Cameo and Loon Lake. In Alberta, with the exception of the southeastern portion, most of the province receives fewer than 2100 CHU on average. Most grain corn hybrids currently grown on the prairies are rated between 2200 and 2400 CHU (Manitoba Agriculture, Food and Rural Initiatives & the Manitoba Seed Growers' Association 2007) with longer season hybrids producing higher yields (Bootsma et al. 1999). According to the distribution of average CHU, most of Alberta would be considered unsuitable for grain corn over 50% of the time. In

Saskatchewan, average annual CHU suggests that much of the northern regions would not sustain a grain corn crop in at least 50% of years. In Manitoba, the northwestern region does not have sufficient mean CHU for grain corn.

At 25% risk, much of south-central Manitoba, southern Saskatchewan, and the area between Lethbridge and Medicine Hat in Alberta would be expected to sustain some grain corn hybrids (Figure 3.6). At 10% risk, few areas outside of Manitoba could be expected to provide adequate heat for a 2200 CHU hybrid (Figure 3.7). Within Manitoba, only the region extending south from Portage la Prairie and Winnipeg to the United States border would be expected to receive more than 2200 CHU in 9 out of 10 years. Only three climate stations, Morden, Altona, and Plum Coulee have a 90% probability of exceeding 2300 CHU in a given year. In Saskatchewan, the stations with the highest CHU accumulations at the 10% risk do not exceed 2200 CHU. In Alberta, Medicine Hat and Empress would be expected to receive more than 2220 CHU in 9 out of 10 years.

The CV's of annual CHU accumulations at most stations range between 9% and 15% (Figure 3.8). The stations with the lowest CV's are situated primarily in the southern prairies with the exception of Klintonel, Saskatchewan and Cardston and Connelly Creek, Alberta. Areas with higher CV's tend to be in northern Alberta around Grande Prairie and northern Saskatchewan, north of Melfort. Within Manitoba, the lower CV's occur towards the western part of the agricultural area around Binscarth.

According to 2006 data from the Field Crop Reporting Series from Statistics Canada (Statistics Canada 2007a), Manitoba was the only prairie

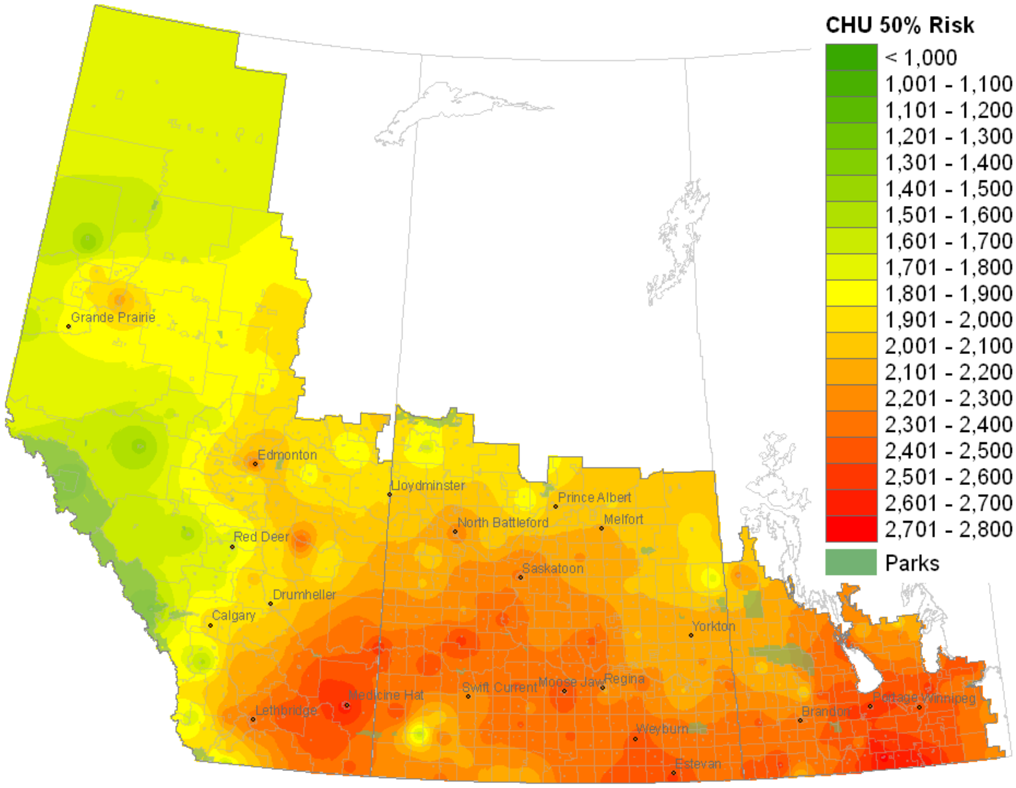

Figure 3.5 Seasonal accumulation of corn heat units at 50% risk

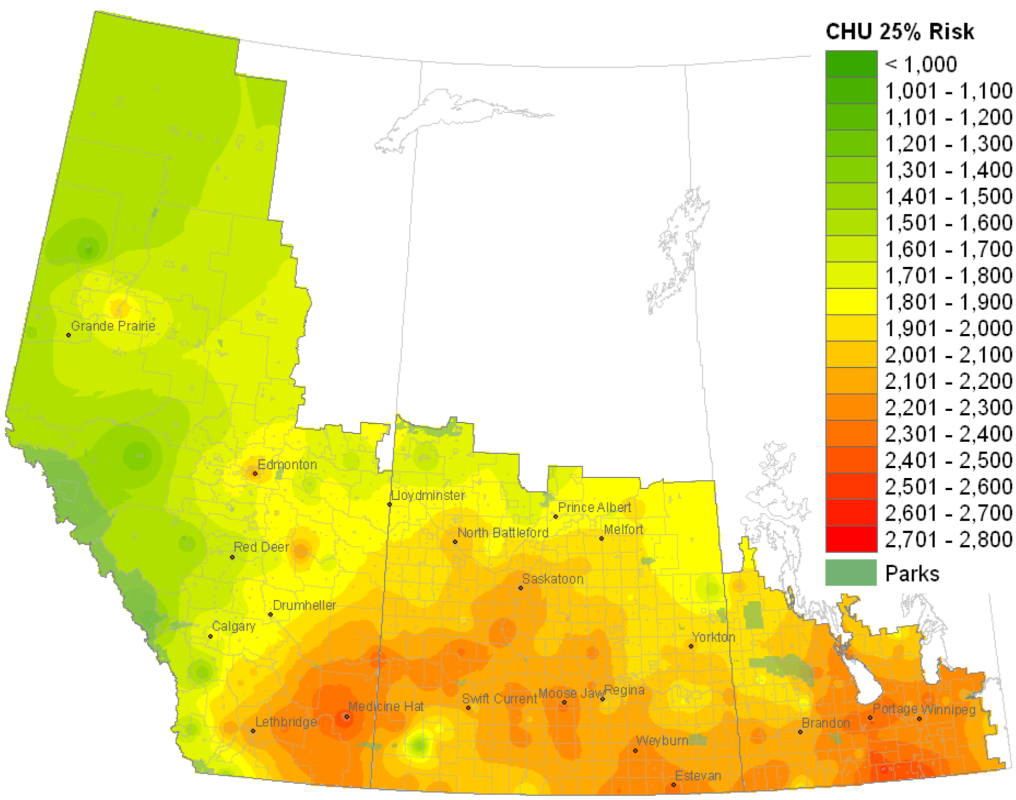

Figure 3.6 Seasonal accumulation of corn heat units at 25% risk

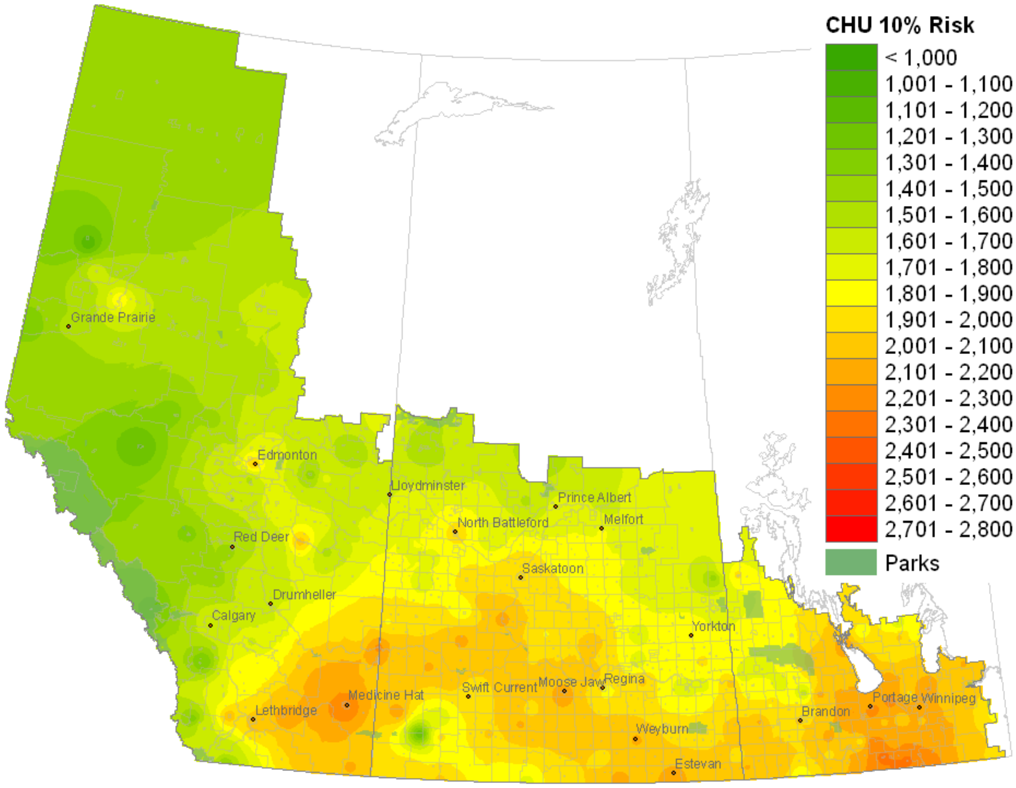

Figure 3.7 Seasonal accumulation of corn heat units at 10% risk

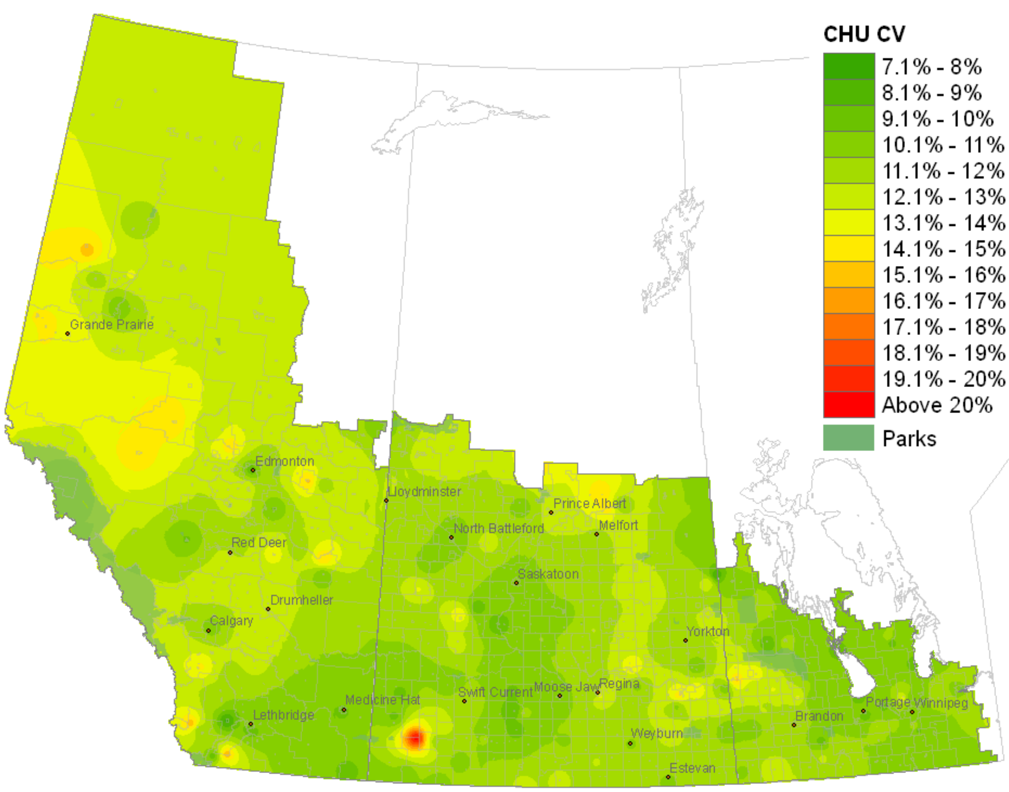

Figure 3.8 Coefficient of variation of corn heat units

province with a significant seeded area of grain corn, reported at 60,900 ha. Saskatchewan had none reported and Alberta had 1,800 ha. These values appear to quite aptly reflect the distribution of corn heat units throughout the prairies. Much of southern Manitoba and part of southern Alberta report enough corn heat units to sustain some production of corn for grain at an acceptable level of risk. Saskatchewan would only have some small pockets with suitable heat units, hardly enough currently to sustain large-scale production of commonly available corn hybrids.

3.4.3 P-Days for Potatoes

At 50% risk, the seasonal accumulation of P-Days for potatoes ranges from 620 to 985 within the agricultural regions of the three prairie provinces (Figure 3.9). This would suggest that on average, potatoes would be able to reach the tuber bulking stage (440 P-Days) throughout most of the prairies. Regions with lower accumulations would only provide a short tuber bulking period prior to season end. A short season would result in small tubers and low yields, thus restricting commercial potato production with the exception perhaps of the production of seed potatoes. The areas with the highest accumulations are found in southern Manitoba and southeastern Alberta, followed by southeastern Saskatchewan. These regions receive on average in excess of 900 P-Days. At 25% risk, the most suitable areas for potato receive between 800 and 900 P-Days (Figure 3.10). At 10% risk, many of these areas receive at least 800 P-Days (Figure 3.11). The areas with the lowest accumulations are in Klintonel,

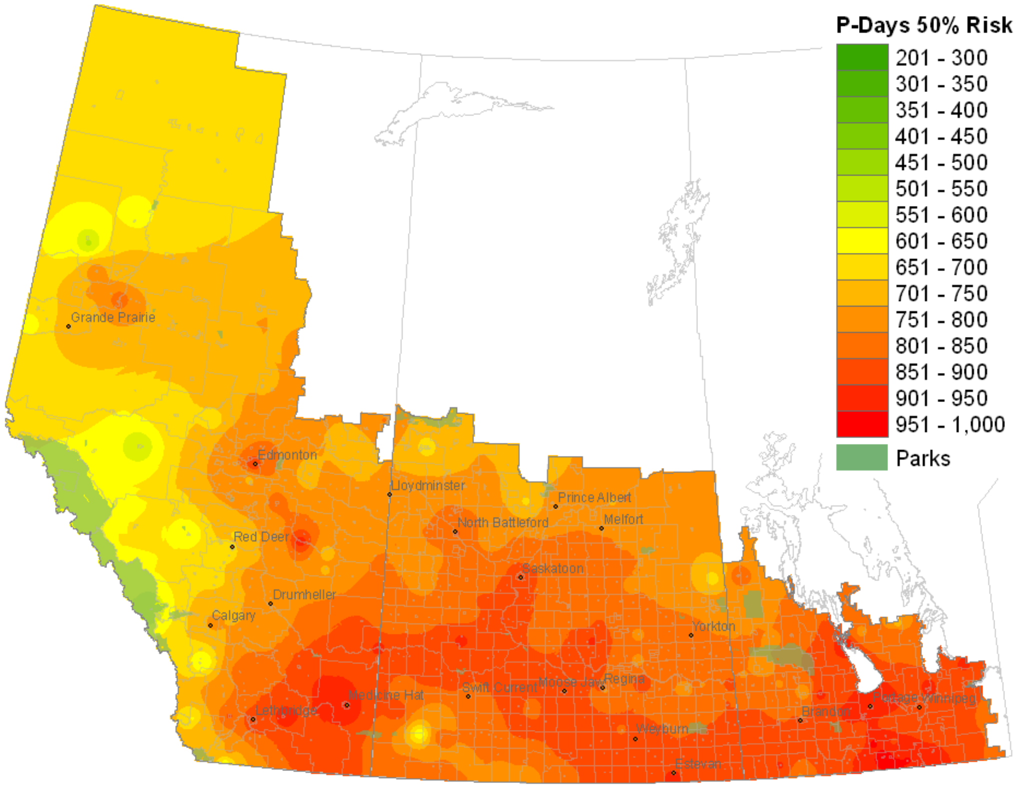

Figure 3.9 Seasonal accumulation of P-Days at 50% risk

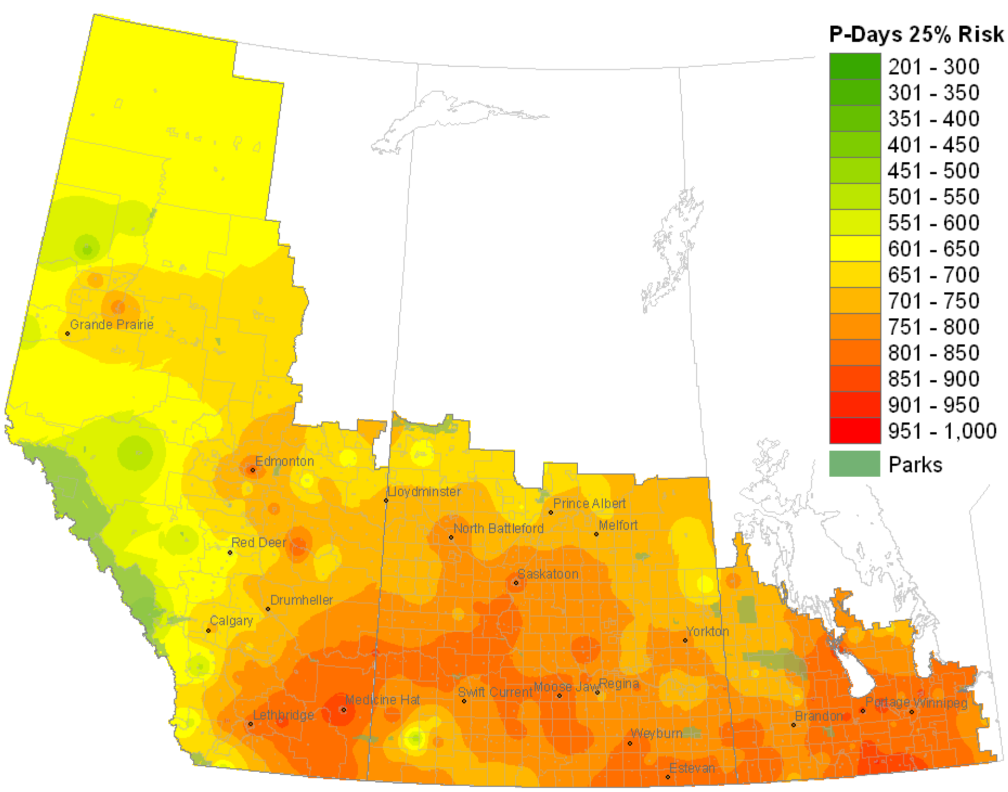

Figure 3.10 Seasonal accumulation of P-Days at 25% risk

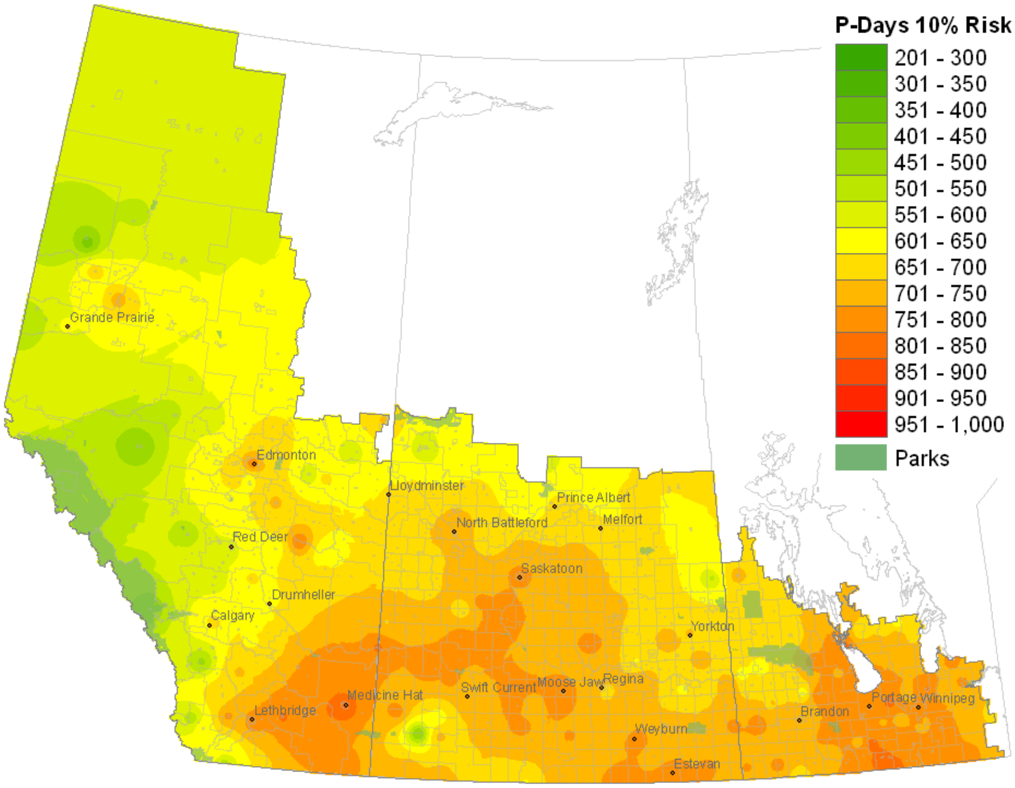

Figure 3.11 Seasonal accumulation of P-Days at 10% risk

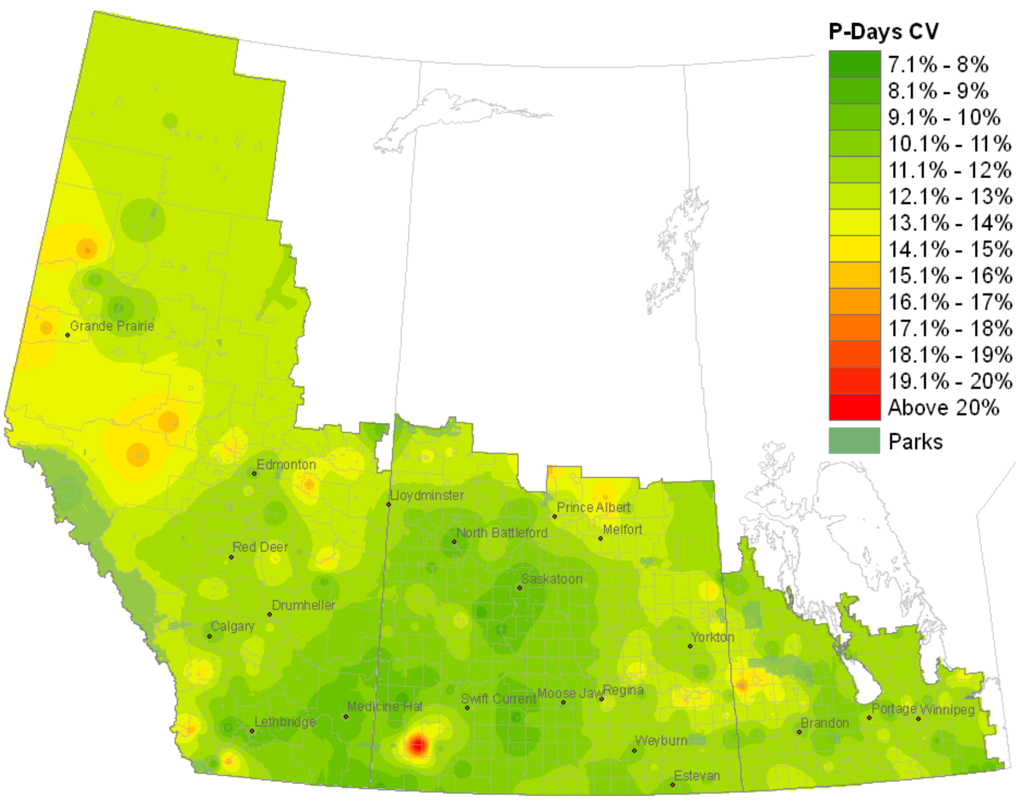

Figure 3.12 Coefficient of variation of P-Days

Saskatchewan and in western Alberta along the foothills of the Rocky Mountains and into northern Alberta.

The CV for P-Days shown in Figure 3.12 shows a similar geographical distribution to the CV for CHU (Figure 3.8), though the values are slightly lower, generally ranging from 7% to 14%. Within the southern regions which are most conducive for potato production, the CV's range from 9% to 13%.

3.4.4 Growing Degree Days for Forages

The accumulation of GDD for forages at the 50% risk is generally highest in southern Manitoba with only a few stations that exceed 1800 GDD (Figure 3.13). Considering that approximately 2100 GDD would be required for three cuts of alfalfa including an adequate period in fall for hardening, these results would suggest that there are no areas on the prairies that could sustain three alfalfa harvests with a 50% or better probability while allowing adequate hardening. Without the fall hardening period, most of the southern regions of the prairies could sustain three cuts of alfalfa, requiring only 1650 GDD. All areas would be able to sustain two cuts of alfalfa without the hardening period (1100 GDD) at 50% risk. A large part of the agricultural region of the prairies, excluding northwestern Manitoba, northern Saskatchewan, and the northern two thirds of Alberta, would receive adequate GDD for two cuts of alfalfa in addition to adequate GDD for fall hardening (1550).

At 25% risk (Figure 3.14), only six stations, five in Manitoba and one in Alberta exceed 1650 GDD allowing for three cuts without a hardening period. Regions with 1550 GDD, allowing for two cuts and hardening occur mainly in southern Manitoba, south of Winnipeg and Portage la Prairie, in Saskatchewan, around Estevan, and in Alberta, from Empress to Medicine Hat. Even at the 25% risk, few stations, mainly those in northern Alberta would not be expected to produce at least two cuts of alfalfa, though sufficient time for winter hardening would not occur.

At 10% risk (Figure 3.15), only a few stations in southern Manitoba as well as Medicine Hat Alberta would receive more than 1550 GDD for two cuts and hardening. Most of agricultural Manitoba and Saskatchewan and the eastern parts of Alberta would receive at least 1100 GDD. With the exception of parts of northern Alberta north of Grande Prairie and west of Rocky Mountain House, all areas would be expected to sustain at least one harvest of alfalfa while allowing a sufficient fall hardening period for adequate winter survival.

The CV's for GDD for forage generally range between 8% and 15% (Figure 3.16). The lowest values appear mainly in southern Alberta, west of Moose Jaw, Saskatchewan, and south-central Manitoba surrounding Altona. Values generally increase into northwestern Manitoba, northeastern Saskatchewan, and northwestern Alberta.

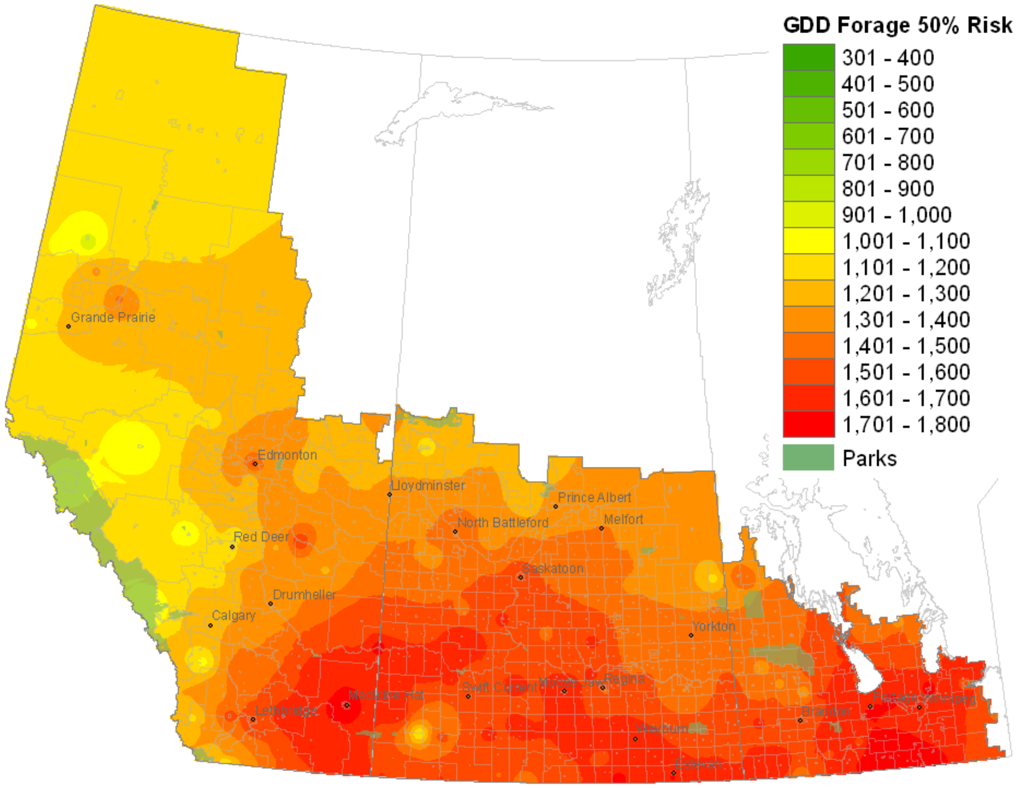

Figure 3.13 Seasonal accumulation of growing degree days for forages at 50% risk

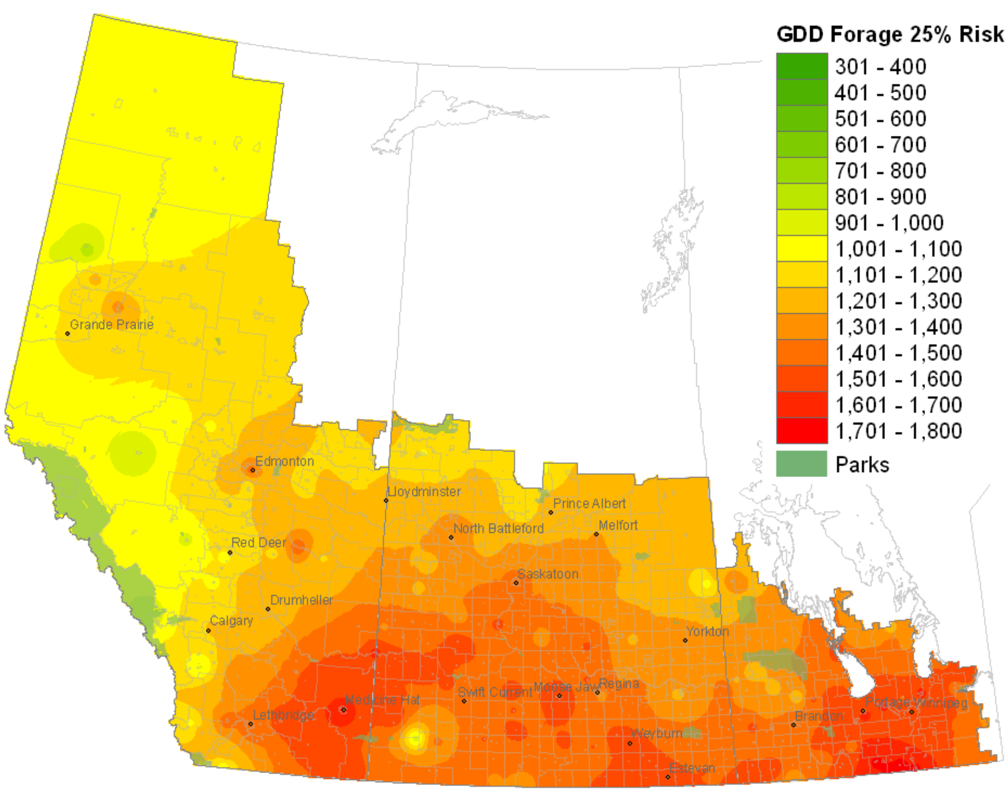

Figure 3.14 Seasonal accumulation of growing degree days for forages at 25% risk

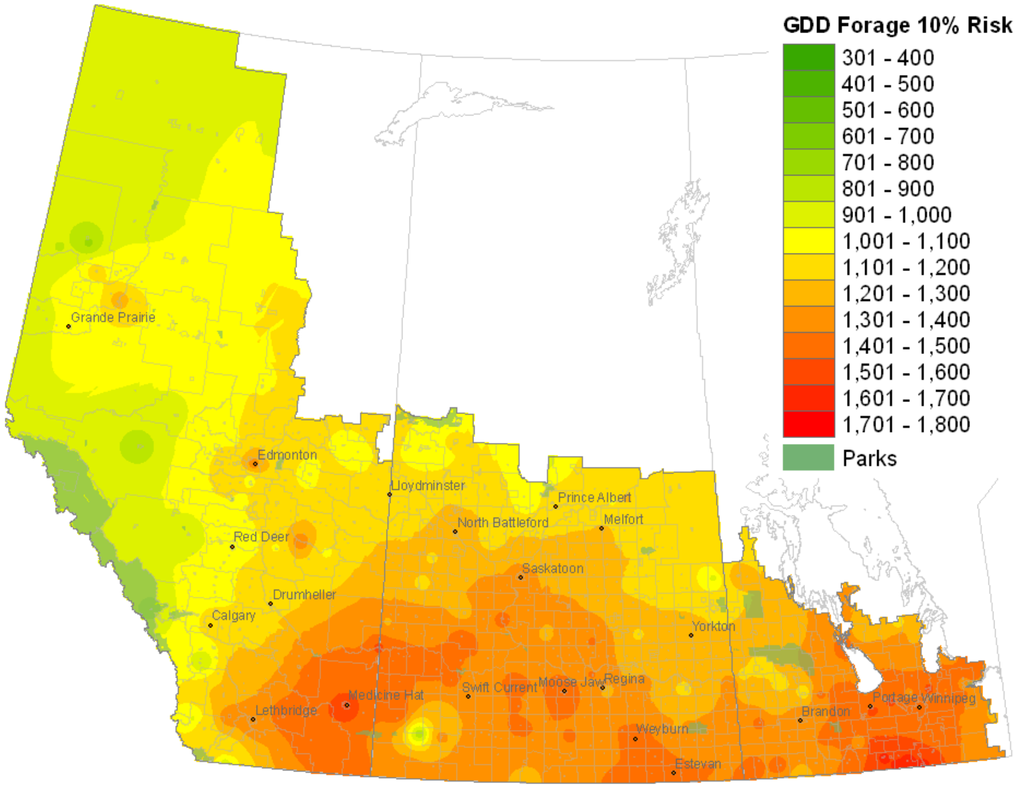

Figure 3.15 Seasonal accumulation of growing degree days for forages at 10% risk

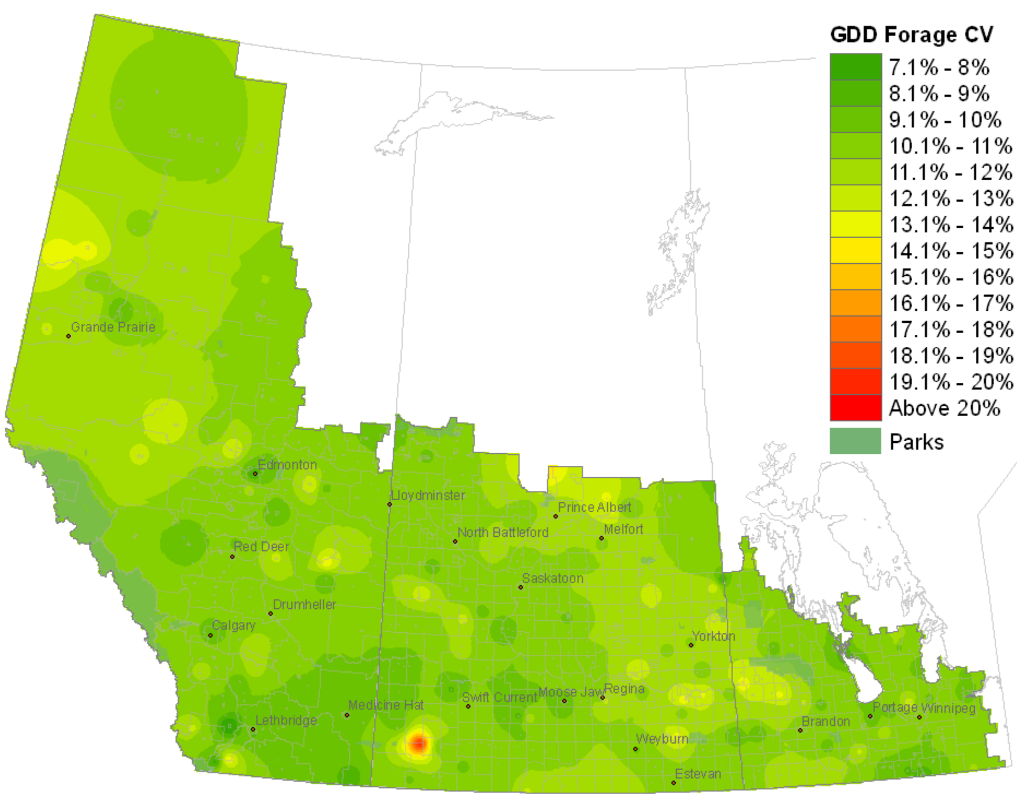

Figure 3.16 Coefficient of variation of growing degree days for forages

3.4.5 Long-Term Trends in Corn Heat Units

A subset of 12 climate stations were each assessed for long-term trends in annual accumulation of CHU since 1921. Of the 12 stations, nine showed a positive linear trend though three of the nine, Lacombe, Olds, and Melfort, were not statistically significant (Table 3.1). Of the six locations with significant positive trends, the average annual rate of change in CHU, or the slope ranged from 1.89 CHU yr^{-1} at Brandon to 5.49 CHU yr^{-1} at Sprague. Medicine Hat, Prince Albert, and Minnedosa all showed significant negative trends of -2.28, -2.07, and -2.64 CHU yr^{-1}, respectively. The varied results demonstrate the regional differences in climatic trends. These observations agree with those of Cutforth et al. (2004) who analyzed frost dates and the length of the frost-free season. In addition to finding an overall warming trend as implied by a longer frost-free season, they also found regional dependency across the Canadian prairies with both increases and some decreases in frost free days.

Table 3.1 Long-term trends in seasonal accumulation of corn heat units

Climate Station	Prov	Duration From	Duration To	Relationship Between Year and CHU	Linear Slope	P-Value	Significance (P<=0.1)
Lacombe	AB	1921	1993	CHU = 895.5 + 0.5 * Yr	0.46	0.656	Not Significant
Olds	AB	1924	2000	CHU = 558.6 + 0.6 * Yr	0.60	0.581	Not Significant
Lethbridge	AB	1921	1999	CHU = -4417.6 + 3.4 * Yr	3.40	0.006	Trend Exists
Medicine Hat	AB	1921	2000	CHU = 7114.4 - 2.3 * Yr	-2.28	0.082	Trend Exists
Indian Head	SK	1921	2000	CHU = -2591.3 + 2.5 * Yr	2.45	0.046	Trend Exists
Scott	SK	1921	1997	CHU = -4172.7 + 3.1 * Yr	3.14	0.005	Trend Exists
Melfort	SK	1921	2000	CHU = -1313.3 + 1.7 * Yr	1.73	0.135	Not Significant
Prince Albert	SK	1921	2000	CHU = 6121.1 - 2.1 * Yr	-2.07	0.084	Trend Exists
Brandon	MB	1921	2000	CHU = -1406.9 + 1.9 * Yr	1.89	0.098	Trend Exists
Minnedosa	MB	1921	1999	CHU = 7261.1 - 2.6 * Yr	-2.64	0.033	Trend Exists
Morden	MB	1921	1998	CHU = -3834.4 + 3.3 * Yr	3.31	0.022	Trend Exists
Sprague	MB	1921	1999	CHU = -8622.6 + 5.5 * Yr	5.49	0.000	Trend Exists
All Locations				CHU = -461.6 + 1.3 * Yr	0.46	0.010	Trend Exists

Of the more southern stations, those south of the 51st parallel (Lethbridge, Medicine Hat, Indian Head, Minnedosa, Brandon, Morden, and Sprague), five out of seven have shown significant increasing trends in growing season CHU over the past 80 years. While these trends should not be extrapolated into the future, we can generalize from this assessment that warming during the growing seasons may have become more pronounced throughout the southern half of the agricultural region of the prairies. Of the five more northerly stations (Olds, Lacombe, Scott, Prince Albert, and Melfort), only one has shown a positive trend in CHU. Whether the locations with no trend or those that appear to be getting cooler over time will continue to do so despite an overall temperature increase on the prairies or whether more time and warming will be required for warming trends to emerge remains unknown. Suffice to say, long term trends in growing season heat unit accumulations have not been spatially uniform over time. Likewise, future shifts in the climate of the prairies will most certainly be distinctive from one region to the next. As such, some areas will fare much better than others to the impacts of climatic changes.

Combining the output from all 12 stations and years of CHU data, the overall trend in CHU was positive and significant at 0.46 CHU yr^{-1}. While 12 stations cannot adequately represent the entire prairie region, the general tendency of the data suggests a shift towards warmer growing seasons with higher accumulations of CHU. This overall warming on the prairies brings the potential to expand the range of crops that may not have traditionally been available. For example, grain corn which can only be grown in certain warmer areas of the prairies would stand to become more feasible in climates that have not traditionally been able to support the crop on a consistent enough basis.

3.5 Summary and Conclusions

A review of GDD, CHU, and P-Days shows a number of regions that clearly offer a greater amount of growing season heat for crop production. These regions include southeastern Alberta, southeastern Saskatchewan, and southern Manitoba. Due to a longer growing season and more available heat, these areas offer a greater range of crops that can be grown and comparatively, less risk than elsewhere on the prairies for conventional crops that can be vulnerable to cooler or shorter growing seasons. Common crops such as canola and forages, and those with similar resource requirements such as flax and spring-seeded small grains like wheat, barley, and oats may be, and are grown throughout most of the prairies (Pettapiece 1995). Wheat, barley, and oats account for nearly 15,000,000 ha of cropland in western Canada (Statistics Canada 2007b). Crops requiring more heat such as corn and soybeans are limited to the warmer regions and are thus limited in production potential. Two or more cuts of alfalfa are only possible where enough heat units are available for adequate re-growth and fall hardening. High yielding potatoes require a climate with a sufficient accumulation of P-Days to provide adequate time for tuber bulking prior to fall harvest.

Throughout the 20th century, temperatures have risen over most land areas of the world (Intergovernmental Panel on Climate Change 2007), including an increase of 1.5°C over the prairies (Zhang et al. 2000). Frost free days have increased by an average of 0.26 days yr^{-1} since 1910 and by 0.31 days yr^{-1} since 1940 (Cutforth et al. 2004). Results from the current analysis show increases in heat units at several locations with an average rate of increase of 0.46 CHU yr^{-1}. With a longer and warmer growing season, there appears to be a potential to expand the range of warm season crops or to possibility introduce new crops to the prairies. There also appears to be areas within the prairies that may not have become warmer during the past century and may not have benefited with respect to additional heat as some other regions have.

This study can act as an indicator of which regions may be conducive for the expansion of certain crops based on thermal considerations at an acceptable level of risk. Of course, climate is not the only factor that makes land suitable for agriculture. Soil and landscape factors are equally important and may prove to be a key impediment to the expansion of arable lands. Furthermore, the limitations related to the various systems of heat units may not adequately represent all parts of the prairies. While this report provides an indication of the thermal capabilities of the region, none of the indices in this analysis consider day length or photoperiod. Northern latitudes, while often subject to shorter growing seasons with less heat, have the benefit of longer days with more sunlight than southern regions. This advantage appears to overcome some of the shortcomings in heat units.

This analysis does not assess crop productivity or potential, which relies on a number of factors such as plant species, management, and annual variability in weather. Other climatic factors apart from heat can be as important. Some of these factors include shortages or excesses in moisture, extreme weather, and disease. According to the Fourth Assessment Report from the Intergovernmental Panel on Climate Change, heat waves and heavy precipitation events are very likely to increase combined with a likely increase in the area affected by drought in the 21st century (Intergovernmental Panel on Climate Change 2007). Non-climatic factors such as policy, markets, and price volatility for both inputs and commodities must also be considered. All of these factors will most certainly introduce new challenges to crop production.

In evaluating an acceptable risk for production, it is impossible to set a universal threshold to be followed under all situations. Risk itself will vary from one operation to the next according to the exposure to certain hazards and resilience of the system itself. An acceptable amount of risk is dependent upon individual stakeholders, their unique circumstance, and the potential gain from taking on a risk. For example, 25% risk may be acceptable to one producer while another may not be comfortable exceeding 10% risk. These thresholds may also change depending on past experience and the level of overall optimism. Risks can also be combined. Where the majority of crops on a farm may have a 90% probability of success, a small percentage of cropland may be exposed to a much higher risk, likely at a much higher potential profit. A producer may be prepared to accept very high risk so long as this risk is combined with a sufficient degree of lower risk as an offset.

Weather remains the most uncontrollable and least predictable factor in crop production. In the northern Great Plains, temperature is always a limitation that must be considered and managed accordingly. An analysis of past weather is an effective method of characterizing the agricultural climate for the purpose of managing risk.

4. AVAILABILITY OF WATER FOR CROP PRODUCTION

4.1 Abstract

An assessment of the moisture-related agricultural climate for the Canadian prairies is presented. Risk maps of growing season precipitation, crop water demand (CWD), and moisture deficit were produced based on the output from a crop phenology and water-use model using daily climate data from 230 stations in Alberta, Saskatchewan, and Manitoba. A subsequent experiment examined a subset of 12 climate stations to determine whether the moisture parameters have changed over the past 80 years. Results for spring wheat (*Triticum aestivum*), grain corn (*Zea mays*), and forages show a decrease in growing season precipitation from east to west and from south to north. The greatest CWD values are in the southern prairies with the highest values in southern Alberta. Forages have the highest average CWD (575 to 750 mm) followed by corn (400 to 500 mm) and then by wheat (275 to 370 mm). The probabilities of moisture deficits are high for all studied crops.

Long-term trends show an average increase of 0.38 mm yr^{-1} in precipitation throughout the growth period of corn combined with a decrease in CWD of -0.32 mm yr^{-1}. The resulting moisture deficit has shown an average decrease of -0.50 mm yr^{-1}. The apparent trends in CWD and moisture deficits are likely attributed to a decrease in daily temperature range over the period of study.

4.2 Introduction

Water is among the most important factors related to crop production. The massive impacts from recent and historic drought events have revealed the continued vulnerability of agriculture and society to moisture deficits. The drought of 2001 and 2002 that affected much of Canada has been considered one of the worst natural disasters in Canada (Wheaton et al. 2007). While deficiencies in precipitation are a normal and recurring phenomenon on the Canadian prairies, the physical, social, and economic impacts of drought remain significant. As such, planning, preparedness, and mitigation efforts are essential to minimize the impacts of agricultural drought. A characterization of the agricultural climate as it relates to moisture is one method to acquire knowledge to describe the supply of water and the demand for water and the risks to which agriculture is exposed.

Soil water content at any given time and location represents the cumulative outcome of infiltration, runoff, surface evaporation, crop transpiration, water redistribution, capillarity action, and deep drainage. The quantity of available water that can be held within the soil has great impact on the duration of time that a crop can survive between episodic periods of moisture recharge, most often from precipitation, irrigation, or snow melt. While the absolute quantity of water is important, so is the frequency of moisture replenishment throughout the growing season. When the demand for water from the crop is not met, water deficit occurs, resulting in crop moisture stress. According to DeJong and Bootsma (1996), soil moisture is more closely related to crop yield than any other soil or meteorological variable. In agricultural regions where moisture is often a limiting factor to productivity (Raddatz et al. 1994), yield can be determined by the extent to which crop water demand (CWD) is met during the growing season. Many yield prediction models are directly related to crop water use (Hanks 1983; Campbell et al. 1988; Raddatz et al. 1994). Drury and Tan (1995) found that higher growing season precipitation resulted in higher corn yields given adequate soil fertility. Wallis et al. (1983) assumed a linear relationship between hay growth and transpiration. Production is optimal when the crop is able to transpire at the potential rate whereas water deficits will decrease crop productivity (Tan and Reynolds 2003).

In addition to determining crop productivity, the amount of moisture within the soil plays an important role in the ability to perform farming operations. Field activities such as tillage, planting, and harvesting are influenced by the trafficability of soil, a direct consequence of soil water content. When a soil is too wet to enable equipment access, field operations cannot take place.

Awareness of soil water content can provide insight into the amount of water that may be available to the crop and can also reveal the amount of water that may be escaping through runoff or deep drainage. These losses can often represent not only a loss of water, but also nutrients, potentially causing negative environmental and economic ramifications. Estimates of long-term soil water status can also assist producers in choosing which crops will be least likely to experience moisture-related stress and can assist in regional crop forecasting and drought assessments (Akinremi et al. 1996).

While it would be desirable to have intensive and continuously monitored soil moisture information over large areas, it is neither feasible nor possible to adequately measure the spatial variability using moisture sensors nor the spatial and temporal variability using manual sampling methods. Most methods to directly measure soil moisture can only provide point readings which do not integrate results over space and time (Baier and Robertson 1966). In addition, intensive manual sampling is both time consuming and expensive. As an alternative to direct measurement, soil moisture modelling provides a means of acquiring estimates of soil water status based on available meteorological data and certain soil parameters. By simulating the effects of weather on the physical and physiological processes within the soil and the plant, a crop response can be predicted and the dynamics of the soil-plant-atmosphere continuum can be quantified.

Modelling soil water over an extended period of time using historical climate records can provide an indication of the long-term moisture regime for a region, including insight into the probability of rainfall, water demand from crops, and moisture deficits, as well as the risks of exceeding certain thresholds. This analysis provides a set of 30-year agricultural climate normals for the Canadian prairies related to moisture for spring wheat (*Triticum aestivum*), grain corn (*Zea mays*), and forages (e.g., *Medicago sativa, Trifolium spp., Phleum pratense, Bromus inermis*). This is accomplished through a modelling process that uses daily meteorological data to simulate crop phenology and soil moisture.

The second part of the analysis looks at the agricultural climate over a longer period of record. Year to year variability can often obscure long-term climate trends making it difficult to ascertain whether the climate has in fact experienced change over time. Changes in heat and moisture among other factors, all of which are integrated into a crop response, can have dramatic impacts on crop production. Therefore, in addition to calculating the most recent set of agricultural climate normals, the subsequent experiment focuses on the past 80 years to assess whether certain moisture related parameters have changed. For this analysis, growing season precipitation, CWD, and water deficit for grain corn are reviewed. Corn was chosen because it is a long season crop that takes advantage of the entire duration of the growing season for heat and moisture. Corn is also a crop that has shown potential for increases in production on the prairies as the climate enables.

Previous studies have looked for long-term trends in various moisture related parameters. Groisman and Easterling (1994) found an increase in precipitation of 0.66 mm yr^{-1} across southern Canada over 100 years. Akinremi et al. (1999) reported an increase in precipitation of 1.28 mm yr^{-1} from 37 climate stations over a 75 year period. With an apparent increase in precipitation and evidence that the prairie climate has experienced warming (Zhang et al. 2000; Intergovernmental Panel on Climate Change 2007), what effect this has on agricultural production is a question that must be answered.

4.2.1 Soil Moisture Models

Differences in soil texture and other properties such as soil organic matter, bulk density, structure, and drainage all affect how water enters, moves, and is stored within the soil. These factors determine the extent to which water is available for plant uptake. Characteristics of the vegetation also influence the soil moisture balance. Crop type, stage, size, architecture, vigour, density, and rooting characteristics influence the rate of water demand. Considering the numerous variables involved in these complex natural processes, all models must make certain assumptions and simplifications of reality. Models that are designed to run on a very small area can normally be provided with a more detailed set of conditions under which they will operate. The assumption is that these parameters related to the soil, crop, and weather will not vary significantly within the limited area of interest. Models being applied to a larger region must make more generalizations considering that all of the aforementioned conditions will become more variable as the area of focus increases. For example, more than one soil type is common within a single field. This will show dissimilarity in water infiltration, drainage, and water holding capacity which will in turn affect the availability or water, nutrients, and ultimately the performance of a plant. Topography can have similar effects. If moisture is limiting, depressions will generally perform better than elevated areas. During wet periods, the low ground may experience problems with excess moisture while the higher ground may be more productive. In addition to the spatial variability in soil properties, there is also a large degree of variability in the weather throughout a region, most notably precipitation. Summer rainfall is dominated by local convective storms, more so than other seasons causing a high degree of spatial variability in moisture (Topp et al. 1996).

There are three types of models that are typically used to predict soil water content. These methods include physically based models, water budget models, and combinations of physical and budget models (DeJong 1988). Physically based models are process-oriented using parameters that can be assigned physical meanings. The difficulty with physically based models is that they often require very detailed soil information that is difficult to obtain in the field. These models must also simulate extremely complex interactions such as water uptake by roots, a process for which accounting is difficult.

Water budget models use a defined upper and lower limit of water that can be stored within a certain volume or depth of the soil. These models are also referred to as bucket models because they consider the storage capacity of the effective rooting zone similar to a bucket or reservoir (Scanlon et al. 2002). As water is added or removed, mainly through precipitation and evapotranspiration respectively, a budgeting process accounts for the additions and subtractions of water in the soil. More sophisticated models divide the soil into zones, representing specific horizons within the soil profile which may hold different amounts of moisture and allow the flow between zones.

Combination models use the water budgeting technique but in combination with the numeric solutions to various physically based equations related to water movement. The type of model to be used for a certain applications is most often dictated by the availability of input data as well as the requirements of the application. For a regional analysis, either a water budget or a combination model will likely be the most feasible.

Most soil moisture models simulate three main interacting components; the atmosphere, the crop, and the soil (DeJong and Bootsma 1996). The atmospheric component consists of the magnitude of the vapour pressure deficit and the energy available to cause evaporation from open water and soil surfaces or transpiration through vegetation. Evapotranspiration (ET) is the process of water vapour moving into the atmosphere through both evaporation and transpiration. Reference evapotranspiration (ET_0) represents the water demand from a fully covered and well watered grass surface (Allen et al. 1998). Grass, a perennial crop with complete surface cover and a fully developed root system from spring through fall, can transpire at appreciable rates throughout the entire growing season, limited only by the atmospheric demand. In contrast, annual crops must germinate from seed and establish a canopy and root system each year. Until the time when the annual crop has become established, the surface and roots will behave quite differently than a typical perennial crop. A landscape void of vegetation cover will be dominated by surface evaporation rather than by transpiration. The absence of root penetration prevents water from being extracted from depths and water loss is limited to the top layer of soil. In contrast, an actively growing crop with a fully developed root system will transpire a great deal of moisture as the water is extracted from the soil at greater depths. At this point, evaporation from the soil surface will be less than 10% of the ET (Allen et al. 1998). Since the majority of commercially grown crops on the prairies are annuals, an estimate of water use must consider that the soil surface does not have full cover nor is there a developed root system during the spring prior to seeding and emergence and in the fall after ripening. This will result in reduced transpiration and increased evaporation at the start and end of the season, with an overall decrease in seasonal ET.

The crop type, stage, and vigour, combined with the available moisture in the soil will dictate the actual ET and how that relates to ET_0. Since the rate of water extraction is greatly dependent upon crop characteristics, it is necessary within a model to simulate the vegetative processes that occur above and below the soil surface. To represent the water consumption by a crop at a particular point in the growing season, the development of the crop from planting to maturity must be simulated and be incorporated into the overall process.

4.2.2 Evapotranspiration

Similar to soil water models, ET models may also be physically or empirically based. Physically based models use process oriented parameters to simulate natural processes and frequently require extensive meteorological and micrometeorological data which are often unavailable (DeJong and Tugwood 1987), particularly from historic climate records. Empirical estimates of ET_0 are derived from regression-type equations based on standard and more widely available climatological observations. Baier and Robertson (1965) and Baier (1971) derived regression coefficients from observations at six locations throughout central and western Canada. Baier and Robertson (1965) and Baier

(1971) developed a set of eight empirical equations used to calculate ET. Formula I requires the most basic daily meteorological inputs; radiation at the top of the atmosphere, daily maximum air temperature (T_{MAX}), and daily range of air temperature. Formulas II through VIII require additional inputs such as wind speed, solar radiation, and vapour pressure enabling the reliability of daily ET estimates to increase with the number of variables involved (Baier and Robertson 1965). Since many historic climate datasets provide only daily T_{MAX}, T_{MIN}, and rainfall, formula I is often the sole option available for estimating ET. Baier and Robertson (1965) found that 68% of the variations in ET could be explained using formula I, compared with 75% to 84% of the variation in results explained by incorporating additional variables using formulas II through VIII.

Empirical equations often have the limitation of being specific to a period or area. To overcome this constraint, Baier and Robertson (1965) derived their regression equations using data from many weather stations across Canada spanning several years. The intent was to avoid regional bias as well as to ensure that the resulting model would better represent the physical input from each variable (Baier 1971).

4.2.3 Soil Properties

Soil characteristics have a profound influence on the vegetation that can be supported. Soil can often determine which crops can or cannot be grown in a certain area. In terms of soil moisture, the available water holding capacity (AWHC) of the soil could be considered the most important soil characteristic for crop production. The AWHC is the quantity of available water that is held between the field capacity (FC) and the permanent wilting point (PWP) of the soil. The volume of available water that can be stored within the soil profile will control the length of time that a crop may survive between moisture replenishment. Vegetation on a soil with a low AWHC will generally be less resilient to extended dry periods than on a soil with higher AWHC since a fine textured soil can hold much more moisture than a coarse textured soil.

Laboratory methods of determining FC normally consider the matric potential to be at -33 kPa (DeJong and Shields 1988). While laboratory testing for FC is considered faster and less expensive than field testing, Cassel and Nielson (1986) argue that there is no good alternative to *in situ* field methods. Within the agricultural region of southern Manitoba, Haluschak et al. (2004) have assembled field data that provides textural and moisture characteristics by horizon for numerous soil series. Following the methods described by Zwarich and Shaykewich (1969), FC was determined on site by saturating a soil profile and allowing the moisture to redistribute and drain for three days. The soil was then analyzed for water content and bulk density (D_B). While Cutforth et al. (1991) suggest that the WP should also be measured in the field, Haluschak et al. (2004) obtained WP in the laboratory with the use of a pressure membrane apparatus at -1500 kPa. The AWHC was determined on a weight basis as the difference between FC and PWP. Expressed volumetrically, the AWHC by weight is multiplied by the D_B and by the depth of the horizon or root zone for equivalent depth of moisture. Based on detailed field moisture characterization, Haluschak et al. (2004) produced some general guidelines that relate AWHC to textural class (Table 4.1).

Table 4.1 Relationship between soil textural class and water characteristics (based on facts from Haluschak, et al., 2004)

Code	Texture	Permanent Wilting Point (mm/120cm)	Field Capacity (mm/120cm)	Available Water (mm/120cm)
CS	Coarse sand	43.2	108.0	64.8
S	Sand	39.6	140.4	100.8
FS	Fine sand	38.4	170.4	132.0
VS	Very fine sand	55.2	205.2	150.0
LS	Loamy sand	75.6	205.2	129.6
LFS	Loamy fine sand	73.4	207.6	134.2
LVFS	Loamy very fine sand	71.0	248.4	177.4
GSL	Gravely sandy loam	84.0	252.0	168.0
SL	Sandy loam	104.4	278.4	174.0
FL	Fine sandy loam	103.2	294.0	190.8
VL	Very fine sandy loam	102.0	307.2	205.2
L	Loam	132.0	378.0	246.0
SCL	Sandy clay loam	146.4	388.8	242.4
CL	Clay loam	156.0	421.2	265.2
SIL	Silt loam	146.4	405.6	259.2
SICL	Silty clay loam	162.0	421.2	259.2
SIC	Silty clay	189.6	475.2	285.6
C	Clay	225.6	540.0	314.4

AWHC values can vary considerably between soils, thus affecting the availability of water to the crop and consequently the performance of the crop. While the FC and PWP are often considered constant physical properties for each soil, DeJong and Bootsma (1996) point out that these values are somewhat arbitrary. Depending on the hydraulic characteristics of a soil, the FC is not exact but subject to the unsaturated redistribution of soil water. The PWP is also subject to variation being affected not only by the soil but by the environmental conditions and the plant characteristics. Despite the inadequacies of the FC and PWP concepts, more specific soil hydraulic characteristics such as retention characteristics and hydraulic conductivity are not available nor would they be uniform enough on a regional scale, making the AWHC based on soil texture the only feasible soil input for regional soil moisture budget modelling.

4.2.4 Winter

For a model to provide continuous moisture simulations in the absence of actual moisture measurements, an over-wintering procedure is necessary to provide the budgeting process with a starting point for spring soil water content. This value represents the important partition of stored moisture that is carried over from the previous season. The spring soil moisture is influenced by a number of factors, including precipitation in fall, winter, and spring, the characteristics of the snow melt, and the amount of water that escapes from the soil profile at various times.

The moisture acquired through the winter season from the snow pack is a contributing factor to spring and summer moisture conditions. A great deal of water can be held in the snow pack and a certain amount of this water will enter into the soil beneath. Meteorological elements and site characteristics will influence how much water enters the soil for use by the subsequent crop. As new snow falls and accumulates, wind may cause a heterogeneous distribution of snow accumulation on the ground through drifting (Walter et al. 2004). The greatest rate of snow transport occurs over flat, open areas with high winds. The areas of deposition occur in regions of roughness where obstacles and barriers cause a deceleration of wind speed (McKay and Gray 1981). Due to differences in vegetation and terrain, there is often a wide variation in snow accumulation. Comparing measured snowfall amounts with measured snow courses, McKay

(1964) found that about 55% of the accumulated snow is retained on well exposed open prairie terrain. Partly wooded areas and forested areas were found to retain anywhere from 65% to over 100% of measured snowfall amounts. In southwestern Saskatchewan, Staple and Lehane (1952) found that only 33% of winter precipitation was retained in a stubble field. Akinremi et al. (1996) used a value of 70% surface snow retention in their modelling procedures though they found that in some years, this value appeared to be too low, particularly during winters that were less windy than normal. While the retention ratio could be highly varied over short distances based on surface roughness and cover, topography, and nearby features, the ratio tended to remain constant at most sites.

The melting of snow is caused by an influx of energy in excess of that required to maintain the snow pack at 0°C. There are two main factors that cause the snow pack to melt in the spring; air temperature and rainfall. Rainfall most often occurs in combination with air temperatures above freezing since rainfall would seldom occur when the air temperature is below 0°C. Soil temperature could be considered an additional driver of snow melt as the soil may emit heat to the snow above. However, with cold and long prairie winters and relatively shallow snow packs, the upper layers of the soil are frozen by mid-winter which causes the flow of heat to be from the snow pack to the soil (McKay 1964). Melting from solar energy during the winter can be considered negligible since the angle of the sun is low and the snow pack is highly reflective. Melting from solar energy is expected to increase in spring as the angle of the sun is higher and the snow becomes older and less reflective.

The amount of spring melt water that is retained in the soil rather than lost as runoff is largely dependent upon the amount of water in the soil prior to freezing, particularly in the top 30 to 40 cm. Spring runoff is expected to be less over dry soils and a lower percentage of melt water will be retained over wetter soils or those whose surface has been wetted producing a nearly impervious layer of soil (Willis et al. 1961, Willis et al. 1969). In North Dakota, Willis and Haas (1969) found that approximately 50% of snowmelt was lost as runoff over a dry soil while 80% was lost over a wet soil. Bauder et al. (1975) measured 80% or more of the snowmelt as runoff. Infiltration is not expected to occur into a frozen saturated soil (Steppuhn 1981).

4.3 Methods

4.3.1 Model Description

To assess the agricultural climate as it relates to moisture for spring wheat, grain corn, and forages, each crop is simulated to "grow" within every possible location and growing season from 1971 through 2000. A 30-year period was chosen for the calculation of agroclimatic normals while a subset of climate stations were assessed over an 80-year period to determine whether the agricultural climate has changed with regards to precipitation, crop water demand (CWD), and crop moisture deficit for grain corn.

As the crop develops from seed to maturity, the water demand, the actual water use, and the soil moisture is simulated on a daily time increment. For these simulations, the First Generation Agrometeorological model developed and described by Raddatz (1989) and Raddatz et al. (1996) has been adapted for use with the dataset. Since this model has been described elsewhere (Raddatz 1989; Ash 1991; Ash et al. 1992; Raddatz et al. 1996), only a brief overview of some of the main components will be provided herein.

One of the advantages of this model is that a minimal number of climate variables are required for each station. This is especially important since the available archive of climatological stations contains only daily T_{MAX} and T_{MIN} and daily quantity of precipitation. Requiring only minimum meteorological inputs enables ordinary climatological stations to be included in the analysis. By including the maximum possible number of climate stations, the analysis may be performed at a greater spatial resolution which will better represent regional differences in the agricultural climate. The climate dataset used in this analysis is from the Eastern Cereal and Oilseeds Research Centre with climate data collected by the Meteorological Service of Canada, Environment Canada. Climate stations with 20 or more years of record between the years of 1971 and 2000 were included. This provides a total of 230 stations; 60 in Alberta, 93 in Saskatchewan, and 77 in Manitoba (Figure 2.1). A subset of 12 stations having between 70 and 80 years of data were selected to be analyzed for long-term trends in moisture.

4.3.1.1 Rainfall. Rainfall during the growth period of a crop provides a general means of assessing the moisture regime of a region as it relates to the production of that crop. In addition to growing season rainfall, there are numerous other factors that influence crop water supply. For example, rainfall outside of the growing season provides a necessary supplementary source of water for crops. This water from rain or snow melt is stored in the root zone which acts as a reservoir. Another factor that influences crop water supply is the nature of the rainfall, specifically the timing and intensity of the rainfall events. Prolonged dry periods within the growing season can cause severe stress on a crop. Water from very heavy rains over a short duration of time may escape as runoff or deep drainage.

Surface runoff occurs when the rate of precipitation exceeds the intake capacity of the upper layers of the soil. Within this model, there are two situations that can cause surface runoff. The first case is when the soil is wet. As the water content of the soil increases, there is less internal pore volume that can hold additional moisture causing the intake rate of the soil to decrease to zero. When a soil is at field capacity, the model does not permit additional entry of water into the soil, thus resulting in runoff. As the soil water decreases to below field capacity, infiltration of water can resume.

The second situation that may cause surface runoff is when the intensity of precipitation exceeds the intake rate of the soil. Heavy amounts of precipitation over a short duration can easily bring water to the soil surface faster than the surface can absorb. The result is either ponding of water or the water will drain laterally into low spots or away into drainage ditches. Rainfall intensity is reported as the amount of rainfall per unit of time, normally as millimetres per hour. Given that the climate data is in a daily time increment, the true intensity of a given rainfall cannot be determined. For example, a daily recorded amount of precipitation of 50 mm could have steadily fallen over the entire 24-hour period resulting in a rainfall intensity of 2.1 mm/hour. At this intensity, much of the precipitation could be absorbed into the soil. In contrast, had that same 50 mm rainfall arrived within a 30-minute period, the resulting intensity would be 100 mm/hour, one that would exceed the intake rate of almost any soil surface resulting in significant runoff.

To account for runoff due to wet soil and intense precipitation, the model does not consider the individual intake rate nor the saturated hydraulic conductivity or internal drainage of each soil. As a regional model, this would be impractical since these rates will vary considerably based on soil characteristics, local topography, time of year, and management practices. Instead, a single rainfall intensity threshold is applied where runoff is expected to occur when the daily quantity of precipitation exceeds the daily CWD by more than 25.4 mm. When this threshold is surpassed, a runoff function based on work by Baier et al. (1979) is triggered. Within this function, the proportion of runoff increases with increasing rainfall intensity and greater soil moisture content such that:

$$I = (0.9177+(1.811 \times \log(EX/25.4))-(0.0097 \times ((AWHC) \times \log(EX/25.4))) \times 25.4 \quad [1]$$

Where I is infiltration and EX is excess moisture or the amount that precipitation exceeds CWD. Regardless of I, once the AWHC reaches 100%, the remainder of water is allocated as runoff and is considered to be lost from the system. Therefore, the total amount of runoff is equal to EX subtract I. When water is removed as runoff, the water will no longer be available and cannot be recovered to satisfy the evaporative demand of the crop in subsequent days.

4.3.1.2 Crop Water Demand. To calculate ET, the model first estimates the amount of latent evaporation (E_L) per day using formula I of Baier and Robertson (1965) from which ET_0 is derived based on the method of Baier (1971). Formula I requires observed daily T_{MAX}, daily temperature range, and radiation at the top of the atmosphere derived from the latitude of the climate station and the day of the year. Since historic data from most climate stations contains only daily T_{MAX} and T_{MIN} and quantity of precipitation, the three-parameter formula I was the only regression equation that could be used. The equations for E_L and ET_0 (converted into metric units) are as follows,

$$E_L = -57.334 + (1.6704)(T_{MAX}) + (1.6794(T_{MAX}-T_{MIN})) + (0.0486)(Q_0) \qquad [2]$$

$$ET_0 = 0.08 + (0.0076)(E_L) \qquad [3]$$

where: E_L = Daily amount of latent evaporation ($cm^3\ day^{-1}$)
ET_0 = Daily reference evapotranspiration ($cm\ day^{-1}$)
T_{MAX} = Daily maximum temperature ($^{\circ}C$)
T_{MAX} = Daily minimum temperature ($^{\circ}C$)
Q_0 = Solar radiation at the top of the atmosphere ($cal\ cm^{-2}$)

To relate ET_0 to the actual demand of the crop, the stage of the crop must be determined. The relationship between ET_0 and CWD is referred to as the consumptive use (CU) factor, a coefficient that changes throughout the growing season to reflect the stage of an annual crop. The CU is a ratio of CWD to ET_0 where the CWD is determined by ET_0 x CU. During periods with little or no crop, such as prior to seeding and from seeding to emergence, the consumptive use factor will be very low (CU = 0.3). When the crop is well established and actively transpiring, the CU ratio will approach unity as CWD nears ET_0. Normally the CU will again decrease once the crop approaches maturity and post harvest. The individual CU values used for each crop based on the development of the crop are provided in Table 4.2. For wheat, the biometeorological time (BMT) scale (Robertson 1968) is used where 0 = planting, 1 = emergence, 2 = jointing, 3 = heading, 4 = soft dough, and 5 = ripe. For the phenology of corn, the corn heat unit (CHU) system is used. A forage crop may contain a number of different types of plants, both legumes and grasses, each with unique moisture-related characteristics. The composition of forage crops varies, thus the water-use also varies among forage crops. The model must make some generalizations in simulating a typical forage crop. Certain similarities in perennial forages have been assumed, specifically (i) that most forage species enter into active growth very early in the growing season, (ii) they continue to use water late into the season, and (iii) the CU remains constant throughout the growth period.

Table 4.2 Consumptive use factors for wheat, corn, and forage

Wheat	**Consumptive Use Factor**
BMT < 1.0:	CU = 0.3
1.0 ≤ BMT < 2.0:	CU = 0.3 + (0.5 x ((BMT) - 1.0))
2.0 ≤ BMT < 3.0:	CU = 0.8 + (0.2 x ((BMT) - 2.0))
3.0 ≤ BMT < 4.0:	CU = 1.0 - (0.2 x ((BMT) - 3.0))
4.0 ≤ BMT < 5.0:	CU = 0.8 - (0.3 x ((BMT) - 4.0)); If CU < 0.3, CU = 0.3
Corn	**Consumptive Use Factor**
CHU < 300:	CU = 0.3
300 ≤ CHU < 1200:	CU = 0.3 + (0.7 x (CHU/1200))
1200 ≤ CHU < 1800:	CU = 1.0
CHU ≥ 1800:	CU = 1.0 - (0.3 x (CHU/2300))
Forage	**Consumptive Use Factor**
Entire active growth period:	CU = 1.0

In addition to dictating the water demand of a crop through the CU, the stage of the crop also affects the depth of the root zone. This will determine the depth of soil from which the plant can extract water. Prior to the germination of a newly seeded crop, the rooting depth will be the same as the seed depth.

Therefore, the amount of water available for ET will be that which is contained within the narrow layer from the surface to the seed below. Once the crop emerges and grows, the roots become deeper, gradually increasing the size of reservoir for potential water extraction. The depth of the root zone is assumed to increase proportional to the phenological development of the crop with the exception of perennial forage species whose root zones are assumed to be already established in spring and constant throughout the entire period of growth. The following equations describe the estimated root depth in relation to heat units for wheat based on Rasmussen and Hanks (1978) and for corn and forages based on (Raddatz 1989).

Rooting Depths (Z_R) (cm)

Wheat:

$$Z_R = 5.0 + (115.0 / (1.0 + \exp (5.0 - (8.0 \times BMT / 3.5)))) \qquad [4]$$

Corn:

$$Z_R = 5.0 + (115.0 / (1.0 + \exp (5.0 - (8.0 \times ((CHU) / 1200)))) \qquad [5]$$

Forages:

$$Z_R = 120 \qquad [6]$$

For wheat, corn, and forage, the depth of the effective root zones do not exceed 120 cm. Rooting depths tend to vary between different studies. Incerti and O'Leary (1990) found that maximum root penetration in wheat reached a maximum depth of 104 cm and in some cases as shallow as 83 cm. Timlin et al. (2001) used a maximum depth of 90 cm for modelling of corn while Dale (1968) used a rooting depth of 150 cm for corn. Jamieson et al. (1995) observed substantial changes in moisture content as deep as 130 cm for wheat and 150 cm for corn. Stone et al. (1973) found that 99.9% of sorghum roots were within the top 130 cm of soil. Some of the variation in rooting depth is likely due to soil and climate variations.

4.3.1.3 Crop Water Deficit. Under non-water-limited conditions, the daily crop water demand can be met either by precipitation on that day or by the available moisture in the root zone of the soil. If sufficient moisture is accessible, the actual ET will be equal to the CWD. Plant stress occurs when the water demand is not met. By definition, the water that is held between FC and PWP of the soil in the root zone can be extracted by the plant until the soil water becomes depleted to its PWP. However, the entire quantity of available soil moisture is not equally available. As the soil dries, the roots cannot extract moisture at the required rate. At this point the CWD is not being met and the plant begins to experience stress. Within the model, once the available water is depleted to 60% of AWHC, a root zone drying function is implemented to represent the reduced soil water uptake. The function for soil moisture withdrawal (SMW) when the available water is less than 60% of AWHC is as follows:

$$SMW = CWD \times (AWHC/100) \times 1.67 \quad [7]$$

This function assumes that the ratio of actual ET to CWD remains at unity from 100% to 60% of AWHC. As the soil dries below 60%, the ratio decreases linearly to zero at the permanent wilting point. The sum of the daily moisture deficit values between planting and maturity for wheat and corn and from the start of active growth to the first killing frost for forage provide an annual total moisture deficit for each crop in each growing season.

4.3.1.4 Soil Properties. The water balance calculation requires an estimate of the available water holding capacity of the soil profile. Soil water characteristics are dependent upon numerous factors such as texture, structure, bulk density, organic matter content, and horizons. Most of these attributes are not readily available for all sites. To determine the appropriate soil characteristics for each climate station, the Soil Landscapes of Canada (SLC) version 2.2 was used (Centre for Land and Biological Resources Research 1996). This dataset describes the general soil properties at a reconnaissance level which provides a scale of 1:1,000,000.

To match each climate station with the soil that is representative of the region, the SLC datasets for Alberta, Saskatchewan, and Manitoba were imported into ArcGIS/ArcInfo (Environmental Systems Research Institute Inc. 2006) geographic information system (GIS) software as polygons. Each polygon in the SLC has an SL code that can be linked to various polygon attribute tables. These tables contain the detailed information associated with each soil polygon, including the surface texture of the dominant soil type within the polygon. In the GIS, the weather station locations were plotted based on their latitude and longitude and overlaid onto the SLC layer. This enabled each station to fall within an SLC polygon. A spatial join function was performed enabling the point and polygon data to be combined based on their spatial location. Using this procedure, each point or station is able to extract the information of the polygon within which it sits. The output file is a list of weather stations, each with their own soil texture (Appendix I).

Since the scale of this assessment is regional, based on the climate that is meant to encompass a considerable area around each weather station, the intention was that the attributes associated with each weather station be regional in nature. Therefore, the soil characteristics should represent those that are common in the region rather than those that are unique to a very small area. For this reason, stations that fell within soil polygons that were very small (area ≤ 0.01 km^2) adopted the characteristics of the nearest larger polygon (area > 0.10 km^2).

Within the derived dataset of climate stations with their respective soil properties, not all locations that have weather stations could be assigned a textural class. For example, stations located in areas of ice, rock, or high water tables were not assigned a texture by the SLC classification. While the immediate sites surrounding these weather stations would not be considered suitable for agricultural production due to the soil limitations, the meteorological data from the station is valuable for representing the greater region. In addition, the inclusion of monitoring points beyond the agricultural area assists with the interpolation procedure near the edges of the region of interest. This could also help to identify future suitable areas for crop production that are presently not considered able to support agriculture. The locations that did not have a textural designation were assigned the characteristics of the nearest polygon with a designated textural class.

4.3.1.5 Winter/Spring Period. Precipitation that occurs on or after November 1 or when the daily mean temperature is below -1°C is considered snowfall and accumulates to form a snow pack. Normally, the snow pack will accumulate from late fall through winter with some melt, but with the bulk of the melting occurring in spring. The water stored within the snow pack is considered stored moisture. Since a certain amount of snow on a typical field is subject to blowing and drifting, a blow-off ratio is used where 40% of the snow is retained on a stubble field and 50% is retained on a forage field. In addition to blow-off, the snow pack will also be reduced by evaporation and sublimation and by melt. While loss from evaporation is considered to be negligible (McKay 1964), evaporation and sublimation are simulated together using the formulas of Baier and Robertson (1965) and Baier (1971), similar to the method that is used for ET during the growing season.

The melting of the snow pack is handled by the method of McKay (1964) which considers T_{MAX} and the Julian Date (JD) as a proxy for the intensity of solar radiation. The method uses a series of snowmelt curves for a given daily T_{MAX} above 0°C to provide the daily potential snowmelt. Melting may also occur on days with rain when the heat energy is given up as the rain water cools to the temperature of the snowpack. A routine from the U.S. Army Corps of Engineers (1989) is employed where the temperature of the rain is assumed to be the same as the air temperature and the extent of melt occurs based on the average temperature and the amount of rainfall. As melt occurs, generally from the upper portions of the snowpack, a certain amount of melt water is expected to be retained and re-frozen while moving through the snowpack. The quantity of water that is able to be retained is 10% of the volume of the snow pack, similar to the method of Baier et al. (1979) used in the Versatile Soil Moisture Budget model.

Melt water in excess of ET is partitioned into infiltration or runoff, depending on the daily quantity of melt, the soil moisture content, and the soil temperature. If the amount of melt exceeds 25.4 mm, some runoff is assumed to occur. Soil temperature is estimated based on the past ten-day average maximum air temperature and the depth of the snowpack. If the temperature of the soil is below freezing, the amount of water that enters the soil is reduced as soil moisture content increases to simulate the inhibited intake rate of a moist frozen soil. Once the soil reaches field capacity, all of the melt water is partitioned into runoff, similar to what is simulated during the summer.

Warming temperatures and loss of snow pack begin to occur towards the end of winter and early spring. Beginning in April, a seeding date model based on that of McGinn et al. (1999) scans daily air temperature, precipitation, and modelled soil moisture to determine if conditions are suitable for seeding. According to the criteria, daily mean temperature must exceed 10°C for 10 days though not necessarily consecutively, the available water within the top 5 cm of soil must be less than 90% of AWHC, and daily precipitation must be less than 2.0 mm. If the model did not yield a reasonable seeding date in a given year, a cut-off date was applied using the latest insurable seeding deadlines of the three provincial crop insurance organizations (Manitoba Agricultural Services Corporation, Canada Saskatchewan Crop Insurance Corporation, and Agricultural Financial Services Corporation of Alberta). For wheat, the seeding cut-off date was June 20. For corn the cut-off was June 6. A modelled seeding date that occurred past the cut-off date was set to occur on the cut-off date. Perennial forages were considered to begin active growth following five days with an average temperature above 5°C, a method used in other simulations of forage growth (Selirio and Brown 1979; Dunlop 1981; Raddatz 1989).

4.3.2 Probability Analysis

For each moisture-related agroclimatic parameter, a test for normality was performed to determine whether the dataset conformed to a Gaussian distribution which would allow a standard probability analysis to be performed by calculating the area under the curve. Analyses based on the assumption of normality for a non-normal dataset would produce misleading results (World Meteorological Organization 1983). Model output from a subset of climate stations was tested for normality using the Shapiro-Wilk test (Shapiro and Wilk 1965). The outputs that were tested included growth period precipitation, CWD, and crop moisture deficit for wheat, corn, and forage. Generally, whether a set of rainfall accumulations are normally distributed or not depends on the time frame and the location. While annual totals are nearly normally distributed, monthly mean values are often skewed and daily values are highly skewed (World Meteorological Organization 1983). In semi-arid regions, annual total rainfall distributions may also be skewed (Jackson 1977). Therefore, with growing season rainfall, particularly in drier pars of the prairies and for shorter season crops such as wheat, performing a test for normality was essential. For all normally distributed parameters, it was expected that outliers would prevent some stations from conforming to the normal distribution (Ash 1991). In this case, if most of the stations met the criteria for normality, a normal distribution was assumed for the parameter at all locations. If the majority of stations did not meet the criteria for normality for a parameter, the parameter was assumed to be non-normal and was excluded from the probability analysis.

The Shapiro-Wilk test showed the majority of 30-year time series for growth period rainfall and CWD to be normally distributed for all crops (Table 4.3). These parameters were evaluated for 10%, 25%, 50%, 75%, and 90% probability of occurrence along with the coefficient of variation (CV) as a percentage. The CV is used as an indicator of the year to year variability where a low CV (CV≈0%) would suggest a very low degree of inter-annual variability while a larger CV (CV≈100%) would indicate a high degree of variability and less consistency from year to year. Maps of growing season precipitation and CWD for wheat, corn, and forage at risks of 50%, 25%, and 10% were generated. Results were also produced for Canola however the output did not vary substantially from that of wheat and therefore, canola was not included in the final dataset or maps.

Annual crop moisture deficit was found to be non-normal in nearly all cases and could not be dealt with in the same manner as the other parameters. The distribution for moisture deficit was highly skewed since some climate stations had a number of years with very low stress values and some years with a very high degree of stress. Rather than attempting to normalize the data, an extreme value distribution approach was employed whereby the recurrence interval of extremes is provided using a probability of being exceeded. The frequency of stress events of given magnitudes were determined using the annual maximum method (World Meteorological Organization 1983). With this method, the value of largest magnitude per year is selected and assessed for a probability of occurrence. In this case, the value of the total annual crop moisture deficit was input while in a non-stress year, the value is zero.

Table 4.3 Results of test for normality for various moisture-related parameters

Parameter	Wheat	Corn	Forages
Precipitation	Normal	Normal	Normal
Crop Water Demand	Normal	Normal	Normal
Crop Moisture deficit	Not Normal	Not Normal	Not Normal

In selecting a valid series for an extreme value analysis, the World Meteorological Organization (1983) recommends that two important conditions be met. The first is that data must be numerous and consistent. A minimum of 15 values should be present in a time series and the time series should not contain trends. For this analysis, a minimum of 20 values are used for each climate station. Temporal trends are considered undesirable since the results of the analysis are assumed to persist into the future. While trends in the climate dataset are likely to exist, by using only the past 20 to 30 years of data, the values remain contemporary and should reflect the most current climatic conditions without being severely affected by trends.

The second assumption recommended by the World Meteorological Organization (1983) to satisfy an extreme value analysis is that the values are independent of one another. This assumption is not always met since the soil moisture in one growing season is affected by the preceding season. This would be the case in multi-year droughts where soils depleted of moisture in fall will increase the risk of drought in the subsequent year. Since the soil moisture from the past year is only one of several factors that cause crop moisture deficits, it is unlikely that coupling of one stress year to the next will greatly affect the results.

Once all years of stress have been compiled for each station, the annual values are ranked (m) in ascending order and the probability (P) of occurrence for each value is assessed as $P = 1.0 - m / (n+1)$. To determine the likelihood of achieving various thresholds of annual crop water stress, the values were plotted according to their probability on a logarithmic scale where the line of best fit represents the probability of an event of a given magnitude being exceeded. For wheat, maps of probability of moisture deficits in excess of 0, 25, 50, and 100 mm were generated. For corn, the probability of exceeding deficits of 0, 25, 50, 100, and 150 mm were mapped. For forage, the probability of exceeding 100, 150, 200, and 250 mm of stress were mapped. A high probability value indicates a high likelihood of receiving the given amount of stress over a growing season. Since probability is related to return period (T) such that $P = 1/T$, the return period can easily be determined by $T = 1/P$. Furthermore, to find the probability of an event with a known T, occurring in the next n years, the equation $P = 1 - (1 - 1/T)^n$ can be used. For example, if a given stress level has a probability of P = 25%, the return period will be T = 4.0. Therefore while a single year would have a 25% probability of experiencing this amount of stress, the probability of occurrence once during a five year period is 76% or during 10 years is 94%.

From the point data associated with each climate station, an inverse distance weighted technique was applied to generate a continuous surface using Spatial Analyst of ArcGIS/ArcInfo (Environmental Systems Research Institute Inc. 2006). Each generated surface was then added to a base map of the agricultural regions of the three prairie provinces.

A separate analysis looking at long-term trends in moisture was performed on a subset of 12 climate stations. The stations were chosen based on their duration of record and to provide a general representation of the prairies. Each station had from 73 to 80 years of record between 1921 and 2000. The data was analyzed using the First Generation Agrometeorological model (Raddatz 1989) with corn as the selected crop. Seasonal totals of rainfall, CWD, and water deficit were tabulated and fitted to a least-squares regression function. The slope of the linear trend line was used to determine if a trend exists and a probability level of $P \leq 0.10$ was selected for statistical significance. A value above 0.10 would indicate that the trend is not significant.

4.4 Results and Discussion

Moisture-related climatologies were generated for wheat, corn, and forages from 230 weather stations across Alberta, Saskatchewan, and Manitoba. To provide a spatial representation of the results, the model output was interpolated into maps encompassing the agricultural portions of the three provinces. While there are numerous modelled parameters that were generated and countless others that can be derived from the crop water-use and phenology model output, three fundamental water-related results were selected to be represented in this risk assessment. These parameters include growing season rainfall, crop water demand, and crop water deficit. Each parameter was generated for wheat, corn, and forages for various risks.

4.4.1 Wheat

With wheat being a short season crop, the amount of rainfall during the growth period for wheat will depend not only on the aridity of the area but also on the length of the growing season. Most crops would be expected to take longer to reach maturity in cooler areas, lengthening the period of time that will receive growing season rainfall. This region is not necessarily wetter overall than the warmer region with a shorter growing season. Rather, the growing season may simply be longer causing the location to appear more humid than warmer areas. This is pronounced in the warmer southern regions where wheat has a comparatively rapid advancement to maturity and hence, a short growing season that may appear quite dry.

Throughout the agricultural region, growing season rainfall for wheat ranges between 125 mm and 355 mm at 50% risk (Figure 4.1). At 25% risk, this range decreases to between 100 mm and 290 mm (Figure 4.2). At 10% risk or the amount of rainfall that would be expected to occur in 10% of years is between 55 mm and 245 mm (Figure 4.3). The lowest rainfall amounts occur exclusively in southeastern Alberta and southwestern Saskatchewan including all locations south of Lethbridge, Taber, Suffield, Empress, Swift Current, and Chaplin, reaching as far north as Outlook and Saskatoon. Average rainfall in these areas is below 175 mm. In contrast, the average CWD for this region ranges from 300 mm to 340 mm (Figure 4.5), a substantial difference between the water demand and that supplied from rainfall during the growing period. Throughout the majority of the eastern prairie region, growing season rainfall for wheat ranges from 175 mm to 225 mm at 50% risk (Figure 4.1) while average crop water demand is between 275 mm and 325 mm (Figure 4.5). Central Alberta receives the highest average amount of growing season rainfall for wheat with values ranging from 225 mm to as high as 355 at Edson. Average water demand for this area is generally in excess of 300 mm.

Crop water demand for wheat tends to increase from east to west. At 50% risk, the demand in central and eastern Manitoba varies from 275 mm to 300 mm. West of Brandon and through much of Saskatchewan, the demand exceeds 300 mm (Figure 4.5). The water demand in western Alberta exceeds 325 mm with values as high as 370 mm at some locations. At 25% risk, the CWD in the eastern prairies is between 280 mm and 350 mm while the western prairies mostly range from 300 mm to 380 mm (Figure 4.6). At 10% risk, the CWD for most of the prairies is between 290 mm and 400 mm (Figure 4.7).

The CV for growing season rainfall for wheat ranges from as low as 16% to greater than 50% at some locations (Figure 4.4). The lowest values are generally found in central Alberta, the region with the highest growing season rainfall for wheat. These values generally fall between 15% and 25%. The lower CV's in this region is likely attributed to the longer growing season which would be expected to receive less variability over a longer period. For example, annual precipitation would have less variability than monthly precipitation. Generally, the southern prairies with a shorter growing season for wheat and less rainfall during that period have higher CV's. The CV's in most of these regions range from 30% to 40%. A large portion of southern Alberta and the region south of Moose Jaw Saskatchewan have CV's greater than 40%. The CV's for CWD are much lower than those of rainfall. Nearly all values fall below 20% with the majority of climate stations below 10% (Figure 4.8). There is a slight increase in CV's from west to east; however the overall distribution shows little variation in annual CWD for wheat.

Crop moisture deficit is an amalgamation of growing season rainfall and crop water demand taking into account contributing factors such as non-growing season precipitation, spring soil moisture, soil water holding capacity, and timing of precipitation. Seasonal crop water deficit or stress is the additive total of daily stress values that occur when the daily CWD is not met by that day's rainfall or soil moisture. Certain moisture deficit values were chosen for analyses for the probability of occurrence for each crop. A probability above 90% represents a very high likelihood of receiving the given amount of stress in a given year.

The map in Figure 4.9 shows the likelihood of a wheat crop receiving any stress during the growing season. At all locations across the prairies, the probability exceeds 60%. Most of the agricultural areas exceed 70% while western Saskatchewan and southern Alberta exceed 90% probability. Throughout the prairies, at least some degree of moisture stress is more likely to occur than not.

Stress levels in wheat that exceed 25 mm are less likely to occur in all areas (Figure 4.10). Roughly two thirds of the climate stations have less than a 50% probability of receiving 25 mm of water stress. The areas with the lowest probabilities are mainly in central Alberta and in eastern and northern Manitoba. Regions with a very high likelihood of stress, those with greater than 90% probability are found in southeastern Alberta, east of Suffield through to southwestern Saskatchewan extending to regions as far north as Cameo. The probability of 50 mm of stress is high only at a few locations (Figure 4.11), including Ingebright Lake, Saskatchewan, extending west into Alberta. Most of the rest of the prairies, with the exception of southeastern Alberta and southwestern Saskatchewan, have less than a 30% chance of receiving more than 50 mm of stress. The probability of receiving more than 100 mm of moisture stress is very low in all areas of the province (Figure 4.12). There are only eight climate stations, seven in Alberta and one in Saskatchewan, with a greater than 30% probability of wheat receiving a moisture deficit of 100 mm or more.

Low rainfall during the growth period and high crop water demand are obvious indicators of probable crop water stress. As is the case in southeastern Alberta and southwestern Saskatchewan, the water demand is much higher than the supply of water during the season. Unless spring soil moisture levels were extremely high or rainfall during the growth period was much greater than normal, stress would almost always occur in this region. In contrast, central

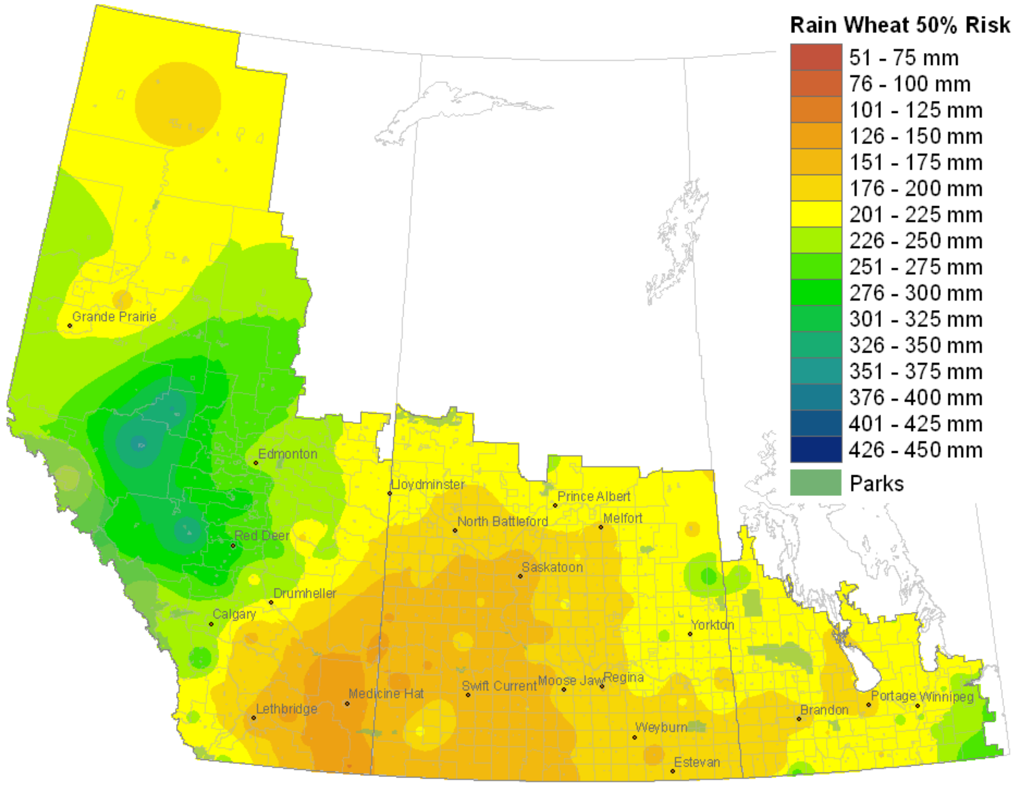

Figure 4.1 Rainfall during the growth period of wheat at 50% risk

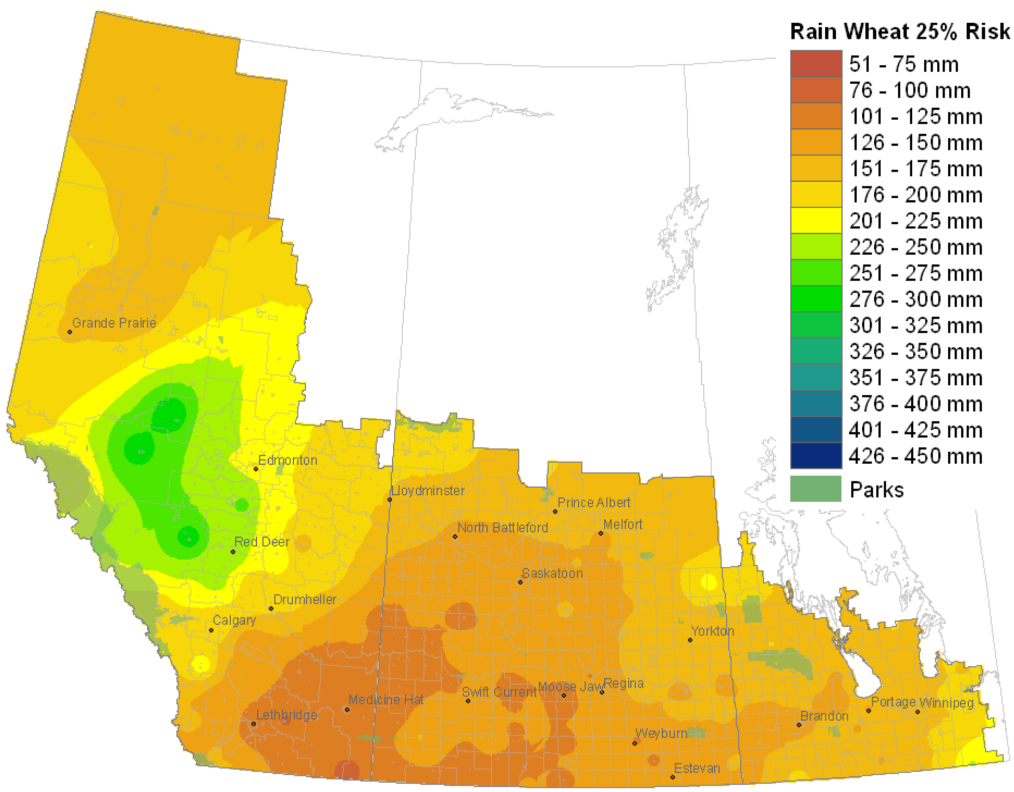

Figure 4.2 Rainfall during the growth period of wheat at 25% risk

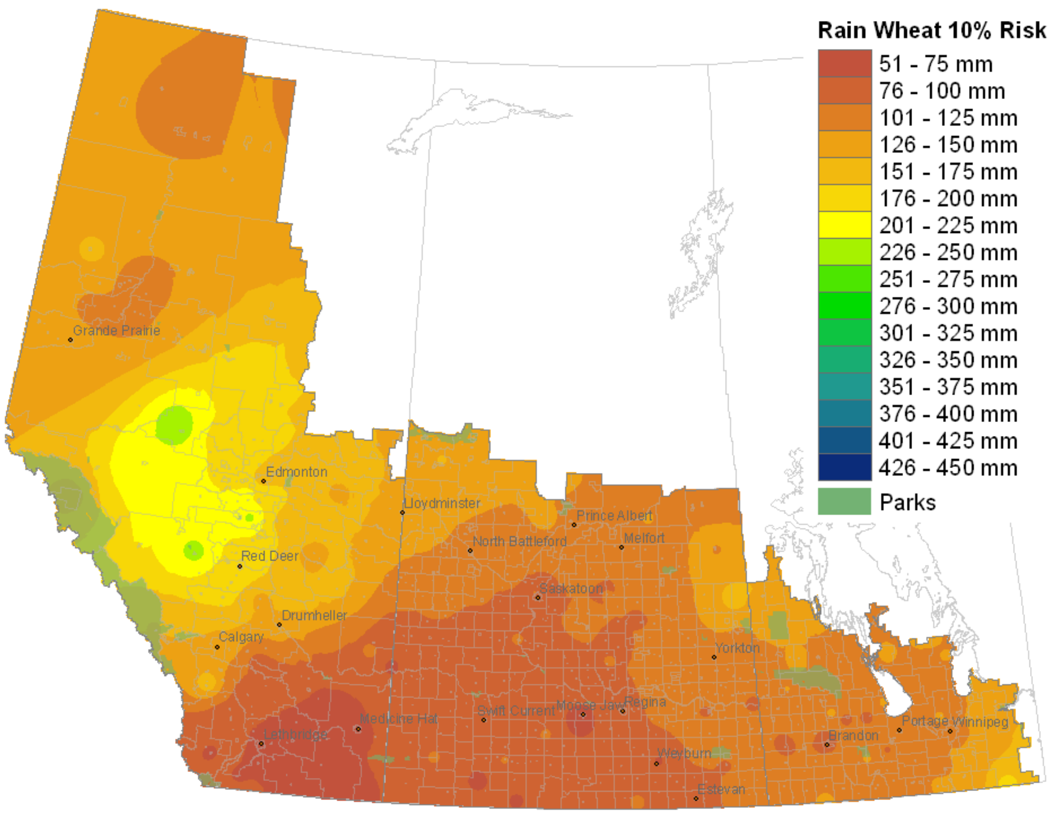

Figure 4.3 Rainfall during the growth period of wheat at 10% risk

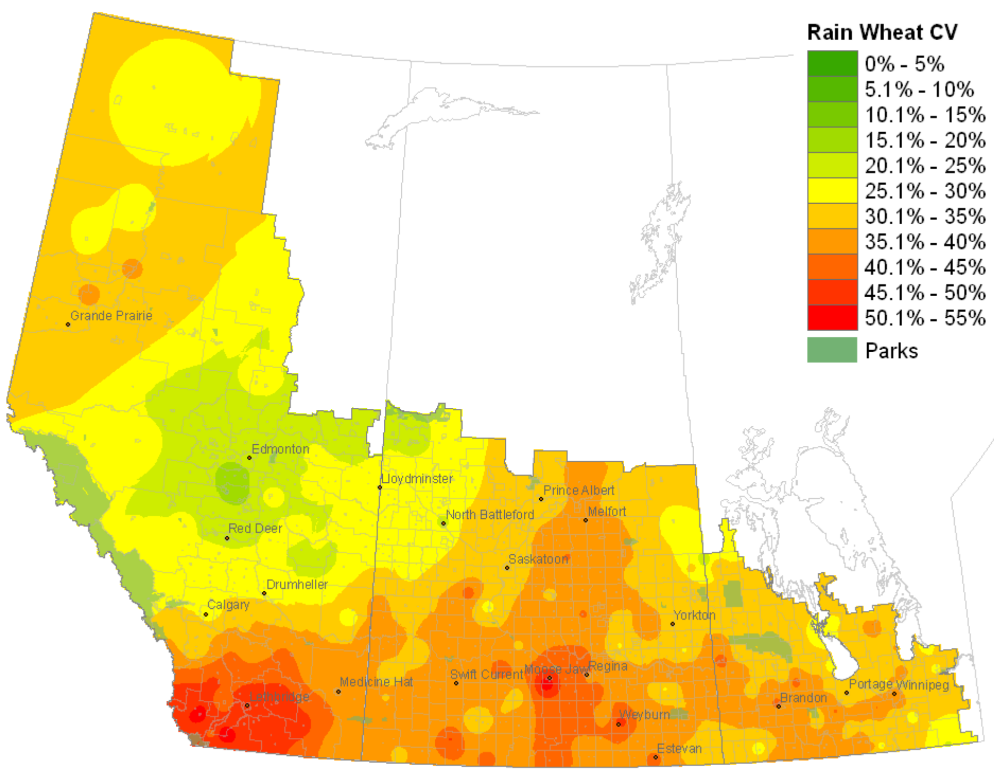

Figure 4.4 Coefficient of variation of rainfall during the growth period of wheat

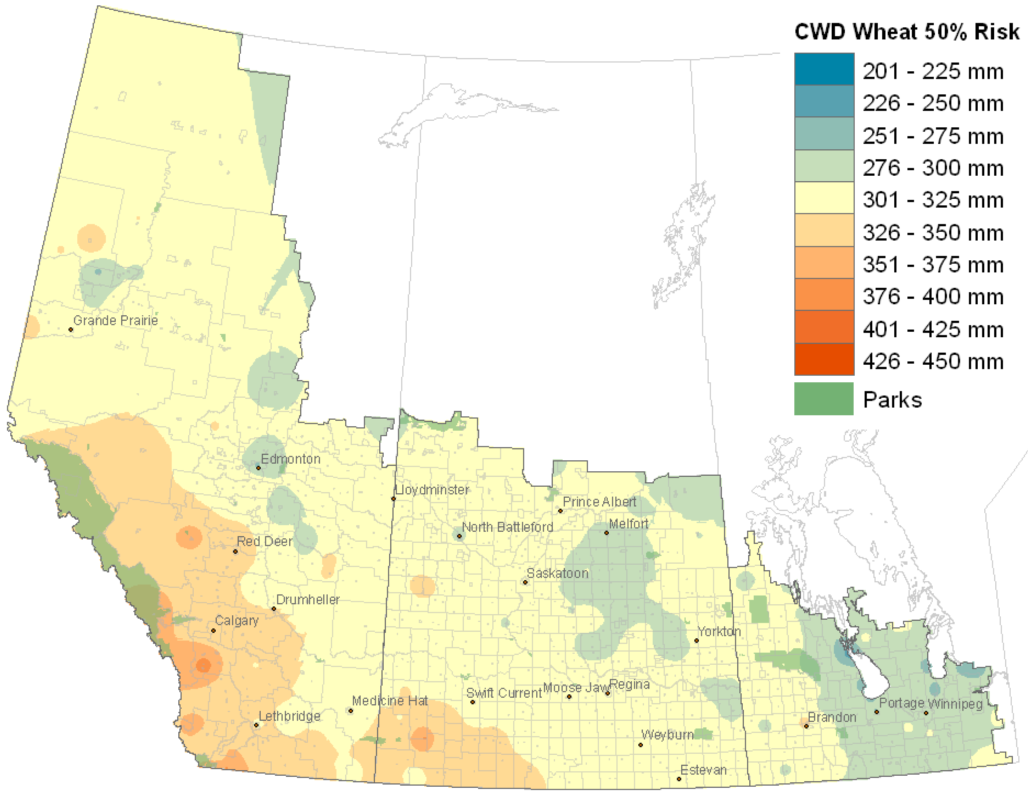

Figure 4.5 Crop water demand during the growth period of wheat at 50% risk

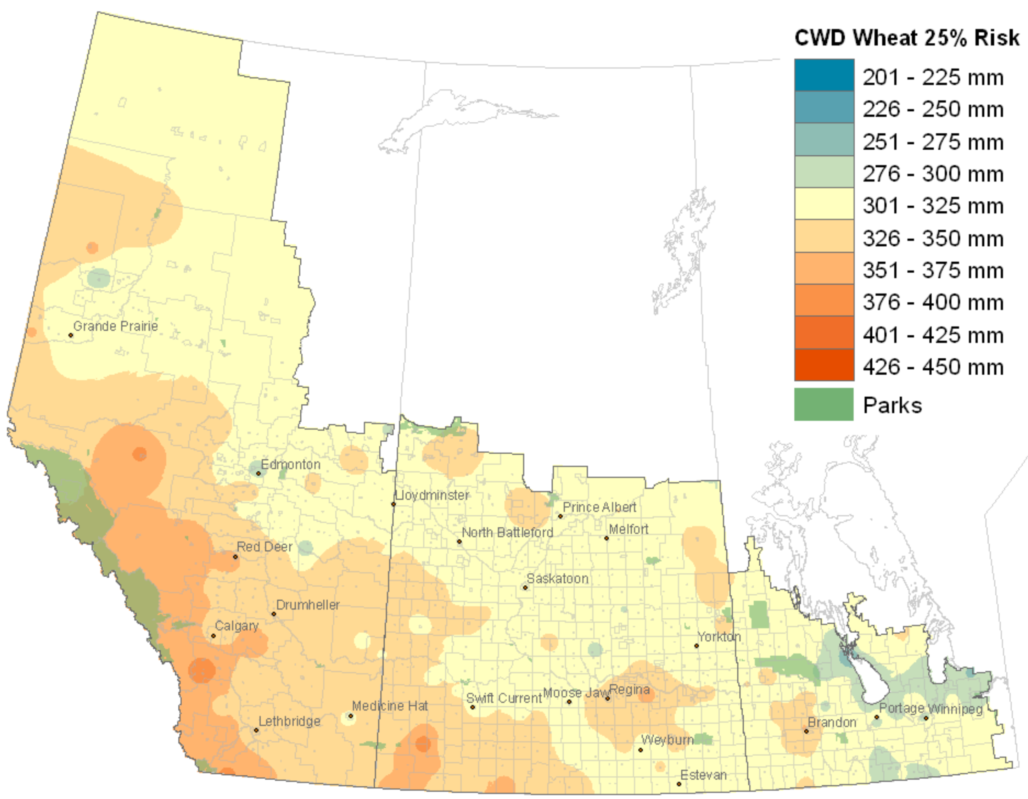

Figure 4.6 Crop water demand during the growth period of wheat at 25% risk

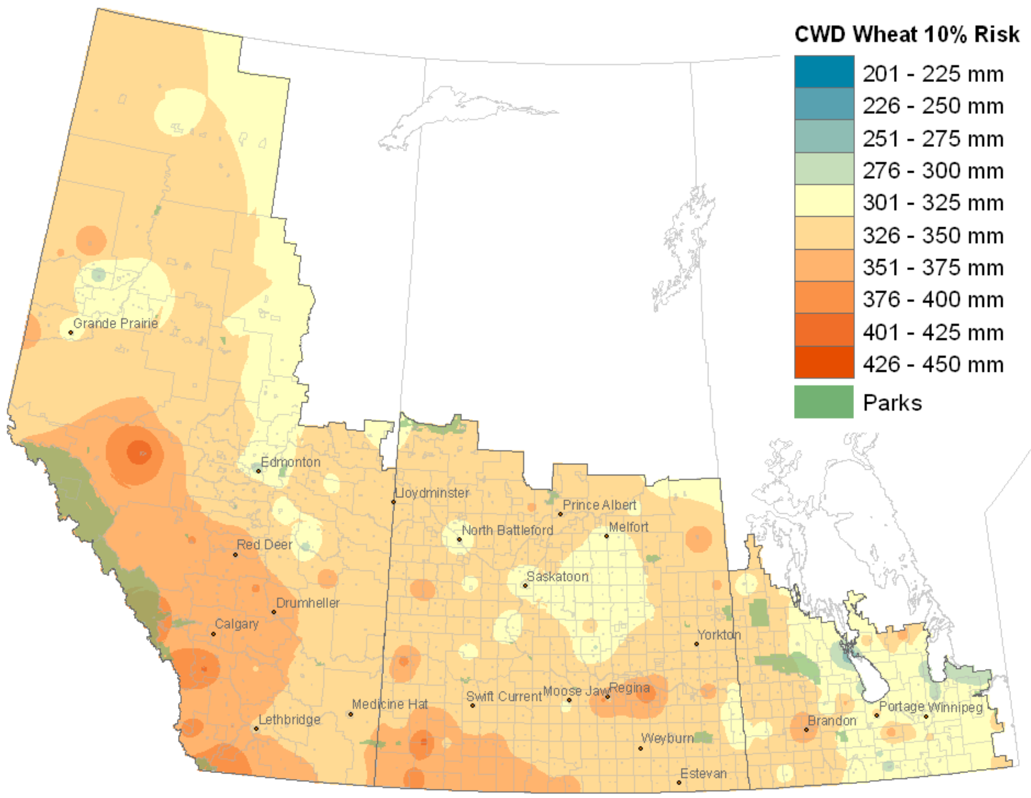

Figure 4.7 Crop water demand during the growth period of wheat at 10% risk

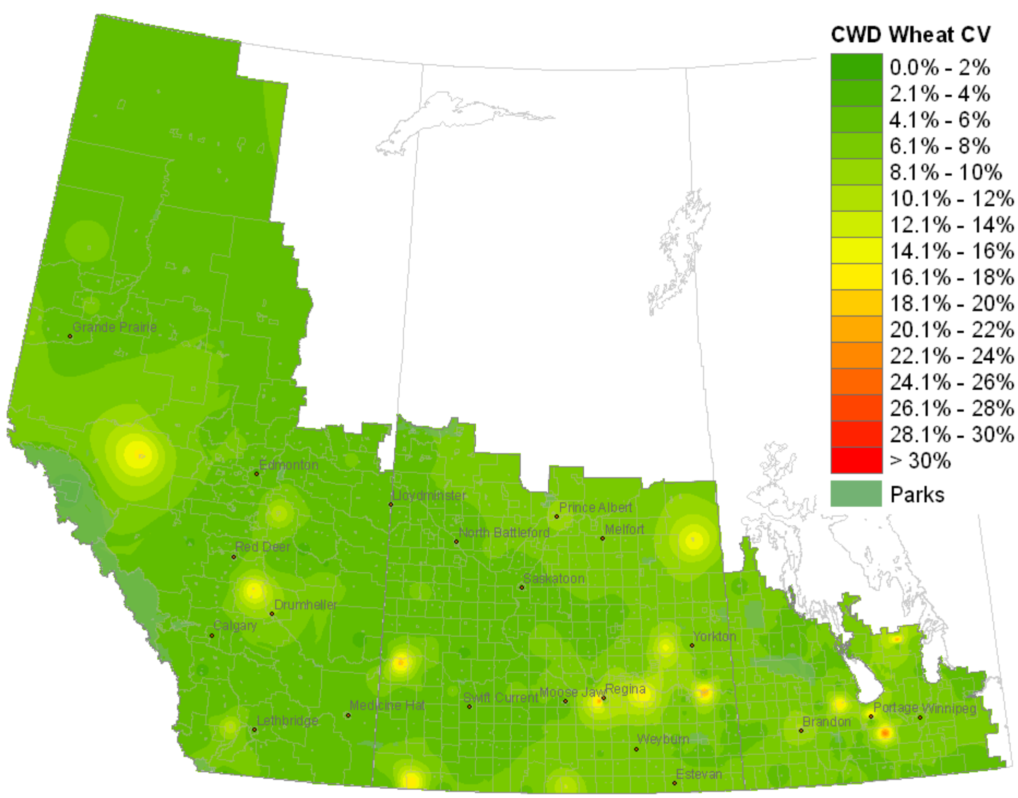

Figure 4.8 Coefficient of variation of water demand during the growth period of wheat

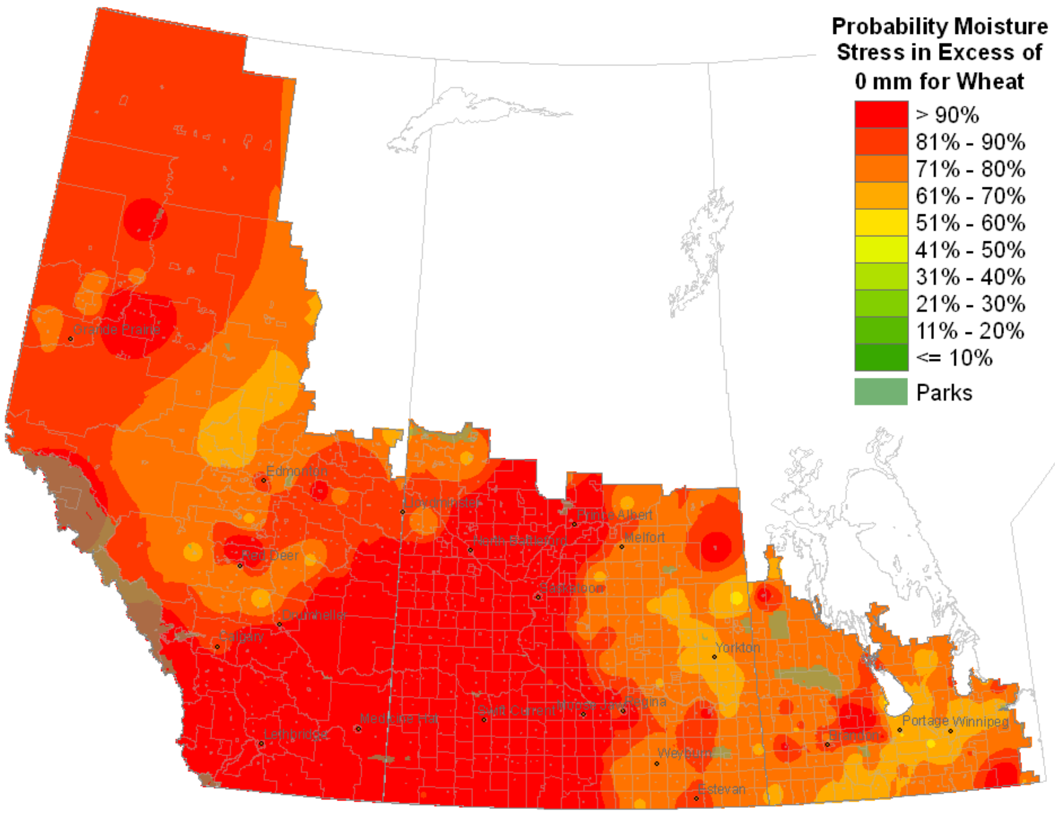

Figure 4.9 Probability of moisture deficit for wheat

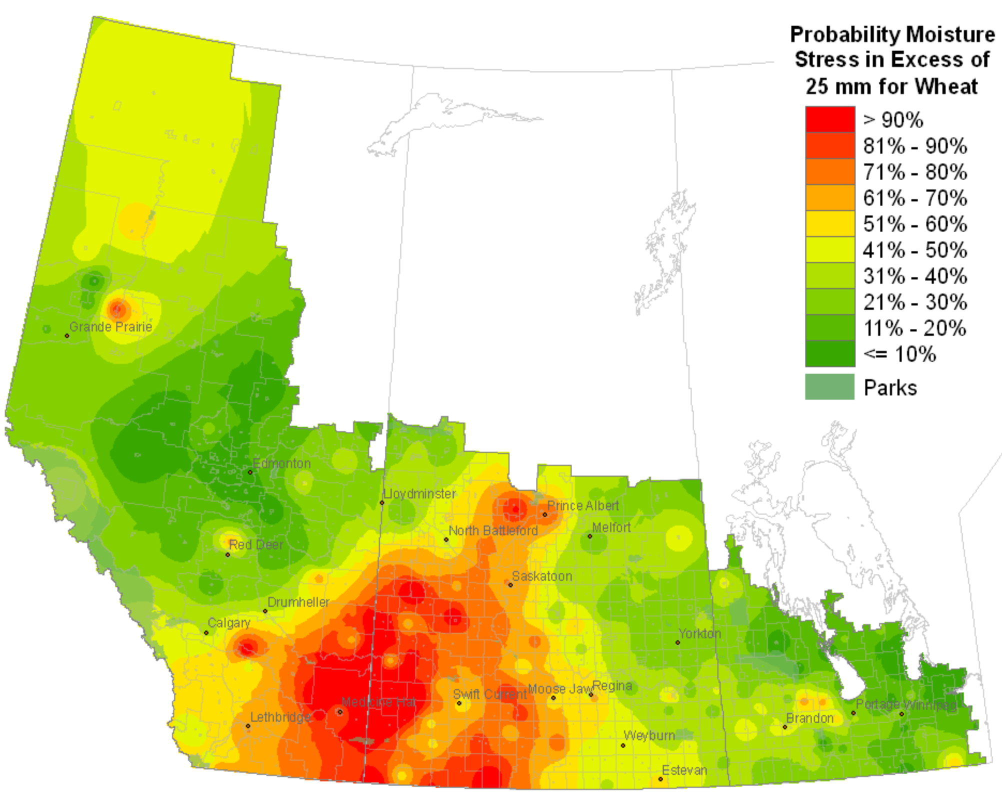

Figure 4.10 Probability of moisture deficit in excess of 25 mm for wheat

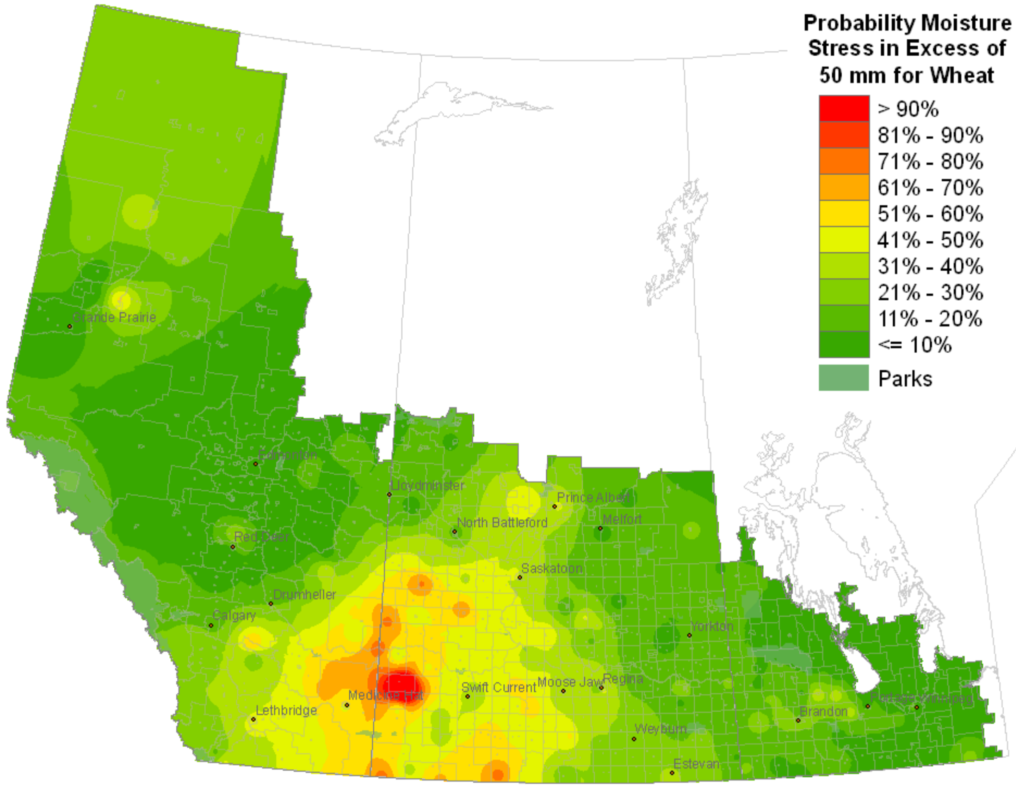

Figure 4.11 Probability of moisture deficit in excess of 50 mm for wheat

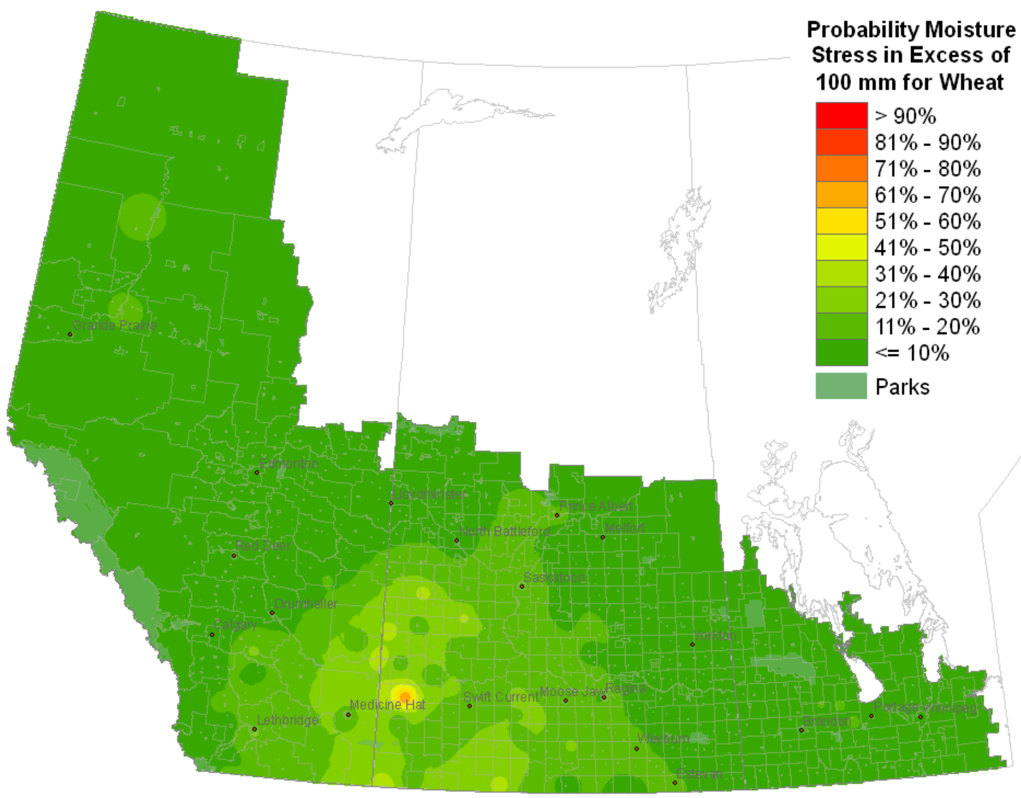

Figure 4.12 Probability of moisture deficit in excess of 100 mm for wheat

Alberta and eastern Manitoba have lower rates of crop water demand while receiving higher amounts of rainfall during the growth period. As such, the probability of stress in these areas is much lower. Generally, the cooler areas with and extended growth period and usually more rainfall during that period in addition to slightly less crop water demand are at a much lower risk of moisture stress than the hotter areas. The warmer regions to the south have less rainfall and higher crop water demand during the growth period.

Relating growth period rainfall, CWD, and water deficit to yield is quite complicated, particularly if moisture is not always the limiting factor. In southern Saskatchewan, where moisture is often the most limiting factor for yield, Campbell et al. (1988) proposed that wheat yield could be estimated as a linear function of total ET from planting to ripe. As ET increased, so would yield. Using a base value of 71.8 mm, each additional millimetre of ET would add 9.2 kg ha^{-1} to the total grain yield. This relationship would not be expected to apply to all parts of the prairies since water use efficiency (WUE) varies between different climates where the same amount of water will not produce a comparable yield (French and Schultz 1984). Arid regions have lower WUE while humid regions have higher WUE which means that more water is needed to transpire through a crop in an arid region to achieve similar yields to those in a more humid region. On the prairies, regions with the highest average CWD, such as southern Alberta (Figure 4.5), would not necessarily have the highest yields if water demands were met since the WUE would generally be low in these regions.

Rather than using ET alone, Rasmussen and Hanks (1978) derived yields as a function of the ratio of total ET to CWD while also considering the number of days to maturity (DTM) where slower phenological development would result in higher yields. A model similar to that of Rasmussen and Hanks (1978) was proposed by Raddatz et al. (1994) to estimate yields of spring wheat across the Canadian prairies such that:

$$\text{Yield (kg ha}^{-1}\text{)} = 10.8\ ((\text{ET/CWD})\ (\text{DTM}))^{1.2} \quad [8]$$

Since total ET during the growing season is equal to the CWD minus the water deficit, the equation could also be presented in the following form to make use of the moisture information provide in Figures 4.5 to 4.7 and 4.9 to 4.12:

$$\text{Yield (kg ha}^{-1}\text{)} = 10.8\ (((\text{CWD-Deficit})/\text{CWD})\ (\text{DTM}))^{1.2} \quad [9]$$

According to this model, yield will increase either from a higher ratio of ET to CWD or by an increase in the number of days from planting to maturity. As crop water deficit decreases, the ratio of ET to CWD would increase, resulting in higher yield predictions. For example, using an average seasonal CWD of 300 mm and assuming 95 DTM, each millimetre of water deficit would result in a yield decrease of approximately 10 kg ha^{-1}. Normally, the DTM required for wheat is between 90 and 100 (Dunlop and Shaykewich 1984). Within this range, each additional day required for the crop to reach maturity would add approximately 1.2% to 1.3% to the final yield. This would be advantageous for some of the cooler regions of the prairies, such as those to the north, which require a longer period for wheat to reach maturity.

4.4.2 Corn

The water requirements of corn are much greater than those of wheat, mainly due to the length of the growing season. While wheat requires between 90 to 100 days to reach maturity, grain corn often requires 110 to 120 days (Dunlop and Shaykewich 1984). Wheat will normally reach maturity in mid summer, while corn continues to grow and use water well into the fall. This will result in a much greater crop water demand although there will also be more rainfall during this extended growth period to meet some of this demand. The potential for moisture stress in corn is quite high.

At 50% risk, the rainfall during the growth period of corn varies widely geographically ranging from 200 mm to 400 mm across the prairies (Figure 4.13). Similar to wheat, the lowest rainfall accumulations, those from 200 mm to 250 mm, are found between Manyberries, Medicine Hat, and Kindersley. At 25% (Figure 4.14) and 10% risk (Figure 4.15), this area is expected to receive less than 200 mm and less than 150 mm respectively. At 50% risk, growth period rainfall for corn in central Alberta is as high as 400 mm at Whitecourt. In Saskatchewan, the areas with the highest seasonal rainfall are located along the eastern border at locations such as Pelly and Moosomin with around 340 mm. Within Manitoba, the least rainfall generally occurs to the western edge of the province with values between 290 mm and 310 mm. While some areas to the extreme southeast may receive on average more than 400 mm, most of the eastern half of Manitoba receives 340 mm to 375 mm.

The CV's of rainfall during the growth period of corn are generally slightly higher throughout the southern prairies, particularly in Alberta and Manitoba (Figure 4.16). The CV's in these areas range between 30% and 40%. The CV's for remainder of the southern prairies range from 25% to 30% while much of the northern regions are below 25%.

The region with the greatest CWD for corn at 50% risk is in southwestern Saskatchewan from Willow Creek to Ingebright Lake to Mankota with values that exceed 500 mm (Figure 4.17). In southern Alberta, the CWD at stations east of Lethbridge and south of Empress, ranges from 475 mm to 500 mm. The CWD in this entire region is more than twice the average rainfall that is received within the same period (Figure 4.13). Within the remainder of the prairies, the CWD at 50% risk is generally between 400 mm and 450 mm with the exception of the northern regions of the agricultural zone which would be severely limited for warm season crops like corn due to a short growing season with a limited amount of heat. At 25% risk, the CWD throughout most of the southern prairies is between 375 mm and 530 mm (Figure 4.18). At 10% risk, the CWD ranges from 400 mm to 550 mm (Figure 4.19).

The CV's of CWD for grain corn are generally low, with the majority of values between 5% and 15% (Figure 4.20). This indicates a low degree of year to year variation in CWD. The CV's for both growth period rainfall and CWD for corn are consistently lower than those of wheat. This could most likely be attributed to the differences in the lengths of the growth periods of corn and wheat. A longer time period, such as the growth period of corn, will show a lesser degree of variability than that of wheat.

At least some degree of crop water stress is almost certain to occur in corn. Even the areas with the least chance of stress have probabilities greater than 60% while the probability of stress throughout the majority of the prairies exceeds 90% (Figure 4.21). Water stress of 25 mm or greater is almost certain to occur throughout most of Saskatchewan and southern Alberta (Figure 4.22). Within western Manitoba and northeastern Saskatchewan, the probability of 25 mm stress is greater than 60%. This probability is between 40% and 60% in central and northwestern Manitoba.

The probability of stress in excess of 50 mm remains very high in much of southern Alberta and Saskatchewan (Figure 4.23). Eastern Saskatchewan and western Manitoba have probabilities between 30% and 50% while the remainder of Manitoba is generally at less than 40%. The likelihood of water stress in excess of 100 mm is relatively low throughout most of the prairies with the exception of southeastern Alberta and southwestern Saskatchewan where the likelihood remains very high (Figure 4.24). Central and northern Alberta, eastern Saskatchewan, and all of Manitoba have a less than 40% probability of receiving more than 100 mm of moisture stress. The probability of stress greater than 150 mm is quite low with only nine climate stations with probabilities equal to or greater than 60% (Figure 4.25). Probabilities in Manitoba and central to northern Alberta are all less than 30%. Probabilities in western Saskatchewan range from less than 10% to 50%, generally decreasing to the northeast.

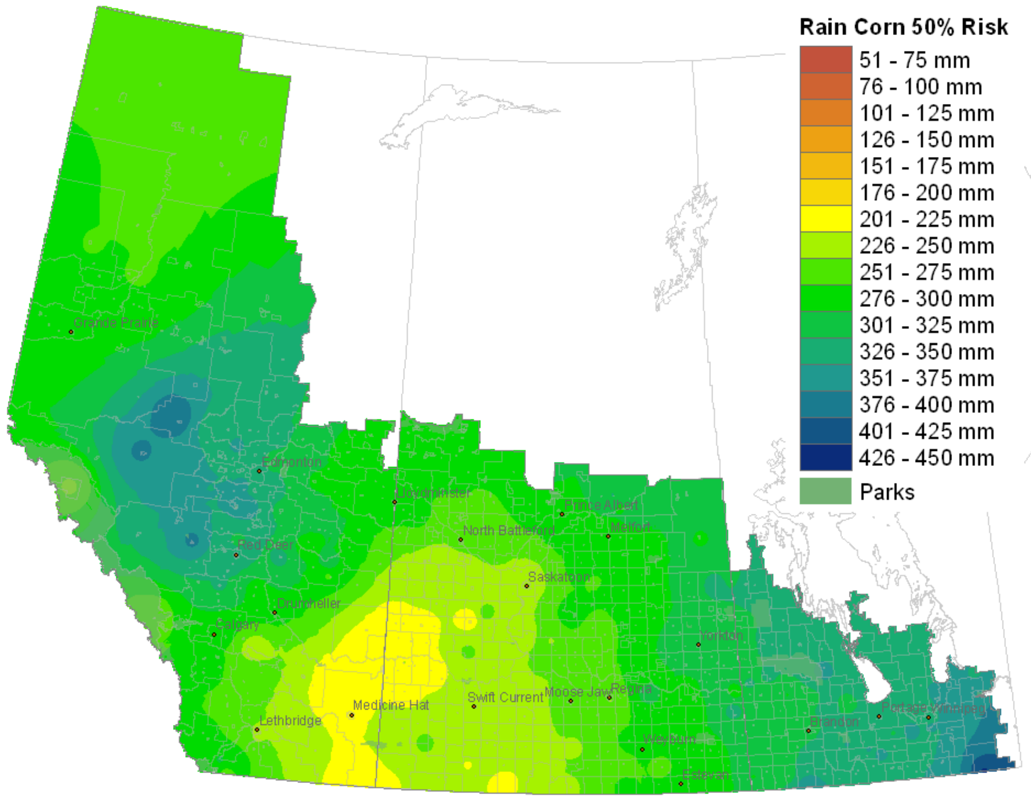

Figure 4.13 Rainfall during the growth period of corn at 50% risk

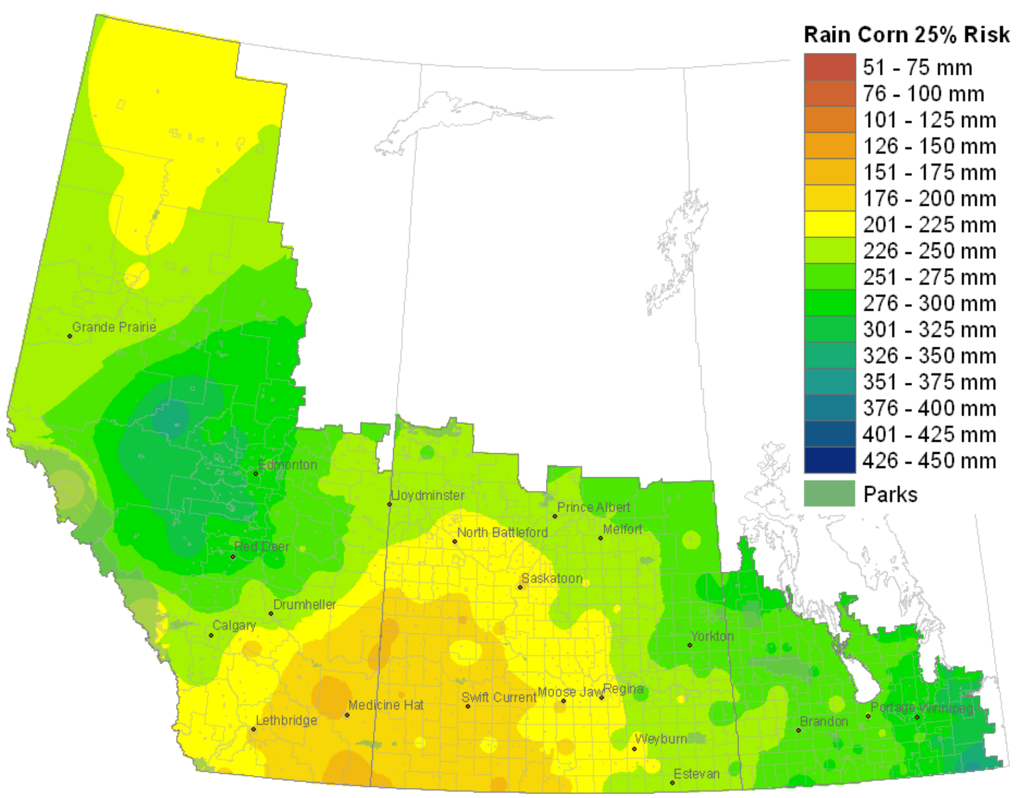

Figure 4.14 Rainfall during the growth period of corn at 25% risk

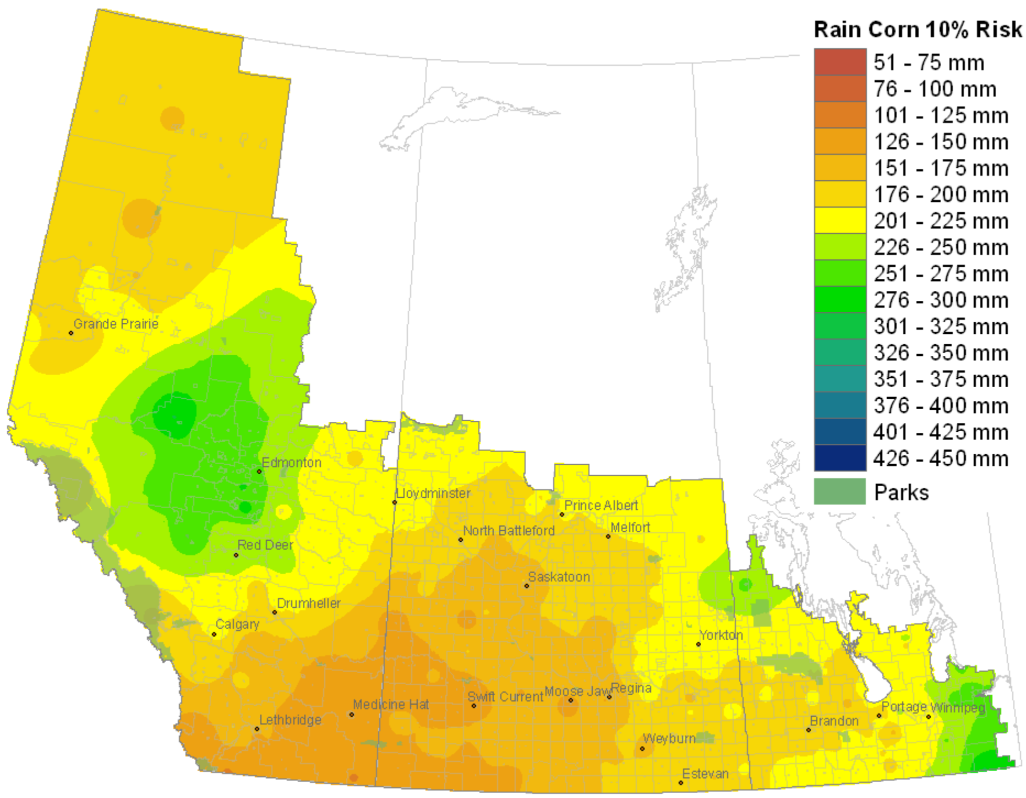

Figure 4.15 Rainfall during the growth period of corn at 10% risk

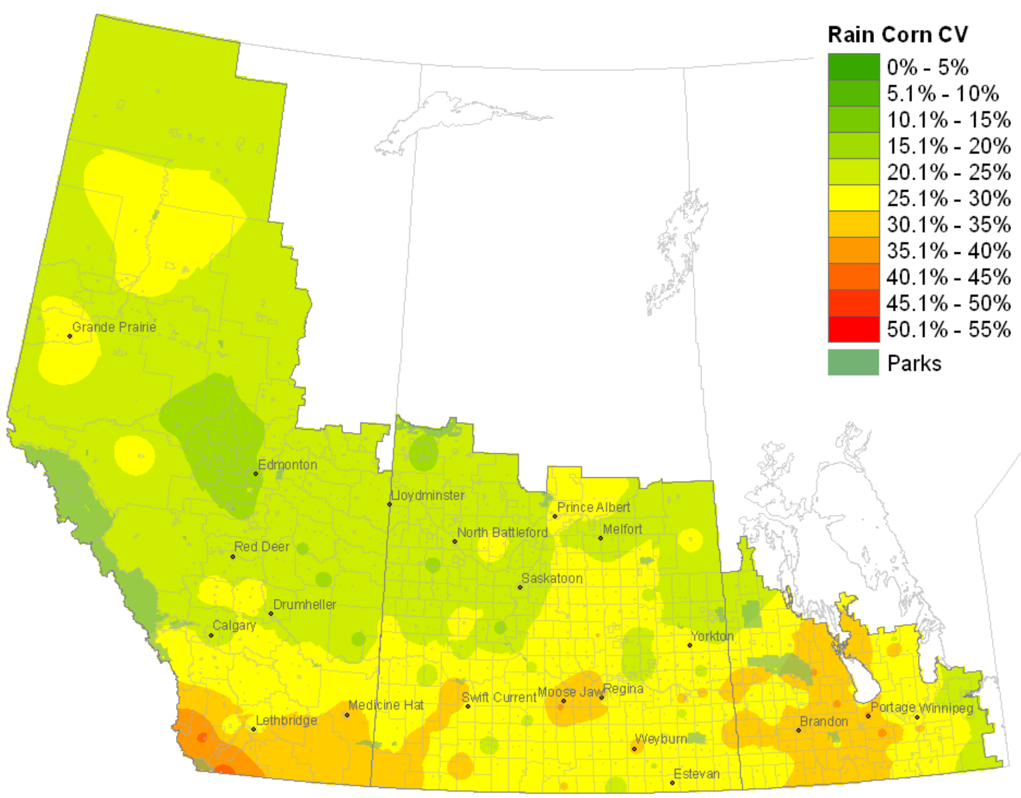

Figure 4.16 Coefficient of variation of rainfall during the growth period of corn

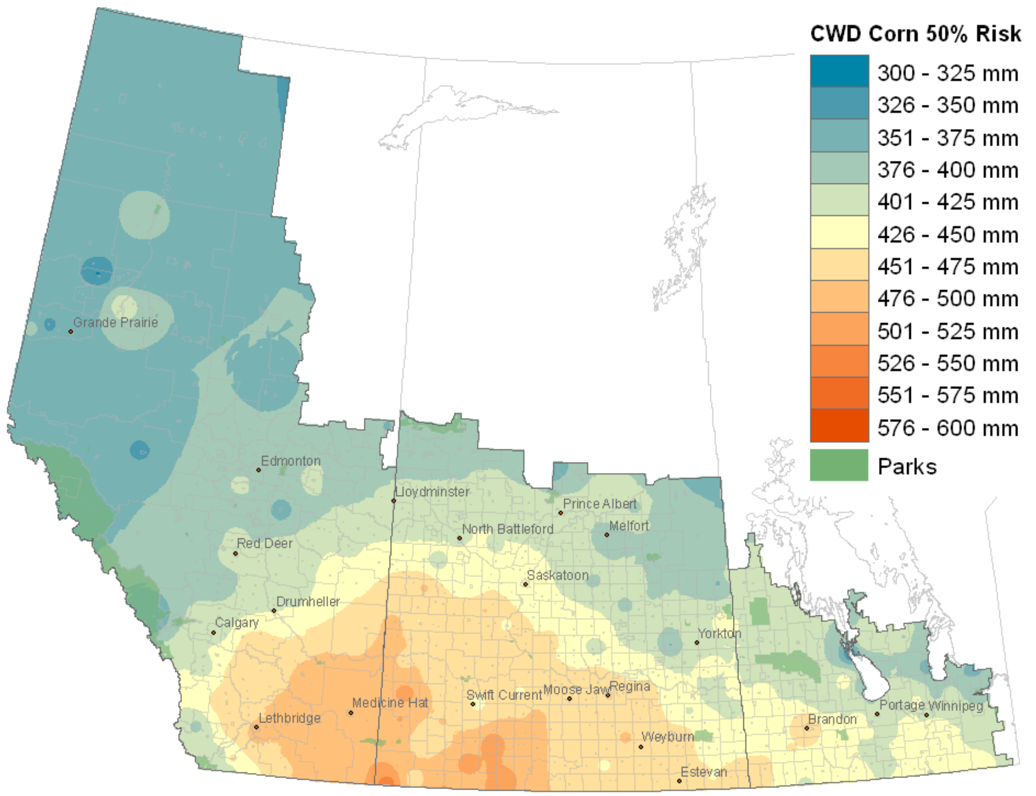

Figure 4.17 Crop water demand during the growth period of corn at 50% risk

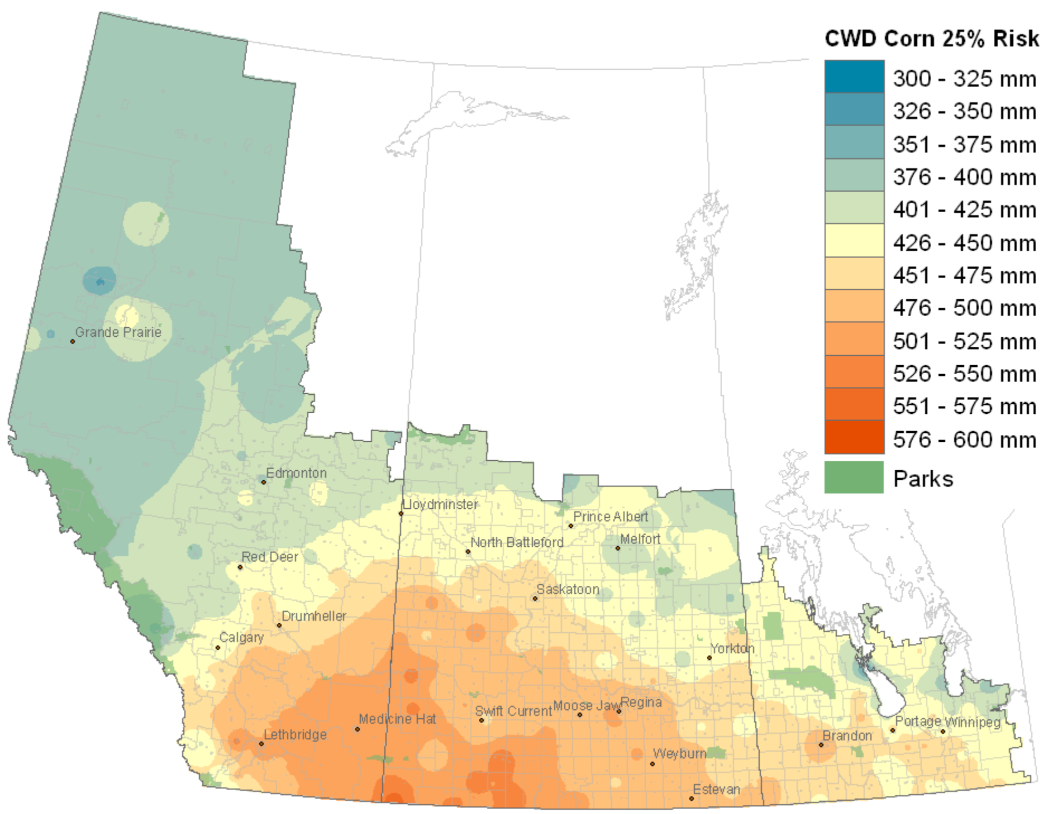

Figure 4.18 Crop water demand during the growth period of corn at 25% risk

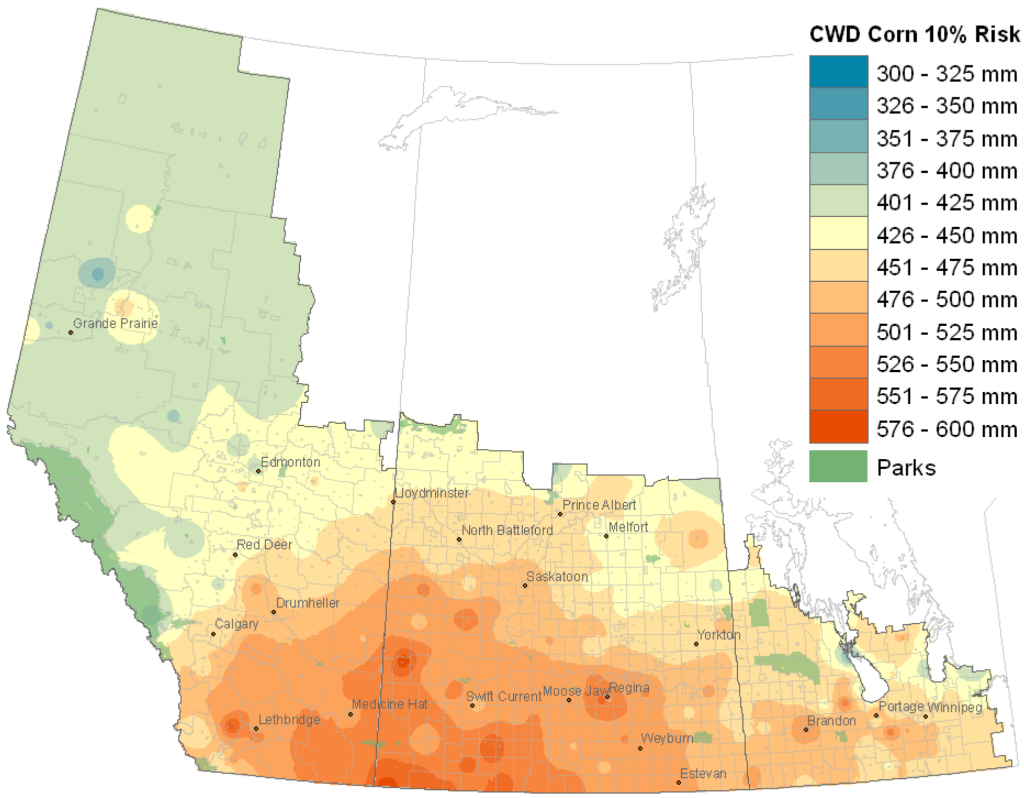

Figure 4.19 Crop water demand during the growth period of corn at 10% risk

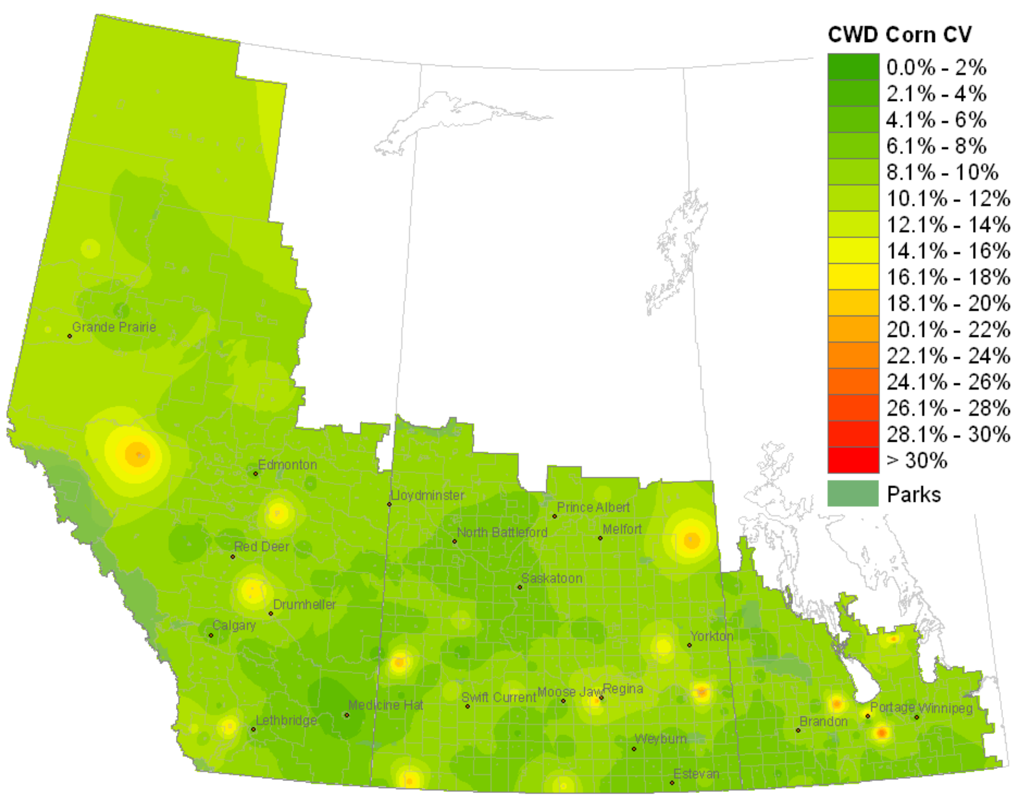

Figure 4.20 Coefficient of variation of water demand during the growth period of corn

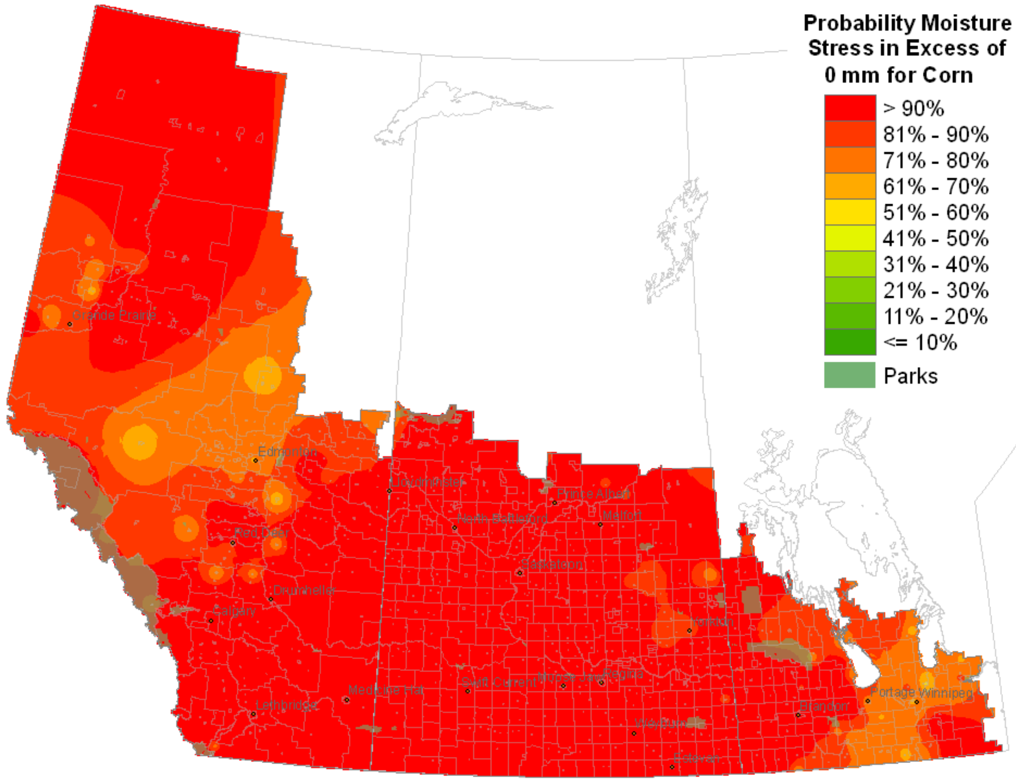

Figure 4.21 Probability of moisture deficit for corn

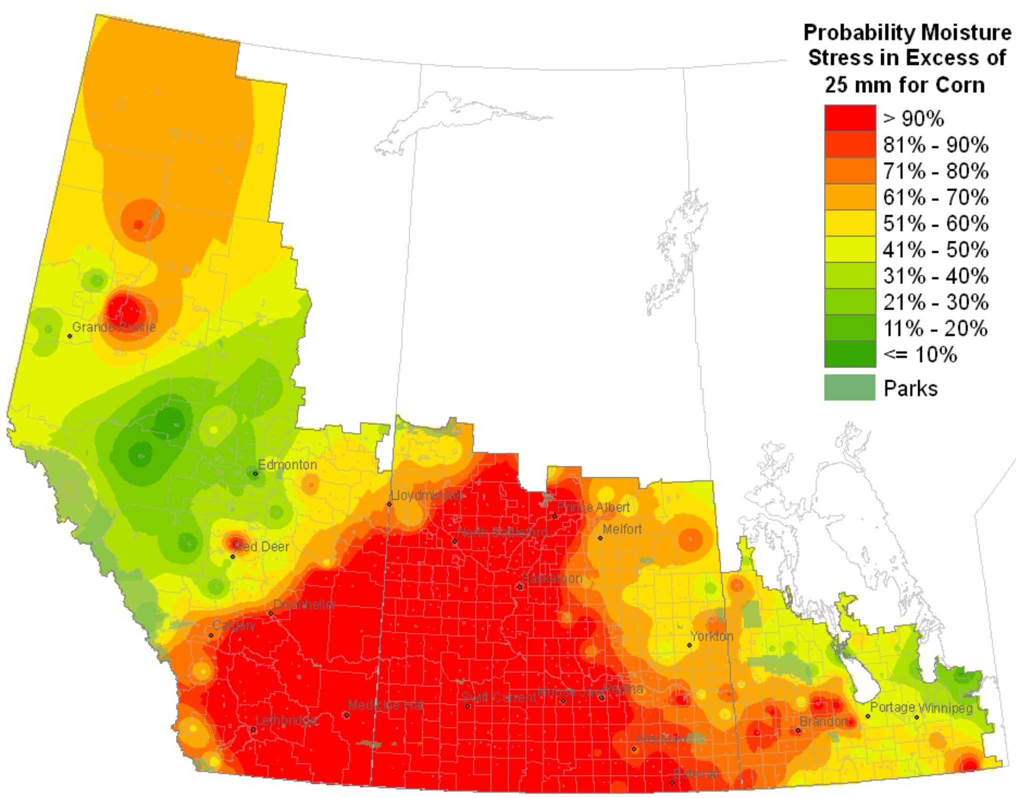

Figure 4.22 Probability of moisture deficit in excess of 25 mm for corn

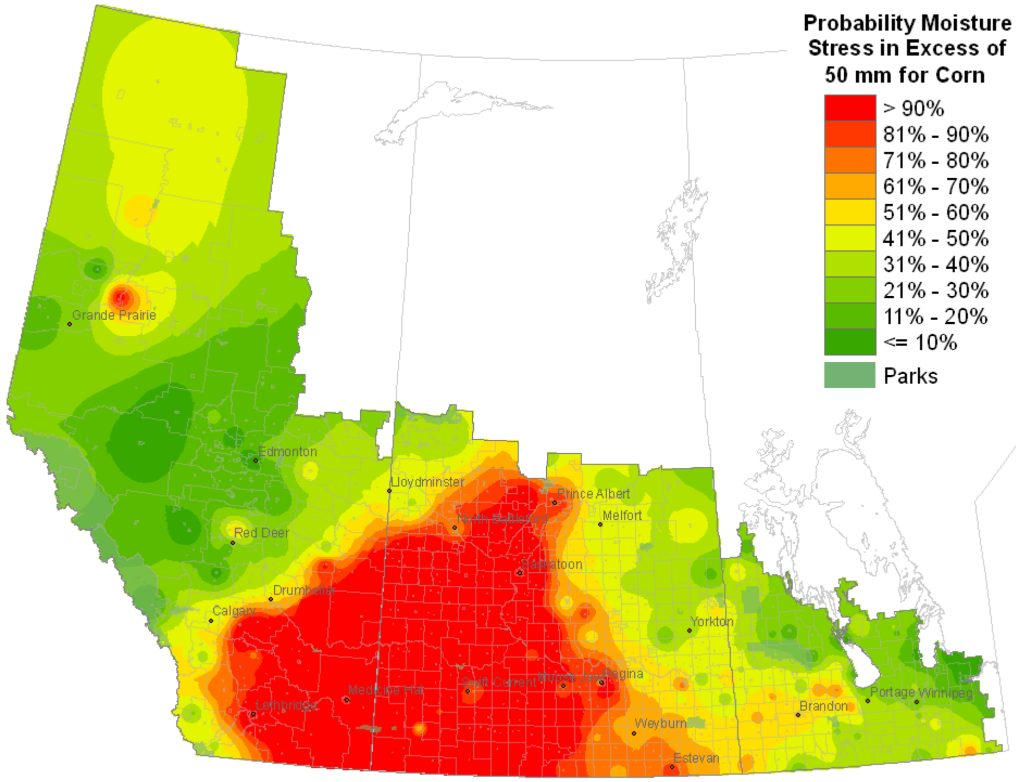

Figure 4.23 Probability of moisture deficit in excess of 50 mm for corn

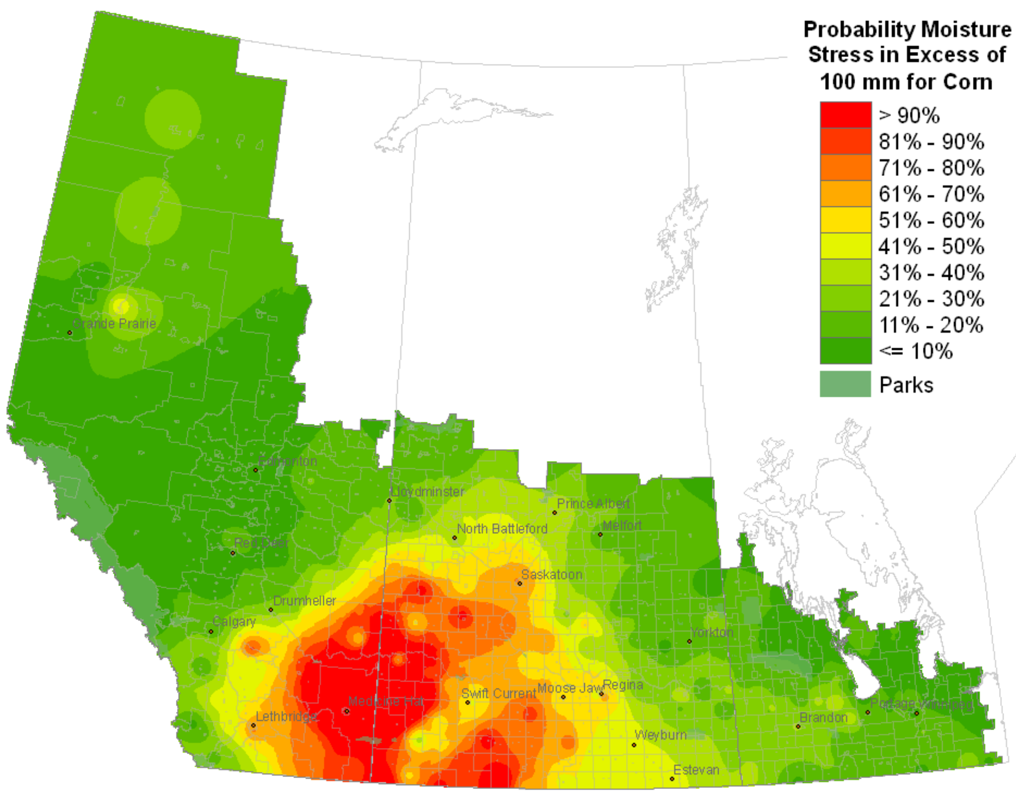

Figure 4.24 Probability of moisture deficit in excess of 100 mm for corn

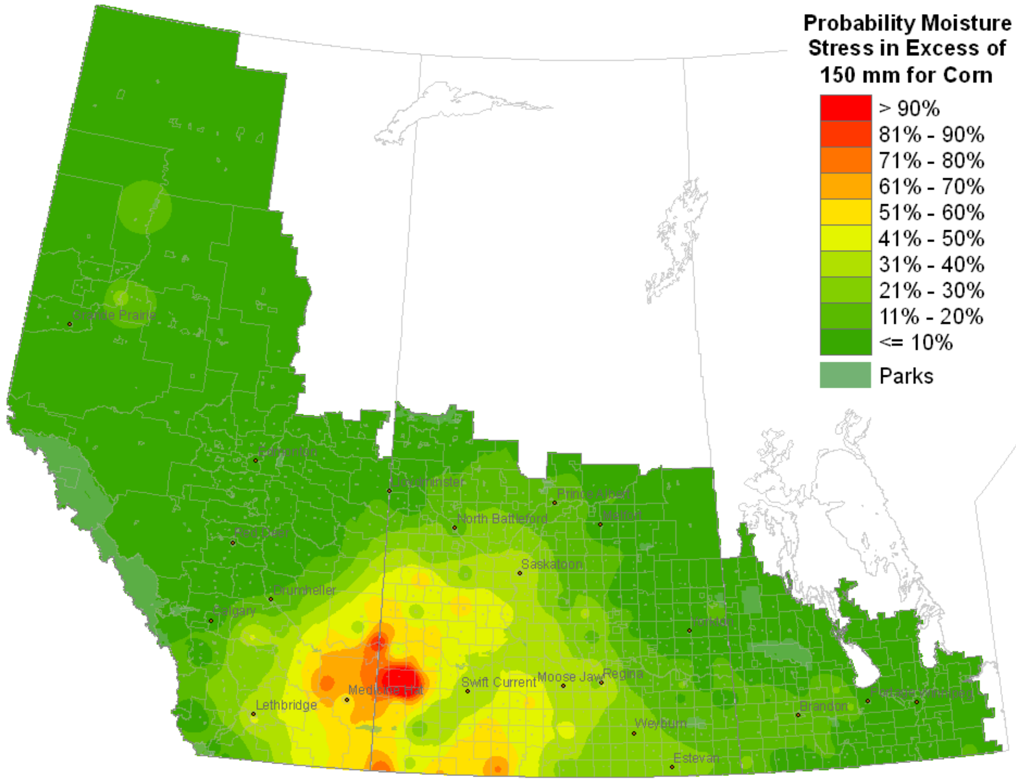

Figure 4.25 Probability of moisture deficit in excess of 150 mm for corn

While the primary requirements of grain corn are long and warm growing seasons (Bootsma, et al. 1999), the results of this analysis show that moisture can also be a major limitation to the production of corn, particularly in the warmer parts of southern Alberta and southwestern Saskatchewan where severe water stress is virtually certain. In such cases, yields would be tremendously limited due to moisture limitations unless supplemental water was available. In regions where temperatures during the growing season would support corn yet a significant amount of stress is probable, irrigation would be essential. Results from this analysis can assist with identifying the required irrigation capacity. For example, if the desire were to mitigate all water stress for the majority of years, one could determine the probabilities of various amounts of stress and design their systems accordingly. When irrigation is not an option, producers in areas with severe water limitations would be well advised to plant corn only in years where spring soil moisture is higher than normal in order to take advantage of the additional water that is available. In years with less spring soil moisture, crops with lower water demands such as wheat may be a better option. In all cases, soil water conservation practices would be beneficial.

4.4.3 Forages

Perennial forage crops have the longest active growth period and therefore the highest water demand of all crops. The amount of CWD is especially greater than annual crops during the early season prior to seeding and when the annual crops are first starting out. At this time, forages already have a full canopy and an established root system enabling the extraction of water from well below the soil surface.

Across the agricultural region of the prairies, there is a huge disparity in the amount of rainfall received during the growth period of forages. At 50% risk, the driest areas of southeastern Alberta and southwestern Saskatchewan receive as little as 225 mm of rainfall while the more humid regions of central Alberta and eastern Manitoba receive well over 400 mm of precipitation (Figure 4.26). Most of the prairies receive in excess of 300 mm at 50% risk. At 25% risk, the areas south of Lethbridge, Kindersley, and Saskatoon would be expected to receive less than 225 mm (Figure 4.27). The remainder of Saskatoon receives between 225 mm and 300 mm while Manitoba and central Alberta receive more than 275 mm. At 10% risk, the driest areas receive less than 150 mm while some of the more humid areas receive more than 300 mm of rainfall in a growing season (Figure 4.28). The CV of growing season precipitation for forage is less than that of corn and wheat (Figure 4.29). This is attributed to a longer growth period for forages.

The CWD for forages is exceptionally high. The average amount of water demand during the growth period at some locations exceeds 750 mm (figure 4.30). Of the nine stations with more than 750 mm of CWD, seven of these stations are located in southern Saskatchewan and two are in southern Alberta. None of these stations receive more than 270 mm of precipitation during the average growing season. Water demand generally declines towards the north and to the east. The CWD at 50% risk in central and northern Alberta and northeastern Saskatchewan is between 575 mm and 650 mm. Values in Manitoba are slightly higher, mostly in excess of 625 mm with a few stations exceeding 700 mm. At 25% risk the CWD values throughout the agricultural regions range from 620 mm to 800 mm (Figure 4.31). At 10% risk, the CWD values are between 650 mm and 850 mm (Figure 4.32). Climate stations that are beyond the northern fringes of the agricultural region tend to have very low CWD values due to the shorter growing seasons and the cooler temperatures. These stations are not shown on the maps though their values will influence the interpolation of the maps towards the fringes. The CV of CWD is consistently low at most locations (Figure 4.33). Nearly all of the CV’s fall between 5% and 10%.

Considerable crop water deficits for forage are virtually certain to occur at all locations across the prairies. Maps showing the likelihood of moisture stress amounts less than 100 mm are not shown since all parts of the prairies have a greater than 90% probability. Figure 4.34 shows the probability of moisture stress in excess of 100 mm. All areas have a greater than 90% probability of receiving 100 mm of stress with the exception of central Alberta from Rocky Mountain House to Edson to Athabasca. This region experiences higher precipitation than most of the prairies combined with a slightly lower CWD to result in a lower risk of severe water stress for forage.

The probability of stress amounts greater than 150 mm begin to show deceases in some areas (Figure 4.35). Specifically these decreases can be seen in central Alberta where the probability drops below 30% and in Manitoba and northeastern Saskatchewan where the probabilities range from 50% to 80%. While significant portions of southern Alberta and Saskatchewan continue to have a greater than 90% probability of moisture deficits of 200 mm, the probability in many parts of the prairies is less than 50% (Figure 4.36). The likelihood of moisture stress in excess of 250 mm is noticeably lower in many areas (Figure 4.37). Most of Manitoba is below 30% with the exception of the area southwest of Brandon, a large portion of northern Saskatchewan has probabilities below 40%, while those in central and northern Alberta are generally less than 30%. The area between Lethbridge to North Battleford to Regina remains at a high probability of receiving moisture stress amounts greater than 250 mm.

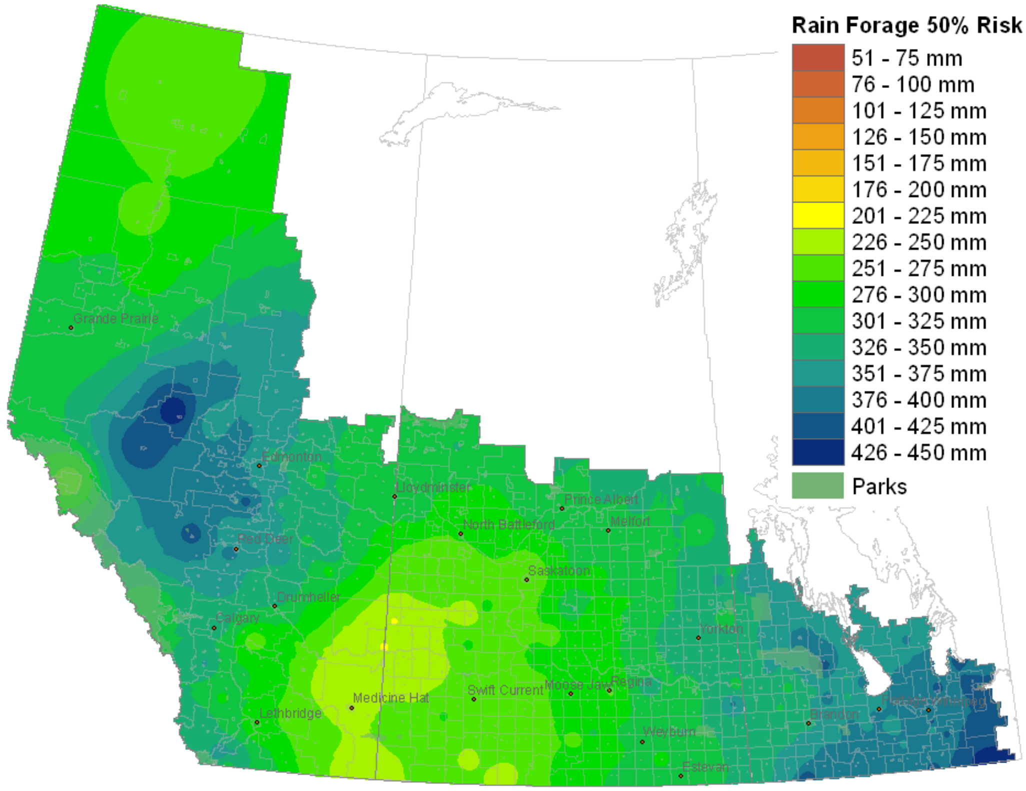

Figure 4.26 Rainfall during the growth period of forage at 50% risk

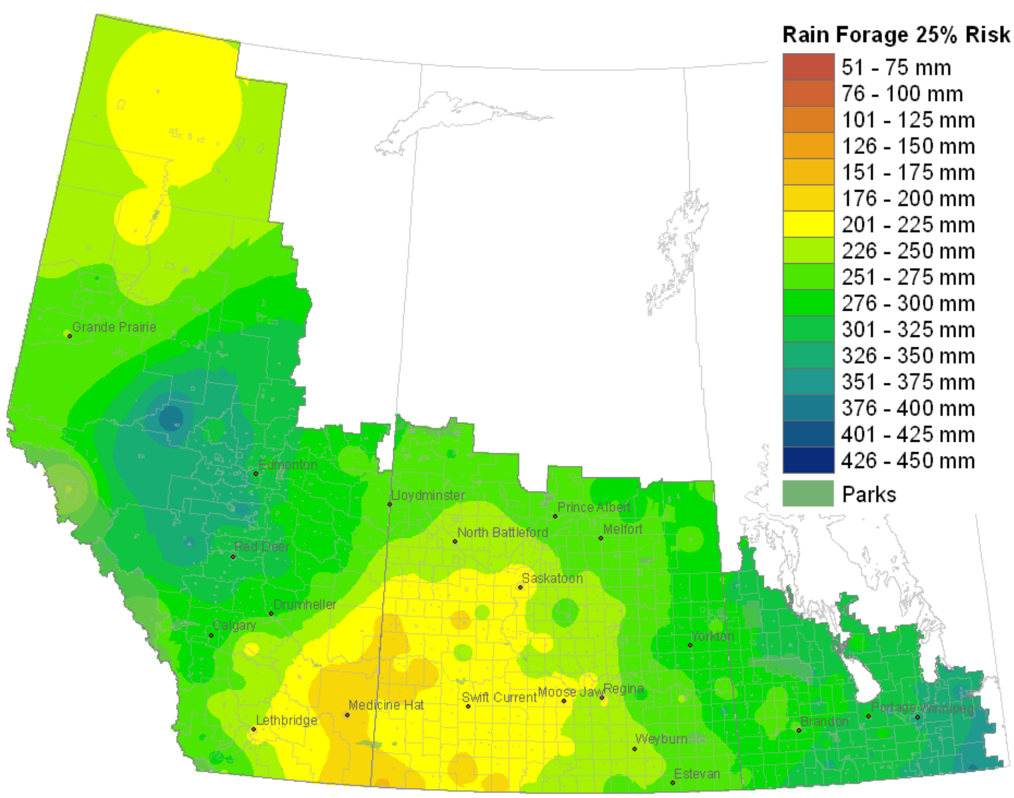

Figure 4.27 Rainfall during the growth period of forage at 25% risk

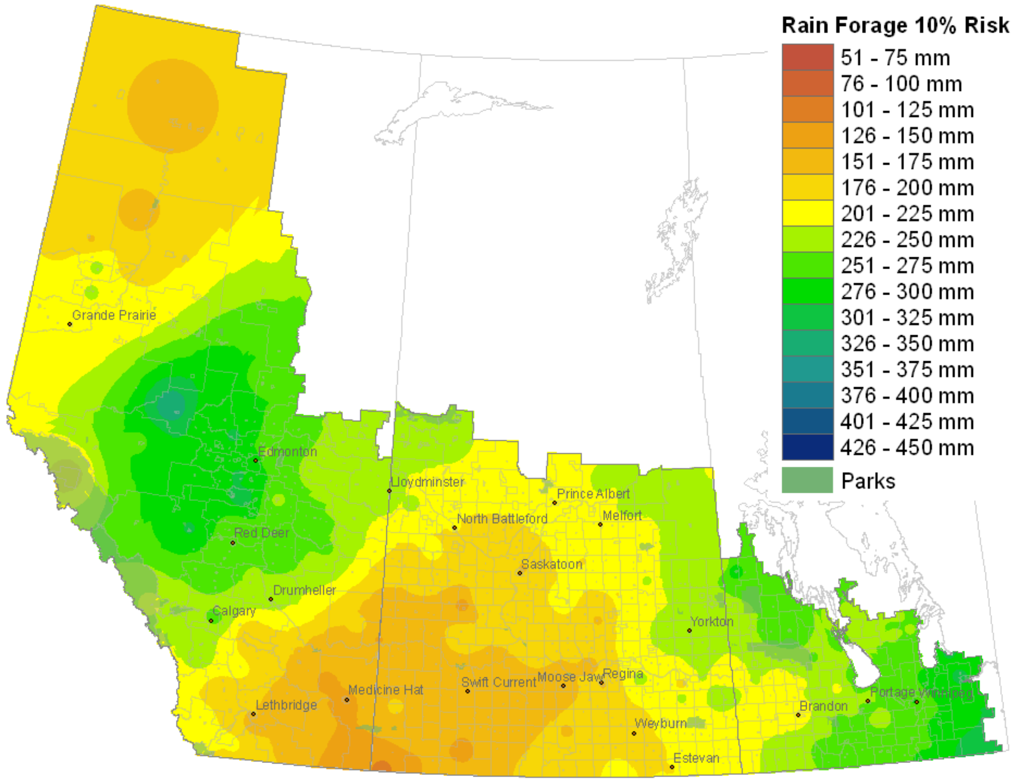

Figure 4.28 Rainfall during the growth period of forage at 10% risk

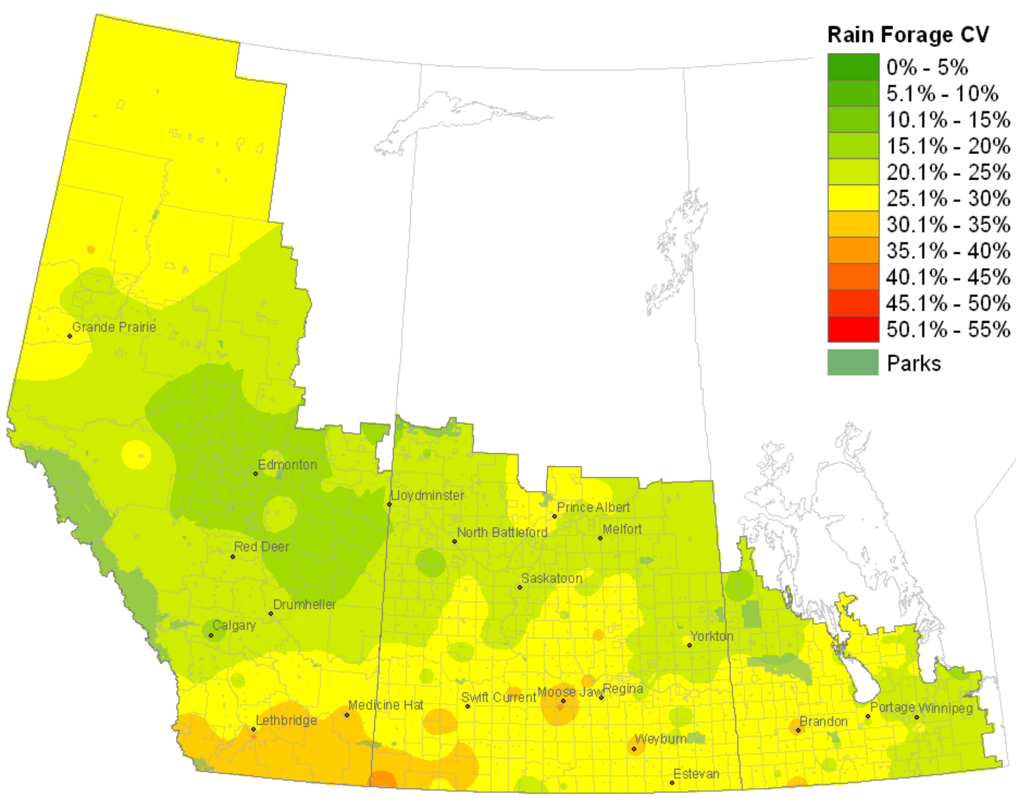

Figure 4.29 Coefficient of variation rainfall during the growth period of forage

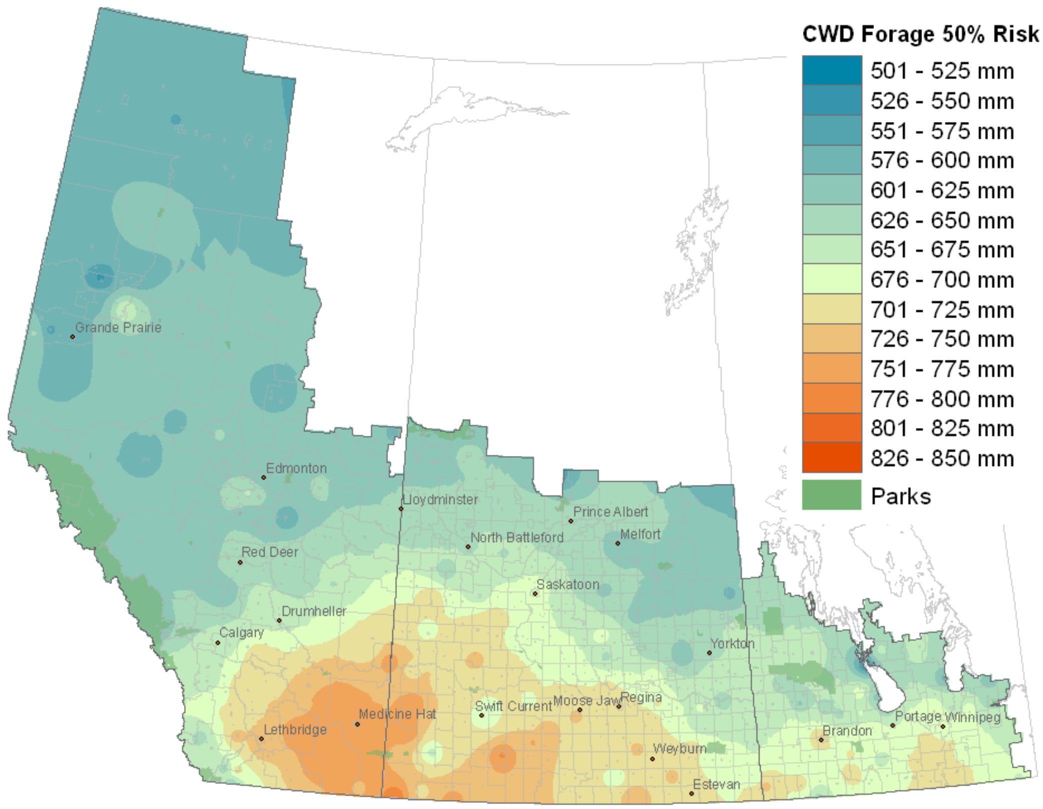

Figure 4.30 Crop water demand during the growth period of forage at 50% risk

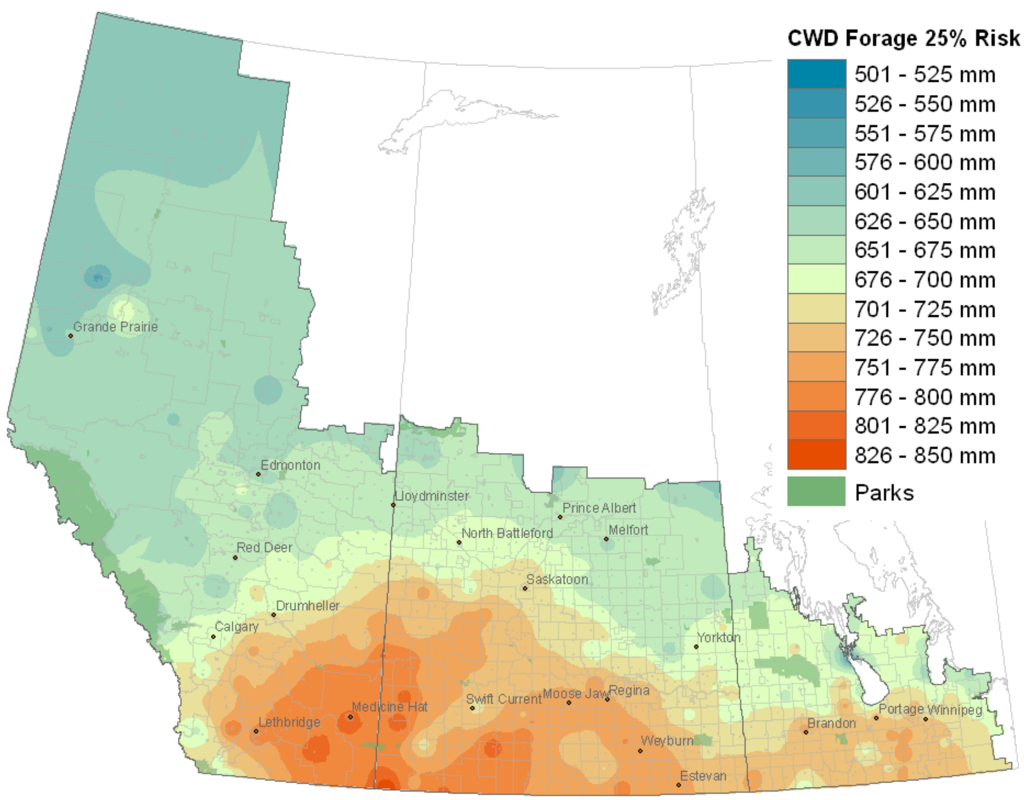

Figure 4.31 Crop water demand during the growth period of forage at 25% risk

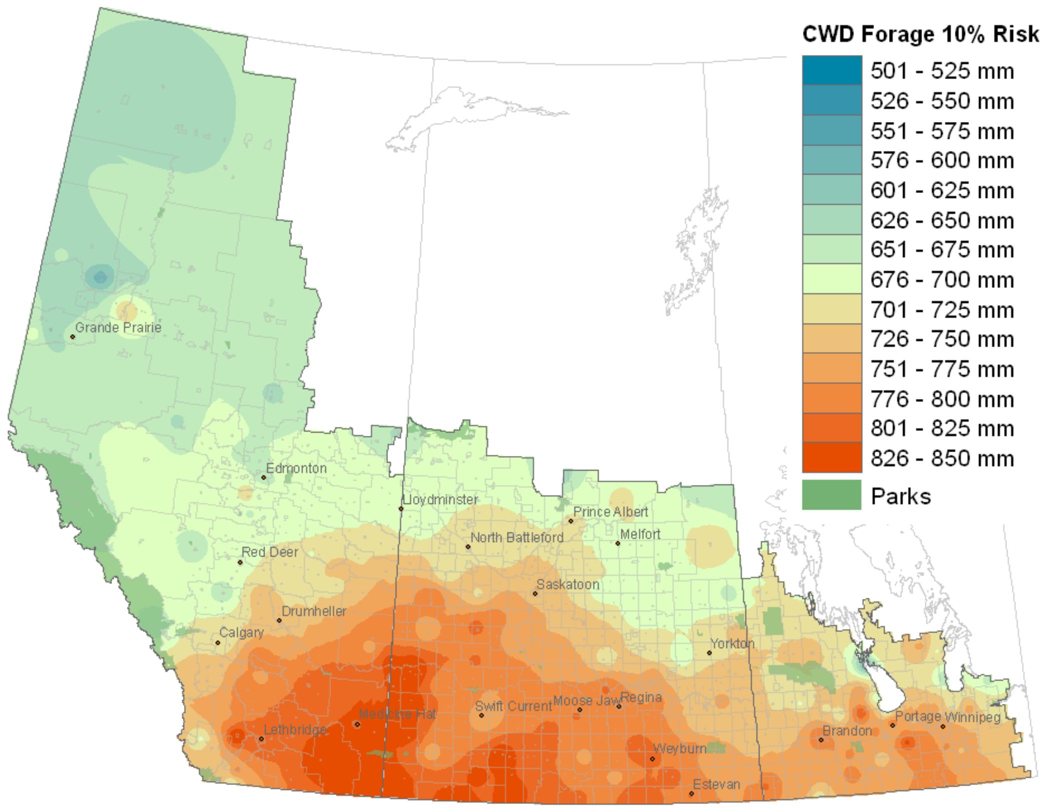

Figure 4.32 Crop water demand during the growth period of forage at 10% risk

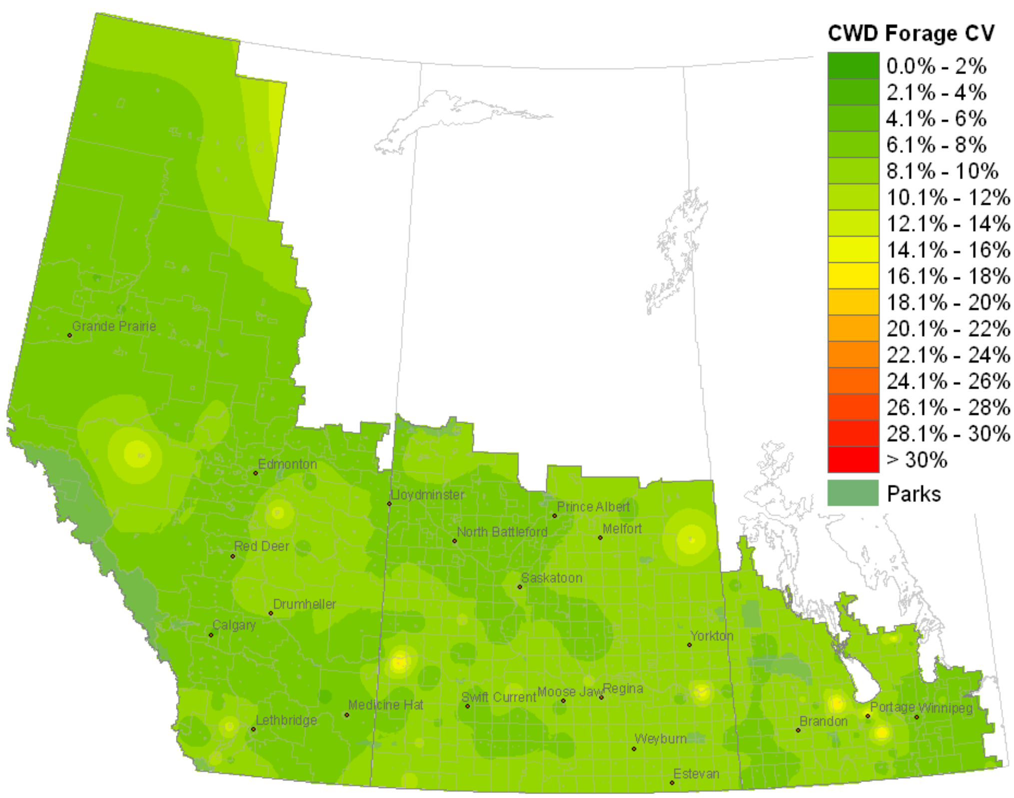

Figure 4.33 Coefficient of variation of water demand during the growth period of forage

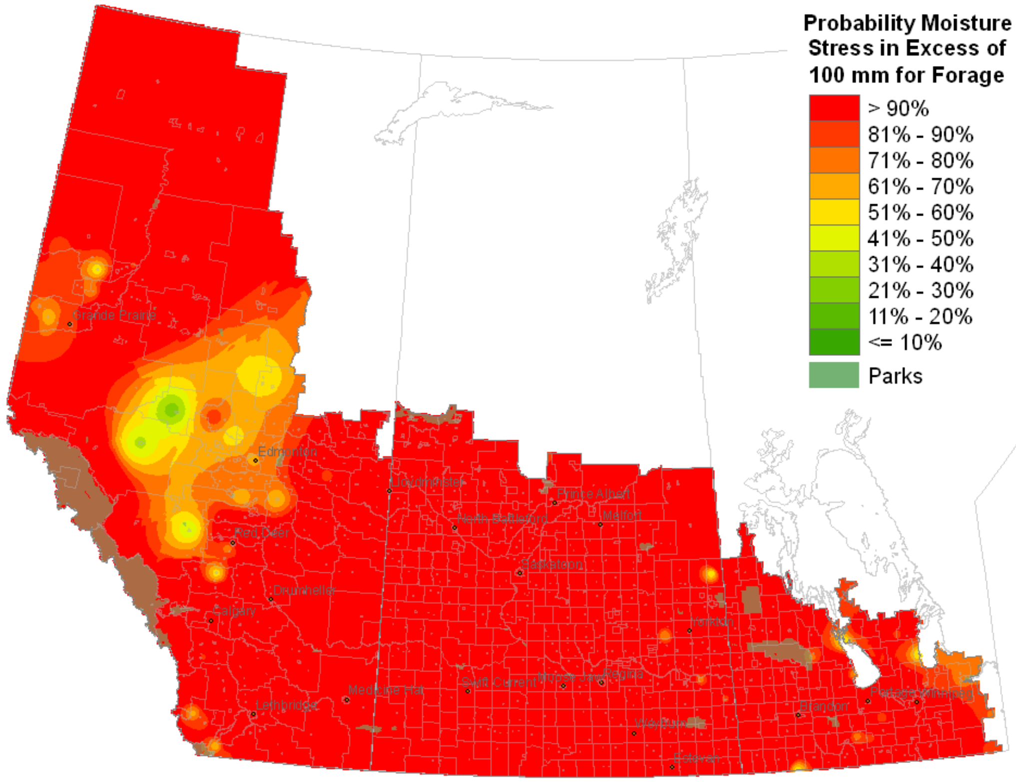

Figure 4.34 Probability of moisture deficit in excess of 100 mm for forage

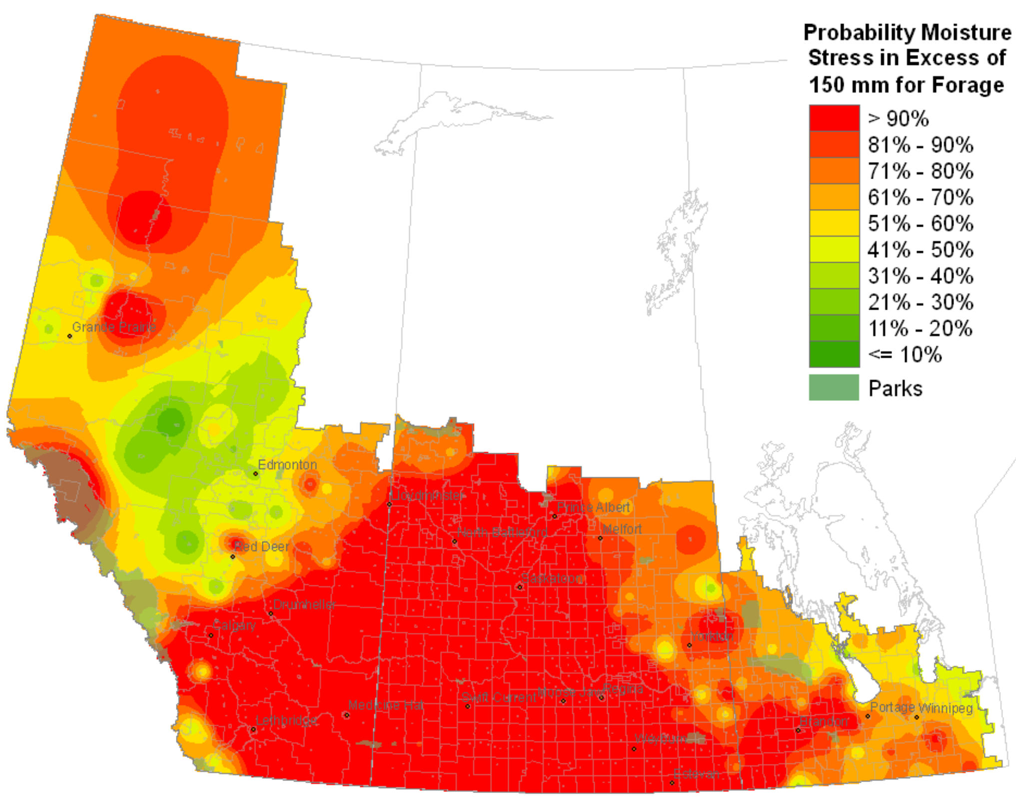

Figure 4.35 Probability of moisture deficit in excess of 150 mm for forage

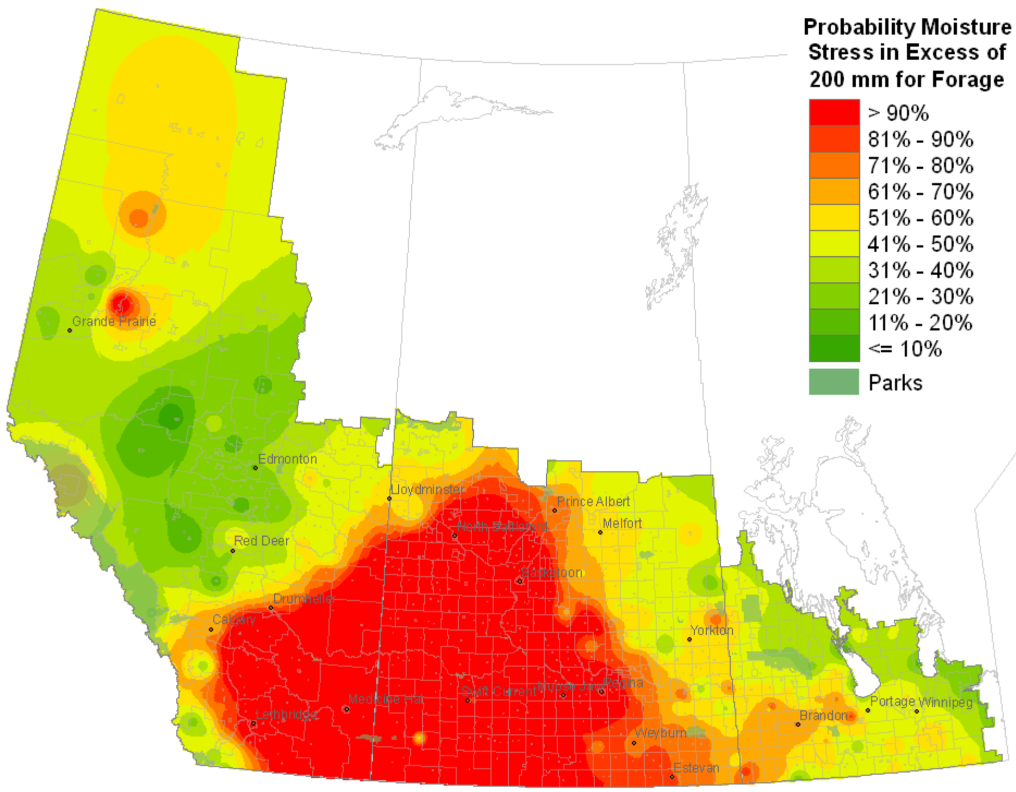

Figure 4.36 Probability of moisture deficit in excess of 200 mm for forage

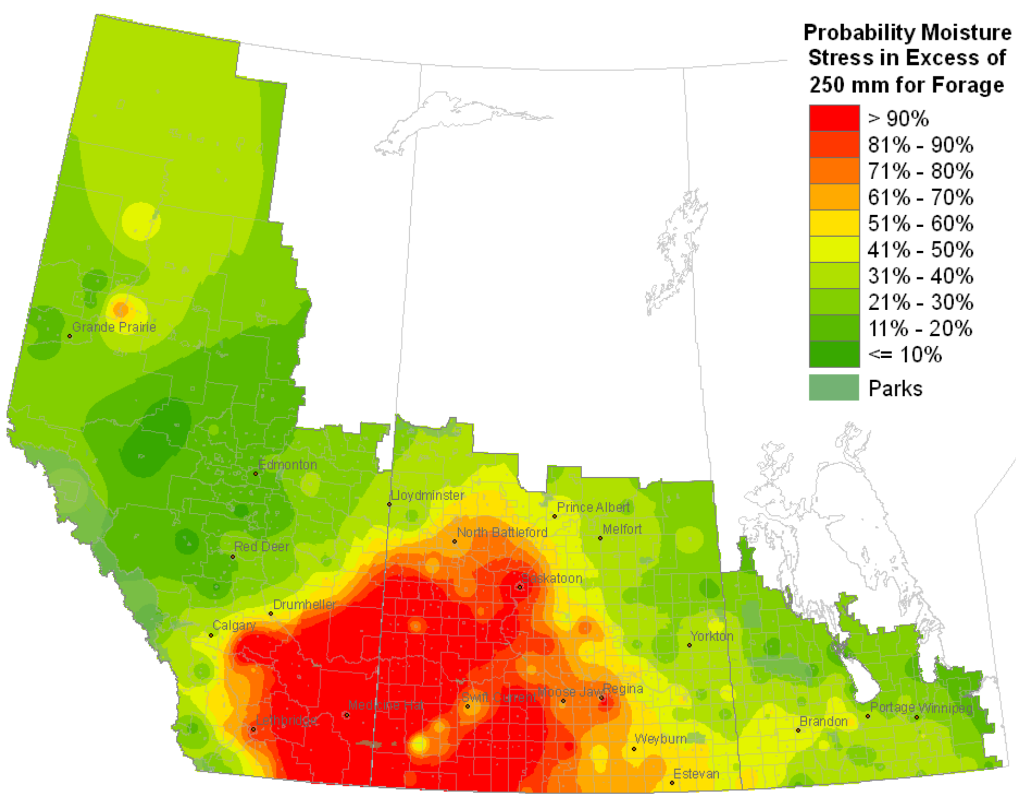

Figure 4.37 Probability of moisture deficit in excess of 250 mm for forage

Clearly, a non-irrigated forage crop will experience significant moisture deficits over the course of a growing season. These deficits would be expected to reduce the yield of the crop, particularly later in the season when soil moisture is most depleted. While certain to be stressed, perennial forage crops possess a well established root system to make the most of any water that is available. Moisture that is deep in the soil, beyond the reach of most developing root systems of annual crops can be taken up by the roots of forages. This attribute enables this crop to survive through prolonged dry periods through which many other crops could not survive.

4.4.4 Temporal Trends in Moisture

An important factor to consider when assessing the agricultural climate is whether the climate has been stationary for a period of time. Should major temporal trends exist in the climate record, results of a climatic characterization such as that presented in this report would become less relevant. The risk in doing such an analysis in a rapidly changing climate would be that the period of record being observed is unlike the present climate. The past 30-years of record would therefore not represent the current climatic risk. In a rapidly changing climate, these results could quickly become obsolete and unusable. To evaluate whether the moisture regime has changed over the past 80 years and to what extent, an assessment of some of the long term trends related to rainfall, crop water demand, and water stress for corn are presented.

Precipitation during the growth period of corn over the past 80 years has shown increasing trends in 10 of the 12 stations though only one of these climate stations, Sprague Manitoba, had a positive trend that was significantly different from zero (Table 4.4). The slopes of nine stations were positive though none were significant. Combined, the 12 stations did show a significant increase of 0.38 mm yr^{-1}. Over the 80-year period, an average increase of 0.38 mm yr^{-1} would result in an overall increase of 30.4 mm in growing season precipitation. Over a 30-year period, this trend would result in an increase of 11.4 mm.

Table 4.4 Long term trends in growing season precipitation for corn

Climate Station	Prov	Duration		Relationship Between Year and Rainfall	Linear Slope	P-Value	Significance (P<=0.1)
		From	To				
Lacombe	AB	1921	1993	= -220.6 + 0.27 * Yr	0.27	0.521	Not Significant
Olds	AB	1924	2000	= -735.5 + 0.53 * Yr	0.53	0.221	Not Significant
Lethbridge	AB	1921	1999	= -174.9 + 0.21 * Yr	0.21	0.554	Not Significant
Medicine Hat	AB	1921	2000	= -38.5 + 0.13 * Yr	0.13	0.736	Not Significant
Indian Head	SK	1921	2000	= -489.4 + 0.39 * Yr	0.39	0.310	Not Significant
Scott	SK	1921	1997	= -698.3 + 0.47 * Yr	0.47	0.113	Not Significant
Melfort	SK	1921	2000	= 367.9 + -0.05 * Yr	-0.05	0.886	Not Significant
Prince Albert	SK	1921	2000	= -683 + 0.49 * Yr	0.49	0.156	Not Significant
Brandon	MB	1921	2000	= 917.9 + -0.31 * Yr	-0.31	0.489	Not Significant
Minnedosa	MB	1921	1999	= -658.7 + 0.49 * Yr	0.49	0.205	Not Significant
Morden	MB	1921	1998	= -1125.6 + 0.74 * Yr	0.74	0.113	Not Significant
Sprague	MB	1921	1999	= -2179.7 + 1.30 * Yr	1.30	0.005	Trend Exists
All Locations				= -461.2 + 0.38 * Yr	0.38	0.003	Trend Exists

From the long term record of CWD for corn, seven of the 12 climate stations showed significant decreases over time and an additional three stations showed decreasing trends though not significantly different from zero (Table 4.5). The results from all 12 stations showed an overall decrease of 0.32 mm yr^{-1}. Over 80 years, the general trend for the 12 stations would indicate an overall decrease of 25.6 mm in annual CWD for corn.

Table 4.5 Long term trends in growing season crop water demand for corn

Climate Station	Prov	Duration From	Duration To	Relationship Between Yr and Water Demand	Linear Slope	P-Value	Significance (P<=0.1)
Lacombe	AB	1921	1993	= 2890.6 + -1.26 * Yr	-1.26	0.000	Trend Exists
Olds	AB	1924	2000	= 1267.3 + -0.45 * Yr	-0.45	0.021	Trend Exists
Lethbridge	AB	1921	1999	= -1152.9 + 0.84 * Yr	0.84	0.192	Not Significant
Medicine Hat	AB	1921	2000	= 893.5 + -0.2 * Yr	-0.20	0.108	Not Significant
Indian Head	SK	1921	2000	= 1249 + -0.41 * Yr	-0.41	0.029	Trend Exists
Scott	SK	1921	1997	= 1539.3 + -0.56 * Yr	-0.56	0.004	Trend Exists
Melfort	SK	1921	2000	= 1136.5 + -0.37 * Yr	-0.37	0.053	Trend Exists
Prince Albert	SK	1921	2000	= 647.4 + -0.12 * Yr	-0.12	0.441	Not Significant
Brandon	MB	1921	2000	= 509.2 + -0.03 * Yr	-0.03	0.872	Not Significant
Minnedosa	MB	1921	1999	= 958.5 + -0.28 * Yr	-0.28	0.127	Not Significant
Morden	MB	1921	1998	= 1648.2 + -0.62 * Yr	-0.62	0.000	Trend Exists
Sprague	MB	1921	1999	= 1468.1 + -0.53 * Yr	-0.53	0.009	Trend Exists
All Locations				= 1065.4 + -0.32 * Yr	-0.32	0.000	Trend Exists

As air temperatures have warmed over the past century (Zhang et al. 2000; Intergovernmental Panel on Climate Change 2007), one might expect that crop water demand would also have increased as growing seasons have lengthened and as more energy is potentially available for ET. While perhaps counterintuitive, the decrease in crop water demand is consistent with some of the observed climate trends. Several studies have found that temperature increases have been most pronounced in minimum daily temperatures rather than daily maximums (Zhang et al. 1999; Easterling et al. 1997). Dai et al. (1997) reported that the observed long-term decreases in daily temperature range were strongly correlated with increases in cloud cover. Within the equations of Baier and Robertson (1965) used to calculate ET, daily T_{MAX} and temperature range are two of the main drivers of ET. T_{MAX} is meant to represent the temperature of the evaporating surface and the daily temperature range is meant to characterize the solar energy and vapour pressure deficit, two factors that are positively correlated with E_L (Baier and Roberston 1965). Therefore, less of a daily temperature range caused by a long-term increase in T_{MIN} would result in an overall decrease in ET, as indicated by the observed trends in CWD. Andresen et al. (2001) found similar results when assessing the long-term climate trends in the Great Lakes region of the United States. An observed decline in potential ET between 1895 and 1996 corresponded with a decrease in the generated daily solar irradiance over that period. Previous research has shown decreases in pan evaporation during the latter half of the 20th century, which is postulated by some to be a result of decreased solar irradiance from increasing anthropogenic aerosol levels in the atmosphere (Roderick and Farquhar 2002).

With some change in growing season precipitation over the past 80 years combined with decreases in CWD, it would seem reasonable that water deficits would become less over time. As expected, all stations but two showed decreasing trends in stress, ranging from -0.27 mm yr^{-1} to -1.30 mm yr^{-1}. Six of these decreases were significant (Table 4.6). Crop water deficit for corn has decreased overall with a trend for all 12 stations of -0.50 mm yr^{-1}. Over 80 years, this amounts to an average decrease in moisture deficit of 40.0 mm.

Table 4.6 Long term trends in crop water deficit for corn

Climate Station	Prov	Duration From	Duration To	Relationship Between Year and Water Stress	Linear Slope	P-Value	Significance (P<=0.1)
Lacombe	AB	1921	1993	= 2664.9 + -1.3 * Yr	-1.30	0.000	Trend Exists
Olds	AB	1924	2000	= 1495.5 + -0.74 * Yr	-0.74	0.002	Trend Exists
Lethbridge	AB	1921	1999	= -1778.7 + 0.99 * Yr	0.99	0.135	Not Significant
Medicine Hat	AB	1921	2000	= 890 + -0.35 * Yr	-0.35	0.370	Not Significant
Indian Head	SK	1921	2000	= 1878.3 + -0.91 * Yr	-0.91	0.015	Trend Exists
Scott	SK	1921	1997	= 1142.7 + -0.51 * Yr	-0.51	0.124	Not Significant
Melfort	SK	1921	2000	= 615.7 + -0.27 * Yr	-0.27	0.401	Not Significant
Prince Albert	SK	1921	2000	= 965.1 + -0.43 * Yr	-0.43	0.111	Not Significant
Brandon	MB	1921	2000	= 79.9 + 0 * Yr	0.00	0.998	Not Significant
Minnedosa	MB	1921	1999	= 1625.4 + -0.8 * Yr	-0.80	0.006	Trend Exists
Morden	MB	1921	1998	= 1409.1 + -0.68 * Yr	-0.68	0.024	Trend Exists
Sprague	MB	1921	1999	= 1956 + -0.96 * Yr	-0.96	0.001	Trend Exists
All Locations				= 1084.6 + -0.5 * Yr	-0.50	0.000	Trend Exists

A contributing factor to the long-term decreases in moisture deficits can be related to the work of Akinremi et al. (1999) who reported a significant increase in the number of low intensity precipitation events over a 75 year period on the prairies. Consequently, there was a decline in the number of high intensity events, those that exceed 25 mm. From the perspective of crop production, more frequent rainfalls rather than less frequent larger rainfall events would result in fewer days of moisture stress. Fewer larger events would also reduce the amount of water loss through runoff or deep drainage, making a higher proportion of the rainfall available for crop water use.

According to the long-term trends, greater amounts of precipitation combined with lower water demand and lower water deficits has made the agricultural climate more favourable for crop production as it relates to moisture, particularly for non-irrigated crops. Over the past 80 years, actual demand for water has likely increased due to the adoption of crop cultivars with higher yield potential and higher water consumption (Tan and Reynolds 2003). In addition, with diversification into new crops such as corn, a crop that is relatively new to the prairies, which uses 25% more water than a conventional wheat crop (Figures 4.5 and 4.17), the actual deficits have not necessarily decreased.

While moisture-related trends can indeed be detected in the long-term climate record, it seems unlikely that these changes would take away the relevancy of a risk assessment based on past climate. Particularly since climatic risk assessments focus on the variability in climate rather than the mean climate on which trend analyses often focus. However, consideration of the observed trends is an important factor to consider when evaluating risk, particularly in planning activities. For example, long-term planning should reflect the current climatic risk and also consider the positive or negative tendency that the variable appears to be trending. Depending on the scope of the planning, one may also consult longer term climate predictions for more insight. Above all, the existence of trends provides justification to update a risk analyses such as this at a higher frequency to ensure that the assessments of risk are most current and to avoid obsolescence.

4.5 Summary and Conclusions

The maps presented in this report describe the agricultural climate of the Canadian prairies as it relates to selected moisture parameters for three major crops; wheat, corn, and forages. The probability of rainfall for each crop, the water requirements, and the moisture deficits provide a method to assess agroclimatic risk. The probability of moisture deficits is very high with some crops, particularly corn and forages. Wheat uses much less water and is therefore less prone to experiencing the same degree of stress. Geographically, the risk of moisture stress increases from east to west and from south to north throughout most of the prairie agricultural area.

Evidence of increases in growing season precipitation, combined with decreases in CWD and moisture deficit introduce some unique changes that appear to have occurred throughout some parts of the prairies; changes that undoubtedly have and will continue to shape the evolution of agriculture. Agricultural production is linked very closely to meteorological conditions, both because farming activities are directly affected by the weather and also because the final output, both in yield and quality, are closely linked to the effects of weather. The preceding sets of analyses are intended to assist agricultural producers in the management of weather related risks. As these risks apply to the supply and demand of water for crop production, practitioners may examine certain strategies and determine the associated degree of risk and decide whether the potential benefits warrant that risk. They may also look at methods to reduce their risks through various adaptation strategies related to water conservation and management. As weather conditions are never guaranteed, the management of risk through probability is a proven method to help ensure success over the long-term.

5. OVERALL SYNTHESIS

5.1 Conclusions

Crop response is intimately linked to the weather. Favourable weather conditions will result in high yields while adverse conditions can ruin crops. Extended periods of inclement weather such as multi-year droughts can devastate a farming operation and could eventually cripple an economy. Despite advancements in technology and farming methods, agriculture will always be vulnerable to the weather. Agriculture must therefore work within the constraints of the weather, accounting for the risks that it presents. Anticipatory decisions to address these risks when they first become perceptible are preferable to waiting for problems to escalate into crisis status. The preceding work has presented a quantification of some of the risks related to the agricultural climate of the Canadian prairies through an examination of frost, heat units, and moisture characteristics.

For all parameters that were investigated, a high degree of spatial variability was evident throughout the agricultural region. The average number of FFD above 0.0°C ranges from 65 to 141, a difference of 76 days between the climate stations with the shortest and those with the longest frost free periods (Figure 2.18). Similarly, average seasonal CHU values differ by about 1000 from north to south (Figure 3.5). While rainfall generally decreases from east to west, the CWD also increases towards the west, resulting in a much higher probability of severe water deficits in southwestern Saskatchewan and southern Alberta compared with the rest of the prairies. The probability of water deficit generally decreases towards the north due to lower CWD and generally more rainfall. Given the spatial variability in the agroclimate of the prairies, the risk of production is very diverse throughout the region.

Most small grain cereal and oilseed crops such as wheat and canola are grown widely across the prairies with few thermal limitations. Areas with shorter frost free seasons or with more variability in frost dates are more vulnerable to frost damage or insufficient heat, although the risks are lower with shorter season crops. These types of crops also use less water throughout their growth period compared with most others. Average crop water demand for wheat is between 275 mm and 370 mm (Figure 4.5) while rainfall during the growth period of wheat is between 125 mm and 355 mm (Figure 4.1). Though some stress is likely to occur, seasonal water deficits would normally not exceed 25 to 50 mm at most locations (Figures 4.10 and 4.11).

The thermal requirements for corn limit the geographical extent to which the crop can be grown. The number of FFD and seasonal accumulation of CHU, suggest that grain corn could be sustainable in at least three out of four years in southern Manitoba, southern Saskatchewan, and southern Alberta between Lethbridge and Medicine Hat (Figure 3.6). With a nine out of ten year likelihood of success, only southern Manitoba and some small pockets in Alberta would be suitable for grain corn (Figure 3.7). However, the moisture regime in some of these areas, particularly towards the western prairies would result in severe water deficits that would reduce productivity. In southwestern Saskatchewan, the probability of moisture stress in excess of 150 mm is greater than 90%. Areas such as these would benefit from irrigation if it were feasible.

Forage crops can be grown throughout the prairies according to the general thermal requirements of most forage species. Areas that provide higher accumulations of GDD at 50% risk, such as the southern regions, could sustain as many as three harvest of alfalfa during a growing season however, allowing suitable time for fall hardening would reduce the number of harvests to two (Figure 3.13). In three years out of four, most parts of the prairies could sustain two cuts of alfalfa though some areas would not have adequate fall hardening (Figure 3.14).

The very high water requirements of many forage species virtually guarantee that moisture stress will occur. The average CWD across the prairies ranges between 575 mm and 750 mm resulting in some areas with a greater than 90% chance of exceeding 250 mm of moisture deficit. Forage crops would also benefit from irrigation if the costs could be justified by the expected returns. An advantage of forages versus most annual crops is that early harvests or grazing by ruminants can take advantage of early season moisture, perhaps prior to the onset of severe moisture stress after which the productivity of the crop would decline. In contrast, severe stress experienced by an annual crop midway through the season could result in total loss if the grain yield is greatly reduced.

The thermal attributes related to the production of potatoes indicates that the crop would be capable of reaching the tuber bulking stage throughout most of the prairies at 50% risk (Figure 3.9). The accumulation of P-Days in southern Manitoba and southeastern Alberta are sufficient to allow an adequate tuber bulking period for reasonable yields. The moisture characteristics of potatoes have not been addressed in this thesis despite being a topic of great importance. Commercial potato production requires close management of soil moisture through irrigation to achieve high yields and optimum quality. The management and subsequent risks associated with an irrigated potato crop are much different than those of a non-irrigated crop. The objective of this study is to characterize the agroclimate without the influences of technology or individual management practices. The model used in this analysis does not account for growth stage-specific moisture stress thresholds often used in potato production nor does the model consider specific irrigation requirements. A moisture-related agroclimatic assessment of potatoes is necessary and should be completed; however major revisions to the model were beyond the scope of this project.

Changes to the agricultural climate have occurred as demonstrated by the results of the analyses presented in Chapters 3 and 4 and by other investigators. An analysis of long term trends in CHU at 12 climate stations has shown an overall increase of 0.46 CHU yr^{-1} (Table 3.1). This trend appears to be more consistent and prominent at stations located in the southern parts of the prairies. If this apparent warming continues, there could potentially be greater opportunity to expand the areas of some warmer season crops on the prairies. While the overall trend was positive, some stations, particularly those north of the 51st

parallel showed decreasing trends or trends that were not significant. This suggests considerable spatial variability in long-term heat-related trends.

Trends in precipitation during the growth period of corn have shown an overall increase of 0.38 mm yr^{-1} among 12 climate stations combined though most individual stations show no significant trends. Modelled CWD for corn has generally decreased over the past 80 years at an average rate of 0.32 mm yr^{-1}. The resulting change in moisture deficit for the 12 stations was -0.50 mm yr^{-1}, indicating that the degree of annual crop water stress has decreased over time. Some of the observed changes suggest the possibility of a gradual shift towards a more favourable agroclimate.

5.2 Limitations of the Analyses

While agroclimatic risk can be quantified based on the behaviour of past weather and the expected crop response, the true risk to a farming operation is much more complicated. This risk varies by individual operation based on their vulnerability and whether strategies have been implemented towards reducing risk. For example, management of crop residues can increase soil moisture levels through trapping of snow and reducing evaporation. This can in turn reduce moisture deficits. Other approaches include adjustment of seeding dates in order to avoid moisture stress during the more vulnerable stages of crop development. Technology can also reduce risk. Irrigation can minimize the effects of moisture shortages by supplying water to the crop when rainfall is inadequate. The development of new crop varieties that are more resistant to adverse weather conditions, pests, and other stresses may reduce the likelihood of loss due to inclement weather. All of these strategies represent adaptation measures that have been implemented over the past decades to reduce vulnerability. These specific management strategies could not and have not been accounted for within this risk assessment as the purpose of this analysis has been to characterize the climatic risks related to agriculture.

There are also a multitude of climatic risks that have not been addressed in the preceding chapters, particularly those related to extreme weather events such as heat waves, hail, tornadoes, severe winds, localized thunderstorms, and flooding. All of these events can cause substantial losses though few occur at a large enough scale to be detected at a regional level. A major limitation to analyzing such events is the bias involved in their detection (Easterling et al. 2000). For example, increased population improves the likelihood of a severe event being reported but more reporting does not necessarily mean that the events have been occurring more frequently. Furthermore, increases in the value of property damage due to extreme weather may only indicate that population growth and distribution combined with more affluence has increased the risk of damage rather than suggesting an increase in the occurrence of extreme events.

The timing of stress is another important factor that will influence the outcome of a growing season. Vulnerability and damage caused by freezing temperatures is dependent upon the stage of a crop. Water deficits at different stages of development will also have variable results on final yield and quality. During the vegetative stages, corn is relatively tolerant to moisture deficits while the tasseling and silking periods are very sensitive. The grain filling period is moderately sensitive to stress (Shanahan and Nielson 1987). Water stress early in the season can reduce above and below ground biomass accumulation. By virtue of a shallower or less dense rooting system, the amount of water available to the crop will be further reduced (Ritchie 1981). Wet conditions early in the season will decrease root penetration into the profile. Ritchie (1981) observed that a corn crop is more sensitive to drought when exposed to early season wet conditions.

This report does not address the long-term climate predictions and general circulation model (GCM) forecasts. While there is general agreement between models that future temperatures are virtually certain to increase within a certain range, there is less certainty as to the future of precipitation and extreme events, particularly at the spatial and temporal scales required for agricultural decision making. The current forecasting techniques cannot generate predictions with the accuracies or detail that could provide specific adaptation advice at a local or farm scale. A gradual shift in mean values will not have nearly the impact on production as increases in variability or extreme events which can have devastating effects on crop production. The most severe impacts of climate change will likely be the result of an increase in frequency or intensity of extreme events rather than from changes in mean values of atmospheric variables such as temperature (Nichols 1995).

5.3 Contributions to Knowledge

Changes in the climate can have major negative repercussions to a farming operation, particularly if additional pressures are present on an operation, be it economic, environmental, or social. Alternatively, agriculture may benefit from a changing climate, particularly if these changes can be detected or anticipated. This would allow the associated risks to be managed properly through adaptation towards greater resiliency. The indices presented in this thesis are meant to offer a sort of 'operator's manual' for dealing with agroclimatic risk in hopes of providing a valuable tool for prairie agriculture. A critical step in developing adaptation strategies to manage climate risks is to understand the interactions between climate and society and to identify how society has evolved to cope with these hazards (Jones and Boer 2005).

One of the most noteworthy contributions to knowledge offered by the contents of this thesis is a presentation of a more current assessment of the agricultural climate of the prairies. Each and every growing season that passes offers up an additional piece of knowledge that can be applied to the characterization of the agroclimate. As the climate changes, these tools unfortunately become obsolete. The author knows of no other agroclimatic risk assessment of the entire prairie region that has been undertaken within the past two decades. The process of updating this information with more recent climate data provides an enhancement of a valuable set of production tools. These tools can be made available to practitioners to be used for risk management applications.

An assessment of long-term agroclimatic trends is another contribution to knowledge offered by this thesis. A snapshot of the current agroclimate is valuable though it would be unwise to assume that risks remain static or that new hazards will not arise (Jones and Boer 2005). An indication of how the various components have changed over time can reveal how agriculture has adapted to both the positive and negative aspects of the changing climate and how adaptation to future climates might be best carried out.

5.4 Recommendations for Future Research

Based on the work that was undertaken in the preparation of this thesis, there are several recommendations that could be considered for subsequent work. The first recommendation is to provide agroclimatic assessments for many more crops. Great value could come from assessing the agroclimatic risk associated with other crops, including those that are not currently produced in the region. This could help identify new crops that could have the potential of being well suited to the prairie climate. A challenge with this endeavour is in acquiring the agronomic attributes of the crop to enable a characterization of its climatic requirements. There are also the non-climatic elements that must be considered.

An analysis based on historic climate data demonstrates the importance of weather monitoring throughout the country and around the world. Records of meteorological variables measured over time and space are the only means with which to assess how climate can influence crop production. Poor or incomplete weather records can corrupt results or prevent any meaningful analyses from being generated. The foresight of previous generations has produced a reasonably good climate dataset. Only through continued commitment on the part of public agencies will quality climate data continue to be available - data that must remain freely available in order to facilitate analyses such as this. With new technology there may also be additional sources of information available such as remotely sensed data and output from products such as GCM's. These additional tools hold great potential for improving the prediction capabilities of models.

The final recommendation from this study is that agroclimatic information must be updated frequently and this information must be distributed widely. Changes and trends in the climate have revealed that agroclimatic parameters and consequently the associated risks do not remain constant over time. Information about these risks should be kept current to reflect these changes. Modern computers and software should enable more frequent updates to be completed. Computers and the internet have also allowed vast quantities of information to be disseminated. Information related to agroclimatic risk can quite effectively be made available over the internet as well as through other means. Only by making this information available can it be accessed and be put to use.

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7. APPENDICES

I. Climate stations used in analsyis

Station Code	Station Name	Prov	Lat (DD)	Long (DD)	Elev (M)	Years of Record First	Last	Count	Soil Properties Texture	AWHC
3060321	ATHABASCA2	AB	54.81	-113.53	610	1971	2000	30	L	246
3050520	BANFF	AB	51.18	-115.56	1397	1971	1994	24	L	246
3070560	BEAVERLODGE_CDA	AB	55.20	-119.40	732	1971	2000	30	SIL	259
3010830	BRIGHTVIEW	AB	52.98	-113.71	815	1971	2000	30	SL	174
3010890	BROWNFIELD	AB	52.33	-111.46	747	1971	2000	30	L	246
3031000	CALDWELL	AB	49.15	-113.63	1311	1971	1990	20	L	246
3031093	CALGARYA	AB	51.10	-114.01	1084	1971	2000	30	L	246
3011120	CALMAR	AB	53.28	-113.83	716	1971	2000	30	L	246
3061200	CAMPSIE	AB	54.13	-114.68	671	1971	2000	30	L	246
3011240	CAMROSE	AB	53.01	-112.83	732	1971	1993	23	L	246
3031320	CARDSTON	AB	49.20	-113.31	1154	1971	2000	30	L	246
3031400	CARWAY	AB	49.00	-113.36	1359	1971	2000	30	L	246
3031658	CLARESHOLM_WATERW	AB	50.01	-113.71	1018	1971	2000	30	SIL	259
307JF5R	CLEARDALE	AB	56.31	-119.48	671	1971	2000	30	SICL	259
3081680	COLDLAKEA	AB	54.41	-110.28	541	1971	2000	30	L	246
3031805	CONNELLY CREEK	AB	49.61	-114.23	1158	1980	2000	21	CL	265
3011880	CORONATIONA	AB	52.06	-111.45	791	1971	1993	23	SL	174
3012205	EDMONTONA	AB	53.30	-113.58	715	1971	2000	30	L	246
3012208	EDMONTONMUN	AB	53.56	-113.51	671	1971	1993	23	SICL	259
3062244	EDSONA	AB	53.58	-116.45	922	1971	1993	23	L	246
3012280	ELKPOINT	AB	53.88	-111.06	605	1971	1997	27	L	246
3072322	ELMWORTHCDA	AB	55.10	-119.75	754	1975	1995	21	SIL	259
3022400	EMPRESS	AB	50.95	-110.00	613	1972	2000	29	L	246
3072475	EUREKARIVER	AB	56.46	-118.73	661	1971	2000	30	SICL	259
3072520	FAIRVIEW	AB	56.06	-118.38	670	1971	1991	21	SIL	259
3032640	FOREMOST	AB	49.48	-111.45	884	1971	2000	30	L	246
3012652	FORESTBURG_PLANT	AB	52.46	-112.13	671	1971	2000	30	L	246
3072658	FORT_CHIPEWYANA	AB	58.76	-111.11	232	1971	2000	30	L	246
3012710	FORT_SASKATCHEWAN	AB	53.71	-113.18	625	1971	2000	30	L	246
3032680	FORTMACLEOD	AB	49.71	-113.40	950	1971	1993	23	SIL	259
3062693	FORTMCMURRAYA	AB	56.65	-111.21	369	1971	2000	30	L	246
3032800	GLEICHEN	AB	50.86	-113.05	902	1971	2000	30	SIL	259
3072920	GRANDEPRAIRIEA	AB	55.18	-118.88	669	1971	2000	30	SIL	259
3073146	HIGHLEVELA	AB	58.61	-117.16	338	1971	2000	30	SIL	259
3033240	HIGHRIVER	AB	50.48	-114.16	1219	1971	2000	30	L	246
3053520	JASPER	AB	52.88	-118.06	1061	1971	1995	25	L	246
3023720	LACOMBECDA	AB	52.46	-113.75	847	1971	1993	23	LS	130
3033880	LETHBRIDGEA	AB	49.63	-112.80	929	1971	2000	30	L	246
3033890	LETHBRIDGECDA	AB	49.70	-112.78	899	1971	1999	29	SIL	259
3044200	MANYBERRIESCDA	AB	49.11	-110.46	934	1971	1990	20	L	246
3034480	MEDICINEHATA	AB	50.01	-110.71	717	1971	2000	30	SIL	259
3074902	NOTIKEWINEAST	AB	57.01	-117.56	465	1971	1993	23	SICL	259
3024920	OLDS	AB	51.78	-114.10	1040	1971	2000	30	L	246
3024961	OYEN CAPPON	AB	51.16	-110.51	793	1974	2000	27	L	246
3075040	PEACERIVERA	AB	56.23	-117.43	571	1971	2000	30	SICL	259
3035202	PINCHERCREEKA	AB	49.51	-114.00	1189	1971	1993	23	CL	265
3035340	QUEENSTOWN	AB	50.60	-112.98	945	1971	2000	30	L	246
3015400	RANFURLY	AB	53.45	-111.65	686	1971	2000	30	L	246
3025480	REDDEERA	AB	52.18	-113.90	905	1971	2000	30	L	246
3015522	ROCKYMTN_HOUSEA	AB	52.38	-114.91	1015	1971	1993	23	SIL	259
3015960	SION	AB	53.88	-114.11	701	1971	2000	30	L	246
3016119	STETTLERNORTH	AB	52.33	-112.71	821	1971	2000	30	L	246
3036240	SUFFIELDA	AB	50.26	-111.18	770	1971	2000	30	L	246
3036360	TABER	AB	49.78	-112.11	808	1971	2000	30	SIL	259
3026540	TROCHU TOWN	AB	51.83	-113.21	876	1981	2000	20	C	314
3016761	VEGREVILLECDA	AB	53.48	-112.03	636	1971	1993	23	L	246
3036881	VULCAN	AB	50.40	-113.25	1049	1975	2000	26	SIL	259
3076940	WANHAMCDAEPF	AB	55.73	-118.40	607	1971	1995	25	SIL	259
3077246	WATINO	AB	55.71	-117.63	393	1971	1996	26	LS	130
3067372	WHITECOURTA	AB	54.15	-115.78	783	1971	2000	30	L	246
4020020	ABBEY	SK	50.70	-108.78	695	1977	2000	24	HC	314

Station Code	Station Name	Prov	Lat (DD)	Long (DD)	Elev (M)	Years of Record First	Last	Count	Soil Properties Texture	AWHC
4020130	ALSASKHARDENE	SK	51.35	-109.83	658	1971	1997	27	HC	314
4010150	AMULET	SK	49.61	-104.73	728	1971	2000	30	CL	265
4020160	ANEROID	SK	49.71	-107.30	754	1971	2000	30	L	246
4080262	ARRAN23N	SK	52.20	-101.63	450	1971	1991	21	C	314
4010310	ATWATER	SK	50.81	-102.21	536	1977	2000	24	L	246
4040600	BIGGAR	SK	52.06	-107.98	671	1971	2000	30	SL	174
4010879	BROADVIEW	SK	50.38	-102.68	601	1971	1994	24	L	246
4051080	CAMEO	SK	53.28	-106.53	480	1971	1995	25	FS	132
4011160	CARLYLE	SK	49.63	-102.26	631	1971	1996	26	SIL	259
4011441	CEYLON	SK	49.38	-104.65	753	1971	1995	25	CL	265
4021520	CHAPLIN	SK	50.46	-106.65	671	1971	1994	24	SL	174
4071560	CHOICELAND	SK	53.50	-104.48	442	1971	1994	24	CL	265
4031581	CLAYDON	SK	49.13	-109.10	975	1972	2000	29	CL	265
4021600	CODERRE	SK	50.13	-106.36	685	1971	2000	30	SL	174
4031844	CORONACH	SK	49.11	-105.51	773	1972	2000	29	CL	265
4011846	COTE	SK	51.51	-101.80	457	1971	2000	30	CL	265
4061861	CREELAKE	SK	57.35	-107.13	497	1971	1992	22	S	101
4012050	DAHINDA	SK	49.75	-105.00	725	1974	2000	27	CL	265
4012120	DAVIDSON	SK	51.26	-105.98	619	1971	2000	30	L	246
4012300	DUVAL	SK	51.16	-104.85	591	1971	2000	30	L	246
4022368	ELROSE	SK	51.13	-108.03	610	1974	2000	27	SL	174
4012400	ESTEVANA	SK	49.06	-103.00	572	1971	2000	30	FL	191
4012483	FENWOOD	SK	51.15	-103.06	625	1974	2000	27	L	246
4012485	FERTILE	SK	49.33	-101.45	511	1971	2000	30	L	246
4022960	GRAVELBOURG	SK	49.88	-106.55	700	1971	1994	24	CL	265
4023060	GULLLAKECDAEPF	SK	49.95	-108.46	907	1971	1991	21	SIL	259
4053080	HAFFORD	SK	52.71	-107.36	587	1971	1993	23	SL	174
4013098	HANDSWORTH	SK	49.83	-102.86	678	1978	2000	23	L	246
4053120	HARRIS	SK	51.73	-107.58	578	1977	2000	24	SL	174
4083321	HUDSONBAYA	SK	52.81	-102.31	357	1971	1992	22	SL	174
4013401	HUMBOLDT	SK	52.26	-105.11	549	1978	2000	23	L	246
4013480	INDIANHEAD_CDA	SK	50.53	-103.66	586	1971	2000	30	C	314
4023500	INGEBRIGHT_LAKE	SK	50.36	-109.35	701	1971	1998	28	S	101
4063560	ISLANDFALLS2	SK	55.53	-102.35	299	1971	2000	30	L	246
4013660	KELLIHER	SK	51.25	-103.75	671	1971	2000	30	L	246
4043750	KERROBERT	SK	51.96	-109.05	660	1978	2000	23	SL	174
4043900	KINDERSLEYA	SK	51.46	-109.16	683	1971	2000	30	C	314
4014040	KIPLING	SK	50.20	-102.73	671	1971	2000	30	L	246
4024080	KLINTONEL	SK	49.68	-108.91	1070	1971	1994	24	CL	265
4014115	KUROKI	SK	52.00	-103.45	585	1971	1994	24	L	246
4014138	LAKE ALMA	SK	49.06	-104.25	724	1981	2000	20	CL	265
4024161	LEADER2	SK	50.88	-109.53	674	1971	1996	26	HC	314
4014480	LIPTON	SK	50.85	-103.76	602	1971	2000	30	C	314
4064600	LOONLAKE_CDAEPF	SK	54.05	-109.10	543	1971	2000	30	L	246
4074640	LOSTRIVER	SK	53.28	-104.33	375	1971	1994	24	VL	205
4014720	LUMSDEN	SK	50.65	-104.86	497	1971	1993	23	L	246
4034910	MANKOTA	SK	49.10	-107.03	830	1971	2000	30	L	246
4024936	MAPLECREEK_NORTH	SK	50.00	-109.46	764	1971	2000	30	FL	191
4015045	MARYFIELD	SK	49.83	-101.51	576	1971	2000	30	L	246
4065058	MEADOWLAKEA	SK	54.13	-108.51	480	1971	2000	30	SICL	259
4055085	MELFORTCDA	SK	52.81	-104.60	480	1971	2000	30	C	314
4015160	MIDALE	SK	49.40	-103.40	582	1971	2000	30	CL	265
4015320	MOOSEJAWA	SK	50.33	-105.55	577	1971	2000	30	HC	314
4015360	MOOSOMIN	SK	50.15	-101.66	576	1971	1999	29	L	246
4015440	MUENSTER	SK	52.18	-105.00	579	1971	2000	30	L	246
4075518	NIPAWIN	SK	53.33	-104.00	372	1971	2000	30	L	246
4015560	NOKOMIS	SK	51.51	-105.00	526	1977	2000	24	L	246
4045600	NORTH_BATTLEFORDA	SK	52.76	-108.25	548	1971	2000	30	L	246
4015680	ORMISTON	SK	49.71	-105.36	686	1971	1995	25	GSL	168
4055736	OUTLOOKPFRA	SK	51.48	-107.05	540	1971	2000	30	FL	191
4015800	OXBOW	SK	49.21	-102.16	572	1971	2000	30	L	246
4015960	PASWEGIN	SK	51.98	-103.91	533	1971	2000	30	L	246

Station Code	Station Name	Prov	Lat (DD)	Long (DD)	Elev (M)	Years of Record First	Last	Count	Soil Properties Texture	AWHC
4086000	PELLY	SK	52.08	-101.86	509	1971	2000	30	CL	265
4026040	PENNANT	SK	50.53	-108.23	723	1971	1995	25	L	246
4056120	PILGER	SK	52.41	-105.15	552	1971	2000	30	L	246
4056240	PRINCEALBERTA	SK	53.21	-105.68	428	1971	2000	30	LS	130
4016560	REGINAA	SK	50.43	-104.66	577	1971	2000	30	HC	314
4016640	REGINACDA	SK	50.40	-104.56	573	1971	1993	23	HC	314
4016842	ROCANVILLE	SK	50.46	-101.55	479	1971	2000	30	L	246
4046879	ROSETOWN	SK	51.61	-108.01	586	1971	1999	29	CL	265
4057120	SASKATOONA	SK	52.16	-106.68	501	1971	2000	30	GSL	168
4057180	SASKATOONSRC	SK	52.15	-106.60	497	1971	1992	22	CL	265
4047240	SCOTTCDA	SK	52.36	-108.83	660	1971	1997	27	L	246
4017320	SEMANS	SK	51.40	-104.71	562	1971	1994	24	L	246
4027440	SHAMROCK	SK	50.16	-106.61	739	1971	1992	22	L	246
4027485	SHAUNAVON2	SK	49.65	-108.41	914	1971	2000	30	SIL	259
4028060	SWIFTCURRENT_CDA	SK	50.26	-107.73	825	1971	2000	30	SIL	259
4028040	SWIFTCURRENTA	SK	50.28	-107.68	817	1971	2000	30	SIL	259
4038116	TREELON	SK	49.00	-108.38	902	1972	2000	29	CL	265
4018160	TUGASKE	SK	50.86	-106.30	607	1971	2000	30	L	246
4038400	VALMARIE	SK	49.36	-107.88	792	1971	2000	30	CL	265
4048520	WASECA	SK	53.13	-109.40	648	1971	2000	30	L	246
4068560	WASKESIULAKE	SK	53.91	-106.08	532	1971	1994	24	SL	174
4018640	WATROUS	SK	51.66	-105.46	541	1971	2000	30	L	246
4038740	WESTPOPLAR_RIVER	SK	49.00	-106.38	876	1971	2000	30	L	246
4018760	WEYBURN	SK	49.65	-103.83	570	1977	2000	24	CL	265
4068840	WHITESAND_DAM	SK	56.23	-103.15	341	1971	2000	30	L	246
4018880	WHITEWOOD	SK	50.46	-102.23	584	1974	2000	27	L	246
4039001	WILLOWCREEK2	SK	49.00	-109.73	846	1979	1998	20	CL	265
4019035	WYNYARD	SK	51.76	-104.20	561	1971	2000	30	L	246
4019040	YELLOWGRASS	SK	49.80	-104.16	579	1971	2000	30	HC	314
4019080	YORKTONA	SK	51.26	-102.46	498	1971	2000	30	SICL	259
5020040	ALTONA	MB	49.10	-97.55	248	1971	2000	30	C	314
5030080	ARBORG	MB	50.98	-97.10	229	1971	2000	30	C	314
5040120	ASHERN	MB	51.11	-98.35	271	1971	1990	20	L	246
5010140	BALDUR	MB	49.30	-99.33	450	1971	2000	30	L	246
5030160	BEAUSEJOUR2	MB	50.11	-96.50	238	1971	2000	30	C	314
5010216	BINSCARTH	MB	50.58	-101.26	526	1974	2000	27	L	246
5040218	BIRCHRIVER	MB	52.45	-100.98	305	1971	2000	30	CL	265
5010240	BIRTLE	MB	50.43	-100.85	548	1971	1995	25	L	246
5030282	BISSETT	MB	51.03	-95.66	258	1971	1997	27	C	314
5010480	BRANDONA	MB	49.91	-99.95	409	1971	2000	30	L	246
5010485	BRANDONCDA	MB	49.86	-99.98	363	1971	2000	30	C	314
5030510	BROADVALLEY	MB	50.98	-97.46	259	1971	1991	21	C	314
5060600	CHURCHILLA	MB	58.75	-94.06	29	1971	2000	30	L	246
5060623	CROSSLAKE_JENPEG	MB	54.53	-98.03	219	1973	2000	28	C	314
5010640	CYPRESSRIVER	MB	49.55	-99.08	375	1971	2000	30	CL	265
5040680	DAUPHINA	MB	51.10	-100.05	304	1971	1994	24	C	314
5020720	DEERWOOD	MB	49.40	-98.31	338	1971	1994	24	CL	265
5010760	DELORAINE	MB	49.18	-100.50	500	1971	1994	24	L	246
5040764	DELTA_UNIVERSITYFS	MB	50.18	-98.38	248	1971	2000	30	L	246
5020870	ELMCREEK	MB	49.71	-98.01	252	1973	1993	21	C	314
5020880	EMERSON	MB	49.01	-97.20	236	1971	1996	26	C	314
5030912	FALCONLAKE_TCPL45	MB	49.68	-95.36	338	1971	1997	27	L	246
5030917	FISHERBRANCHS	MB	51.05	-97.51	259	1978	2000	23	L	246
5050920	FLINFLON	MB	54.76	-101.85	335	1971	2000	30	LS	130
5050960	FLINFLONA	MB	54.68	-101.68	304	1971	2000	30	LS	130
5040985	GILBERTPLAINS	MB	51.10	-100.46	404	1971	2000	30	CL	265
5061001	GILLAMA	MB	56.35	-94.70	145	1971	2000	30	L	246
5031038	GIMLI	MB	50.61	-96.98	223	1971	1990	20	C	314
50410N0	GLADSTONE_SOUTH	MB	50.18	-99.01	282	1974	1997	24	LFS	134
5011051	GLENBORO	MB	49.56	-99.33	373	1971	1991	21	L	246
5021054	GLENLEA	MB	49.65	-97.11	234	1971	2000	30	C	314
5031111	GRANDRAPIDS_HYDRO	MB	53.15	-99.28	223	1971	2000	30	L	246

Station Code	Station Name	Prov	Lat (DD)	Long (DD)	Elev (M)	Years of Record			Soil Properties	
						First	Last	Count	Texture	AWHC
5041140	GRASSRIVER	MB	50.51	-98.96	270	1971	1995	25	CL	265
5031200	GREATFALLS	MB	50.46	-96.00	249	1971	2000	30	C	314
5011240	HAMIOTA	MB	50.13	-100.58	518	1971	1991	21	L	246
5031301	HODGSON2	MB	51.18	-97.45	232	1971	2000	30	L	246
5031320	INDIANBAY	MB	49.61	-95.20	327	1971	2000	30	L	246
5061376	ISLANDLAKE	MB	53.86	-94.66	238	1971	2000	30	L	246
5041530	LANGRUTH	MB	50.40	-98.56	251	1971	2000	30	CL	265
5061646	LYNNLAKEA	MB	56.86	-101.06	357	1971	2000	30	LS	130
5041684	MACGREGOR	MB	49.90	-98.70	301	1974	1994	21	LFS	134
5021695	MARQUETTE	MB	50.01	-97.80	244	1971	2000	30	L	246
5011760	MINNEDOSA	MB	50.26	-99.83	518	1971	2000	30	L	246
5021848	MORDENCDA	MB	49.18	-98.08	297	1971	1998	28	L	246
5021975	MYRTLE	MB	49.40	-97.83	251	1971	2000	30	C	314
5042005	NEEPAWAWATER	MB	50.21	-99.46	358	1971	2000	30	S	101
5022043	NIVERVILLE	MB	49.60	-97.05	237	1971	1991	21	C	314
506B047	NORWAYHOUSEA	MB	53.96	-97.83	223	1973	1994	22	L	246
506B0M7	NORWAYHOUSEF	MB	54.00	-97.80	217	1971	1999	29	L	246
5012054	OAKNER	MB	50.10	-100.63	503	1971	2000	30	L	246
5052060	PASQUIAPROJ_PFRA	MB	53.71	-101.58	262	1971	2000	30	CL	265
5022065	PEACEGARDENS	MB	49.00	-100.05	685	1971	2000	30	CL	265
5012080	PIERSON	MB	49.18	-101.26	469	1971	2000	30	L	246
5032162	PINAWAWNRE	MB	50.18	-96.05	267	1971	2000	30	L	246
5032163	PINEDOCK	MB	51.66	-96.85	219	1971	1997	27	C	314
5032164	PINEFALLS	MB	50.56	-96.21	231	1971	1994	24	L	246
5022171	PINEY	MB	49.03	-96.01	326	1981	2000	20	S	101
5022245	PLUMCOULEE	MB	49.05	-97.80	265	1971	2000	30	CL	265
5012320	PORTAGELAPR	MB	49.90	-98.26	270	1971	1991	21	C	314
5012322	PORTAGELAPR2	MB	49.98	-98.31	261	1971	1995	25	L	246
5022335	RATHWELL	MB	49.68	-98.55	326	1971	2000	30	L	246
5012500	ROSSBURN	MB	50.66	-100.81	590	1971	1990	20	L	246
5022630	SELKIRK	MB	50.15	-96.88	225	1971	2000	30	C	314
5012710	SOMERSET	MB	49.45	-98.61	496	1971	1997	27	L	246
5022759	SPRAGUE	MB	49.03	-95.63	327	1971	2000	30	FL	191
5022770	STARBUCK	MB	49.73	-97.61	238	1971	2000	30	C	314
5022780	STEINBACH	MB	49.53	-96.78	268	1971	2000	30	SL	174
5022788	STONEWALL	MB	50.11	-97.33	251	1971	1990	20	C	314
5022791	STONYMTN	MB	50.11	-97.16	236	1972	2000	29	CL	265
5012796	STRATHCLAIR	MB	50.40	-100.40	579	1971	2000	30	L	246
5042800	SWANRIVER	MB	52.11	-101.26	340	1971	2000	30	LFS	134
5052880	THEPASA	MB	53.96	-101.10	271	1971	2000	30	L	246
5062922	THOMPSONA	MB	55.80	-97.86	215	1971	2000	30	C	314
5012960	VIRDEN	MB	49.85	-100.93	437	1971	2000	30	SL	174
5043020	VOGAR	MB	50.91	-98.75	250	1971	2000	30	L	246
5043158	WILSONCRWEIR	MB	50.71	-99.53	366	1972	2000	29	CL	265
5023222	WINNIPEGA	MB	49.90	-97.23	239	1971	2000	30	C	314

II. Risk of last spring frost of 0.0°C and -2.2°C

Station Name	Prov	Risk of Last Spring Frost of 0°C								Risk of Last Spring Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
ATHABASCA2	AB	141.6	9.6	6.8	Jun 02	May 27	May 21	May 14	May 08	125.3	10.4	8.3	May 18	May 11	May 04	Apr 27	Apr 21
BANFF	AB	155.0	12.9	8.3	Jun 20	Jun 12	Jun 03	May 25	May 17	132.2	10.1	7.7	May 24	May 18	May 11	May 04	Apr 28
BEAVERLODGE_CDA	AB	143.7	10.4	7.2	Jun 05	May 30	May 23	May 16	May 09	128.8	13.1	10.2	May 25	May 17	May 08	Apr 29	Apr 21
BRIGHTVIEW	AB	138.6	9.6	6.9	May 30	May 24	May 18	May 11	May 05	126.6	12.2	9.6	May 21	May 14	May 06	Apr 27	Apr 20
BROWNFIELD	AB	150.6	12.4	8.2	Jun 14	Jun 07	May 30	May 21	May 14	131.4	12.8	9.8	May 27	May 19	May 10	May 02	Apr 24
CALDWELL	AB	152.2	12.4	8.1	Jun 16	Jun 09	May 31	May 23	May 15	127.6	10.1	7.9	May 20	May 13	May 07	Apr 30	Apr 24
CALGARYA	AB	141.8	12.7	9.0	Jun 06	May 29	May 21	May 12	May 04	127.3	10.6	8.3	May 20	May 13	May 06	Apr 29	Apr 23
CALMAR	AB	142.4	7.9	5.5	May 31	May 27	May 21	May 16	May 11	129.2	11.9	9.2	May 23	May 16	May 08	Apr 30	Apr 23
CAMPSIE	AB	153.6	10.6	6.9	Jun 15	Jun 09	Jun 02	May 25	May 19	139.0	9.4	6.8	May 30	May 24	May 18	May 12	May 06
CAMROSE	AB	135.8	8.9	6.6	May 26	May 21	May 15	May 09	May 03	123.6	11.1	9.0	May 17	May 10	May 03	Apr 25	Apr 18
CARDSTON	AB	147.6	14.7	10.0	Jun 14	Jun 06	May 27	May 17	May 08	128.9	12.9	10.0	May 24	May 17	May 08	Apr 29	Apr 21
CARWAY	AB	163.8	15.1	9.2	Jul 01	Jun 22	Jun 12	Jun 02	May 24	139.5	14.9	10.7	Jun 07	May 29	May 19	May 08	Apr 29
CLARESHOLM_WATERW	AB	149.0	9.8	6.6	Jun 10	Jun 04	May 28	May 21	May 16	129.3	11.1	8.6	May 23	May 16	May 08	May 01	Apr 24
CLEARDALE	AB	152.8	9.9	6.5	Jun 13	Jun 07	Jun 01	May 25	May 19	134.3	10.4	7.8	May 27	May 20	May 13	May 06	Apr 30
COLDLAKEA	AB	141.3	9.1	6.5	Jun 01	May 26	May 20	May 14	May 09	126.0	11.6	9.2	May 20	May 13	May 05	Apr 27	Apr 20
CONNELLY CREEK	AB	154.4	15.6	10.1	Jun 22	Jun 13	Jun 02	May 23	May 13	131.0	10.7	8.2	May 24	May 17	May 10	May 03	Apr 26
CORONATIONA	AB	142.3	11.5	8.1	Jun 05	May 29	May 21	May 13	May 06	129.1	12.7	9.8	May 24	May 17	May 08	Apr 30	Apr 22
EDMONTONA	AB	142.9	8.6	6.0	Jun 02	May 28	May 22	May 16	May 11	130.8	10.3	7.9	May 23	May 17	May 10	May 03	Apr 27
EDMONTONMUN	AB	125.1	11.7	9.4	May 19	May 12	May 04	Apr 26	Apr 19	117.7	10.6	9.0	May 10	May 04	Apr 27	Apr 20	Apr 13
EDSONA	AB	162.9	14.2	8.7	Jun 29	Jun 20	Jun 11	Jun 01	May 24	139.6	10.7	7.6	Jun 01	May 26	May 19	May 11	May 05
ELKPOINT	AB	156.9	12.8	8.2	Jun 21	Jun 13	Jun 05	May 27	May 19	137.0	11.2	8.2	May 30	May 24	May 16	May 08	May 02
ELMWORTHCDA	AB	154.0	8.3	5.4	Jun 13	Jun 08	Jun 02	May 27	May 22	136.7	8.8	6.5	May 27	May 22	May 16	May 10	May 04
EMPRESS	AB	139.7	9.9	7.1	May 31	May 25	May 19	May 12	May 06	123.1	9.2	7.4	May 14	May 08	May 02	Apr 26	Apr 20
EUREKARIVER	AB	162.8	13.8	8.5	Jun 28	Jun 20	Jun 11	Jun 01	May 24	143.3	9.1	6.4	Jun 03	May 28	May 22	May 16	May 11
FAIRVIEW	AB	135.9	11.3	8.4	May 29	May 23	May 15	May 07	Apr 30	119.9	12.6	10.5	May 15	May 07	Apr 29	Apr 20	Apr 13
FOREMOST	AB	140.5	12.6	9.0	Jun 05	May 28	May 20	May 11	May 03	121.3	10.6	8.7	May 14	May 07	Apr 30	Apr 23	Apr 17
FORESTBURG_PLANT	AB	129.0	11.7	9.0	May 23	May 16	May 08	Apr 30	Apr 23	116.4	11.1	9.5	May 10	May 03	Apr 25	Apr 18	Apr 11
FORT_CHIPEWYANA	AB	154.0	14.7	9.6	Jun 21	Jun 12	Jun 02	May 23	May 14	139.6	12.7	9.1	Jun 04	May 27	May 19	May 10	May 02
FORT_SASKATCHEWAN	AB	141.2	10.7	7.6	Jun 03	May 27	May 20	May 13	May 07	129.1	10.9	8.4	May 22	May 15	May 08	May 01	Apr 24
FORTMACLEOD	AB	140.6	12.8	9.1	Jun 05	May 28	May 20	May 11	May 03	122.2	10.3	8.4	May 14	May 08	May 01	Apr 24	Apr 18
FORTMCMURRAYA	AB	149.9	10.7	7.1	Jun 12	Jun 05	May 29	May 22	May 15	134.9	10.7	7.9	May 28	May 21	May 14	May 07	Apr 30
GLEICHEN	AB	144.9	9.2	6.3	Jun 05	May 30	May 24	May 18	May 12	128.8	9.8	7.6	May 20	May 14	May 08	May 01	Apr 25
GRANDEPRAIRIEA	AB	138.8	8.9	6.4	May 29	May 24	May 18	May 12	May 06	123.6	10.0	8.1	May 15	May 09	May 03	Apr 26	Apr 20
HIGHLEVELA	AB	152.1	10.3	6.8	Jun 13	Jun 07	May 31	May 24	May 18	135.9	10.8	8.0	May 29	May 22	May 15	May 08	May 01
HIGHRIVER	AB	160.9	12.3	7.7	Jun 25	Jun 17	Jun 09	Jun 01	May 24	140.3	10.4	7.4	Jun 02	May 26	May 19	May 12	May 06
JASPER	AB	153.7	14.1	9.2	Jun 20	Jun 11	Jun 02	May 23	May 15	134.6	9.9	7.4	May 26	May 20	May 14	May 07	May 01
LACOMBECDA	AB	148.6	10.5	7.1	Jun 10	Jun 04	May 28	May 21	May 14	133.2	11.0	8.3	May 26	May 20	May 12	May 05	Apr 28
LETHBRIDGEA	AB	138.0	10.8	7.8	May 31	May 24	May 17	May 10	May 03	125.2	11.2	9.0	May 19	May 12	May 04	Apr 27	Apr 20
LETHBRIDGECDA	AB	140.9	13.4	9.5	Jun 06	May 29	May 20	May 11	May 03	124.0	9.9	8.0	May 16	May 10	May 03	Apr 26	Apr 20
MANYBERRIESCDA	AB	137.1	9.7	7.1	May 28	May 23	May 16	May 10	May 04	120.2	11.4	9.5	May 14	May 07	Apr 29	Apr 22	Apr 15
MEDICINEHATA	AB	134.4	9.8	7.3	May 26	May 20	May 13	May 07	May 01	120.8	9.8	8.1	May 12	May 06	Apr 30	Apr 23	Apr 17
NOTIKEWINEAST	AB	151.1	10.7	7.1	Jun 13	Jun 06	May 30	May 23	May 16	137.1	9.7	7.1	May 29	May 23	May 16	May 10	May 04
OLDS	AB	142.0	11.5	8.1	Jun 05	May 29	May 21	May 13	May 06	127.6	10.1	7.9	May 19	May 13	May 07	Apr 30	Apr 24

Station Name	Prov	Risk of Last Spring Frost of 0°C								Risk of Last Spring Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
OYEN CAPPON	AB	140.8	9.6	6.8	Jun 01	May 26	May 20	May 13	May 08	125.3	11.4	9.1	May 19	May 12	May 04	Apr 27	Apr 20
PEACERIVERA	AB	142.7	8.8	6.2	Jun 02	May 28	May 22	May 16	May 10	130.4	10.2	7.8	May 22	May 16	May 09	May 03	Apr 26
PINCHERCREEKA	AB	148.7	12.6	8.5	Jun 13	Jun 05	May 28	May 19	May 11	126.4	10.7	8.5	May 19	May 13	May 05	Apr 28	Apr 22
QUEENSTOWN	AB	141.2	11.8	8.3	Jun 04	May 28	May 20	May 12	May 05	122.8	9.5	7.7	May 14	May 08	May 02	Apr 25	Apr 20
RANFURLY	AB	141.4	10.2	7.2	Jun 02	May 27	May 20	May 14	May 07	124.4	12.8	10.3	May 20	May 12	May 03	Apr 25	Apr 17
REDDEERA	AB	143.7	10.8	7.5	Jun 06	May 30	May 23	May 15	May 09	131.6	9.7	7.4	May 23	May 17	May 11	May 04	Apr 28
ROCKYMTN_HOUSEA	AB	151.0	10.8	7.1	Jun 13	Jun 06	May 30	May 23	May 16	131.9	9.9	7.5	May 24	May 18	May 11	May 04	Apr 28
SION	AB	141.1	12.6	9.0	Jun 05	May 29	May 20	May 12	May 04	122.7	13.1	10.7	May 19	May 11	May 02	Apr 23	Apr 15
STETTLERNORTH	AB	142.6	10.0	7.0	Jun 03	May 28	May 22	May 15	May 09	129.0	11.6	9.0	May 23	May 16	May 08	Apr 30	Apr 23
SUFFIELDA	AB	137.8	10.5	7.6	May 30	May 24	May 17	May 10	May 03	124.9	8.9	7.1	May 15	May 10	May 04	Apr 28	Apr 22
TABER	AB	132.7	9.5	7.2	May 24	May 18	May 12	May 05	Apr 29	118.8	10.3	8.7	May 11	May 05	Apr 28	Apr 21	Apr 15
TROCHU TOWN	AB	141.2	12.2	8.7	Jun 05	May 28	May 20	May 12	May 05	129.2	9.2	7.1	May 20	May 14	May 08	May 02	Apr 26
VEGREVILLECDA	AB	155.5	11.2	7.2	Jun 18	Jun 11	Jun 03	May 27	May 20	137.4	11.0	8.0	May 30	May 24	May 16	May 09	May 02
VULCAN	AB	142.7	11.9	8.3	Jun 06	May 30	May 22	May 14	May 06	125.4	11.0	8.7	May 18	May 12	May 04	Apr 27	Apr 20
WANHAMCDAEPF	AB	139.6	8.9	6.4	May 30	May 25	May 19	May 13	May 07	124.4	12.7	10.2	May 20	May 12	May 03	Apr 25	Apr 17
WATINO	AB	140.0	9.1	6.5	May 31	May 25	May 19	May 13	May 07	124.9	9.2	7.4	May 16	May 10	May 04	Apr 28	Apr 22
WHITECOURTA	AB	146.9	12.1	8.2	Jun 10	Jun 03	May 26	May 18	May 10	130.7	13.5	10.3	May 27	May 19	May 10	May 01	Apr 22
ABBEY	SK	137.8	11.2	8.1	May 31	May 24	May 17	May 09	May 02	122.6	11.9	9.7	May 17	May 10	May 02	Apr 24	Apr 16
ALSASKHARDENE	SK	145.9	11.4	7.8	Jun 09	Jun 02	May 25	May 17	May 10	132.5	11.9	9.0	May 27	May 19	May 11	May 03	Apr 26
AMULET	SK	136.8	10.3	7.5	May 29	May 23	May 16	May 09	May 03	128.3	9.2	7.2	May 19	May 13	May 07	May 01	Apr 25
ANEROID	SK	146.7	16.6	11.3	Jun 16	Jun 06	May 26	May 14	May 04	131.5	11.1	8.4	May 25	May 18	May 11	May 03	Apr 26
ARRAN23N	SK	157.4	11.6	7.4	Jun 20	Jun 13	Jun 05	May 29	May 22	134.5	13.1	9.8	May 30	May 22	May 14	May 05	Apr 27
ATWATER	SK	141.9	9.3	6.6	Jun 02	May 27	May 21	May 15	May 09	132.2	12.6	9.5	May 27	May 20	May 11	May 03	Apr 25
BIGGAR	SK	140.3	11.5	8.2	Jun 03	May 27	May 19	May 12	May 05	126.1	10.0	7.9	May 18	May 12	May 05	Apr 28	Apr 22
BROADVIEW	SK	144.2	12.7	8.8	Jun 08	Jun 01	May 23	May 15	May 07	129.9	10.2	7.9	May 22	May 16	May 09	May 02	Apr 26
CAMEO	SK	158.8	13.6	8.5	Jun 24	Jun 16	Jun 07	May 29	May 20	146.6	11.6	7.9	Jun 09	Jun 02	May 26	May 18	May 11
CARLYLE	SK	140.7	10.6	7.5	Jun 02	May 27	May 20	May 13	May 06	128.6	10.3	8.0	May 21	May 15	May 08	May 01	Apr 24
CEYLON	SK	136.3	10.1	7.4	May 28	May 22	May 15	May 08	May 02	126.3	9.9	7.8	May 18	May 12	May 05	Apr 29	Apr 23
CHAPLIN	SK	138.2	11.7	8.4	Jun 01	May 25	May 17	May 09	May 02	125.3	11.7	9.3	May 19	May 12	May 04	Apr 26	Apr 19
CHOICELAND	SK	143.4	11.1	7.8	Jun 06	May 30	May 22	May 15	May 08	132.0	12.1	9.2	May 27	May 19	May 11	May 03	Apr 26
CLAYDON	SK	138.8	11.4	8.2	Jun 01	May 25	May 18	May 10	May 03	128.0	10.2	8.0	May 20	May 14	May 07	Apr 30	Apr 24
CODERRE	SK	144.2	11.7	8.1	Jun 07	May 31	May 23	May 15	May 08	130.7	10.9	8.3	May 24	May 17	May 10	May 02	Apr 26
CORONACH	SK	140.0	10.4	7.4	Jun 01	May 26	May 19	May 12	May 06	129.3	11.5	8.9	May 23	May 16	May 08	May 01	Apr 24
COTE	SK	154.6	14.8	9.6	Jun 22	Jun 13	Jun 03	May 24	May 15	137.1	10.0	7.3	May 29	May 23	May 16	May 09	May 03
CREELAKE	SK	154.1	9.3	6.1	Jun 14	Jun 08	Jun 02	May 27	May 21	144.4	10.1	7.0	Jun 05	May 30	May 23	May 17	May 10
DAHINDA	SK	140.6	11.9	8.5	Jun 04	May 28	May 20	May 12	May 04	130.6	10.7	8.2	May 23	May 17	May 10	May 02	Apr 26
DAVIDSON	SK	144.1	12.7	8.8	Jun 08	Jun 01	May 23	May 15	May 07	131.3	10.3	7.8	May 23	May 17	May 10	May 03	Apr 27
DUVAL	SK	137.3	12.0	8.8	Jun 01	May 24	May 16	May 08	May 01	123.8	10.1	8.1	May 16	May 10	May 03	Apr 26	Apr 20
ELROSE	SK	141.9	10.9	7.7	Jun 04	May 28	May 21	May 14	May 07	126.2	9.9	7.9	May 18	May 12	May 05	Apr 29	Apr 22
ESTEVANA	SK	133.5	8.8	6.6	May 24	May 18	May 13	May 07	May 01	126.1	10.7	8.5	May 19	May 12	May 05	Apr 28	Apr 21
FENWOOD	SK	139.2	9.6	6.9	May 30	May 25	May 18	May 12	May 06	127.7	10.7	8.4	May 20	May 14	May 07	Apr 29	Apr 23
FERTILE	SK	139.1	10.3	7.4	May 31	May 25	May 18	May 11	May 05	126.0	11.3	8.9	May 19	May 13	May 05	Apr 27	Apr 21
GRAVELBOURG	SK	141.7	12.8	9.0	Jun 06	May 29	May 21	May 12	May 04	131.2	10.5	8.0	May 24	May 17	May 10	May 03	Apr 27
GULLLAKECDAEPF	SK	149.3	12.8	8.6	Jun 14	Jun 06	May 28	May 20	May 12	130.3	12.0	9.2	May 25	May 17	May 09	May 01	Apr 24
HAFFORD	SK	148.4	11.6	7.8	Jun 11	Jun 04	May 27	May 20	May 13	130.1	10.3	7.9	May 22	May 16	May 09	May 02	Apr 26

Station Name	Prov	Risk of Last Spring Frost of 0°C								Risk of Last Spring Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
HANDSWORTH	SK	149.1	12.5	8.4	Jun 13	Jun 06	May 28	May 20	May 12	134.3	14.4	10.7	Jun 01	May 23	May 13	May 04	Apr 25
HARRIS	SK	144.0	10.0	6.9	Jun 05	May 30	May 23	May 16	May 10	128.0	9.7	7.6	May 19	May 14	May 07	Apr 30	Apr 25
HUDSONBAYA	SK	149.8	13.9	9.3	Jun 16	Jun 07	May 29	May 19	May 11	136.9	14.3	10.5	Jun 03	May 26	May 16	May 06	Apr 28
HUMBOLDT	SK	145.2	11.5	7.9	Jun 08	Jun 01	May 24	May 16	May 09	132.4	9.5	7.1	May 24	May 18	May 11	May 05	Apr 29
INDIANHEAD_CDA	SK	141.4	11.6	8.2	Jun 04	May 28	May 20	May 13	May 06	130.7	9.6	7.3	May 22	May 16	May 10	May 03	Apr 27
INGEBRIGHT_LAKE	SK	147.3	13.5	9.1	Jun 13	Jun 04	May 26	May 17	May 09	131.0	11.3	8.6	May 24	May 18	May 10	May 02	Apr 25
ISLANDFALLS2	SK	149.2	10.2	6.9	Jun 10	Jun 04	May 28	May 21	May 15	137.3	7.9	5.8	May 26	May 22	May 16	May 11	May 06
KELLIHER	SK	142.8	13.0	9.1	Jun 07	May 31	May 22	May 13	May 05	131.2	9.2	7.0	May 22	May 16	May 10	May 04	Apr 28
KERROBERT	SK	146.1	11.2	7.7	Jun 08	Jun 02	May 25	May 18	May 11	136.7	12.3	9.0	May 31	May 24	May 16	May 07	Apr 30
KINDERSLEYA	SK	138.3	11.0	8.0	May 31	May 25	May 17	May 10	May 03	126.3	9.9	7.9	May 18	May 12	May 05	Apr 29	Apr 23
KIPLING	SK	139.7	9.6	6.9	May 31	May 25	May 19	May 12	May 06	127.8	10.0	7.8	May 20	May 14	May 07	Apr 30	Apr 24
KLINTONEL	SK	165.9	20.7	12.5	Jul 10	Jun 28	Jun 14	May 31	May 18	144.9	15.5	10.7	Jun 13	Jun 03	May 24	May 13	May 04
KUROKI	SK	142.5	11.7	8.2	Jun 06	May 29	May 22	May 14	May 07	129.2	11.2	8.7	May 23	May 16	May 08	May 01	Apr 24
LAKE ALMA	SK	139.8	9.5	6.8	May 31	May 25	May 19	May 12	May 07	125.0	11.9	9.5	May 19	May 12	May 04	Apr 26	Apr 19
LEADER2	SK	139.1	11.6	8.4	Jun 02	May 26	May 18	May 10	May 03	127.6	9.2	7.2	May 18	May 13	May 07	Apr 30	Apr 25
LIPTON	SK	147.2	13.9	9.4	Jun 13	Jun 05	May 26	May 17	May 08	134.1	12.2	9.1	May 29	May 21	May 13	May 05	Apr 27
LOONLAKE_CDAEPF	SK	159.6	11.7	7.4	Jun 23	Jun 15	Jun 08	May 31	May 24	139.0	9.7	7.0	May 30	May 25	May 18	May 11	May 06
LOSTRIVER	SK	148.1	12.2	8.2	Jun 12	Jun 04	May 27	May 19	May 11	135.1	10.8	8.0	May 28	May 21	May 14	May 07	Apr 30
LUMSDEN	SK	140.6	12.4	8.8	Jun 04	May 28	May 20	May 11	May 04	130.4	9.5	7.2	May 22	May 16	May 09	May 03	Apr 27
MANKOTA	SK	148.1	12.1	8.2	Jun 12	Jun 04	May 27	May 19	May 12	134.5	12.6	9.4	May 30	May 22	May 13	May 05	Apr 27
MAPLECREEK_NORTH	SK	144.2	12.9	9.0	Jun 09	Jun 01	May 23	May 14	May 07	128.5	9.0	7.0	May 19	May 14	May 08	May 01	Apr 26
MARYFIELD	SK	141.0	9.4	6.7	Jun 01	May 26	May 20	May 14	May 08	125.5	9.4	7.5	May 17	May 11	May 05	Apr 28	Apr 22
MEADOWLAKEA	SK	145.7	14.0	9.6	Jun 12	Jun 03	May 25	May 15	May 07	133.7	13.5	10.1	May 30	May 22	May 13	May 04	Apr 25
MELFORTCDA	SK	144.8	11.9	8.2	Jun 08	Jun 01	May 24	May 16	May 09	128.7	9.9	7.7	May 20	May 14	May 08	May 01	Apr 25
MIDALE	SK	139.2	9.3	6.7	May 30	May 24	May 18	May 12	May 06	128.5	10.9	8.5	May 21	May 15	May 07	Apr 30	Apr 23
MOOSEJAWA	SK	138.0	12.8	9.3	Jun 02	May 26	May 17	May 08	May 01	128.3	9.8	7.6	May 20	May 14	May 07	May 01	Apr 25
MOOSOMIN	SK	141.5	11.1	7.9	Jun 04	May 28	May 20	May 13	May 06	125.7	9.1	7.2	May 16	May 11	May 05	Apr 29	Apr 23
MUENSTER	SK	143.0	12.4	8.7	Jun 07	May 30	May 22	May 14	May 06	128.1	11.2	8.8	May 22	May 15	May 07	Apr 30	Apr 23
NIPAWIN	SK	142.8	10.3	7.2	Jun 04	May 29	May 22	May 15	May 09	130.2	8.7	6.7	May 20	May 15	May 09	May 03	Apr 28
NOKOMIS	SK	144.0	9.6	6.7	Jun 04	May 30	May 23	May 17	May 11	131.2	10.1	7.7	May 23	May 17	May 10	May 03	Apr 27
NORTH_BATTLEFORDA	SK	139.4	10.1	7.2	May 31	May 25	May 18	May 12	May 06	125.5	9.9	7.9	May 17	May 11	May 05	Apr 28	Apr 22
ORMISTON	SK	139.3	12.6	9.0	Jun 03	May 27	May 18	May 10	May 02	126.9	9.2	7.3	May 18	May 12	May 06	Apr 30	Apr 24
OUTLOOKPFRA	SK	136.5	9.9	7.3	May 28	May 22	May 16	May 09	May 03	124.4	11.5	9.2	May 18	May 11	May 03	Apr 26	Apr 19
OXBOW	SK	137.5	8.3	6.1	May 27	May 22	May 17	May 11	May 06	122.3	9.1	7.4	May 13	May 07	May 01	Apr 25	Apr 20
PASWEGIN	SK	147.9	14.4	9.7	Jun 14	Jun 06	May 27	May 17	May 09	130.8	12.6	9.6	May 26	May 18	May 10	May 01	Apr 24
PELLY	SK	161.9	15.7	9.7	Jun 30	Jun 20	Jun 10	May 30	May 21	144.6	11.7	8.1	Jun 08	May 31	May 24	May 16	May 09
PENNANT	SK	136.2	10.8	7.9	May 29	May 22	May 15	May 08	May 01	126.9	10.6	8.3	May 19	May 13	May 06	Apr 29	Apr 22
PILGER	SK	143.6	12.7	8.8	Jun 08	May 31	May 23	May 14	May 06	127.5	10.3	8.1	May 20	May 13	May 06	Apr 30	Apr 23
PRINCEALBERTA	SK	147.8	11.9	8.0	Jun 11	Jun 04	May 27	May 19	May 12	134.1	9.8	7.3	May 26	May 20	May 13	May 06	May 01
REGINAA	SK	139.8	13.8	9.9	Jun 06	May 28	May 19	May 10	May 01	129.8	10.6	8.2	May 22	May 16	May 09	May 02	Apr 25
REGINACDA	SK	147.6	14.2	9.6	Jun 14	Jun 05	May 27	May 17	May 08	133.8	9.7	7.2	May 25	May 19	May 13	May 06	Apr 30
ROCANVILLE	SK	140.6	10.2	7.3	Jun 02	May 26	May 20	May 13	May 06	124.0	11.4	9.2	May 18	May 11	May 03	Apr 25	Apr 18
ROSETOWN	SK	144.4	9.7	6.7	Jun 05	May 30	May 23	May 17	May 11	134.7	10.8	8.0	May 27	May 21	May 14	May 06	Apr 30
SASKATOONA	SK	138.9	10.5	7.5	May 31	May 25	May 18	May 11	May 05	127.7	11.2	8.7	May 21	May 14	May 07	Apr 29	Apr 22
SASKATOONSRC	SK	141.0	9.5	6.7	Jun 01	May 26	May 20	May 14	May 08	128.7	10.6	8.2	May 21	May 15	May 08	May 01	Apr 24

Station Name	Prov	Risk of Last Spring Frost of 0°C								Risk of Last Spring Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
SCOTTCDA	SK	142.7	11.4	8.0	Jun 05	May 29	May 22	May 14	May 07	129.4	9.3	7.2	May 20	May 15	May 08	May 02	Apr 27
SEMANS	SK	142.1	11.9	8.4	Jun 05	May 29	May 21	May 13	May 06	128.4	11.2	8.7	May 22	May 15	May 07	Apr 30	Apr 23
SHAMROCK	SK	137.9	12.5	9.1	Jun 02	May 25	May 17	May 08	May 01	126.7	10.5	8.3	May 19	May 13	May 06	Apr 29	Apr 22
SHAUNAVON2	SK	145.9	13.0	8.9	Jun 11	Jun 03	May 25	May 16	May 08	129.5	9.4	7.3	May 20	May 15	May 08	May 02	Apr 26
SWIFTCURRENT_CDA	SK	139.4	11.2	8.0	Jun 02	May 26	May 18	May 11	May 04	128.5	10.3	8.0	May 21	May 15	May 08	May 01	Apr 24
SWIFTCURRENTA	SK	139.7	14.4	10.3	Jun 06	May 28	May 19	May 09	Apr 30	130.3	12.2	9.3	May 25	May 18	May 09	May 01	Apr 24
TREELON	SK	141.1	11.4	8.1	Jun 04	May 28	May 20	May 12	May 06	127.1	10.0	7.9	May 19	May 13	May 06	Apr 29	Apr 23
TUGASKE	SK	142.7	11.8	8.3	Jun 06	May 30	May 22	May 14	May 07	128.5	11.0	8.6	May 22	May 15	May 07	Apr 30	Apr 23
VALMARIE	SK	150.4	13.7	9.1	Jun 16	Jun 08	May 29	May 20	May 12	133.0	11.4	8.5	May 27	May 20	May 12	May 04	Apr 27
WASECA	SK	142.9	10.6	7.5	Jun 05	May 29	May 22	May 15	May 08	128.9	10.8	8.4	May 22	May 15	May 08	May 01	Apr 24
WASKESIULAKE	SK	154.8	15.2	9.9	Jun 22	Jun 13	Jun 03	May 24	May 14	139.9	16.0	11.4	Jun 08	May 30	May 19	May 08	Apr 28
WATROUS	SK	140.8	10.2	7.3	Jun 02	May 27	May 20	May 13	May 07	129.4	9.1	7.1	May 20	May 15	May 08	May 02	Apr 27
WESTPOPLAR_RIVER	SK	150.7	13.5	8.9	Jun 16	Jun 08	May 30	May 21	May 12	137.6	12.5	9.1	Jun 02	May 25	May 17	May 08	May 01
WEYBURN	SK	140.5	10.6	7.6	Jun 02	May 27	May 20	May 12	May 06	126.4	10.9	8.6	May 19	May 13	May 05	Apr 28	Apr 21
WHITESAND_DAM	SK	150.7	9.0	6.0	Jun 10	Jun 05	May 30	May 24	May 18	141.6	9.1	6.4	Jun 01	May 27	May 21	May 14	May 09
WHITEWOOD	SK	144.0	11.2	7.8	Jun 06	May 31	May 23	May 15	May 09	131.1	10.9	8.3	May 24	May 17	May 10	May 03	Apr 26
WILLOWCREEK2	SK	151.3	11.1	7.4	Jun 14	Jun 07	May 30	May 23	May 16	131.9	12.2	9.2	May 26	May 19	May 11	May 03	Apr 25
WYNYARD	SK	141.3	10.9	7.7	Jun 03	May 28	May 20	May 13	May 06	130.6	9.4	7.2	May 22	May 16	May 10	May 03	Apr 28
YELLOWGRASS	SK	140.6	11.7	8.3	Jun 04	May 27	May 20	May 12	May 05	132.0	11.2	8.5	May 25	May 19	May 11	May 03	Apr 27
YORKTONA	SK	140.3	10.5	7.5	Jun 02	May 26	May 19	May 12	May 06	130.4	9.6	7.4	May 22	May 16	May 09	May 03	Apr 27
ALTONA	MB	135.7	7.7	5.7	May 25	May 20	May 15	May 10	May 05	122.7	11.1	9.1	May 16	May 09	May 02	Apr 24	Apr 17
ARBORG	MB	150.0	10.9	7.2	Jun 12	Jun 05	May 29	May 22	May 15	139.8	10.4	7.5	Jun 01	May 26	May 19	May 12	May 05
ASHERN	MB	158.6	13.9	8.8	Jun 24	Jun 16	Jun 07	May 28	May 20	144.4	11.5	7.9	Jun 07	May 31	May 23	May 16	May 09
BALDUR	MB	143.5	10.1	7.0	Jun 04	May 29	May 22	May 16	May 10	130.6	9.8	7.5	May 22	May 16	May 10	May 03	Apr 27
BEAUSEJOUR2	MB	146.2	13.4	9.2	Jun 11	Jun 03	May 25	May 16	May 08	136.1	9.3	6.8	May 27	May 21	May 15	May 09	May 03
BINSCARTH	MB	145.7	11.3	7.8	Jun 08	Jun 01	May 25	May 17	May 10	130.7	9.8	7.5	May 22	May 16	May 10	May 03	Apr 27
BIRCHRIVER	MB	154.0	12.3	8.0	Jun 18	Jun 10	Jun 02	May 25	May 17	137.6	11.1	8.1	May 31	May 24	May 17	May 09	May 02
BIRTLE	MB	148.8	17.1	11.5	Jun 19	Jun 08	May 28	May 16	May 06	131.5	8.3	6.3	May 21	May 16	May 11	May 05	Apr 30
BISSETT	MB	153.3	13.9	9.1	Jun 19	Jun 11	Jun 01	May 23	May 14	136.7	10.6	7.8	May 29	May 23	May 16	May 09	May 02
BRANDONA	MB	140.6	11.6	8.2	Jun 03	May 27	May 20	May 12	May 05	131.5	11.2	8.5	May 25	May 18	May 11	May 03	Apr 26
BRANDONCDA	MB	145.4	12.6	8.7	Jun 09	Jun 02	May 24	May 16	May 08	130.0	9.4	7.3	May 21	May 15	May 09	May 03	Apr 27
BROADVALLEY	MB	148.0	12.5	8.5	Jun 12	Jun 04	May 27	May 19	May 11	132.8	10.8	8.1	May 26	May 19	May 12	May 05	Apr 28
CHURCHILLA	MB	175.1	9.6	5.5	Jul 05	Jun 30	Jun 23	Jun 17	Jun 11	159.6	9.6	6.0	Jun 20	Jun 14	Jun 08	Jun 01	May 26
CROSSLAKE_JENPEG	MB	146.2	9.2	6.3	Jun 06	May 31	May 25	May 19	May 13	132.1	9.0	6.8	May 23	May 17	May 11	May 05	Apr 30
CYPRESSRIVER	MB	142.0	9.4	6.6	Jun 02	May 27	May 21	May 15	May 09	128.0	11.7	9.2	May 22	May 15	May 07	Apr 29	Apr 22
DAUPHINA	MB	146.7	11.6	7.9	Jun 10	Jun 03	May 26	May 18	May 11	132.1	9.5	7.2	May 23	May 17	May 11	May 05	Apr 29
DEERWOOD	MB	137.0	7.3	5.3	May 25	May 21	May 16	May 11	May 07	126.5	9.6	7.6	May 18	May 12	May 05	Apr 29	Apr 23
DELORAINE	MB	138.8	9.9	7.2	May 31	May 24	May 18	May 11	May 05	127.3	8.3	6.5	May 17	May 12	May 06	May 01	Apr 26
DELTA_UNIVERSITYFS	MB	136.0	10.5	7.7	May 28	May 22	May 15	May 08	May 02	126.0	8.8	7.0	May 16	May 11	May 05	Apr 29	Apr 24
ELMCREEK	MB	142.2	7.6	5.4	May 31	May 26	May 21	May 16	May 11	128.5	10.5	8.2	May 21	May 15	May 07	Apr 30	Apr 24
EMERSON	MB	135.7	6.8	5.0	May 23	May 19	May 15	May 10	May 06	125.5	12.4	9.9	May 20	May 13	May 04	Apr 26	Apr 19
FALCONLAKE_TCPL45	MB	156.9	13.7	8.7	Jun 22	Jun 14	Jun 05	May 27	May 18	140.8	11.1	7.9	Jun 03	May 27	May 20	May 12	May 06
FISHERBRANCHS	MB	153.8	8.6	5.6	Jun 13	Jun 08	Jun 02	May 27	May 22	142.5	8.3	5.8	Jun 01	May 27	May 21	May 16	May 11
FLINFLON	MB	141.1	11.3	8.0	Jun 04	May 28	May 20	May 13	May 06	128.6	10.9	8.5	May 22	May 15	May 08	Apr 30	Apr 24
FLINFLONA	MB	146.3	9.1	6.3	Jun 06	May 31	May 25	May 19	May 14	133.0	7.9	6.0	May 22	May 17	May 12	May 07	May 02

Station Name	Prov	Risk of Last Spring Frost of 0°C								Risk of Last Spring Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
GILBERTPLAINS	MB	155.3	13.8	8.9	Jun 21	Jun 13	Jun 03	May 25	May 17	138.0	13.8	10.0	Jun 04	May 26	May 17	May 08	Apr 29
GILLAMA	MB	163.2	10.7	6.6	Jun 25	Jun 18	Jun 11	Jun 04	May 28	152.3	10.0	6.5	Jun 13	Jun 07	May 31	May 25	May 19
GIMLI	MB	140.0	10.0	7.1	Jun 01	May 26	May 19	May 12	May 06	127.5	9.7	7.6	May 19	May 13	May 07	Apr 30	Apr 24
GLADSTONE_SOUTH	MB	141.8	9.3	6.6	Jun 02	May 27	May 21	May 14	May 09	131.2	8.6	6.6	May 21	May 16	May 10	May 04	Apr 29
GLENBORO	MB	143.9	12.2	8.4	Jun 07	May 31	May 23	May 15	May 07	126.1	9.6	7.6	May 17	May 12	May 05	Apr 29	Apr 23
GLENLEA	MB	144.9	10.9	7.5	Jun 07	May 31	May 24	May 17	May 10	131.5	11.8	9.0	May 26	May 18	May 11	May 03	Apr 25
GRANDRAPIDS_HYDRO	MB	142.5	8.0	5.6	Jun 01	May 27	May 22	May 16	May 11	129.8	8.6	6.6	May 20	May 15	May 09	May 03	Apr 28
GRASSRIVER	MB	143.1	11.0	7.7	Jun 05	May 30	May 22	May 15	May 08	128.8	8.9	6.9	May 19	May 14	May 08	May 02	Apr 26
GREATFALLS	MB	137.2	11.6	8.5	May 31	May 24	May 16	May 08	May 01	122.3	11.1	9.1	May 16	May 09	May 01	Apr 24	Apr 17
HAMIOTA	MB	142.5	14.9	10.5	Jun 10	Jun 01	May 21	May 11	May 02	131.1	8.9	6.8	May 21	May 16	May 10	May 04	Apr 29
HODGSON2	MB	162.9	12.9	7.9	Jun 27	Jun 20	Jun 11	Jun 02	May 25	143.8	10.2	7.1	Jun 05	May 30	May 23	May 16	May 10
INDIANBAY	MB	145.7	12.1	8.3	Jun 09	Jun 02	May 25	May 17	May 09	132.7	10.7	8.1	May 25	May 19	May 12	May 04	Apr 28
ISLANDLAKE	MB	149.9	8.2	5.4	Jun 08	Jun 03	May 29	May 23	May 18	134.8	8.0	5.9	May 24	May 19	May 14	May 08	May 04
LANGRUTH	MB	141.9	10.6	7.4	Jun 03	May 28	May 21	May 14	May 07	129.2	9.9	7.7	May 21	May 15	May 08	May 02	Apr 25
LYNNLAKEA	MB	156.8	8.3	5.3	Jun 15	Jun 10	Jun 05	May 30	May 25	145.4	9.2	6.3	Jun 05	May 31	May 24	May 18	May 13
MACGREGOR	MB	141.8	10.7	7.6	Jun 03	May 28	May 21	May 14	May 07	125.7	11.6	9.2	May 20	May 13	May 05	Apr 27	Apr 20
MARQUETTE	MB	139.9	8.4	6.0	May 30	May 25	May 19	May 13	May 08	128.9	9.5	7.3	May 20	May 14	May 08	May 01	Apr 26
MINNEDOSA	MB	154.8	14.4	9.3	Jun 21	Jun 13	Jun 03	May 24	May 15	137.4	9.8	7.1	May 29	May 23	May 16	May 10	May 04
MORDENCDA	MB	134.9	8.1	6.0	May 24	May 19	May 14	May 08	May 04	123.3	11.6	9.4	May 17	May 10	May 02	Apr 25	Apr 17
MYRTLE	MB	139.8	8.4	6.0	May 29	May 24	May 19	May 13	May 08	128.6	10.8	8.4	May 21	May 15	May 08	Apr 30	Apr 24
NEEPAWAWATER	MB	138.5	9.6	7.0	May 30	May 24	May 17	May 11	May 05	123.5	8.7	7.0	May 14	May 08	May 02	Apr 27	Apr 21
NIVERVILLE	MB	143.4	11.2	7.8	Jun 06	May 30	May 22	May 15	May 08	133.3	14.0	10.5	May 30	May 22	May 12	May 03	Apr 24
NORWAYHOUSEA	MB	146.7	8.9	6.0	Jun 06	Jun 01	May 26	May 20	May 14	135.3	10.5	7.8	May 28	May 21	May 14	May 07	May 01
NORWAYHOUSEF	MB	141.1	6.6	4.7	May 29	May 25	May 20	May 16	May 12	129.7	7.5	5.8	May 18	May 14	May 09	May 04	Apr 29
OAKNER	MB	143.0	12.9	9.0	Jun 07	May 31	May 22	May 13	May 06	130.2	9.9	7.6	May 22	May 16	May 09	May 02	Apr 26
PASQUIAPROJ_PFRA	MB	150.9	10.1	6.7	Jun 12	Jun 06	May 30	May 23	May 17	138.0	9.8	7.1	May 30	May 24	May 17	May 10	May 04
PEACEGARDENS	MB	148.9	13.4	9.0	Jun 14	Jun 06	May 28	May 19	May 11	135.8	12.0	8.8	May 30	May 23	May 15	May 07	Apr 29
PIERSON	MB	139.5	10.4	7.4	Jun 01	May 26	May 19	May 12	May 05	125.4	11.1	8.9	May 19	May 12	May 04	Apr 27	Apr 20
PINAWAWNRE	MB	148.2	12.0	8.1	Jun 11	Jun 04	May 27	May 19	May 12	130.7	10.5	8.0	May 23	May 17	May 10	May 03	Apr 26
PINEDOCK	MB	148.3	11.6	7.8	Jun 11	Jun 04	May 27	May 19	May 12	133.0	9.1	6.8	May 24	May 18	May 12	May 06	Apr 30
PINEFALLS	MB	146.5	11.2	7.6	Jun 09	Jun 02	May 25	May 18	May 11	127.7	11.3	8.9	May 21	May 14	May 07	Apr 29	Apr 22
PINEY	MB	149.9	11.2	7.4	Jun 12	Jun 05	May 29	May 21	May 15	130.9	13.4	10.3	May 27	May 19	May 10	May 01	Apr 23
PLUMCOULEE	MB	137.1	9.0	6.6	May 28	May 22	May 16	May 10	May 05	124.6	11.0	8.9	May 18	May 11	May 04	Apr 26	Apr 19
PORTAGELAPR	MB	139.0	9.5	6.8	May 30	May 24	May 18	May 12	May 06	125.3	9.1	7.3	May 16	May 10	May 04	Apr 28	Apr 23
PORTAGELAPR2	MB	138.0	8.0	5.8	May 27	May 22	May 17	May 12	May 07	126.2	9.3	7.4	May 17	May 11	May 05	Apr 29	Apr 23
RATHWELL	MB	143.2	11.0	7.7	Jun 05	May 30	May 22	May 15	May 08	129.1	9.9	7.7	May 21	May 15	May 08	May 01	Apr 25
ROSSBURN	MB	149.3	14.1	9.5	Jun 15	Jun 07	May 28	May 19	May 10	132.8	9.8	7.4	May 24	May 18	May 12	May 05	Apr 29
SELKIRK	MB	137.9	10.5	7.6	May 30	May 24	May 17	May 10	May 03	125.6	11.7	9.3	May 20	May 12	May 05	Apr 27	Apr 20
SOMERSET	MB	139.5	9.2	6.6	May 30	May 25	May 19	May 12	May 07	128.4	10.7	8.3	May 21	May 15	May 07	Apr 30	Apr 24
SPRAGUE	MB	151.1	11.9	7.9	Jun 14	Jun 07	May 30	May 22	May 15	135.2	9.4	6.9	May 26	May 21	May 14	May 08	May 02
STARBUCK	MB	147.4	12.2	8.3	Jun 11	Jun 04	May 26	May 18	May 11	133.7	10.8	8.1	May 27	May 20	May 13	May 05	Apr 29
STEINBACH	MB	146.9	10.8	7.4	Jun 09	Jun 02	May 26	May 19	May 12	135.2	12.2	9.0	May 30	May 22	May 14	May 06	Apr 29
STONEWALL	MB	145.1	10.1	7.0	Jun 06	May 31	May 24	May 17	May 11	131.7	12.7	9.7	May 27	May 19	May 11	May 02	Apr 24
STONYMTN	MB	142.9	9.5	6.7	Jun 03	May 28	May 22	May 15	May 10	127.2	11.2	8.8	May 21	May 14	May 06	Apr 29	Apr 22
STRATHCLAIR	MB	145.6	12.5	8.6	Jun 10	Jun 02	May 25	May 16	May 09	132.8	8.4	6.3	May 23	May 17	May 12	May 06	May 01

Station Name	Prov	Risk of Last Spring Frost of 0°C								Risk of Last Spring Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
SWANRIVER	MB	145.6	10.8	7.4	Jun 07	Jun 01	May 25	May 17	May 11	131.2	12.7	9.7	May 27	May 19	May 10	May 02	Apr 24
THEPASA	MB	145.9	9.3	6.4	Jun 06	May 31	May 25	May 19	May 13	133.8	9.2	6.9	May 25	May 19	May 13	May 07	May 01
THOMPSONA	MB	166.8	10.6	6.4	Jun 28	Jun 22	Jun 15	Jun 08	Jun 01	154.0	9.6	6.3	Jun 14	Jun 08	Jun 02	May 27	May 21
VIRDEN	MB	138.7	10.0	7.2	May 31	May 24	May 18	May 11	May 05	126.0	8.9	7.1	May 16	May 11	May 05	Apr 29	Apr 24
VOGAR	MB	136.1	9.6	7.1	May 27	May 22	May 15	May 09	May 03	123.1	10.2	8.3	May 15	May 09	May 02	Apr 25	Apr 19
WILSONCRWEIR	MB	145.1	10.9	7.5	Jun 07	May 31	May 24	May 17	May 10	129.7	9.5	7.3	May 21	May 15	May 09	May 02	Apr 27
WINNIPEGA	MB	144.2	10.3	7.1	Jun 05	May 30	May 23	May 16	May 10	131.6	10.1	7.7	May 24	May 17	May 11	May 04	Apr 28

III. Risk of first fall frost of 0.0°C and -2.2°C

Station Name	Prov	Risk of First Fall Frost of 0°C								Risk of First Fall Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
ATHABASCA2	AB	254.8	12.0	4.7	Aug 26	Sep 03	Sep 11	Sep 19	Sep 26	268.3	13.0	4.8	Sep 08	Sep 16	Sep 24	Oct 03	Oct 11
BANFF	AB	249.0	10.2	4.1	Aug 23	Aug 29	Sep 05	Sep 12	Sep 18	266.3	13.5	5.1	Sep 05	Sep 13	Sep 22	Oct 01	Oct 10
BEAVERLODGE_CDA	AB	253.2	15.7	6.2	Aug 20	Aug 30	Sep 09	Sep 20	Sep 29	268.8	13.6	5.1	Sep 07	Sep 16	Sep 25	Oct 04	Oct 12
BRIGHTVIEW	AB	261.1	11.0	4.2	Sep 03	Sep 10	Sep 17	Sep 24	Oct 01	269.6	12.8	4.8	Sep 09	Sep 17	Sep 26	Oct 04	Oct 12
BROWNFIELD	AB	245.7	18.9	7.7	Aug 09	Aug 20	Sep 02	Sep 14	Sep 26	262.2	13.2	5.0	Sep 01	Sep 09	Sep 18	Sep 27	Oct 05
CALDWELL	AB	252.9	15.3	6.0	Aug 20	Aug 30	Sep 09	Sep 19	Sep 28	270.0	11.2	4.1	Sep 12	Sep 18	Sep 26	Oct 04	Oct 10
CALGARYA	AB	257.5	10.9	4.2	Aug 31	Sep 06	Sep 14	Sep 21	Sep 27	271.7	11.1	4.1	Sep 13	Sep 20	Sep 28	Oct 05	Oct 12
CALMAR	AB	257.2	11.1	4.3	Aug 30	Sep 06	Sep 13	Sep 21	Sep 27	269.6	13.6	5.1	Sep 08	Sep 16	Sep 26	Oct 05	Oct 13
CAMPSIE	AB	241.0	14.2	5.9	Aug 10	Aug 18	Aug 28	Sep 07	Sep 15	260.2	11.6	4.4	Sep 01	Sep 08	Sep 16	Sep 24	Oct 01
CAMROSE	AB	259.7	11.6	4.5	Sep 01	Sep 08	Sep 16	Sep 23	Oct 01	272.0	10.3	3.8	Sep 15	Sep 21	Sep 28	Oct 05	Oct 11
CARDSTON	AB	258.5	13.2	5.1	Aug 29	Sep 06	Sep 15	Sep 23	Oct 01	271.2	13.1	4.8	Sep 10	Sep 18	Sep 27	Oct 06	Oct 14
CARWAY	AB	246.7	18.8	7.6	Aug 10	Aug 21	Sep 03	Sep 15	Sep 27	264.1	13.4	5.1	Sep 03	Sep 11	Sep 20	Sep 29	Oct 07
CLARESHOLM_WATERW	AB	251.4	13.3	5.3	Aug 21	Aug 29	Sep 07	Sep 16	Sep 24	267.1	12.0	4.5	Sep 08	Sep 15	Sep 23	Oct 01	Oct 09
CLEARDALE	AB	242.0	12.2	5.1	Aug 13	Aug 21	Aug 29	Sep 06	Sep 14	260.9	12.3	4.7	Sep 01	Sep 09	Sep 17	Sep 25	Oct 03
COLDLAKEA	AB	256.9	11.4	4.5	Aug 29	Sep 05	Sep 13	Sep 21	Sep 28	269.2	10.6	3.9	Sep 12	Sep 18	Sep 25	Oct 02	Oct 09
CONNELLY CREEK	AB	251.7	16.8	6.7	Aug 17	Aug 27	Sep 08	Sep 19	Sep 29	265.6	11.6	4.4	Sep 07	Sep 14	Sep 22	Sep 29	Oct 06
CORONATIONA	AB	255.4	10.8	4.2	Aug 29	Sep 04	Sep 11	Sep 19	Sep 25	263.2	10.9	4.2	Sep 05	Sep 12	Sep 19	Sep 27	Oct 03
EDMONTONA	AB	256.9	12.8	5.0	Aug 27	Sep 04	Sep 13	Sep 22	Sep 29	266.2	14.4	5.4	Sep 04	Sep 12	Sep 22	Oct 02	Oct 11
EDMONTONMUN	AB	267.4	14.7	5.5	Sep 05	Sep 13	Sep 23	Oct 03	Oct 12	278.8	13.7	4.9	Sep 17	Sep 26	Oct 05	Oct 14	Oct 22
EDSONA	AB	241.6	11.8	4.9	Aug 14	Aug 21	Aug 29	Sep 06	Sep 13	258.5	13.2	5.1	Aug 29	Sep 06	Sep 15	Sep 23	Oct 01
ELKPOINT	AB	242.6	12.2	5.0	Aug 14	Aug 21	Aug 30	Sep 07	Sep 14	258.2	11.5	4.5	Aug 30	Sep 06	Sep 14	Sep 22	Sep 29
ELMWORTHCDA	AB	240.0	16.9	7.0	Aug 05	Aug 16	Aug 27	Sep 07	Sep 18	261.1	18.7	7.2	Aug 24	Sep 04	Sep 17	Sep 30	Oct 11
EMPRESS	AB	258.9	10.9	4.2	Sep 01	Sep 08	Sep 15	Sep 22	Sep 29	271.5	11.1	4.1	Sep 13	Sep 20	Sep 27	Oct 05	Oct 12
EUREKARIVER	AB	230.9	17.8	7.7	Jul 26	Aug 06	Aug 18	Aug 30	Sep 10	250.0	10.3	4.1	Aug 24	Aug 30	Sep 06	Sep 13	Sep 19
FAIRVIEW	AB	262.0	13.5	5.2	Sep 01	Sep 09	Sep 18	Sep 27	Oct 05	279.3	10.7	3.8	Sep 22	Sep 28	Oct 05	Oct 13	Oct 19
FOREMOST	AB	263.6	10.1	3.8	Sep 07	Sep 13	Sep 20	Sep 26	Oct 02	276.4	11.3	4.1	Sep 18	Sep 25	Oct 02	Oct 10	Oct 17
FORESTBURG_PLANT	AB	269.0	11.3	4.2	Sep 11	Sep 17	Sep 25	Oct 03	Oct 09	278.9	13.8	5.0	Sep 17	Sep 26	Oct 05	Oct 14	Oct 23
FORT_CHIPEWYANA	AB	243.6	14.6	6.0	Aug 12	Aug 21	Aug 31	Sep 09	Sep 18	256.4	13.6	5.3	Aug 26	Sep 03	Sep 12	Sep 22	Sep 30
FORT_SASKATCHEWAN	AB	252.7	14.7	5.8	Aug 21	Aug 30	Sep 09	Sep 19	Sep 28	268.9	12.4	4.6	Sep 09	Sep 17	Sep 25	Oct 03	Oct 11

Station Name	Prov	Risk of First Fall Frost of 0°C								Risk of First Fall Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
FORTMACLEOD	AB	259.9	10.7	4.1	Sep 02	Sep 09	Sep 16	Sep 23	Sep 30	273.9	9.8	3.6	Sep 17	Sep 23	Sep 30	Oct 06	Oct 12
FORTMCMURRAYA	AB	248.8	11.9	4.8	Aug 20	Aug 28	Sep 05	Sep 13	Sep 20	263.8	11.8	4.5	Sep 05	Sep 12	Sep 20	Sep 28	Oct 05
GLEICHEN	AB	255.8	8.6	3.4	Sep 01	Sep 06	Sep 12	Sep 18	Sep 23	265.0	11.3	4.3	Sep 06	Sep 13	Sep 21	Sep 29	Oct 05
GRANDEPRAIRIEA	AB	255.5	12.9	5.1	Aug 26	Sep 03	Sep 12	Sep 20	Sep 28	267.1	13.4	5.0	Sep 06	Sep 14	Sep 23	Oct 02	Oct 10
HIGHLEVELA	AB	242.8	14.2	5.8	Aug 12	Aug 20	Aug 30	Sep 08	Sep 17	258.5	11.6	4.5	Aug 31	Sep 07	Sep 15	Sep 22	Sep 29
HIGHRIVER	AB	244.0	13.6	5.6	Aug 14	Aug 22	Aug 31	Sep 09	Sep 17	258.2	10.7	4.2	Aug 31	Sep 07	Sep 14	Sep 21	Sep 28
JASPER	AB	253.0	10.8	4.3	Aug 26	Sep 02	Sep 09	Sep 16	Sep 23	264.3	11.9	4.5	Sep 05	Sep 12	Sep 20	Sep 28	Oct 06
LACOMBECDA	AB	250.1	9.6	3.8	Aug 25	Aug 31	Sep 06	Sep 13	Sep 18	262.4	12.1	4.6	Sep 03	Sep 10	Sep 18	Sep 27	Oct 04
LETHBRIDGEA	AB	261.9	9.7	3.7	Sep 05	Sep 11	Sep 18	Sep 24	Sep 30	270.9	9.6	3.5	Sep 15	Sep 20	Sep 27	Oct 03	Oct 09
LETHBRIDGECDA	AB	261.3	11.2	4.3	Sep 03	Sep 10	Sep 17	Sep 25	Oct 02	274.9	13.2	4.8	Sep 14	Sep 22	Oct 01	Oct 10	Oct 18
MANYBERRIESCDA	AB	259.0	11.9	4.6	Aug 31	Sep 07	Sep 15	Sep 23	Sep 30	271.0	11.2	4.1	Sep 13	Sep 19	Sep 27	Oct 04	Oct 11
MEDICINEHATA	AB	266.6	9.8	3.7	Sep 10	Sep 16	Sep 23	Sep 29	Oct 05	274.6	11.1	4.1	Sep 16	Sep 23	Oct 01	Oct 08	Oct 15
NOTIKEWINEAST	AB	240.4	11.8	4.9	Aug 12	Aug 19	Aug 27	Sep 04	Sep 12	255.7	11.4	4.4	Aug 28	Sep 04	Sep 12	Sep 19	Sep 26
OLDS	AB	255.7	9.5	3.7	Aug 31	Sep 05	Sep 12	Sep 18	Sep 24	269.8	11.8	4.4	Sep 11	Sep 18	Sep 26	Oct 04	Oct 11
OYEN CAPPON	AB	261.4	10.4	4.0	Sep 04	Sep 10	Sep 17	Sep 24	Oct 01	274.3	11.5	4.2	Sep 16	Sep 23	Sep 30	Oct 08	Oct 15
PEACERIVERA	AB	251.1	12.5	5.0	Aug 22	Aug 30	Sep 07	Sep 16	Sep 23	263.6	13.4	5.1	Sep 02	Sep 11	Sep 20	Sep 29	Oct 07
PINCHERCREEKA	AB	256.8	12.2	4.7	Aug 28	Sep 05	Sep 13	Sep 21	Sep 28	269.0	13.7	5.1	Sep 07	Sep 16	Sep 25	Oct 04	Oct 13
QUEENSTOWN	AB	261.9	10.6	4.0	Sep 04	Sep 11	Sep 18	Sep 25	Oct 02	272.0	13.1	4.8	Sep 11	Sep 19	Sep 28	Oct 07	Oct 15
RANFURLY	AB	253.5	12.7	5.0	Aug 24	Sep 01	Sep 10	Sep 18	Sep 26	266.0	10.1	3.8	Sep 09	Sep 15	Sep 22	Sep 29	Oct 05
REDDEERA	AB	253.8	11.5	4.5	Aug 26	Sep 02	Sep 10	Sep 18	Sep 24	263.1	10.7	4.1	Sep 05	Sep 12	Sep 19	Sep 26	Oct 03
ROCKYMTN_HOUSEA	AB	248.8	10.4	4.2	Aug 22	Aug 29	Sep 05	Sep 12	Sep 18	260.7	12.0	4.6	Sep 01	Sep 09	Sep 17	Sep 25	Oct 02
SION	AB	258.3	14.8	5.7	Aug 26	Sep 04	Sep 14	Sep 24	Oct 03	271.4	15.6	5.8	Sep 07	Sep 17	Sep 27	Oct 08	Oct 17
STETTLERNORTH	AB	256.8	10.6	4.1	Aug 30	Sep 06	Sep 13	Sep 20	Sep 26	267.9	12.3	4.6	Sep 08	Sep 16	Sep 24	Oct 02	Oct 10
SUFFIELDA	AB	262.6	10.8	4.1	Sep 05	Sep 11	Sep 19	Sep 26	Oct 02	272.6	11.4	4.2	Sep 14	Sep 21	Sep 29	Oct 06	Oct 13
TABER	AB	266.1	11.2	4.2	Sep 08	Sep 15	Sep 22	Sep 30	Oct 06	279.3	13.1	4.7	Sep 18	Sep 26	Oct 05	Oct 14	Oct 22
TROCHU TOWN	AB	257.7	8.9	3.4	Sep 02	Sep 08	Sep 14	Sep 20	Sep 25	268.6	10.5	3.9	Sep 11	Sep 17	Sep 25	Oct 02	Oct 08
VEGREVILLECDA	AB	242.2	14.5	6.0	Aug 11	Aug 19	Aug 29	Sep 08	Sep 17	254.7	14.9	5.9	Aug 23	Sep 01	Sep 11	Sep 21	Sep 30
VULCAN	AB	258.8	9.6	3.7	Sep 03	Sep 08	Sep 15	Sep 21	Sep 27	274.1	10.8	4.0	Sep 16	Sep 23	Sep 30	Oct 07	Oct 14
WANHAMCDAEPF	AB	251.3	13.8	5.5	Aug 21	Aug 29	Sep 07	Sep 17	Sep 25	269.0	12.9	4.8	Sep 09	Sep 16	Sep 25	Oct 04	Oct 11
WATINO	AB	255.8	10.9	4.2	Aug 29	Sep 04	Sep 12	Sep 19	Sep 26	268.4	10.7	4.0	Sep 11	Sep 17	Sep 24	Oct 02	Oct 08
WHITECOURTA	AB	250.2	12.6	5.0	Aug 21	Aug 29	Sep 06	Sep 15	Sep 22	264.0	13.6	5.1	Sep 03	Sep 11	Sep 20	Sep 29	Oct 07
ABBEY	SK	259.8	10.5	4.0	Sep 02	Sep 09	Sep 16	Sep 23	Sep 29	272.5	11.8	4.3	Sep 13	Sep 21	Sep 29	Oct 06	Oct 14
ALSASKHARDENE	SK	250.0	11.4	4.6	Aug 22	Aug 29	Sep 06	Sep 14	Sep 21	263.6	10.8	4.1	Sep 06	Sep 12	Sep 20	Sep 27	Oct 04
AMULET	SK	258.8	9.3	3.6	Sep 03	Sep 09	Sep 15	Sep 21	Sep 27	270.4	11.2	4.2	Sep 12	Sep 19	Sep 26	Oct 04	Oct 11
ANEROID	SK	251.3	15.0	6.0	Aug 19	Aug 28	Sep 07	Sep 17	Sep 27	267.0	10.2	3.8	Sep 10	Sep 16	Sep 23	Sep 30	Oct 06
ARRAN23N	SK	246.1	12.4	5.1	Aug 17	Aug 25	Sep 02	Sep 11	Sep 18	261.5	8.8	3.4	Sep 06	Sep 12	Sep 17	Sep 23	Sep 29
ATWATER	SK	248.0	15.6	6.3	Aug 15	Aug 24	Sep 04	Sep 15	Sep 24	267.6	9.8	3.7	Sep 11	Sep 17	Sep 24	Sep 30	Oct 06
BIGGAR	SK	256.8	13.2	5.2	Aug 27	Sep 04	Sep 13	Sep 22	Sep 30	267.5	10.0	3.8	Sep 11	Sep 17	Sep 24	Sep 30	Oct 06
BROADVIEW	SK	250.3	11.2	4.5	Aug 23	Aug 30	Sep 06	Sep 14	Sep 21	261.1	13.7	5.3	Aug 30	Sep 08	Sep 17	Sep 26	Oct 05
CAMEO	SK	237.0	14.7	6.2	Aug 05	Aug 14	Aug 24	Sep 03	Sep 12	253.6	9.0	3.5	Aug 29	Sep 04	Sep 10	Sep 16	Sep 21

Station Name	Prov	Risk of First Fall Frost of 0°C								Risk of First Fall Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
CARLYLE	SK	259.7	8.5	3.3	Sep 05	Sep 10	Sep 16	Sep 21	Sep 27	269.5	11.3	4.2	Sep 11	Sep 18	Sep 26	Oct 03	Oct 10
CEYLON	SK	259.6	10.4	4.0	Sep 02	Sep 09	Sep 16	Sep 23	Sep 29	270.8	12.3	4.6	Sep 11	Sep 19	Sep 27	Oct 05	Oct 13
CHAPLIN	SK	260.3	9.8	3.8	Sep 04	Sep 10	Sep 16	Sep 23	Sep 29	272.0	9.5	3.5	Sep 16	Sep 22	Sep 28	Oct 04	Oct 10
CHOICELAND	SK	253.7	13.0	5.1	Aug 24	Sep 01	Sep 10	Sep 18	Sep 26	264.1	12.5	4.7	Sep 04	Sep 12	Sep 20	Sep 28	Oct 06
CLAYDON	SK	260.2	9.5	3.7	Sep 04	Sep 10	Sep 16	Sep 23	Sep 28	269.1	9.5	3.5	Sep 13	Sep 19	Sep 25	Oct 01	Oct 07
CODERRE	SK	254.3	10.6	4.2	Aug 28	Sep 03	Sep 10	Sep 17	Sep 24	267.4	10.3	3.9	Sep 10	Sep 16	Sep 23	Sep 30	Oct 07
CORONACH	SK	258.8	12.1	4.7	Aug 30	Sep 07	Sep 15	Sep 23	Sep 30	269.2	9.8	3.6	Sep 13	Sep 19	Sep 25	Oct 02	Oct 08
COTE	SK	241.1	14.2	5.9	Aug 10	Aug 19	Aug 28	Sep 07	Sep 15	262.3	12.9	4.9	Sep 02	Sep 10	Sep 18	Sep 27	Oct 05
CREELAKE	SK	252.4	8.6	3.4	Aug 28	Sep 03	Sep 08	Sep 14	Sep 19	266.7	9.9	3.7	Sep 10	Sep 16	Sep 23	Sep 29	Oct 05
DAHINDA	SK	255.7	8.6	3.3	Sep 01	Sep 06	Sep 12	Sep 17	Sep 23	270.6	10.8	4.0	Sep 13	Sep 19	Sep 27	Oct 04	Oct 10
DAVIDSON	SK	253.2	12.8	5.0	Aug 24	Sep 01	Sep 09	Sep 18	Sep 26	268.5	9.7	3.6	Sep 12	Sep 18	Sep 25	Oct 01	Oct 07
DUVAL	SK	263.3	9.9	3.8	Sep 07	Sep 13	Sep 19	Sep 26	Oct 02	274.5	10.4	3.8	Sep 17	Sep 24	Oct 01	Oct 08	Oct 14
ELROSE	SK	260.2	9.6	3.7	Sep 04	Sep 10	Sep 16	Sep 23	Sep 28	272.0	10.5	3.9	Sep 15	Sep 21	Sep 28	Oct 05	Oct 11
ESTEVANA	SK	263.8	11.2	4.2	Sep 06	Sep 12	Sep 20	Sep 27	Oct 04	274.5	11.0	4.0	Sep 16	Sep 23	Sep 30	Oct 08	Oct 15
FENWOOD	SK	261.4	12.8	4.9	Sep 01	Sep 09	Sep 17	Sep 26	Oct 04	272.9	9.2	3.4	Sep 17	Sep 23	Sep 29	Oct 05	Oct 11
FERTILE	SK	258.2	9.9	3.8	Sep 02	Sep 08	Sep 14	Sep 21	Sep 27	266.1	11.2	4.2	Sep 08	Sep 15	Sep 22	Sep 30	Oct 06
GRAVELBOURG	SK	257.0	8.9	3.5	Sep 02	Sep 07	Sep 13	Sep 19	Sep 24	268.7	10.4	3.9	Sep 11	Sep 18	Sep 25	Oct 02	Oct 08
GULLLAKECDAEPF	SK	246.2	12.4	5.0	Aug 17	Aug 25	Sep 02	Sep 11	Sep 18	263.5	11.2	4.2	Sep 05	Sep 12	Sep 19	Sep 27	Oct 04
HAFFORD	SK	247.5	10.4	4.2	Aug 21	Aug 27	Sep 03	Sep 11	Sep 17	261.8	12.0	4.6	Sep 02	Sep 10	Sep 18	Sep 26	Oct 03
HANDSWORTH	SK	251.4	17.7	7.1	Aug 16	Aug 26	Sep 07	Sep 19	Sep 30	267.8	10.6	4.0	Sep 10	Sep 17	Sep 24	Oct 01	Oct 07
HARRIS	SK	255.3	11.7	4.6	Aug 27	Sep 03	Sep 11	Sep 19	Sep 26	270.8	7.3	2.7	Sep 17	Sep 22	Sep 27	Oct 02	Oct 06
HUDSONBAYA	SK	250.8	10.1	4.0	Aug 25	Aug 31	Sep 07	Sep 14	Sep 20	264.5	11.4	4.3	Sep 06	Sep 13	Sep 20	Sep 28	Oct 05
HUMBOLDT	SK	255.4	9.6	3.7	Aug 30	Sep 05	Sep 11	Sep 18	Sep 24	271.2	9.2	3.4	Sep 15	Sep 21	Sep 27	Oct 03	Oct 09
INDIANHEAD_CDA	SK	258.4	11.4	4.4	Aug 31	Sep 07	Sep 14	Sep 22	Sep 29	269.5	9.9	3.7	Sep 13	Sep 19	Sep 26	Oct 02	Oct 08
INGEBRIGHT_LAKE	SK	250.2	10.8	4.3	Aug 23	Aug 30	Sep 06	Sep 14	Sep 20	266.4	10.5	4.0	Sep 09	Sep 15	Sep 22	Sep 29	Oct 06
ISLANDFALLS2	SK	259.5	9.9	3.8	Sep 03	Sep 09	Sep 16	Sep 22	Sep 28	271.1	8.8	3.3	Sep 16	Sep 21	Sep 27	Oct 03	Oct 08
KELLIHER	SK	255.8	11.3	4.4	Aug 28	Sep 04	Sep 12	Sep 19	Sep 26	268.8	12.1	4.5	Sep 09	Sep 17	Sep 25	Oct 03	Oct 10
KERROBERT	SK	249.9	10.5	4.2	Aug 23	Aug 30	Sep 06	Sep 13	Sep 19	262.6	10.8	4.1	Sep 05	Sep 11	Sep 19	Sep 26	Oct 02
KINDERSLEYA	SK	260.1	9.4	3.6	Sep 04	Sep 10	Sep 16	Sep 22	Sep 28	269.9	8.7	3.2	Sep 15	Sep 20	Sep 26	Oct 02	Oct 07
KIPLING	SK	257.5	12.6	4.9	Aug 28	Sep 05	Sep 14	Sep 22	Sep 30	269.3	9.8	3.7	Sep 13	Sep 19	Sep 25	Oct 02	Oct 08
KLINTONEL	SK	232.5	17.1	7.4	Jul 29	Aug 08	Aug 19	Aug 31	Sep 10	250.6	16.8	6.7	Aug 16	Aug 26	Sep 07	Sep 18	Sep 28
KUROKI	SK	256.6	9.9	3.9	Aug 31	Sep 06	Sep 13	Sep 19	Sep 25	268.0	13.1	4.9	Sep 07	Sep 15	Sep 24	Oct 03	Oct 11
LAKE ALMA	SK	263.9	7.6	2.9	Sep 10	Sep 15	Sep 20	Sep 25	Sep 30	272.4	11.6	4.2	Sep 14	Sep 21	Sep 28	Oct 06	Oct 13
LEADER2	SK	254.1	9.8	3.9	Aug 29	Sep 03	Sep 10	Sep 17	Sep 23	267.2	9.7	3.6	Sep 11	Sep 17	Sep 23	Sep 30	Oct 06
LIPTON	SK	251.6	13.0	5.2	Aug 22	Aug 30	Sep 08	Sep 16	Sep 24	260.9	14.4	5.5	Aug 29	Sep 07	Sep 17	Sep 27	Oct 05
LOONLAKE_CDAEPF	SK	245.1	11.1	4.5	Aug 18	Aug 25	Sep 01	Sep 09	Sep 15	257.7	10.5	4.1	Aug 31	Sep 07	Sep 14	Sep 21	Sep 27
LOSTRIVER	SK	246.3	14.4	5.9	Aug 15	Aug 24	Sep 02	Sep 12	Sep 21	259.0	11.9	4.6	Aug 31	Sep 07	Sep 15	Sep 23	Sep 30
LUMSDEN	SK	250.3	11.5	4.6	Aug 23	Aug 30	Sep 06	Sep 14	Sep 21	266.7	11.4	4.3	Sep 08	Sep 15	Sep 23	Sep 30	Oct 07
MANKOTA	SK	250.8	11.3	4.5	Aug 23	Aug 30	Sep 07	Sep 14	Sep 21	264.1	9.8	3.7	Sep 08	Sep 13	Sep 20	Sep 27	Oct 03
MAPLECREEK_NORTH	SK	257.1	13.5	5.2	Aug 27	Sep 04	Sep 13	Sep 22	Sep 30	270.1	9.4	3.5	Sep 14	Sep 20	Sep 26	Oct 02	Oct 08

Station Name	Prov	Risk of First Fall Frost of 0°C								Risk of First Fall Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
MARYFIELD	SK	258.8	10.3	4.0	Sep 02	Sep 08	Sep 15	Sep 22	Sep 28	271.2	9.8	3.6	Sep 15	Sep 21	Sep 27	Oct 04	Oct 10
MEADOWLAKEA	SK	248.2	10.4	4.2	Aug 22	Aug 28	Sep 04	Sep 11	Sep 18	266.2	10.8	4.1	Sep 08	Sep 15	Sep 22	Sep 29	Oct 06
MELFORTCDA	SK	254.8	11.4	4.5	Aug 27	Sep 03	Sep 11	Sep 19	Sep 25	269.8	9.7	3.6	Sep 13	Sep 19	Sep 26	Oct 02	Oct 08
MIDALE	SK	257.1	11.0	4.3	Aug 30	Sep 06	Sep 13	Sep 21	Sep 27	270.2	12.0	4.4	Sep 11	Sep 18	Sep 26	Oct 04	Oct 12
MOOSEJAWA	SK	264.0	9.3	3.5	Sep 08	Sep 14	Sep 20	Sep 26	Oct 02	273.6	10.2	3.7	Sep 16	Sep 23	Sep 30	Oct 07	Oct 13
MOOSOMIN	SK	258.1	11.1	4.3	Aug 31	Sep 07	Sep 14	Sep 22	Sep 28	269.3	12.2	4.5	Sep 10	Sep 17	Sep 25	Oct 04	Oct 11
MUENSTER	SK	257.2	9.4	3.7	Sep 01	Sep 07	Sep 13	Sep 20	Sep 25	270.1	10.9	4.0	Sep 12	Sep 19	Sep 26	Oct 03	Oct 10
NIPAWIN	SK	255.0	12.2	4.8	Aug 26	Sep 03	Sep 11	Sep 19	Sep 27	269.1	8.6	3.2	Sep 14	Sep 19	Sep 25	Oct 01	Oct 06
NOKOMIS	SK	252.0	12.6	5.0	Aug 23	Aug 30	Sep 08	Sep 16	Sep 24	267.5	10.8	4.0	Sep 10	Sep 16	Sep 23	Oct 01	Oct 07
NORTH_BATTLEFORDA	SK	261.1	10.4	4.0	Sep 04	Sep 10	Sep 17	Sep 24	Sep 30	271.0	8.7	3.2	Sep 16	Sep 21	Sep 27	Oct 03	Oct 08
ORMISTON	SK	257.3	9.8	3.8	Sep 01	Sep 07	Sep 13	Sep 20	Sep 26	267.9	12.1	4.5	Sep 08	Sep 16	Sep 24	Oct 02	Oct 09
OUTLOOKPFRA	SK	262.5	10.8	4.1	Sep 05	Sep 11	Sep 18	Sep 26	Oct 02	272.8	9.0	3.3	Sep 17	Sep 23	Sep 29	Oct 05	Oct 10
OXBOW	SK	260.9	11.1	4.3	Sep 03	Sep 09	Sep 17	Sep 24	Oct 01	273.3	10.7	3.9	Sep 16	Sep 22	Sep 29	Oct 06	Oct 13
PASWEGIN	SK	247.9	10.2	4.1	Aug 22	Aug 28	Sep 04	Sep 11	Sep 17	265.1	13.3	5.0	Sep 04	Sep 12	Sep 21	Sep 30	Oct 08
PELLY	SK	240.8	13.1	5.4	Aug 11	Aug 19	Aug 28	Sep 06	Sep 14	258.7	12.0	4.6	Aug 30	Sep 07	Sep 15	Sep 23	Sep 30
PENNANT	SK	257.7	13.5	5.2	Aug 27	Sep 05	Sep 14	Sep 23	Oct 01	271.8	10.0	3.7	Sep 15	Sep 21	Sep 28	Oct 05	Oct 11
PILGER	SK	258.7	10.8	4.2	Sep 01	Sep 07	Sep 15	Sep 22	Sep 29	271.3	9.6	3.5	Sep 15	Sep 21	Sep 27	Oct 04	Oct 10
PRINCEALBERTA	SK	250.9	11.2	4.5	Aug 24	Aug 30	Sep 07	Sep 14	Sep 21	262.9	11.8	4.5	Sep 04	Sep 11	Sep 19	Sep 27	Oct 04
REGINAA	SK	256.7	11.1	4.3	Aug 29	Sep 05	Sep 13	Sep 20	Sep 27	268.2	10.0	3.7	Sep 11	Sep 17	Sep 24	Oct 01	Oct 07
REGINACDA	SK	244.3	13.2	5.4	Aug 14	Aug 22	Aug 31	Sep 09	Sep 17	258.9	12.2	4.7	Aug 30	Sep 07	Sep 15	Sep 23	Sep 30
ROCANVILLE	SK	256.1	11.5	4.5	Aug 28	Sep 04	Sep 12	Sep 20	Sep 27	268.7	11.1	4.1	Sep 10	Sep 17	Sep 25	Oct 02	Oct 09
ROSETOWN	SK	248.3	13.3	5.3	Aug 18	Aug 26	Sep 04	Sep 13	Sep 21	263.4	12.3	4.7	Sep 04	Sep 11	Sep 19	Sep 28	Oct 05
SASKATOONA	SK	259.3	10.8	4.2	Sep 02	Sep 08	Sep 15	Sep 23	Sep 29	270.2	8.7	3.2	Sep 15	Sep 20	Sep 26	Oct 02	Oct 07
SASKATOONSRC	SK	253.6	12.0	4.7	Aug 25	Sep 01	Sep 10	Sep 18	Sep 25	269.0	10.6	3.9	Sep 11	Sep 18	Sep 25	Oct 02	Oct 09
SCOTTCDA	SK	253.7	10.5	4.1	Aug 27	Sep 03	Sep 10	Sep 17	Sep 23	267.6	9.4	3.5	Sep 12	Sep 17	Sep 24	Sep 30	Oct 06
SEMANS	SK	253.9	12.0	4.7	Aug 26	Sep 02	Sep 10	Sep 18	Sep 25	268.7	12.6	4.7	Sep 09	Sep 16	Sep 25	Oct 03	Oct 11
SHAMROCK	SK	258.2	8.3	3.2	Sep 04	Sep 09	Sep 14	Sep 20	Sep 25	270.0	9.3	3.4	Sep 14	Sep 20	Sep 26	Oct 02	Oct 08
SHAUNAVON2	SK	256.2	9.6	3.7	Aug 31	Sep 06	Sep 12	Sep 19	Sep 25	269.2	10.1	3.8	Sep 12	Sep 18	Sep 25	Oct 02	Oct 08
SWIFTCURRENT_CDA	SK	259.1	12.9	5.0	Aug 30	Sep 06	Sep 15	Sep 24	Oct 02	270.7	10.0	3.7	Sep 14	Sep 20	Sep 27	Oct 03	Oct 10
SWIFTCURRENTA	SK	258.2	10.1	3.9	Sep 01	Sep 07	Sep 14	Sep 21	Sep 27	271.1	9.8	3.6	Sep 15	Sep 21	Sep 27	Oct 04	Oct 10
TREELON	SK	258.2	10.2	4.0	Sep 01	Sep 07	Sep 14	Sep 21	Sep 27	269.8	9.9	3.7	Sep 13	Sep 19	Sep 26	Oct 02	Oct 08
TUGASKE	SK	255.8	12.3	4.8	Aug 27	Sep 04	Sep 12	Sep 20	Sep 27	269.1	11.4	4.3	Sep 10	Sep 17	Sep 25	Oct 03	Oct 10
VALMARIE	SK	247.6	15.0	6.1	Aug 15	Aug 25	Sep 04	Sep 14	Sep 23	261.6	9.1	3.5	Sep 06	Sep 12	Sep 18	Sep 24	Sep 29
WASECA	SK	254.0	13.3	5.3	Aug 24	Sep 01	Sep 10	Sep 19	Sep 27	268.8	10.7	4.0	Sep 11	Sep 18	Sep 25	Oct 02	Oct 09
WASKESIULAKE	SK	249.4	16.1	6.4	Aug 16	Aug 26	Sep 05	Sep 16	Sep 26	268.0	13.3	5.0	Sep 07	Sep 15	Sep 24	Oct 03	Oct 11
WATROUS	SK	254.0	10.8	4.3	Aug 27	Sep 03	Sep 10	Sep 17	Sep 24	271.3	10.2	3.7	Sep 14	Sep 20	Sep 27	Oct 04	Oct 10
WESTPOPLAR_RIVER	SK	244.3	15.8	6.5	Aug 11	Aug 21	Aug 31	Sep 11	Sep 21	260.9	11.0	4.2	Sep 03	Sep 09	Sep 17	Sep 24	Oct 01
WEYBURN	SK	257.9	10.5	4.1	Aug 31	Sep 07	Sep 14	Sep 21	Sep 27	272.6	10.1	3.7	Sep 16	Sep 22	Sep 29	Oct 05	Oct 12
WHITESAND_DAM	SK	257.6	11.9	4.6	Aug 29	Sep 06	Sep 14	Sep 22	Sep 29	269.6	8.8	3.3	Sep 14	Sep 20	Sep 26	Oct 02	Oct 07
WHITEWOOD	SK	253.8	12.8	5.0	Aug 24	Sep 01	Sep 10	Sep 18	Sep 26	265.4	13.0	4.9	Sep 05	Sep 13	Sep 21	Sep 30	Oct 08

Station Name	Prov	Risk of First Fall Frost of 0°C								Risk of First Fall Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
WILLOWCREEK2	SK	251.3	12.6	5.0	Aug 22	Aug 30	Sep 07	Sep 16	Sep 23	263.8	13.0	4.9	Sep 03	Sep 11	Sep 20	Sep 29	Oct 06
WYNYARD	SK	258.8	11.8	4.6	Aug 31	Sep 07	Sep 15	Sep 23	Sep 30	270.8	11.4	4.2	Sep 12	Sep 19	Sep 27	Oct 04	Oct 11
YELLOWGRASS	SK	254.8	10.4	4.1	Aug 28	Sep 04	Sep 11	Sep 18	Sep 24	268.5	11.7	4.4	Sep 09	Sep 17	Sep 24	Oct 02	Oct 10
YORKTONA	SK	258.3	11.3	4.4	Aug 31	Sep 07	Sep 14	Sep 22	Sep 29	268.8	11.8	4.4	Sep 10	Sep 17	Sep 25	Oct 03	Oct 10
ALTONA	MB	269.2	9.2	3.4	Sep 13	Sep 19	Sep 25	Oct 01	Oct 07	281.3	11.5	4.1	Sep 23	Sep 30	Oct 07	Oct 15	Oct 22
ARBORG	MB	255.6	9.0	3.5	Aug 31	Sep 05	Sep 12	Sep 18	Sep 23	268.8	9.3	3.5	Sep 13	Sep 19	Sep 25	Oct 01	Oct 07
ASHERN	MB	244.1	11.2	4.6	Aug 17	Aug 24	Aug 31	Sep 08	Sep 14	260.1	10.0	3.8	Sep 03	Sep 09	Sep 16	Sep 23	Sep 29
BALDUR	MB	261.9	9.5	3.6	Sep 06	Sep 12	Sep 18	Sep 24	Sep 30	270.6	11.8	4.4	Sep 12	Sep 19	Sep 27	Oct 05	Oct 12
BEAUSEJOUR2	MB	259.4	10.4	4.0	Sep 02	Sep 08	Sep 15	Sep 22	Sep 29	271.0	12.6	4.7	Sep 11	Sep 18	Sep 27	Oct 06	Oct 13
BINSCARTH	MB	251.7	14.9	5.9	Aug 20	Aug 29	Sep 08	Sep 18	Sep 27	264.4	13.9	5.3	Sep 03	Sep 11	Sep 20	Sep 30	Oct 08
BIRCHRIVER	MB	252.4	11.6	4.6	Aug 25	Sep 01	Sep 08	Sep 16	Sep 23	264.6	10.0	3.8	Sep 08	Sep 14	Sep 21	Sep 27	Oct 03
BIRTLE	MB	250.4	12.5	5.0	Aug 21	Aug 29	Sep 06	Sep 15	Sep 22	264.0	11.1	4.2	Sep 06	Sep 13	Sep 20	Sep 27	Oct 04
BISSETT	MB	252.0	9.9	3.9	Aug 26	Sep 01	Sep 08	Sep 15	Sep 21	268.5	11.2	4.2	Sep 10	Sep 17	Sep 25	Oct 02	Oct 09
BRANDONA	MB	257.4	11.4	4.4	Aug 30	Sep 06	Sep 13	Sep 21	Sep 28	268.0	10.0	3.7	Sep 11	Sep 17	Sep 24	Oct 01	Oct 07
BRANDONCDA	MB	255.3	9.3	3.6	Aug 30	Sep 05	Sep 11	Sep 18	Sep 23	267.4	10.4	3.9	Sep 10	Sep 16	Sep 23	Sep 30	Oct 07
BROADVALLEY	MB	258.7	11.8	4.6	Aug 31	Sep 07	Sep 15	Sep 23	Sep 30	271.6	10.8	4.0	Sep 14	Sep 20	Sep 28	Oct 05	Oct 11
CHURCHILLA	MB	253.4	17.6	7.0	Aug 18	Aug 29	Sep 09	Sep 21	Oct 02	270.0	10.1	3.7	Sep 13	Sep 19	Sep 26	Oct 03	Oct 09
CROSSLAKE_JENPEG	MB	263.5	10.2	3.9	Sep 06	Sep 13	Sep 20	Sep 26	Oct 03	274.1	9.1	3.3	Sep 18	Sep 24	Sep 30	Oct 06	Oct 12
CYPRESSRIVER	MB	261.8	10.4	4.0	Sep 05	Sep 11	Sep 18	Sep 25	Oct 01	269.0	8.6	3.2	Sep 14	Sep 19	Sep 25	Oct 01	Oct 06
DAUPHINA	MB	259.0	8.7	3.3	Sep 04	Sep 09	Sep 15	Sep 21	Sep 26	269.1	10.3	3.8	Sep 12	Sep 18	Sep 25	Oct 02	Oct 08
DEERWOOD	MB	266.1	7.8	2.9	Sep 12	Sep 17	Sep 22	Sep 27	Oct 02	283.0	11.4	4.0	Sep 24	Oct 01	Oct 09	Oct 17	Oct 24
DELORAINE	MB	262.3	10.6	4.0	Sep 05	Sep 11	Sep 18	Sep 25	Oct 02	270.4	12.4	4.6	Sep 11	Sep 18	Sep 26	Oct 05	Oct 12
DELTA_UNIVERSITYFS	MB	262.7	9.2	3.5	Sep 07	Sep 13	Sep 19	Sep 25	Sep 30	275.4	10.4	3.8	Sep 18	Sep 24	Oct 01	Oct 08	Oct 15
ELMCREEK	MB	261.2	9.0	3.4	Sep 06	Sep 11	Sep 17	Sep 23	Sep 29	273.0	9.2	3.4	Sep 17	Sep 23	Sep 29	Oct 05	Oct 11
EMERSON	MB	264.7	8.6	3.2	Sep 10	Sep 15	Sep 21	Sep 27	Oct 02	276.9	10.6	3.8	Sep 19	Sep 26	Oct 03	Oct 10	Oct 17
FALCONLAKE_TCPL45	MB	248.5	14.9	6.0	Aug 16	Aug 25	Sep 05	Sep 15	Sep 24	264.4	10.9	4.1	Sep 06	Sep 13	Sep 20	Sep 28	Oct 04
FISHERBRANCHS	MB	256.0	10.0	3.9	Aug 30	Sep 05	Sep 12	Sep 19	Sep 25	268.2	12.1	4.5	Sep 09	Sep 16	Sep 24	Oct 02	Oct 10
FLINFLON	MB	265.9	9.6	3.6	Sep 10	Sep 15	Sep 22	Sep 28	Oct 04	279.9	9.7	3.5	Sep 23	Sep 29	Oct 06	Oct 12	Oct 18
FLINFLONA	MB	264.6	9.3	3.5	Sep 09	Sep 14	Sep 21	Sep 27	Oct 03	274.9	9.6	3.5	Sep 19	Sep 24	Oct 01	Oct 07	Oct 13
GILBERTPLAINS	MB	253.8	11.1	4.4	Aug 27	Sep 02	Sep 10	Sep 17	Sep 24	268.7	10.5	3.9	Sep 11	Sep 18	Sep 25	Oct 02	Oct 08
GILLAMA	MB	254.7	10.8	4.3	Aug 28	Sep 03	Sep 11	Sep 18	Sep 25	264.8	7.8	3.0	Sep 11	Sep 16	Sep 21	Sep 26	Oct 01
GIMLI	MB	266.1	8.1	3.1	Sep 12	Sep 17	Sep 22	Sep 28	Oct 02	276.4	11.7	4.2	Sep 17	Sep 24	Oct 02	Oct 10	Oct 17
GLADSTONE_SOUTH	MB	259.0	9.2	3.5	Sep 03	Sep 09	Sep 15	Sep 21	Sep 27	274.3	11.7	4.3	Sep 15	Sep 22	Sep 30	Oct 08	Oct 15
GLENBORO	MB	258.8	10.3	4.0	Sep 02	Sep 08	Sep 15	Sep 22	Sep 28	266.6	9.9	3.7	Sep 10	Sep 16	Sep 23	Sep 29	Oct 05
GLENLEA	MB	260.1	10.8	4.2	Sep 02	Sep 09	Sep 16	Sep 23	Sep 30	271.6	12.5	4.6	Sep 12	Sep 19	Sep 28	Oct 06	Oct 14
GRANDRAPIDS_HYDRO	MB	268.6	8.6	3.2	Sep 14	Sep 19	Sep 25	Sep 30	Oct 06	281.5	9.9	3.5	Sep 25	Oct 01	Oct 07	Oct 14	Oct 20
GRASSRIVER	MB	256.7	11.3	4.4	Aug 29	Sep 05	Sep 13	Sep 20	Sep 27	272.4	9.5	3.5	Sep 16	Sep 22	Sep 28	Oct 05	Oct 11
GREATFALLS	MB	266.4	11.5	4.3	Sep 08	Sep 15	Sep 22	Sep 30	Oct 07	279.3	13.6	4.9	Sep 18	Sep 26	Oct 05	Oct 14	Oct 23
HAMIOTA	MB	250.5	14.0	5.6	Aug 20	Aug 28	Sep 06	Sep 16	Sep 24	268.5	12.4	4.6	Sep 09	Sep 16	Sep 24	Oct 03	Oct 10
HODGSON2	MB	241.9	12.7	5.3	Aug 13	Aug 20	Aug 29	Sep 06	Sep 14	258.9	10.7	4.1	Sep 01	Sep 08	Sep 15	Sep 22	Sep 29

Station Name	Prov	Risk of First Fall Frost of 0°C								Risk of First Fall Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
INDIANBAY	MB	256.2	9.7	3.8	Aug 31	Sep 06	Sep 12	Sep 19	Sep 25	268.4	8.4	3.1	Sep 14	Sep 19	Sep 24	Sep 30	Oct 05
ISLANDLAKE	MB	267.0	7.9	3.0	Sep 13	Sep 18	Sep 23	Sep 28	Oct 03	280.1	8.9	3.2	Sep 25	Sep 30	Oct 06	Oct 12	Oct 17
LANGRUTH	MB	260.5	11.1	4.3	Sep 02	Sep 09	Sep 16	Sep 24	Oct 01	274.7	11.4	4.2	Sep 16	Sep 23	Oct 01	Oct 08	Oct 15
LYNNLAKEA	MB	251.8	9.2	3.7	Aug 27	Sep 02	Sep 08	Sep 14	Sep 20	264.7	10.1	3.8	Sep 08	Sep 14	Sep 21	Sep 28	Oct 04
MACGREGOR	MB	262.2	10.9	4.2	Sep 04	Sep 11	Sep 18	Sep 26	Oct 02	275.9	11.6	4.2	Sep 17	Sep 24	Oct 02	Oct 10	Oct 17
MARQUETTE	MB	267.8	7.3	2.7	Sep 14	Sep 19	Sep 24	Sep 29	Oct 03	276.6	10.9	3.9	Sep 19	Sep 25	Oct 03	Oct 10	Oct 17
MINNEDOSA	MB	250.7	12.8	5.1	Aug 21	Aug 29	Sep 07	Sep 15	Sep 23	264.3	8.8	3.3	Sep 09	Sep 14	Sep 20	Sep 26	Oct 02
MORDENCDA	MB	267.0	9.3	3.5	Sep 11	Sep 17	Sep 23	Sep 29	Oct 05	283.5	11.5	4.1	Sep 25	Oct 02	Oct 10	Oct 17	Oct 24
MYRTLE	MB	260.8	9.1	3.5	Sep 05	Sep 11	Sep 17	Sep 23	Sep 28	273.7	10.4	3.8	Sep 16	Sep 23	Sep 30	Oct 07	Oct 13
NEEPAWAWATER	MB	264.3	10.3	3.9	Sep 07	Sep 13	Sep 20	Sep 27	Oct 03	277.7	11.6	4.2	Sep 19	Sep 26	Oct 04	Oct 12	Oct 19
NIVERVILLE	MB	257.7	8.5	3.3	Sep 03	Sep 08	Sep 14	Sep 19	Sep 25	268.8	8.7	3.2	Sep 14	Sep 19	Sep 25	Oct 01	Oct 06
NORWAYHOUSEA	MB	255.0	9.1	3.6	Aug 30	Sep 05	Sep 11	Sep 17	Sep 23	266.4	9.6	3.6	Sep 10	Sep 16	Sep 22	Sep 29	Oct 05
NORWAYHOUSEF	MB	265.3	10.5	4.0	Sep 08	Sep 14	Sep 21	Sep 28	Oct 05	280.7	7.7	2.7	Sep 27	Oct 02	Oct 07	Oct 12	Oct 17
OAKNER	MB	254.8	11.7	4.6	Aug 27	Sep 03	Sep 11	Sep 19	Sep 26	267.4	9.9	3.7	Sep 11	Sep 17	Sep 23	Sep 30	Oct 06
PASQUIAPROJ_PFRA	MB	251.0	10.6	4.2	Aug 24	Aug 31	Sep 07	Sep 14	Sep 21	265.6	9.9	3.7	Sep 09	Sep 15	Sep 22	Sep 28	Oct 04
PEACEGARDENS	MB	258.5	9.5	3.7	Sep 02	Sep 08	Sep 14	Sep 21	Sep 27	267.2	9.1	3.4	Sep 12	Sep 17	Sep 23	Sep 29	Oct 05
PIERSON	MB	257.8	10.7	4.2	Aug 31	Sep 07	Sep 14	Sep 21	Sep 28	267.4	10.0	3.8	Sep 11	Sep 17	Sep 23	Sep 30	Oct 06
PINAWAWNRE	MB	260.4	8.4	3.2	Sep 06	Sep 11	Sep 16	Sep 22	Sep 27	275.9	10.2	3.7	Sep 19	Sep 25	Oct 02	Oct 09	Oct 15
PINEDOCK	MB	264.3	15.8	6.0	Aug 31	Sep 10	Sep 20	Oct 01	Oct 11	281.3	9.2	3.3	Sep 26	Oct 01	Oct 07	Oct 14	Oct 19
PINEFALLS	MB	259.0	10.7	4.1	Sep 01	Sep 08	Sep 15	Sep 22	Sep 29	277.3	11.1	4.0	Sep 19	Sep 26	Oct 03	Oct 11	Oct 18
PINEY	MB	253.2	8.4	3.3	Aug 29	Sep 03	Sep 09	Sep 15	Sep 20	268.2	12.3	4.6	Sep 08	Sep 16	Sep 24	Oct 02	Oct 10
PLUMCOULEE	MB	266.0	9.3	3.5	Sep 10	Sep 16	Sep 22	Sep 28	Oct 04	278.8	10.4	3.7	Sep 22	Sep 28	Oct 05	Oct 12	Oct 18
PORTAGELAPR	MB	268.2	8.6	3.2	Sep 13	Sep 18	Sep 24	Sep 30	Oct 05	279.3	11.9	4.3	Sep 20	Sep 27	Oct 05	Oct 13	Oct 21
PORTAGELAPR2	MB	269.8	8.2	3.0	Sep 15	Sep 20	Sep 26	Oct 01	Oct 06	281.6	12.7	4.5	Sep 21	Sep 29	Oct 08	Oct 16	Oct 24
RATHWELL	MB	262.7	8.9	3.4	Sep 07	Sep 13	Sep 19	Sep 25	Sep 30	272.2	11.9	4.4	Sep 13	Sep 20	Sep 28	Oct 06	Oct 13
ROSSBURN	MB	250.3	12.4	5.0	Aug 21	Aug 29	Sep 06	Sep 15	Sep 22	260.4	12.7	4.9	Aug 31	Sep 08	Sep 16	Sep 25	Oct 03
SELKIRK	MB	268.4	6.4	2.4	Sep 16	Sep 20	Sep 24	Sep 29	Oct 03	281.5	11.3	4.0	Sep 23	Sep 30	Oct 08	Oct 15	Oct 22
SOMERSET	MB	263.2	8.6	3.3	Sep 08	Sep 13	Sep 19	Sep 25	Sep 30	271.7	12.4	4.6	Sep 12	Sep 19	Sep 28	Oct 06	Oct 14
SPRAGUE	MB	249.9	10.2	4.1	Aug 24	Aug 30	Sep 06	Sep 13	Sep 19	266.6	10.8	4.0	Sep 09	Sep 15	Sep 23	Sep 30	Oct 06
STARBUCK	MB	257.9	9.4	3.7	Sep 02	Sep 08	Sep 14	Sep 20	Sep 26	270.0	11.6	4.3	Sep 11	Sep 18	Sep 26	Oct 04	Oct 11
STEINBACH	MB	260.0	8.5	3.3	Sep 05	Sep 10	Sep 16	Sep 22	Sep 27	269.7	8.3	3.1	Sep 15	Sep 20	Sep 26	Oct 01	Oct 06
STONEWALL	MB	259.5	9.2	3.6	Sep 04	Sep 09	Sep 16	Sep 22	Sep 27	268.8	11.0	4.1	Sep 11	Sep 17	Sep 25	Oct 02	Oct 09
STONYMTN	MB	263.5	8.5	3.2	Sep 08	Sep 14	Sep 19	Sep 25	Sep 30	273.9	10.0	3.7	Sep 17	Sep 23	Sep 30	Oct 07	Oct 13
STRATHCLAIR	MB	254.5	14.0	5.5	Aug 24	Sep 01	Sep 10	Sep 20	Sep 28	264.6	9.5	3.6	Sep 08	Sep 14	Sep 21	Sep 27	Oct 03
SWANRIVER	MB	255.4	14.8	5.8	Aug 23	Sep 01	Sep 11	Sep 21	Sep 30	272.1	10.4	3.8	Sep 15	Sep 21	Sep 28	Oct 05	Oct 11
THEPASA	MB	261.0	8.5	3.3	Sep 06	Sep 11	Sep 17	Sep 23	Sep 28	271.1	9.0	3.3	Sep 16	Sep 21	Sep 27	Oct 03	Oct 09
THOMPSONA	MB	233.2	11.8	5.1	Aug 05	Aug 12	Aug 20	Aug 28	Sep 04	252.6	11.9	4.7	Aug 24	Sep 01	Sep 09	Sep 17	Sep 24
VIRDEN	MB	261.4	8.7	3.3	Sep 06	Sep 12	Sep 17	Sep 23	Sep 29	270.6	8.6	3.2	Sep 16	Sep 21	Sep 27	Oct 02	Oct 08
VOGAR	MB	270.5	10.7	4.0	Sep 13	Sep 19	Sep 26	Oct 04	Oct 10	283.2	13.3	4.7	Sep 22	Sep 30	Oct 09	Oct 18	Oct 26
WILSONCRWEIR	MB	264.5	9.4	3.6	Sep 08	Sep 14	Sep 21	Sep 27	Oct 03	275.8	9.5	3.5	Sep 20	Sep 25	Oct 02	Oct 08	Oct 14

Station Name	Prov	Risk of First Fall Frost of 0°C								Risk of First Fall Frost of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
WINNIPEGA	MB	266.9	6.5	2.4	Sep 15	Sep 19	Sep 23	Sep 27	Oct 01	273.1	11.3	4.2	Sep 15	Sep 21	Sep 29	Oct 07	Oct 14

IV. Risk of frost free days of 0.0°C and -2.2°C

Station Name	Prov	Risk of Frost Free Days of 0°C								Risk of Frost Free Days of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
ATHABASCA2	AB	112.2	16.8	15.0	91	101	112	124	134	142.0	16.5	11.6	121	131	142	153	163
BANFF	AB	93.0	16.3	17.5	72	82	93	104	114	133.1	19.1	14.4	109	120	133	146	158
BEAVERLODGE_CDA	AB	108.5	21.0	19.4	82	94	108	123	135	139.0	21.0	15.1	112	125	139	153	166
BRIGHTVIEW	AB	121.5	15.0	12.3	102	111	121	132	141	142.1	21.8	15.3	114	127	142	157	170
BROWNFIELD	AB	94.2	24.6	26.1	63	78	94	111	126	129.8	17.5	13.5	107	118	130	142	152
CALDWELL	AB	99.7	20.1	20.2	74	86	100	113	125	141.4	15.7	11.1	121	131	141	152	162
CALGARYA	AB	114.8	15.5	13.5	95	104	115	125	135	143.3	18.2	12.7	120	131	143	156	167
CALMAR	AB	113.9	12.9	11.3	97	105	114	123	130	139.4	20.2	14.5	113	126	139	153	165
CAMPSIE	AB	86.4	19.8	22.9	61	73	86	100	112	120.2	15.7	13.0	100	110	120	131	140
CAMROSE	AB	122.8	14.1	11.5	105	113	123	132	141	147.5	16.7	11.3	126	136	147	159	169
CARDSTON	AB	109.9	21.1	19.2	83	96	110	124	137	141.3	21.6	15.3	114	127	141	156	169
CARWAY	AB	81.8	24.6	30.0	50	65	82	98	113	123.6	18.9	15.3	99	111	124	136	148
CLARESHOLM_WATERW	AB	101.3	16.6	16.4	80	90	101	113	123	136.9	20.5	15.0	111	123	137	151	163
CLEARDALE	AB	88.3	19.4	22.0	63	75	88	101	113	125.6	14.3	11.4	107	116	126	135	144
COLDLAKEA	AB	114.6	14.8	12.9	96	105	115	125	134	142.2	16.6	11.7	121	131	142	153	163
CONNELLY CREEK	AB	96.3	24.4	25.3	65	80	96	113	128	133.6	17.3	13.0	111	122	134	145	156
CORONATIONA	AB	112.2	15.4	13.7	93	102	112	123	132	133.1	17.2	12.9	111	121	133	145	155
EDMONTONA	AB	113.0	14.8	13.1	94	103	113	123	132	134.4	19.6	14.6	109	121	134	148	160
EDMONTONMUN	AB	141.3	22.3	15.8	113	126	141	156	170	160.1	19.3	12.1	135	147	160	173	185
EDSONA	AB	77.7	17.2	22.2	56	66	78	89	100	117.9	20.4	17.3	92	104	118	132	144
ELKPOINT	AB	84.7	15.8	18.7	64	74	85	95	105	120.1	16.2	13.5	99	109	120	131	141
ELMWORTHCDA	AB	85.0	17.9	21.1	62	73	85	97	108	123.4	17.0	13.8	102	112	123	135	145
EMPRESS	AB	118.2	15.5	13.1	98	108	118	129	138	147.3	13.2	9.0	130	138	147	156	164
EUREKARIVER	AB	67.2	24.0	35.7	36	51	67	83	98	105.7	14.0	13.2	88	96	106	115	124
FAIRVIEW	AB	125.1	16.4	13.1	104	114	125	136	146	158.5	18.9	11.9	134	146	158	171	183
FOREMOST	AB	122.1	15.6	12.8	102	112	122	133	142	154.1	17.4	11.3	132	142	154	166	176
FORESTBURG_PLANT	AB	138.9	18.6	13.4	115	126	139	152	163	161.5	16.2	10.0	141	151	162	172	182
FORT_CHIPEWYANA	AB	88.6	24.7	27.9	57	72	89	105	120	115.8	22.1	19.1	87	101	116	131	144
FORT_SASKATCHEWAN	AB	110.5	20.9	18.9	84	96	111	125	137	138.8	17.8	12.8	116	127	139	151	162
FORTMACLEOD	AB	118.3	16.2	13.7	98	107	118	129	139	150.7	16.0	10.6	130	140	151	162	171
FORTMCMURRAYA	AB	97.9	17.2	17.6	76	86	98	109	120	127.9	17.6	13.8	105	116	128	140	150
GLEICHEN	AB	109.9	12.8	11.7	93	101	110	118	126	135.1	16.7	12.3	114	124	135	146	157
GRANDEPRAIRIEA	AB	115.7	14.7	12.7	97	106	116	126	135	142.5	17.3	12.2	120	131	142	154	165
HIGHLEVELA	AB	89.7	17.0	18.9	68	78	90	101	111	121.6	17.8	14.6	99	110	122	134	144

Station Name	Prov	Risk of Frost Free Days of 0°C								Risk of Frost Free Days of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
HIGHRIVER	AB	82.2	18.6	22.6	58	70	82	95	106	116.9	14.7	12.5	98	107	117	127	136
JASPER	AB	98.3	16.3	16.6	77	87	98	109	119	128.7	16.4	12.7	108	118	129	140	150
LACOMBECDA	AB	100.5	11.3	11.2	86	93	101	108	115	128.2	18.1	14.1	105	116	128	140	151
LETHBRIDGEA	AB	122.9	15.6	12.7	103	112	123	133	143	144.7	17.0	11.8	123	133	145	156	167
LETHBRIDGECDA	AB	119.4	14.1	11.8	101	110	119	129	137	149.8	18.4	12.3	126	137	150	162	173
MANYBERRIESCDA	AB	121.0	15.3	12.7	101	111	121	131	141	149.8	16.6	11.1	128	139	150	161	171
MEDICINEHATA	AB	131.2	15.0	11.4	112	121	131	141	150	152.8	16.1	10.5	132	142	153	164	173
NOTIKEWINEAST	AB	88.3	16.7	18.9	67	77	88	100	110	117.7	16.0	13.6	97	107	118	128	138
OLDS	AB	112.8	15.1	13.4	93	103	113	123	132	141.2	18.9	13.4	117	128	141	154	165
OYEN CAPPON	AB	119.7	15.3	12.8	100	109	120	130	139	148.0	16.6	11.2	127	137	148	159	169
PEACERIVERA	AB	107.4	13.9	13.0	90	98	107	117	125	132.2	17.6	13.3	110	120	132	144	155
PINCHERCREEKA	AB	107.2	17.6	16.4	85	95	107	119	130	141.7	21.0	14.8	115	128	142	156	169
QUEENSTOWN	AB	119.7	17.7	14.8	97	108	120	132	142	148.2	18.0	12.1	125	136	148	160	171
RANFURLY	AB	111.1	16.4	14.8	90	100	111	122	132	140.7	15.4	11.0	121	130	141	151	160
REDDEERA	AB	109.1	16.4	15.0	88	98	109	120	130	130.5	16.9	12.9	109	119	130	142	152
ROCKYMTN_HOUSEA	AB	96.7	18.5	19.2	73	84	97	109	120	127.8	18.8	14.7	104	115	128	141	152
SION	AB	116.2	21.1	18.2	89	102	116	130	143	147.7	23.9	16.2	117	132	148	164	178
STETTLERNORTH	AB	113.2	13.2	11.7	96	104	113	122	130	137.9	21.3	15.4	111	124	138	152	165
SUFFIELDA	AB	123.8	14.7	11.9	105	114	124	134	143	146.8	15.6	10.6	127	136	147	157	167
TABER	AB	132.4	17.0	12.8	111	121	132	144	154	159.5	20.1	12.6	134	146	160	173	185
TROCHU TOWN	AB	115.5	16.6	14.3	94	104	116	127	137	138.4	14.9	10.8	119	128	138	148	157
VEGREVILLECDA	AB	85.7	20.5	23.9	59	72	86	99	112	116.3	16.2	13.9	96	105	116	127	137
VULCAN	AB	115.1	13.6	11.8	98	106	115	124	132	147.7	18.7	12.7	124	135	148	160	172
WANHAMCDAEPF	AB	110.7	17.2	15.5	89	99	111	122	133	143.6	22.4	15.6	115	128	144	159	172
WATINO	AB	114.8	15.3	13.3	95	104	115	125	134	142.5	14.2	10.0	124	133	142	152	161
WHITECOURTA	AB	102.4	20.5	20.1	76	89	102	116	129	132.3	19.1	14.4	108	119	132	145	157
ABBEY	SK	121.0	17.0	14.1	99	110	121	133	143	149.0	17.7	11.9	126	137	149	161	172
ALSASKHARDENE	SK	103.1	16.5	16.0	82	92	103	114	124	130.2	16.6	12.8	109	119	130	141	151
AMULET	SK	121.0	12.4	10.3	105	113	121	129	137	141.1	16.4	11.6	120	130	141	152	162
ANEROID	SK	103.7	25.0	24.1	72	87	104	120	136	134.5	16.1	12.0	114	124	134	145	155
ARRAN23N	SK	87.7	19.5	22.2	63	75	88	101	113	126.0	14.9	11.8	107	116	126	136	145
ATWATER	SK	105.1	18.8	17.9	81	92	105	118	129	134.5	16.5	12.3	113	123	134	146	156
BIGGAR	SK	115.5	17.7	15.4	93	104	115	127	138	140.4	15.3	10.9	121	130	140	151	160
BROADVIEW	SK	105.1	18.9	18.0	81	92	105	118	129	130.2	18.3	14.1	107	118	130	143	154
CAMEO	SK	77.2	24.3	31.5	46	61	77	94	108	106.0	15.7	14.8	86	95	106	117	126
CARLYLE	SK	118.0	12.6	10.7	102	109	118	126	134	139.9	15.5	11.1	120	129	140	150	160
CEYLON	SK	122.3	14.9	12.2	103	112	122	132	141	143.5	17.7	12.3	121	132	144	155	166
CHAPLIN	SK	121.1	16.6	13.7	100	110	121	132	142	145.7	15.8	10.8	126	135	146	156	166
CHOICELAND	SK	109.3	19.0	17.4	85	97	109	122	134	131.0	18.2	13.9	108	119	131	143	154
CLAYDON	SK	120.4	15.2	12.6	101	110	120	131	140	140.0	15.4	11.0	120	130	140	150	160

Station Name	Prov	Risk of Frost Free Days of 0°C								Risk of Frost Free Days of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
CODERRE	SK	109.1	15.4	14.1	89	99	109	119	129	135.8	17.8	13.1	113	124	136	148	159
CORONACH	SK	117.8	17.0	14.5	96	106	118	129	140	138.9	17.3	12.4	117	127	139	151	161
COTE	SK	85.5	21.9	25.6	58	71	86	100	114	124.2	15.5	12.5	104	114	124	135	144
CREELAKE	SK	97.3	15.3	15.7	78	87	97	108	117	121.3	15.2	12.5	102	111	121	131	141
DAHINDA	SK	114.1	13.7	12.0	96	105	114	123	132	139.0	17.9	12.9	116	127	139	151	162
DAVIDSON	SK	108.1	18.8	17.4	84	95	108	121	132	136.2	15.4	11.3	116	126	136	147	156
DUVAL	SK	125.0	16.8	13.5	103	114	125	136	147	149.7	16.2	10.8	129	139	150	161	170
ELROSE	SK	117.3	16.9	14.4	96	106	117	129	139	144.8	16.9	11.7	123	133	145	156	166
ESTEVANA	SK	129.3	16.9	13.1	108	118	129	141	151	147.3	16.7	11.3	126	136	147	159	169
FENWOOD	SK	121.3	17.0	14.0	99	110	121	133	143	144.2	14.8	10.3	125	134	144	154	163
FERTILE	SK	118.1	14.3	12.1	100	108	118	128	136	139.1	17.3	12.5	117	127	139	151	161
GRAVELBOURG	SK	114.3	18.3	16.0	91	102	114	127	138	136.5	17.4	12.7	114	125	136	148	159
GULLLAKECDAEPF	SK	95.9	18.2	19.0	73	84	96	108	119	132.2	18.4	13.9	109	120	132	145	156
HAFFORD	SK	98.1	14.8	15.1	79	88	98	108	117	130.7	14.2	10.9	112	121	131	140	149
HANDSWORTH	SK	101.3	24.5	24.2	70	85	101	118	133	132.6	19.7	14.9	107	119	133	146	158
HARRIS	SK	110.3	16.4	14.8	89	99	110	121	131	141.8	12.7	9.0	126	133	142	150	158
HUDSONBAYA	SK	100.0	20.3	20.3	74	86	100	114	126	126.6	18.5	14.6	103	114	127	139	150
HUMBOLDT	SK	109.3	16.1	14.7	89	98	109	120	130	137.7	14.8	10.8	119	128	138	148	157
INDIANHEAD_CDA	SK	116.0	17.1	14.7	94	104	116	127	138	137.8	13.5	9.8	120	129	138	147	155
INGEBRIGHT_LAKE	SK	101.9	16.2	15.9	81	91	102	113	123	134.4	13.2	9.8	117	125	134	143	151
ISLANDFALLS2	SK	109.3	16.1	14.8	89	98	109	120	130	132.8	13.4	10.1	116	124	133	142	150
KELLIHER	SK	112.0	18.7	16.7	88	99	112	125	136	136.7	15.3	11.2	117	126	137	147	156
KERROBERT	SK	102.8	18.2	17.7	80	91	103	115	126	124.9	17.9	14.3	102	113	125	137	148
KINDERSLEYA	SK	120.8	14.5	12.0	102	111	121	131	139	142.7	13.5	9.4	125	134	143	152	160
KIPLING	SK	116.8	14.3	12.3	98	107	117	126	135	140.6	15.9	11.3	120	130	141	151	161
KLINTONEL	SK	65.6	33.6	51.3	22	43	66	88	109	104.7	24.2	23.1	74	88	105	121	136
KUROKI	SK	113.1	19.2	17.0	89	100	113	126	138	137.8	16.9	12.3	116	126	138	149	159
LAKE ALMA	SK	123.1	11.9	9.7	108	115	123	131	138	146.4	17.9	12.2	123	134	146	158	169
LEADER2	SK	114.0	14.8	13.0	95	104	114	124	133	138.6	13.9	10.0	121	129	139	148	156
LIPTON	SK	103.5	19.0	18.4	79	91	103	116	128	125.8	19.8	15.7	100	112	126	139	151
LOONLAKE_CDAEPF	SK	84.5	14.5	17.2	66	75	84	94	103	117.7	17.1	14.5	96	106	118	129	140
LOSTRIVER	SK	97.2	17.7	18.2	75	85	97	109	120	122.9	14.8	12.1	104	113	123	133	142
LUMSDEN	SK	108.7	15.3	14.1	89	98	109	119	128	135.2	16.9	12.5	114	124	135	147	157
MANKOTA	SK	101.7	16.1	15.8	81	91	102	113	122	128.6	17.7	13.8	106	117	129	141	151
MAPLECREEK_NORTH	SK	111.9	14.9	13.3	93	102	112	122	131	140.6	14.7	10.4	122	131	141	150	159
MARYFIELD	SK	116.8	13.3	11.3	100	108	117	126	134	144.7	15.3	10.6	125	134	145	155	164
MEADOWLAKEA	SK	101.5	19.1	18.8	77	89	102	114	126	131.5	20.0	15.2	106	118	132	145	157
MELFORTCDA	SK	109.0	18.3	16.8	86	97	109	121	132	140.0	13.4	9.6	123	131	140	149	157
MIDALE	SK	117.0	15.7	13.4	97	106	117	128	137	140.7	18.0	12.8	118	129	141	153	164
MOOSEJAWA	SK	125.0	16.9	13.5	103	114	125	136	147	144.3	14.1	9.8	126	135	144	154	162

Station Name	Prov	Risk of Frost Free Days of 0°C								Risk of Frost Free Days of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
MOOSOMIN	SK	115.6	16.5	14.3	94	104	116	127	137	142.7	16.3	11.4	122	132	143	154	164
MUENSTER	SK	113.2	16.4	14.5	92	102	113	124	134	141.0	14.6	10.4	122	131	141	151	160
NIPAWIN	SK	111.2	17.4	15.6	89	99	111	123	133	137.8	13.4	9.7	121	129	138	147	155
NOKOMIS	SK	106.9	18.2	17.0	84	95	107	119	130	135.3	15.3	11.3	116	125	135	146	155
NORTH_BATTLEFORDA	SK	120.7	16.1	13.4	100	110	121	132	141	144.5	13.4	9.3	127	135	144	154	162
ORMISTON	SK	117.0	16.5	14.1	96	106	117	128	138	140.0	15.8	11.3	120	129	140	151	160
OUTLOOKPFRA	SK	124.9	16.8	13.5	103	114	125	136	146	147.4	15.6	10.6	127	137	147	158	167
OXBOW	SK	122.4	12.8	10.4	106	114	122	131	139	149.9	14.6	9.8	131	140	150	160	169
PASWEGIN	SK	99.0	18.4	18.6	75	87	99	111	123	133.3	18.0	13.5	110	121	133	145	156
PELLY	SK	77.9	21.6	27.7	50	63	78	92	106	113.1	19.2	17.0	89	100	113	126	138
PENNANT	SK	120.5	19.1	15.9	96	108	120	133	145	143.9	17.8	12.3	121	132	144	156	167
PILGER	SK	114.1	19.4	17.0	89	101	114	127	139	142.8	13.5	9.5	125	134	143	152	160
PRINCEALBERTA	SK	102.1	17.1	16.7	80	91	102	114	124	127.9	15.0	11.8	109	118	128	138	147
REGINAA	SK	115.8	17.4	15.0	94	104	116	128	138	137.4	15.2	11.0	118	127	137	148	157
REGINACDA	SK	95.7	19.4	20.3	71	83	96	109	121	124.0	16.2	13.0	103	113	124	135	145
ROCANVILLE	SK	114.5	14.6	12.8	96	105	114	124	133	143.6	17.0	11.9	122	132	144	155	165
ROSETOWN	SK	102.9	18.6	18.1	79	90	103	115	127	127.7	17.2	13.5	106	116	128	139	150
SASKATOONA	SK	119.4	14.8	12.4	100	109	119	129	138	141.6	13.6	9.6	124	132	142	151	159
SASKATOONSRC	SK	111.6	15.2	13.6	92	101	112	122	131	139.3	14.6	10.5	121	129	139	149	158
SCOTTCDA	SK	110.0	17.8	16.2	87	98	110	122	133	137.2	14.7	10.7	118	127	137	147	156
SEMANS	SK	110.8	17.8	16.0	88	99	111	123	134	139.3	17.5	12.5	117	128	139	151	162
SHAMROCK	SK	119.3	16.0	13.4	99	109	119	130	140	142.2	15.1	10.6	123	132	142	152	162
SHAUNAVON2	SK	109.3	15.2	13.9	90	99	109	120	129	138.8	17.1	12.3	117	127	139	150	161
SWIFTCURRENT_CDA	SK	118.6	17.0	14.3	97	107	119	130	140	141.2	17.2	12.2	119	130	141	153	163
SWIFTCURRENTA	SK	117.5	19.6	16.7	92	104	118	131	143	139.8	18.7	13.4	116	127	140	152	164
TREELON	SK	116.0	16.6	14.3	95	105	116	127	137	141.6	16.3	11.5	121	131	142	153	163
TUGASKE	SK	112.0	20.0	17.8	86	99	112	125	138	139.6	16.6	11.9	118	128	140	151	161
VALMARIE	SK	96.3	22.1	23.0	68	81	96	111	125	127.6	12.5	9.8	112	119	128	136	144
WASECA	SK	110.1	18.3	16.6	87	98	110	122	134	138.9	16.0	11.5	118	128	139	150	159
WASKESIULAKE	SK	93.6	27.4	29.2	59	75	94	112	129	127.1	23.9	18.8	96	111	127	143	158
WATROUS	SK	112.3	15.5	13.8	92	102	112	123	132	140.9	13.8	9.8	123	132	141	150	159
WESTPOPLAR_RIVER	SK	92.7	19.1	20.6	68	80	93	106	117	122.3	18.2	14.9	99	110	122	135	146
WEYBURN	SK	116.4	15.7	13.5	96	106	116	127	137	145.2	16.8	11.6	124	134	145	157	167
WHITESAND_DAM	SK	105.9	17.1	16.2	84	94	106	117	128	127.1	11.1	8.7	113	120	127	135	141
WHITEWOOD	SK	108.8	17.0	15.7	87	97	109	120	131	133.4	18.2	13.6	110	121	133	146	157
WILLOWCREEK2	SK	99.0	15.2	15.3	80	89	99	109	118	131.0	15.9	12.1	111	120	131	142	151
WYNYARD	SK	116.5	16.6	14.2	95	105	116	128	138	139.2	15.1	10.8	120	129	139	149	159
YELLOWGRASS	SK	113.3	16.6	14.6	92	102	113	124	134	135.5	19.3	14.2	111	122	135	148	160
YORKTONA	SK	117.0	16.9	14.4	95	106	117	128	139	137.4	18.0	13.1	114	125	137	150	160
ALTONA	MB	132.5	10.9	8.2	119	125	132	140	146	157.7	15.7	10.0	138	147	158	168	178

Station Name	Prov	Risk of Frost Free Days of 0°C								Risk of Frost Free Days of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
ARBORG	MB	104.6	14.4	13.8	86	95	105	114	123	128.0	13.9	10.9	110	119	128	137	146
ASHERN	MB	84.5	18.4	21.8	61	72	84	97	108	114.8	16.4	14.3	94	104	115	126	136
BALDUR	MB	117.5	15.3	13.0	98	107	117	128	137	139.0	15.1	10.9	120	129	139	149	158
BEAUSEJOUR2	MB	112.2	18.1	16.1	89	100	112	124	135	133.9	18.6	13.9	110	121	134	146	158
BINSCARTH	MB	105.0	18.5	17.6	81	93	105	117	129	132.7	19.6	14.8	108	120	133	146	158
BIRCHRIVER	MB	97.4	19.2	19.7	73	84	97	110	122	125.9	14.6	11.6	107	116	126	136	145
BIRTLE	MB	100.6	19.2	19.1	76	88	101	114	125	131.5	15.1	11.5	112	121	132	142	151
BISSETT	MB	97.8	17.9	18.4	75	86	98	110	121	130.8	14.5	11.1	112	121	131	141	149
BRANDONA	MB	115.8	16.4	14.1	95	105	116	127	137	135.5	15.1	11.2	116	125	136	146	155
BRANDONCDA	MB	109.0	16.0	14.7	88	98	109	120	129	136.5	15.2	11.1	117	126	136	147	156
BROADVALLEY	MB	109.7	16.1	14.7	89	99	110	121	130	137.8	17.2	12.5	116	126	138	149	160
CHURCHILLA	MB	77.3	22.8	29.5	48	62	77	93	106	109.4	14.1	12.9	91	100	109	119	127
CROSSLAKE_JENPEG	MB	116.3	14.4	12.4	98	107	116	126	135	141.0	13.0	9.2	124	132	141	150	158
CYPRESSRIVER	MB	118.8	13.7	11.5	101	110	119	128	136	140.0	14.3	10.2	122	130	140	150	158
DAUPHINA	MB	111.3	17.4	15.7	89	100	111	123	134	136.0	13.0	9.6	119	127	136	145	153
DEERWOOD	MB	128.1	11.9	9.3	113	120	128	136	143	155.5	17.2	11.1	133	144	155	167	178
DELORAINE	MB	122.5	15.2	12.4	103	112	122	133	142	142.1	15.5	10.9	122	132	142	153	162
DELTA_UNIVERSITYFS	MB	125.8	14.3	11.4	107	116	126	135	144	148.4	13.4	9.0	131	139	148	157	165
ELMCREEK	MB	118.0	13.9	11.8	100	109	118	127	136	143.5	11.9	8.3	128	135	143	152	159
EMERSON	MB	128.0	11.6	9.1	113	120	128	136	143	150.4	16.8	11.2	129	139	150	162	172
FALCONLAKE_TCPL45	MB	90.6	21.9	24.2	63	76	91	105	119	122.6	11.8	9.6	107	115	123	131	138
FISHERBRANCHS	MB	101.2	13.1	13.0	84	92	101	110	118	124.7	15.9	12.7	104	114	125	135	145
FLINFLON	MB	123.8	15.4	12.4	104	113	124	134	143	150.2	12.8	8.5	134	142	150	159	167
FLINFLONA	MB	117.3	14.8	12.6	98	107	117	127	136	140.9	12.2	8.7	125	133	141	149	157
GILBERTPLAINS	MB	97.5	19.4	20.0	73	84	97	111	122	129.7	20.3	15.6	104	116	130	143	156
GILLAMA	MB	90.5	17.0	18.8	69	79	90	102	112	111.5	13.2	11.8	95	103	112	120	128
GIMLI	MB	125.1	14.7	11.7	106	115	125	135	144	147.9	10.2	6.9	135	141	148	155	161
GLADSTONE_SOUTH	MB	116.2	14.7	12.7	97	106	116	126	135	142.1	14.8	10.4	123	132	142	152	161
GLENBORO	MB	113.9	16.5	14.5	93	103	114	125	135	139.5	14.4	10.3	121	130	139	149	158
GLENLEA	MB	114.2	18.5	16.2	91	102	114	127	138	139.1	17.4	12.5	117	127	139	151	161
GRANDRAPIDS_HYDRO	MB	125.1	10.7	8.6	111	118	125	132	139	150.7	13.7	9.1	133	141	151	160	168
GRASSRIVER	MB	112.6	17.5	15.6	90	101	113	124	135	142.6	10.1	7.1	130	136	143	149	155
GREATFALLS	MB	128.2	15.1	11.8	109	118	128	138	148	156.0	15.3	9.8	136	146	156	166	176
HAMIOTA	MB	107.0	23.7	22.2	77	91	107	123	137	136.4	16.5	12.1	115	125	136	148	158
HODGSON2	MB	78.0	20.4	26.1	52	64	78	92	104	114.0	14.8	12.9	95	104	114	124	133
INDIANBAY	MB	109.5	17.2	15.7	87	98	110	121	132	134.6	15.6	11.6	115	124	135	145	155
ISLANDLAKE	MB	116.0	13.3	11.5	99	107	116	125	133	144.2	12.0	8.3	129	136	144	152	160
LANGRUTH	MB	117.6	18.0	15.3	95	105	118	130	141	144.5	14.2	9.8	126	135	145	154	163
LYNNLAKEA	MB	94.0	13.7	14.5	77	85	94	103	112	118.3	13.7	11.6	101	109	118	127	136
MACGREGOR	MB	119.4	15.2	12.7	100	109	119	130	139	149.2	15.1	10.1	130	139	149	159	169

Station Name	Prov	Risk of Frost Free Days of 0°C								Risk of Frost Free Days of -2.2°C							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
MARQUETTE	MB	126.8	10.9	8.6	113	120	127	134	141	146.7	14.3	9.8	128	137	147	156	165
MINNEDOSA	MB	94.9	19.3	20.4	70	82	95	108	120	125.9	13.9	11.0	108	116	126	135	144
MORDENCDA	MB	131.1	10.3	7.9	118	124	131	138	144	159.2	16.5	10.3	138	148	159	170	180
MYRTLE	MB	120.0	13.6	11.4	103	111	120	129	137	144.1	14.8	10.3	125	134	144	154	163
NEEPAWAWATER	MB	124.8	15.8	12.6	105	114	125	135	145	153.3	14.4	9.4	135	144	153	163	172
NIVERVILLE	MB	113.3	17.2	15.2	91	102	113	125	135	134.5	18.3	13.6	111	122	135	147	158
NORWAYHOUSEA	MB	107.2	13.0	12.1	91	98	107	116	124	130.1	13.4	10.3	113	121	130	139	147
NORWAYHOUSEF	MB	123.2	13.1	10.7	106	114	123	132	140	150.1	11.1	7.4	136	143	150	158	164
OAKNER	MB	110.8	20.1	18.1	85	97	111	124	137	136.2	14.1	10.4	118	127	136	146	154
PASQUIAPROJ_PFRA	MB	99.1	14.6	14.8	80	89	99	109	118	126.6	13.7	10.8	109	117	127	136	144
PEACEGARDENS	MB	108.6	19.1	17.6	84	96	109	122	133	130.4	14.5	11.1	112	121	130	140	149
PIERSON	MB	117.3	14.9	12.7	98	107	117	127	136	140.9	16.5	11.7	120	130	141	152	162
PINAWAWNRE	MB	111.3	14.7	13.2	92	101	111	121	130	144.2	12.5	8.7	128	136	144	153	160
PINEDOCK	MB	115.0	22.6	19.7	86	100	115	130	144	147.3	12.8	8.7	131	139	147	156	164
PINEFALLS	MB	111.5	17.3	15.5	89	100	112	123	134	148.6	15.2	10.2	129	138	149	159	168
PINEY	MB	102.3	14.6	14.2	84	92	102	112	121	136.3	18.2	13.3	113	124	136	149	160
PLUMCOULEE	MB	127.9	13.1	10.2	111	119	128	137	145	153.2	14.6	9.5	134	143	153	163	172
PORTAGELAPR	MB	128.3	14.2	11.1	110	119	128	138	146	153.0	15.0	9.8	134	143	153	163	172
PORTAGELAPR2	MB	130.8	12.0	9.1	115	123	131	139	146	154.4	16.8	10.9	133	143	154	166	176
RATHWELL	MB	118.5	14.9	12.5	99	108	118	129	138	142.2	14.4	10.1	124	132	142	152	161
ROSSBURN	MB	100.0	20.4	20.4	74	86	100	114	126	126.6	18.5	14.6	103	114	127	139	150
SELKIRK	MB	129.6	12.4	9.6	114	121	130	138	145	154.9	14.7	9.5	136	145	155	165	174
SOMERSET	MB	122.7	12.4	10.1	107	114	123	131	139	142.4	16.2	11.4	122	131	142	153	163
SPRAGUE	MB	97.8	16.2	16.6	77	87	98	109	119	130.3	13.1	10.1	114	122	130	139	147
STARBUCK	MB	109.5	17.0	15.5	88	98	110	121	131	135.3	17.0	12.6	113	124	135	147	157
STEINBACH	MB	112.1	15.0	13.4	93	102	112	122	131	133.5	16.8	12.6	112	122	134	145	155
STONEWALL	MB	113.5	15.5	13.7	94	103	113	124	133	136.1	17.9	13.2	113	124	136	148	159
STONYMTN	MB	119.6	12.9	10.8	103	111	120	128	136	145.6	15.2	10.4	126	135	146	156	165
STRATHCLAIR	MB	107.9	19.6	18.2	83	95	108	121	133	130.7	11.6	8.8	116	123	131	139	146
SWANRIVER	MB	108.8	18.2	16.7	85	97	109	121	132	139.9	18.0	12.9	117	128	140	152	163
THEPASA	MB	114.1	13.6	11.9	97	105	114	123	132	136.3	15.2	11.2	117	126	136	147	156
THOMPSONA	MB	65.4	18.0	27.5	42	53	65	78	88	97.6	14.5	14.8	79	88	98	107	116
VIRDEN	MB	121.7	12.9	10.6	105	113	122	130	138	143.6	13.3	9.2	127	135	144	153	161
VOGAR	MB	133.4	14.8	11.1	114	123	133	143	152	159.1	17.8	11.2	136	147	159	171	182
WILSONCRWEIR	MB	118.4	16.0	13.5	98	108	118	129	139	145.1	14.5	10.0	127	135	145	155	164
WINNIPEGA	MB	121.8	13.2	10.8	105	113	122	131	139	140.4	15.0	10.7	121	130	140	151	160

V. Risk of growing degree days for canola and corn heat units

Station Name	Prov	Growing Degree Days for Canola								Corn Heat Units							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
ATHABASCA2	AB	1134	148.2	13.1	944	1034	1134	1234	1324	1885	232.4	12.3	1587	1728	1885	2042	2183
BANFF	AB	876	116.2	13.3	727	798	876	955	1025	1494	186.2	12.5	1255	1369	1494	1620	1733
BEAVERLODGE_CDA	AB	1033	162.9	15.8	824	923	1033	1143	1242	1732	256.4	14.8	1403	1559	1732	1904	2060
BRIGHTVIEW	AB	1153	142.4	12.4	970	1057	1153	1249	1336	1902	236.0	12.4	1599	1743	1902	2061	2204
BROWNFIELD	AB	1200	192.3	16.0	954	1071	1200	1330	1447	1951	290.4	14.9	1579	1756	1951	2147	2324
CALDWELL	AB	1152	85.1	7.4	1043	1094	1152	1209	1261	1894	182.9	9.7	1659	1771	1894	2017	2128
CALGARYA	AB	1193	124.4	10.4	1033	1109	1193	1277	1352	1951	205.9	10.6	1687	1812	1951	2090	2215
CALMAR	AB	1198	152.7	12.8	1002	1095	1198	1301	1393	1989	250.5	12.6	1668	1821	1989	2158	2311
CAMPSIE	AB	1045	134.9	12.9	873	955	1045	1136	1218	1754	216.1	12.3	1477	1608	1754	1899	2031
CAMROSE	AB	1235	129.1	10.5	1069	1148	1235	1322	1400	2041	203.1	9.9	1781	1904	2041	2178	2302
CARDSTON	AB	1262	201.1	15.9	1004	1126	1262	1397	1519	2029	315.8	15.6	1625	1816	2029	2242	2434
CARWAY	AB	1015	134.3	13.2	843	925	1015	1106	1187	1676	215.7	12.9	1400	1531	1676	1822	1953
CLARESHOLM_WATERW	AB	1298	151.5	11.7	1104	1196	1298	1401	1493	2092	237.9	11.4	1787	1932	2092	2252	2397
CLEARDALE	AB	968	150.8	15.6	775	866	968	1070	1161	1629	236.8	14.5	1325	1469	1629	1788	1932
COLDLAKEA	AB	1233	131.3	10.6	1065	1145	1233	1322	1402	2039	211.1	10.4	1769	1897	2039	2181	2310
CONNELLY CREEK	AB	1018	168.8	16.6	801	904	1018	1131	1234	1700	262.9	15.5	1363	1523	1700	1877	2037
CORONATIONA	AB	1202	120.9	10.1	1047	1120	1202	1283	1356	1950	196.2	10.1	1699	1818	1950	2082	2202
EDMONTONA	AB	1129	144.9	12.8	943	1032	1129	1227	1315	1874	232.4	12.4	1576	1717	1874	2031	2172
EDMONTONMUN	AB	1389	146.3	10.5	1201	1290	1389	1487	1576	2287	214.2	9.4	2012	2142	2287	2431	2561
EDSONA	AB	866	132.5	15.3	697	777	866	956	1036	1476	217.3	14.7	1198	1330	1476	1623	1755
ELKPOINT	AB	1089	151.7	13.9	895	987	1089	1192	1284	1822	225.3	12.4	1533	1670	1822	1974	2110
ELMWORTHCDA	AB	970	133.3	13.7	799	880	970	1060	1141	1633	225.1	13.8	1345	1481	1633	1785	1922
EMPRESS	AB	1650	177.3	10.7	1423	1531	1650	1770	1877	2549	255.5	10.0	2222	2377	2549	2722	2877
EUREKARIVER	AB	827	140.6	17.0	646	732	827	921	1007	1425	219.5	15.4	1144	1277	1425	1573	1706
FAIRVIEW	AB	1165	135.8	11.7	991	1074	1165	1257	1339	1941	219.9	11.3	1659	1793	1941	2089	2223
FOREMOST	AB	1545	166.5	10.8	1332	1433	1545	1657	1759	2425	260.2	10.7	2092	2250	2425	2601	2759
FORESTBURG_PLANT	AB	1459	170.6	11.7	1241	1344	1459	1574	1678	2372	265.2	11.2	2032	2193	2372	2551	2712
FORT_CHIPEWYANA	AB	1028	153.1	14.9	832	925	1028	1132	1225	1712	239.6	14.0	1405	1550	1712	1873	2019
FORT_SASKATCHEWAN	AB	1246	156.7	12.6	1045	1140	1246	1351	1446	2062	245.5	11.9	1747	1896	2062	2228	2377
FORTMACLEOD	AB	1438	106.7	7.4	1302	1366	1438	1510	1575	2292	180.8	7.9	2060	2170	2292	2414	2524
FORTMCMURRAYA	AB	1156	139.9	12.1	977	1062	1156	1251	1336	1899	224.6	11.8	1611	1748	1899	2051	2187
GLEICHEN	AB	1270	166.2	13.1	1057	1158	1270	1382	1483	2025	261.4	12.9	1690	1849	2025	2201	2360
GRANDEPRAIRIEA	AB	1114	151.6	13.6	920	1012	1114	1217	1309	1850	249.6	13.5	1530	1682	1850	2018	2170
HIGHLEVELA	AB	1032	124.2	12.0	873	948	1032	1116	1191	1719	213.1	12.4	1446	1575	1719	1862	1992
HIGHRIVER	AB	961	139.0	14.5	783	868	961	1055	1139	1589	224.3	14.1	1302	1438	1589	1741	1877
JASPER	AB	962	113.4	11.8	817	886	962	1039	1108	1586	177.2	11.2	1359	1467	1586	1706	1813
LACOMBECDA	AB	1071	120.6	11.3	917	990	1071	1153	1226	1778	201.0	11.3	1520	1642	1778	1913	2035
LETHBRIDGEA	AB	1468	141.1	9.6	1287	1373	1468	1563	1649	2323	210.1	9.0	2053	2181	2323	2464	2592
LETHBRIDGECDA	AB	1484	171.9	11.6	1264	1368	1484	1600	1704	2363	259.0	11.0	2031	2189	2363	2538	2695
MANYBERRIESCDA	AB	1546	153.2	9.9	1350	1443	1546	1650	1743	2406	233.5	9.7	2107	2249	2406	2564	2705
MEDICINEHATA	AB	1693	172.0	10.2	1472	1577	1693	1809	1913	2629	259.1	9.9	2297	2455	2629	2804	2962
NOTIKEWINEAST	AB	990	119.5	12.1	837	910	990	1071	1143	1646	186.7	11.3	1407	1520	1646	1772	1886
OLDS	AB	1054	133.5	12.7	883	964	1054	1144	1225	1752	224.5	12.8	1465	1601	1752	1904	2040

Station Name	Prov	Growing Degree Days for Canola								Corn Heat Units							
		Mean	**SD**	**CV**	**10%**	**25%**	**50%**	**75%**	**90%**	**Mean**	**SD**	**CV**	**10%**	**25%**	**50%**	**75%**	**90%**
OYEN CAPPON	AB	1458	178.9	12.3	1229	1338	1458	1579	1687	2313	271.8	11.8	1964	2129	2313	2496	2661
PEACERIVERA	AB	1082	149.4	13.8	891	982	1082	1183	1274	1803	235.2	13.0	1501	1644	1803	1961	2104
PINCHERCREEKA	AB	1179	134.9	11.4	1007	1089	1179	1270	1352	1907	215.3	11.3	1631	1761	1907	2052	2183
QUEENSTOWN	AB	1378	179.3	13.0	1148	1257	1378	1499	1608	2199	282.5	12.8	1837	2008	2199	2389	2561
RANFURLY	AB	1217	161.2	13.2	1011	1108	1217	1326	1424	2012	231.0	11.5	1716	1856	2012	2168	2308
REDDEERA	AB	1055	131.6	12.5	886	966	1055	1143	1223	1747	214.0	12.2	1473	1603	1747	1891	2021
ROCKYMTN_HOUSEA	AB	929	97.3	10.5	804	863	929	995	1054	1573	156.3	9.9	1373	1468	1573	1679	1774
SION	AB	1179	181.9	15.4	946	1056	1179	1302	1412	1955	286.1	14.6	1589	1762	1955	2148	2322
STETTLERNORTH	AB	1186	171.9	14.5	966	1071	1186	1302	1407	1946	264.2	13.6	1607	1768	1946	2124	2285
SUFFIELDA	AB	1606	177.8	11.1	1378	1486	1606	1726	1834	2514	267.0	10.6	2172	2334	2514	2694	2857
TABER	AB	1569	161.7	10.3	1362	1460	1569	1678	1776	2483	251.1	10.1	2161	2313	2483	2652	2804
TROCHU TOWN	AB	1241	164.3	13.2	1031	1131	1241	1352	1452	2017	248.0	12.3	1699	1850	2017	2184	2335
VEGREVILLECDA	AB	1095	171.9	15.7	875	979	1095	1211	1316	1818	274.5	15.1	1466	1633	1818	2003	2170
VULCAN	AB	1354	154.0	11.4	1157	1251	1354	1458	1552	2167	238.7	11.0	1861	2006	2167	2328	2473
WANHAMCDAEPF	AB	1150	156.6	13.6	949	1045	1150	1256	1351	1911	247.5	13.0	1593	1744	1911	2078	2228
WATINO	AB	1306	133.9	10.2	1135	1216	1306	1396	1478	2135	213.4	10.0	1861	1991	2135	2279	2408
WHITECOURTA	AB	1012	156.8	15.5	811	907	1012	1118	1213	1696	254.2	15.0	1370	1524	1696	1867	2021
ABBEY	SK	1563	180.0	11.5	1332	1441	1563	1684	1793	2448	264.6	10.8	2109	2270	2448	2626	2787
ALSASKHARDENE	SK	1414	178.8	12.6	1185	1293	1414	1534	1643	2233	264.0	11.8	1895	2055	2233	2411	2572
AMULET	SK	1512	198.3	13.1	1258	1378	1512	1645	1766	2378	283.9	11.9	2014	2187	2378	2570	2742
ANEROID	SK	1525	183.8	12.1	1289	1401	1525	1648	1760	2335	257.4	11.0	2005	2161	2335	2508	2665
ARRAN23N	SK	1194	105.8	8.9	1059	1123	1194	1266	1330	1960	161.7	8.2	1752	1851	1960	2069	2167
ATWATER	SK	1370	149.8	10.9	1178	1269	1370	1471	1562	2204	223.5	10.1	1917	2053	2204	2354	2490
BIGGAR	SK	1396	166.2	11.9	1183	1284	1396	1508	1609	2236	254.1	11.4	1910	2065	2236	2407	2562
BROADVIEW	SK	1305	191.3	14.7	1060	1176	1305	1434	1550	2093	301.3	14.4	1706	1890	2093	2296	2479
CAMEO	SK	1121	124.4	11.1	961	1037	1121	1205	1280	1838	194.1	10.6	1590	1708	1838	1969	2087
CARLYLE	SK	1464	182.2	12.4	1230	1341	1464	1587	1698	2327	266.8	11.5	1985	2147	2327	2507	2669
CEYLON	SK	1471	196.1	13.3	1220	1339	1471	1604	1723	2322	279.9	12.1	1963	2133	2322	2511	2681
CHAPLIN	SK	1529	159.7	10.4	1324	1421	1529	1636	1733	2410	238.7	9.9	2104	2249	2410	2571	2716
CHOICELAND	SK	1256	201.5	16.0	998	1120	1256	1392	1514	2049	306.3	14.9	1656	1842	2049	2255	2441
CLAYDON	SK	1464	163.7	11.2	1254	1353	1464	1574	1674	2289	237.0	10.4	1986	2130	2289	2449	2593
CODERRE	SK	1446	181.1	12.5	1213	1323	1446	1568	1678	2256	260.0	11.5	1923	2081	2256	2432	2590
CORONACH	SK	1479	191.6	13.0	1233	1350	1479	1608	1725	2309	283.1	12.3	1946	2118	2309	2499	2671
COTE	SK	1315	179.5	13.7	1085	1194	1315	1436	1545	2126	274.7	12.9	1774	1940	2126	2311	2478
CREELAKE	SK	946	130.3	13.8	779	858	946	1034	1113	1585	189.4	12.0	1342	1457	1585	1713	1828
DAHINDA	SK	1503	179.4	11.9	1274	1383	1503	1624	1733	2379	272.2	11.4	2030	2195	2379	2563	2728
DAVIDSON	SK	1392	163.8	11.8	1182	1282	1392	1502	1602	2206	242.8	11.0	1895	2043	2206	2370	2518
DUVAL	SK	1516	182.3	12.0	1282	1393	1516	1639	1749	2429	274.9	11.3	2077	2244	2429	2614	2781
ELROSE	SK	1610	212.7	13.2	1338	1467	1610	1754	1883	2524	311.7	12.3	2124	2314	2524	2734	2923
ESTEVANA	SK	1606	190.5	11.9	1362	1477	1606	1734	1850	2514	272.5	10.8	2165	2331	2514	2698	2864
FENWOOD	SK	1334	160.6	12.0	1128	1225	1334	1442	1539	2170	240.2	11.1	1862	2008	2170	2332	2478
FERTILE	SK	1457	182.4	12.5	1223	1334	1457	1580	1691	2316	274.1	11.8	1965	2131	2316	2501	2667
GRAVELBOURG	SK	1552	164.4	10.6	1341	1441	1552	1663	1763	2408	230.2	9.6	2113	2253	2408	2563	2703
GULLLAKECDAEPF	SK	1305	188.0	14.4	1064	1179	1305	1432	1546	2059	262.0	12.7	1723	1882	2059	2235	2394
HAFFORD	SK	1246	159.7	12.8	1042	1139	1246	1354	1451	2026	252.3	12.5	1702	1856	2026	2196	2349

Station Name	Prov	Growing Degree Days for Canola								Corn Heat Units							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
HANDSWORTH	SK	1473	208.2	14.1	1207	1333	1473	1614	1740	2337	299.0	12.8	1954	2136	2337	2539	2720
HARRIS	SK	1477	154.2	10.4	1279	1373	1477	1581	1674	2331	219.1	9.4	2050	2183	2331	2478	2612
HUDSONBAYA	SK	1210	138.2	11.4	1033	1117	1210	1303	1387	1986	212.5	10.7	1713	1842	1986	2129	2258
HUMBOLDT	SK	1323	167.2	12.6	1109	1211	1323	1436	1538	2144	245.0	11.4	1830	1979	2144	2310	2458
INDIANHEAD_CDA	SK	1465	168.0	11.5	1250	1352	1465	1578	1680	2343	253.6	10.8	2018	2172	2343	2514	2668
INGEBRIGHT_LAKE	SK	1508	157.6	10.4	1306	1402	1508	1614	1710	2328	226.3	9.7	2038	2176	2328	2481	2618
ISLANDFALLS2	SK	1089	157.5	14.5	888	983	1089	1196	1291	1812	229.9	12.7	1517	1657	1812	1967	2106
KELLIHER	SK	1293	173.6	13.4	1070	1176	1293	1410	1515	2090	263.1	12.6	1753	1913	2090	2268	2427
KERROBERT	SK	1319	186.3	14.1	1081	1194	1319	1445	1558	2090	272.6	13.0	1740	1906	2090	2273	2439
KINDERSLEYA	SK	1416	172.3	12.2	1195	1300	1416	1532	1637	2261	249.1	11.0	1942	2093	2261	2429	2580
KIPLING	SK	1342	156.0	11.6	1142	1237	1342	1447	1542	2167	235.6	10.9	1865	2008	2167	2325	2469
KLINTONEL	SK	1016	230.8	22.7	720	860	1016	1172	1312	1665	337.4	20.3	1233	1438	1665	1893	2098
KUROKI	SK	1280	173.3	13.5	1058	1163	1280	1397	1502	2080	264.7	12.7	1741	1902	2080	2259	2419
LAKE ALMA	SK	1616	206.3	12.8	1351	1477	1616	1755	1880	2496	285.5	11.4	2130	2304	2496	2689	2862
LEADER2	SK	1520	165.1	10.9	1308	1409	1520	1631	1732	2370	249.9	10.5	2050	2201	2370	2538	2690
LIPTON	SK	1337	194.6	14.6	1087	1206	1337	1468	1586	2133	299.1	14.0	1749	1931	2133	2334	2516
LOONLAKE_CDAEPF	SK	1062	135.8	12.8	888	971	1062	1154	1236	1776	214.4	12.1	1501	1631	1776	1920	2051
LOSTRIVER	SK	1204	189.8	15.8	960	1076	1204	1331	1447	1962	285.0	14.5	1597	1770	1962	2154	2327
LUMSDEN	SK	1524	177.0	11.6	1297	1405	1524	1643	1751	2396	270.1	11.3	2050	2214	2396	2578	2742
MANKOTA	SK	1401	164.1	11.7	1191	1290	1401	1512	1611	2169	241.1	11.1	1860	2006	2169	2331	2478
MAPLECREEK_NORTH	SK	1601	161.8	10.1	1393	1492	1601	1710	1808	2462	240.9	9.8	2153	2300	2462	2624	2771
MARYFIELD	SK	1458	152.0	10.4	1263	1356	1458	1561	1653	2336	232.9	10.0	2037	2179	2336	2493	2634
MEADOWLAKEA	SK	1172	152.4	13.0	977	1069	1172	1275	1368	1940	248.3	12.8	1621	1772	1940	2107	2258
MELFORTCDA	SK	1288	172.5	13.4	1066	1171	1288	1404	1509	2117	243.4	11.5	1805	1953	2117	2281	2429
MIDALE	SK	1546	193.1	12.5	1298	1415	1546	1676	1793	2410	286.3	11.9	2043	2216	2410	2603	2776
MOOSEJAWA	SK	1590	179.9	11.3	1359	1468	1590	1711	1820	2491	251.1	10.1	2169	2321	2491	2660	2812
MOOSOMIN	SK	1433	193.4	13.5	1185	1302	1433	1563	1680	2299	290.1	12.6	1927	2103	2299	2494	2671
MUENSTER	SK	1314	163.3	12.4	1105	1204	1314	1424	1524	2131	251.2	11.8	1809	1961	2131	2300	2453
NIPAWIN	SK	1290	159.3	12.4	1086	1182	1290	1397	1494	2106	230.9	11.0	1810	1951	2106	2262	2402
NOKOMIS	SK	1412	169.1	12.0	1195	1298	1412	1526	1628	2255	247.6	11.0	1937	2088	2255	2422	2572
NORTH_BATTLEFORDA	SK	1380	149.6	10.8	1188	1279	1380	1480	1571	2237	227.3	10.2	1946	2084	2237	2390	2528
ORMISTON	SK	1531	172.4	11.3	1310	1415	1531	1648	1752	2409	261.4	10.9	2074	2233	2409	2585	2744
OUTLOOKPFRA	SK	1528	154.7	10.1	1330	1424	1528	1633	1727	2424	230.0	9.5	2129	2268	2424	2579	2718
OXBOW	SK	1501	179.8	12.0	1270	1379	1501	1622	1731	2380	267.0	11.2	2038	2200	2380	2560	2723
PASWEGIN	SK	1266	167.6	13.2	1051	1153	1266	1379	1481	2066	255.3	12.4	1739	1894	2066	2238	2393
PELLY	SK	1047	151.1	14.4	853	945	1047	1149	1241	1763	226.3	12.8	1473	1610	1763	1916	2053
PENNANT	SK	1526	161.4	10.6	1319	1417	1526	1634	1732	2391	241.1	10.1	2082	2228	2391	2553	2700
PILGER	SK	1366	165.7	12.1	1154	1255	1366	1478	1579	2220	252.3	11.4	1897	2050	2220	2390	2543
PRINCEALBERTA	SK	1246	165.4	13.3	1034	1134	1246	1357	1458	2040	253.2	12.4	1716	1869	2040	2211	2365
REGINAA	SK	1495	179.0	12.0	1266	1375	1495	1616	1725	2364	266.4	11.3	2023	2185	2364	2544	2706
REGINACDA	SK	1372	185.2	13.5	1134	1247	1372	1497	1609	2158	286.9	13.3	1790	1964	2158	2351	2526
ROCANVILLE	SK	1476	156.2	10.6	1276	1371	1476	1582	1677	2352	244.1	10.4	2039	2187	2352	2516	2665
ROSETOWN	SK	1389	199.5	14.4	1133	1254	1389	1523	1644	2191	304.5	13.9	1801	1986	2191	2397	2582
SASKATOONA	SK	1445	169.7	11.7	1228	1331	1445	1560	1663	2309	250.5	10.9	1988	2140	2309	2478	2630
SASKATOONSRC	SK	1439	161.3	11.2	1232	1330	1439	1548	1646	2299	236.2	10.3	1997	2140	2299	2459	2602

Station Name	Prov	Growing Degree Days for Canola								Corn Heat Units							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
SCOTTCDA	SK	1266	138.4	10.9	1088	1172	1266	1359	1443	2052	212.6	10.4	1780	1909	2052	2196	2325
SEMANS	SK	1439	187.2	13.0	1199	1313	1439	1565	1679	2302	277.1	12.0	1947	2116	2302	2489	2657
SHAMROCK	SK	1515	147.1	9.7	1327	1416	1515	1614	1704	2374	213.2	9.0	2101	2230	2374	2518	2647
SHAUNAVON2	SK	1425	168.7	11.8	1208	1311	1425	1538	1641	2246	253.6	11.3	1921	2075	2246	2416	2571
SWIFTCURRENT_CDA	SK	1443	181.1	12.6	1211	1321	1443	1565	1675	2291	261.6	11.4	1956	2115	2291	2468	2626
SWIFTCURRENTA	SK	1419	173.4	12.2	1197	1302	1419	1536	1641	2255	258.8	11.5	1923	2080	2255	2429	2587
TREELON	SK	1507	169.2	11.2	1291	1393	1507	1622	1724	2325	242.8	10.4	2014	2161	2325	2489	2636
TUGASKE	SK	1464	173.3	11.8	1242	1348	1464	1581	1687	2314	249.3	10.8	1995	2146	2314	2482	2634
VALMARIE	SK	1405	159.3	11.3	1201	1298	1405	1512	1609	2185	231.2	10.6	1888	2029	2185	2340	2481
WASECA	SK	1254	154.1	12.3	1057	1150	1254	1358	1452	2051	244.4	11.9	1738	1886	2051	2216	2365
WASKESIULAKE	SK	1093	179.2	16.4	864	972	1093	1214	1323	1829	261.7	14.3	1493	1652	1829	2005	2164
WATROUS	SK	1409	156.5	11.1	1208	1303	1409	1514	1609	2259	235.4	10.4	1958	2101	2259	2418	2561
WESTPOPLAR_RIVER	SK	1352	187.6	13.9	1112	1226	1352	1479	1593	2109	263.0	12.5	1772	1932	2109	2286	2446
WEYBURN	SK	1570	182.0	11.6	1336	1447	1570	1692	1803	2462	267.3	10.9	2119	2282	2462	2642	2804
WHITESAND_DAM	SK	1011	147.0	14.5	823	912	1011	1111	1200	1694	225.5	13.3	1405	1542	1694	1846	1983
WHITEWOOD	SK	1329	194.6	14.6	1080	1198	1329	1460	1578	2137	293.2	13.7	1762	1940	2137	2335	2513
WILLOWCREEK2	SK	1502	173.0	11.5	1281	1386	1502	1619	1724	2282	229.7	10.1	1988	2127	2282	2437	2577
WYNYARD	SK	1353	168.5	12.5	1137	1239	1353	1467	1569	2198	261.4	11.9	1863	2022	2198	2374	2533
YELLOWGRASS	SK	1510	183.9	12.2	1274	1386	1510	1634	1745	2357	263.8	11.2	2018	2179	2357	2534	2695
YORKTONA	SK	1341	161.7	12.1	1134	1232	1341	1450	1548	2170	239.7	11.0	1863	2008	2170	2332	2477
ALTONA	MB	1680	212.8	12.7	1407	1536	1680	1823	1953	2683	283.4	10.6	2320	2492	2683	2874	3047
ARBORG	MB	1318	164.9	12.5	1106	1207	1318	1429	1529	2170	229.9	10.6	1875	2015	2170	2325	2464
ASHERN	MB	1319	155.1	11.8	1120	1214	1319	1423	1518	2153	228.1	10.6	1860	1999	2153	2306	2445
BALDUR	MB	1479	195.7	13.2	1228	1347	1479	1611	1730	2348	286.1	12.2	1982	2155	2348	2541	2715
BEAUSEJOUR2	MB	1474	194.9	13.2	1224	1343	1474	1605	1724	2369	277.1	11.7	2014	2182	2369	2556	2724
BINSCARTH	MB	1320	206.3	15.6	1056	1181	1320	1459	1585	2132	321.8	15.1	1720	1915	2132	2349	2544
BIRCHRIVER	MB	1262	162.8	12.9	1054	1152	1262	1372	1471	2055	243.9	11.9	1743	1891	2055	2220	2368
BIRTLE	MB	1349	178.7	13.3	1120	1228	1349	1469	1578	2183	271.4	12.4	1835	2000	2183	2366	2531
BISSETT	MB	1308	185.8	14.2	1070	1183	1308	1433	1546	2152	262.7	12.2	1815	1975	2152	2329	2489
BRANDONA	MB	1419	166.5	11.7	1206	1307	1419	1532	1633	2270	248.3	10.9	1951	2102	2270	2437	2588
BRANDONCDA	MB	1501	187.9	12.5	1260	1374	1501	1628	1742	2378	274.5	11.5	2026	2193	2378	2563	2730
BROADVALLEY	MB	1430	163.9	11.5	1220	1319	1430	1540	1640	2317	216.5	9.3	2040	2171	2317	2463	2595
CHURCHILLA	MB	532	112.3	21.1	388	456	532	608	676	883	188.1	21.3	642	756	883	1009	1124
CROSSLAKE_JENPEG	MB	1175	173.6	14.8	953	1058	1175	1292	1398	1975	228.4	11.6	1682	1821	1975	2128	2267
CYPRESSRIVER	MB	1536	195.6	12.7	1285	1404	1536	1668	1786	2437	280.9	11.5	2077	2248	2437	2626	2797
DAUPHINA	MB	1357	172.5	12.7	1136	1241	1357	1473	1578	2211	246.1	11.1	1896	2045	2211	2377	2526
DEERWOOD	MB	1670	219.3	13.1	1389	1522	1670	1818	1951	2668	292.7	11.0	2293	2471	2668	2866	3043
DELORAINE	MB	1585	222.1	14.0	1300	1435	1585	1734	1869	2512	325.1	12.9	2095	2293	2512	2731	2929
DELTA_UNIVERSITYFS	MB	1469	161.3	11.0	1263	1360	1469	1578	1676	2398	231.5	9.7	2101	2242	2398	2554	2695
ELMCREEK	MB	1542	228.7	14.8	1249	1388	1542	1696	1835	2457	295.2	12.0	2079	2258	2457	2656	2836
EMERSON	MB	1653	205.3	12.4	1390	1515	1653	1792	1916	2641	271.9	10.3	2293	2458	2641	2824	2990
FALCONLAKE_TCPL45	MB	1345	181.5	13.5	1113	1223	1345	1468	1578	2195	264.4	12.0	1856	2017	2195	2373	2534
FISHERBRANCHS	MB	1382	173.9	12.6	1160	1265	1382	1500	1605	2227	260.3	11.7	1893	2052	2227	2403	2561
FLINFLON	MB	1355	144.8	10.7	1169	1257	1355	1453	1541	2204	230.2	10.4	1908	2048	2204	2359	2499
FLINFLONA	MB	1229	142.3	11.6	1047	1133	1229	1325	1411	2023	220.1	10.9	1741	1874	2023	2171	2305

Station Name	Prov	Growing Degree Days for Canola								Corn Heat Units							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
GILBERTPLAINS	MB	1309	134.0	10.2	1137	1219	1309	1400	1481	2133	195.8	9.2	1882	2001	2133	2265	2384
GILLAMA	MB	810	123.1	15.2	652	726	810	893	967	1392	197.7	14.2	1139	1259	1392	1526	1646
GIMLI	MB	1353	163.7	12.1	1143	1243	1353	1463	1563	2288	218.5	9.5	2008	2141	2288	2436	2568
GLADSTONE_SOUTH	MB	1547	179.2	11.6	1318	1426	1547	1668	1777	2446	262.6	10.7	2110	2269	2446	2623	2783
GLENBORO	MB	1534	154.1	10.0	1337	1430	1534	1638	1732	2427	230.7	9.5	2132	2272	2427	2583	2723
GLENLEA	MB	1527	200.9	13.2	1269	1391	1527	1662	1784	2449	283.2	11.6	2086	2258	2449	2640	2812
GRANDRAPIDS_HYDRO	MB	1321	139.0	10.5	1143	1228	1321	1415	1500	2189	201.2	9.2	1931	2053	2189	2324	2446
GRASSRIVER	MB	1492	182.3	12.2	1258	1369	1492	1614	1725	2367	260.8	11.0	2033	2192	2367	2543	2702
GREATFALLS	MB	1517	216.4	14.3	1239	1371	1517	1662	1794	2490	297.7	12.0	2108	2289	2490	2691	2871
HAMIOTA	MB	1421	172.6	12.1	1200	1304	1421	1537	1642	2280	269.0	11.8	1935	2099	2280	2461	2625
HODGSON2	MB	1208	155.2	12.8	1009	1103	1208	1312	1407	1975	218.5	11.1	1695	1828	1975	2122	2255
INDIANBAY	MB	1351	194.4	14.4	1102	1220	1351	1482	1600	2239	282.4	12.6	1877	2049	2239	2430	2601
ISLANDLAKE	MB	1150	141.2	12.3	969	1054	1150	1245	1331	1912	210.5	11.0	1642	1770	1912	2054	2182
LANGRUTH	MB	1452	176.9	12.2	1225	1333	1452	1571	1679	2384	248.1	10.4	2066	2216	2384	2551	2702
LYNNLAKEA	MB	908	128.3	14.1	743	821	908	994	1072	1527	191.6	12.5	1282	1398	1527	1657	1773
MACGREGOR	MB	1603	185.9	11.6	1364	1477	1603	1728	1841	2541	265.8	10.5	2200	2362	2541	2720	2882
MARQUETTE	MB	1603	170.7	10.6	1384	1488	1603	1718	1822	2567	248.7	9.7	2249	2400	2567	2735	2886
MINNEDOSA	MB	1219	171.8	14.1	999	1103	1219	1335	1440	1997	261.5	13.1	1662	1820	1997	2173	2332
MORDENCDA	MB	1714	210.9	12.3	1444	1572	1714	1856	1984	2732	296.4	10.9	2352	2532	2732	2932	3112
MYRTLE	MB	1573	200.3	12.7	1317	1438	1573	1708	1830	2497	273.4	10.9	2147	2313	2497	2682	2848
NEEPAWAWATER	MB	1509	156.9	10.4	1308	1403	1509	1615	1710	2434	243.4	10.0	2122	2270	2434	2598	2746
NIVERVILLE	MB	1510	171.3	11.3	1290	1394	1510	1625	1729	2416	231.9	9.6	2118	2259	2416	2572	2713
NORWAYHOUSEA	MB	1112	136.1	12.2	938	1020	1112	1204	1287	1857	207.0	11.1	1592	1717	1857	1996	2122
NORWAYHOUSEF	MB	1268	154.8	12.2	1069	1163	1268	1372	1466	2104	218.0	10.4	1825	1957	2104	2251	2384
OAKNER	MB	1394	182.1	13.1	1161	1271	1394	1517	1627	2238	270.8	12.1	1890	2055	2238	2420	2585
PASQUIAPROJ_PFRA	MB	1216	140.3	11.5	1037	1122	1216	1311	1396	2010	203.4	10.1	1750	1873	2010	2147	2271
PEACEGARDENS	MB	1313	173.6	13.2	1090	1196	1313	1430	1535	2139	257.1	12.0	1810	1966	2139	2313	2469
PIERSON	MB	1561	176.7	11.3	1334	1442	1561	1680	1787	2443	261.7	10.7	2108	2267	2443	2620	2779
PINAWAWNRE	MB	1445	176.3	12.2	1219	1327	1445	1564	1671	2360	252.7	10.7	2036	2189	2360	2530	2684
PINEDOCK	MB	1338	167.6	12.5	1123	1225	1338	1451	1552	2259	218.1	9.7	1980	2112	2259	2407	2539
PINEFALLS	MB	1474	178.5	12.1	1246	1354	1474	1595	1703	2406	256.3	10.7	2077	2233	2406	2578	2734
PINEY	MB	1476	167.1	11.3	1262	1364	1476	1589	1690	2397	249.3	10.4	2078	2229	2397	2565	2717
PLUMCOULEE	MB	1709	209.4	12.3	1441	1568	1709	1850	1978	2698	295.2	10.9	2320	2499	2698	2897	3077
PORTAGELAPR	MB	1610	190.7	11.8	1366	1482	1610	1739	1855	2577	242.6	9.4	2267	2414	2577	2741	2888
PORTAGELAPR2	MB	1564	177.8	11.4	1336	1444	1564	1684	1792	2513	257.8	10.3	2182	2339	2513	2686	2843
RATHWELL	MB	1548	184.2	11.9	1312	1424	1548	1673	1784	2464	263.1	10.7	2127	2287	2464	2641	2801
ROSSBURN	MB	1265	181.6	14.4	1032	1142	1265	1387	1498	2059	279.3	13.6	1701	1871	2059	2247	2417
SELKIRK	MB	1585	193.6	12.2	1337	1454	1585	1715	1833	2559	274.7	10.7	2207	2374	2559	2744	2911
SOMERSET	MB	1434	189.1	13.2	1192	1306	1434	1561	1676	2315	273.2	11.8	1965	2131	2315	2499	2665
SPRAGUE	MB	1392	158.3	11.4	1189	1286	1392	1499	1595	2259	228.8	10.1	1966	2105	2259	2414	2553
STARBUCK	MB	1511	193.2	12.8	1264	1381	1511	1642	1759	2401	266.5	11.1	2060	2222	2401	2581	2743
STEINBACH	MB	1517	168.8	11.1	1300	1403	1517	1631	1733	2443	246.0	10.1	2128	2277	2443	2609	2758
STONEWALL	MB	1488	228.8	15.4	1195	1334	1488	1642	1781	2369	315.3	13.3	1964	2156	2369	2581	2773
STONYMTN	MB	1544	179.8	11.6	1314	1423	1544	1666	1775	2471	252.9	10.2	2147	2301	2471	2642	2795
STRATHCLAIR	MB	1280	181.1	14.1	1048	1158	1280	1402	1512	2097	273.7	13.1	1746	1913	2097	2282	2448

Station Name	Prov	Growing Degree Days for Canola Mean	SD	CV	10%	25%	50%	75%	90%	Corn Heat Units Mean	SD	CV	10%	25%	50%	75%	90%
SWANRIVER	MB	1374	154.1	11.2	1176	1270	1374	1478	1571	2221	232.1	10.5	1924	2065	2221	2378	2519
THEPASA	MB	1219	146.8	12.0	1031	1120	1219	1318	1407	2017	211.9	10.5	1746	1874	2017	2160	2289
THOMPSONA	MB	840	135.7	16.1	666	749	840	932	1014	1447	202.8	14.0	1187	1310	1447	1584	1707
VIRDEN	MB	1515	161.0	10.6	1308	1406	1515	1623	1721	2425	248.6	10.3	2107	2258	2425	2593	2744
VOGAR	MB	1496	163.9	11.0	1285	1385	1496	1606	1706	2492	237.1	9.5	2188	2332	2492	2652	2796
WILSONCRWEIR	MB	1486	167.2	11.3	1272	1374	1486	1599	1701	2393	245.9	10.3	2078	2227	2393	2559	2708
WINNIPEGA	MB	1531	197.3	12.9	1279	1398	1531	1664	1784	2470	265.2	10.7	2130	2291	2470	2649	2810

VI. Risk of P-Days for potato and growing degree days for forage

Station Name	Prov	P-Days for Potato Mean	SD	CV	10%	25%	50%	75%	90%	Growing Degree Days for Forage Mean	SD	CV	10%	25%	50%	75%	90%
ATHABASCA2	AB	747	90.7	12.2	630	686	747	808	863	1263	129.9	10.3	1096	1175	1263	1350	1429
BANFF	AB	561	73.1	13.0	468	512	561	611	655	1016	112.1	11.0	872	940	1016	1091	1159
BEAVERLODGE_CDA	AB	685	106.1	15.5	549	614	685	757	822	1165	141.0	12.1	984	1070	1165	1260	1346
BRIGHTVIEW	AB	756	87.9	11.6	643	697	756	815	869	1260	134.9	10.7	1087	1169	1260	1351	1433
BROWNFIELD	AB	739	108.3	14.7	600	666	739	812	878	1314	177.9	13.5	1086	1194	1314	1434	1542
CALDWELL	AB	722	67.8	9.4	636	677	722	768	809	1272	100.1	7.9	1144	1205	1272	1340	1401
CALGARYA	AB	758	79.0	10.4	657	705	758	811	859	1288	122.7	9.5	1131	1205	1288	1371	1445
CALMAR	AB	774	91.8	11.9	656	712	774	836	892	1313	141.0	10.7	1133	1218	1313	1409	1494
CAMPSIE	AB	681	82.2	12.1	575	625	681	736	786	1173	122.5	10.4	1016	1091	1173	1256	1330
CAMROSE	AB	813	81.3	10.0	709	758	813	868	917	1348	122.4	9.1	1192	1266	1348	1431	1505
CARDSTON	AB	761	119.6	15.7	608	680	761	841	914	1374	186.5	13.6	1135	1248	1374	1500	1613
CARWAY	AB	635	80.6	12.7	532	581	635	689	738	1129	134.4	11.9	957	1038	1129	1220	1301
CLARESHOLM_WATERW	AB	790	83.5	10.6	683	734	790	846	897	1389	137.6	9.9	1213	1297	1389	1482	1566
CLEARDALE	AB	634	92.3	14.6	516	572	634	697	753	1088	149.4	13.7	896	987	1088	1188	1279
COLDLAKEA	AB	800	77.1	9.6	702	748	800	852	899	1339	126.6	9.5	1177	1254	1339	1424	1501
CONNELLY CREEK	AB	647	100.3	15.5	519	580	647	715	776	1178	145.0	12.3	992	1081	1178	1276	1364
CORONATIONA	AB	747	72.7	9.7	654	698	747	796	840	1294	117.8	9.1	1143	1215	1294	1373	1445
EDMONTONA	AB	737	90.2	12.2	622	676	737	798	853	1243	142.0	11.4	1061	1147	1243	1338	1424
EDMONTONMUN	AB	900	93.0	10.3	780	837	900	962	1019	1517	122.8	8.1	1360	1434	1517	1600	1674
EDSONA	AB	569	87.6	15.4	457	510	569	628	682	1005	121.8	12.1	849	923	1005	1087	1161
ELKPOINT	AB	701	95.6	13.6	578	636	701	765	823	1204	120.7	10.0	1050	1123	1204	1286	1359
ELMWORTHCDA	AB	628	89.8	14.3	513	568	628	689	743	1087	127.8	11.8	923	1001	1087	1173	1251
EMPRESS	AB	913	82.3	9.0	807	857	913	968	1018	1736	168.4	9.7	1520	1623	1736	1850	1952
EUREKARIVER	AB	545	87.8	16.1	432	486	545	604	657	949	127.8	13.5	785	863	949	1035	1113
FAIRVIEW	AB	779	80.0	10.3	676	725	779	833	881	1312	131.9	10.1	1143	1223	1312	1401	1481
FOREMOST	AB	885	91.5	10.3	768	823	885	947	1002	1647	153.3	9.3	1450	1543	1647	1750	1843
FORESTBURG_PLANT	AB	920	100.7	11.0	791	852	920	988	1049	1568	158.0	10.1	1365	1461	1568	1674	1770
FORT_CHIPEWYANA	AB	665	91.5	13.8	548	603	665	726	782	1116	145.8	13.1	929	1017	1116	1214	1303
FORT_SASKATCHEWAN	AB	807	95.0	11.8	685	743	807	871	929	1363	133.2	9.8	1192	1273	1363	1453	1534

Station Name	Prov	P-Days for Potato								Growing Degree Days for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
FORTMACLEOD	AB	855	73.0	8.5	761	806	855	904	948	1529	99.2	6.5	1402	1462	1529	1596	1656
FORTMCMURRAYA	AB	733	83.9	11.4	626	677	733	790	841	1270	124.4	9.8	1111	1186	1270	1354	1430
GLEICHEN	AB	759	94.0	12.4	639	696	759	823	880	1372	158.9	11.6	1168	1265	1372	1479	1576
GRANDEPRAIRIEA	AB	735	98.5	13.4	608	668	735	801	861	1233	142.2	11.5	1051	1137	1233	1329	1415
HIGHLEVELA	AB	669	80.2	12.0	567	615	669	723	772	1137	114.2	10.0	991	1060	1137	1214	1284
HIGHRIVER	AB	603	86.7	14.4	492	545	603	662	714	1078	121.6	11.3	922	996	1078	1160	1234
JASPER	AB	620	72.8	11.7	527	571	620	669	714	1090	113.8	10.4	944	1013	1090	1167	1236
LACOMBECDA	AB	697	76.5	11.0	599	646	697	749	796	1179	117.0	9.9	1029	1100	1179	1258	1329
LETHBRIDGEA	AB	862	75.9	8.8	765	811	862	913	959	1553	136.8	8.8	1377	1460	1553	1645	1728
LETHBRIDGECDA	AB	888	91.8	10.3	770	826	888	949	1005	1577	159.9	10.1	1372	1469	1577	1684	1782
MANYBERRIESCDA	AB	867	81.2	9.4	763	812	867	922	971	1642	138.8	8.5	1465	1549	1642	1736	1820
MEDICINEHATA	AB	942	88.6	9.4	829	883	942	1002	1056	1775	169.3	9.5	1558	1661	1775	1889	1992
NOTIKEWINEAST	AB	635	72.0	11.3	543	587	635	684	728	1103	118.7	10.8	951	1023	1103	1183	1255
OLDS	AB	690	84.0	12.2	582	633	690	747	798	1174	124.0	10.6	1015	1091	1174	1258	1333
OYEN CAPPON	AB	862	92.9	10.8	742	799	862	924	981	1555	157.8	10.2	1352	1448	1555	1661	1757
PEACERIVERA	AB	712	87.3	12.3	601	654	712	771	824	1198	142.0	11.9	1016	1102	1198	1294	1380
PINCHERCREEKA	AB	725	84.5	11.6	617	668	725	782	834	1303	132.9	10.2	1132	1213	1303	1392	1473
QUEENSTOWN	AB	827	101.7	12.3	696	758	827	895	957	1475	171.8	11.6	1255	1359	1475	1591	1695
RANFURLY	AB	780	93.8	12.0	660	717	780	843	900	1343	131.9	9.8	1174	1254	1343	1432	1512
REDDEERA	AB	680	81.8	12.0	575	625	680	735	785	1173	123.3	10.5	1015	1090	1173	1256	1331
ROCKYMTN_HOUSEA	AB	611	67.7	11.1	524	565	611	656	698	1050	96.7	9.2	926	984	1050	1115	1174
SION	AB	771	114.6	14.9	624	694	771	848	918	1305	169.9	13.0	1087	1190	1305	1419	1523
STETTLERNORTH	AB	754	99.8	13.2	626	687	754	821	882	1298	158.9	12.2	1094	1191	1298	1405	1501
SUFFIELDA	AB	908	90.2	9.9	793	847	908	969	1024	1690	163.8	9.7	1480	1580	1690	1800	1900
TABER	AB	920	90.0	9.8	805	859	920	981	1035	1664	150.1	9.0	1471	1563	1664	1765	1856
TROCHU TOWN	AB	772	92.5	12.0	653	710	772	834	891	1365	146.4	10.7	1177	1266	1365	1464	1552
VEGREVILLECDA	AB	700	108.8	15.5	561	627	700	773	839	1209	155.4	12.9	1010	1104	1209	1314	1408
VULCAN	AB	814	85.2	10.5	704	756	814	871	923	1457	139.0	9.5	1279	1363	1457	1551	1635
WANHAMCDAEPF	AB	753	98.2	13.0	627	687	753	819	879	1268	149.8	11.8	1076	1167	1268	1369	1460
WATINO	AB	824	79.9	9.7	721	770	824	877	926	1411	126.8	9.0	1248	1325	1411	1496	1573
WHITECOURTA	AB	670	103.5	15.4	538	600	670	740	803	1149	147.8	12.9	960	1049	1149	1249	1338
ABBEY	SK	894	85.5	9.6	784	836	894	951	1003	1658	169.0	10.2	1441	1544	1658	1771	1874
ALSASKHARDENE	SK	816	91.1	11.2	699	754	816	877	932	1505	165.2	11.0	1293	1394	1505	1616	1717
AMULET	SK	865	96.1	11.1	742	800	865	930	988	1622	179.6	11.1	1392	1501	1622	1743	1852
ANEROID	SK	830	86.0	10.4	720	772	830	888	941	1619	173.0	10.7	1397	1502	1619	1735	1841
ARRAN23N	SK	740	71.1	9.6	649	692	740	788	831	1310	110.6	8.4	1168	1235	1310	1384	1451
ATWATER	SK	823	82.1	10.0	717	767	823	878	928	1481	153.9	10.4	1284	1377	1481	1585	1678
BIGGAR	SK	839	90.0	10.7	723	778	839	899	954	1494	154.8	10.4	1295	1389	1494	1598	1692
BROADVIEW	SK	781	115.6	14.8	633	703	781	859	929	1397	189.0	13.5	1155	1270	1397	1524	1639
CAMEO	SK	696	70.0	10.0	607	649	696	743	786	1222	128.0	10.5	1058	1135	1222	1308	1386

Station Name	Prov	P-Days for Potato								Growing Degree Days for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
CARLYLE	SK	856	102.8	12.0	724	787	856	925	988	1565	167.0	10.7	1351	1452	1565	1678	1779
CEYLON	SK	852	91.4	10.7	735	791	852	914	970	1574	188.3	12.0	1333	1447	1574	1701	1816
CHAPLIN	SK	887	83.3	9.4	781	831	887	944	994	1621	145.8	9.0	1434	1523	1621	1720	1808
CHOICELAND	SK	772	116.6	15.1	623	694	772	851	922	1353	178.7	13.2	1124	1232	1353	1473	1582
CLAYDON	SK	830	77.3	9.3	731	778	830	882	929	1558	154.6	9.9	1360	1454	1558	1662	1756
CODERRE	SK	821	86.4	10.5	711	763	821	880	932	1545	176.9	11.5	1318	1426	1545	1664	1772
CORONACH	SK	842	99.1	11.8	715	775	842	909	969	1578	178.6	11.3	1349	1457	1578	1698	1807
COTE	SK	784	104.0	13.3	650	714	784	854	917	1419	182.1	12.8	1186	1297	1419	1542	1653
CREELAKE	SK	628	82.6	13.2	522	572	628	684	734	1037	122.5	11.8	880	954	1037	1119	1194
DAHINDA	SK	871	95.4	11.0	749	807	871	936	993	1600	174.0	10.9	1377	1483	1600	1717	1823
DAVIDSON	SK	814	86.5	10.6	703	756	814	872	925	1484	156.8	10.6	1283	1379	1484	1590	1685
DUVAL	SK	910	97.6	10.7	785	844	910	975	1035	1628	166.0	10.2	1415	1516	1628	1740	1841
ELROSE	SK	908	102.7	11.3	777	839	908	978	1040	1700	193.8	11.4	1452	1569	1700	1831	1948
ESTEVANA	SK	909	94.5	10.4	788	845	909	973	1030	1702	178.1	10.5	1474	1582	1702	1822	1930
FENWOOD	SK	837	94.4	11.3	716	773	837	900	958	1449	157.0	10.8	1248	1343	1449	1555	1650
FERTILE	SK	852	98.9	11.6	726	786	852	919	979	1576	173.4	11.0	1354	1459	1576	1693	1798
GRAVELBOURG	SK	868	78.8	9.1	767	814	868	921	969	1645	163.6	9.9	1435	1534	1645	1755	1855
GULLLAKECDAEPF	SK	756	100.8	13.3	627	688	756	824	886	1407	154.3	11.0	1210	1303	1407	1511	1605
HAFFORD	SK	769	91.7	11.9	652	708	769	831	887	1346	154.5	11.5	1148	1242	1346	1451	1545
HANDSWORTH	SK	845	99.0	11.7	718	778	845	912	972	1563	208.0	13.3	1296	1422	1563	1703	1829
HARRIS	SK	855	72.6	8.5	762	806	855	903	947	1566	151.5	9.7	1372	1464	1566	1668	1760
HUDSONBAYA	SK	752	84.6	11.3	644	695	752	809	860	1311	131.7	10.0	1142	1222	1311	1400	1480
HUMBOLDT	SK	813	81.7	10.1	708	758	813	868	918	1435	163.8	11.4	1225	1324	1435	1545	1645
INDIANHEAD_CDA	SK	870	93.2	10.7	750	807	870	932	989	1543	164.5	10.7	1332	1432	1543	1654	1754
INGEBRIGHT_LAKE	SK	837	71.1	8.5	745	789	837	884	928	1607	148.5	9.2	1417	1507	1607	1707	1798
ISLANDFALLS2	SK	704	93.8	13.3	584	641	704	767	824	1198	144.0	12.0	1014	1101	1198	1295	1383
KELLIHER	SK	792	99.5	12.6	665	725	792	859	920	1399	164.2	11.7	1189	1288	1399	1510	1610
KERROBERT	SK	770	88.1	11.4	657	711	770	829	883	1404	176.5	12.6	1178	1285	1404	1523	1630
KINDERSLEYA	SK	836	92.2	11.0	718	774	836	898	954	1520	151.8	10.0	1325	1418	1520	1622	1715
KIPLING	SK	815	90.4	11.1	699	754	815	876	931	1455	150.9	10.4	1261	1353	1455	1556	1648
KLINTONEL	SK	619	130.5	21.1	452	531	619	707	786	1118	214.2	19.2	844	974	1118	1263	1393
KUROKI	SK	795	98.9	12.4	669	729	795	862	922	1384	172.2	12.4	1164	1268	1384	1500	1605
LAKE ALMA	SK	892	92.9	10.4	773	829	892	955	1011	1718	206.1	12.0	1454	1579	1718	1857	1982
LEADER2	SK	863	87.1	10.1	752	805	863	922	975	1613	147.4	9.1	1424	1513	1613	1712	1801
LIPTON	SK	789	111.0	14.1	647	715	789	864	932	1440	186.2	12.9	1202	1315	1440	1566	1679
LOONLAKE_CDAEPF	SK	685	89.8	13.1	570	624	685	745	800	1174	115.7	9.9	1026	1096	1174	1252	1322
LOSTRIVER	SK	744	108.3	14.6	605	671	744	817	883	1310	171.7	13.1	1090	1194	1310	1426	1530
LUMSDEN	SK	869	93.1	10.7	749	806	869	931	988	1615	161.9	10.0	1408	1506	1615	1724	1823
MANKOTA	SK	780	83.4	10.7	673	724	780	836	887	1499	154.1	10.3	1301	1395	1499	1603	1696
MAPLECREEK_NORTH	SK	874	83.2	9.5	767	817	874	930	980	1698	155.4	9.2	1499	1593	1698	1803	1897

Station Name	Prov	P-Days for Potato								Growing Degree Days for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
MARYFIELD	SK	871	86.4	9.9	760	812	871	929	981	1567	142.4	9.1	1384	1471	1567	1663	1749
MEADOWLAKEA	SK	747	97.4	13.0	622	681	747	812	871	1286	140.4	10.9	1106	1191	1286	1381	1466
MELFORTCDA	SK	800	101.4	12.7	670	731	800	868	930	1410	153.8	10.9	1213	1306	1410	1513	1607
MIDALE	SK	868	104.7	12.1	733	797	868	938	1002	1659	174.5	10.5	1436	1542	1659	1777	1883
MOOSEJAWA	SK	898	89.7	10.0	783	837	898	958	1013	1692	158.5	9.4	1489	1585	1692	1799	1895
MOOSOMIN	SK	851	111.5	13.1	708	776	851	926	994	1556	186.7	12.0	1317	1430	1556	1682	1795
MUENSTER	SK	817	90.8	11.1	700	755	817	878	933	1412	158.0	11.2	1209	1305	1412	1518	1614
NIPAWIN	SK	803	91.1	11.3	686	742	803	864	920	1390	137.4	9.9	1214	1298	1390	1483	1566
NOKOMIS	SK	834	84.2	10.1	726	777	834	890	941	1511	162.1	10.7	1303	1401	1511	1620	1719
NORTH_BATTLEFORDA	SK	852	79.9	9.4	749	798	852	905	954	1468	147.1	10.0	1279	1369	1468	1567	1656
ORMISTON	SK	875	96.1	11.0	752	811	875	940	998	1622	166.4	10.3	1408	1510	1622	1734	1835
OUTLOOKPFRA	SK	901	79.0	8.8	800	848	901	954	1002	1612	151.3	9.4	1418	1510	1612	1714	1806
OXBOW	SK	878	96.0	10.9	755	813	878	943	1001	1610	161.5	10.0	1403	1501	1610	1719	1817
PASWEGIN	SK	787	93.4	11.9	667	724	787	850	907	1372	161.0	11.7	1166	1264	1372	1481	1579
PELLY	SK	671	100.5	15.0	543	604	671	739	800	1167	145.5	12.5	981	1069	1167	1265	1354
PENNANT	SK	873	86.2	9.9	763	815	873	931	984	1618	144.2	8.9	1433	1520	1618	1715	1803
PILGER	SK	843	90.5	10.7	727	782	843	904	959	1469	149.6	10.2	1277	1368	1469	1570	1661
PRINCEALBERTA	SK	778	94.0	12.1	657	714	778	841	898	1343	156.1	11.6	1143	1238	1343	1448	1543
REGINAA	SK	863	91.3	10.6	746	802	863	925	980	1591	168.2	10.6	1375	1477	1591	1704	1806
REGINACDA	SK	787	105.0	13.3	653	716	787	858	922	1469	182.7	12.4	1235	1346	1469	1592	1703
ROCANVILLE	SK	867	94.3	10.9	746	804	867	931	988	1583	159.8	10.1	1379	1476	1583	1691	1788
ROSETOWN	SK	805	104.5	13.0	671	735	805	875	939	1476	181.2	12.3	1243	1353	1476	1598	1708
SASKATOONA	SK	859	82.7	9.6	753	803	859	914	965	1521	161.9	10.6	1313	1412	1521	1630	1728
SASKATOONSRC	SK	859	78.5	9.1	758	806	859	912	960	1522	167.2	11.0	1308	1410	1522	1635	1736
SCOTTCDA	SK	785	77.6	9.9	686	733	785	837	885	1364	132.8	9.7	1193	1274	1364	1453	1534
SEMANS	SK	854	98.4	11.5	728	788	854	920	980	1538	181.3	11.8	1305	1416	1538	1660	1770
SHAMROCK	SK	871	74.3	8.5	776	821	871	921	966	1598	140.0	8.8	1419	1504	1598	1693	1778
SHAUNAVON2	SK	826	89.2	10.8	711	766	826	886	940	1519	152.3	10.0	1323	1416	1519	1621	1714
SWIFTCURRENT_CDA	SK	850	90.1	10.6	734	789	850	910	965	1539	160.1	10.4	1334	1431	1539	1647	1744
SWIFTCURRENTA	SK	835	92.9	11.1	716	772	835	898	954	1515	156.3	10.3	1315	1410	1515	1620	1715
TREELON	SK	834	82.6	9.9	729	779	834	890	940	1605	165.9	10.3	1392	1493	1605	1716	1817
TUGASKE	SK	852	91.8	10.8	734	790	852	914	970	1560	160.5	10.3	1355	1452	1560	1669	1766
VALMARIE	SK	789	74.1	9.4	694	739	789	839	884	1503	147.7	9.8	1313	1403	1503	1602	1692
WASECA	SK	793	86.6	10.9	682	735	793	852	904	1357	148.2	10.9	1167	1257	1357	1457	1547
WASKESIULAKE	SK	716	110.5	15.4	574	642	716	791	858	1192	174.6	14.6	968	1074	1192	1310	1416
WATROUS	SK	847	85.7	10.1	737	790	847	905	957	1517	149.0	9.8	1326	1417	1517	1617	1708
WESTPOPLAR_RIVER	SK	760	87.5	11.5	648	701	760	819	872	1464	177.5	12.1	1237	1345	1464	1584	1692
WEYBURN	SK	895	95.2	10.6	773	831	895	960	1017	1677	166.7	9.9	1463	1565	1677	1789	1891
WHITESAND_DAM	SK	661	88.1	13.3	548	602	661	721	774	1125	142.2	12.6	943	1029	1125	1221	1307
WHITEWOOD	SK	798	114.6	14.3	652	721	798	876	945	1447	189.3	13.1	1204	1319	1447	1574	1689

Station Name	Prov	P-Days for Potato								Growing Degree Days for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
WILLOWCREEK2	SK	806	70.8	8.8	715	758	806	853	896	1602	163.1	10.2	1393	1492	1602	1712	1811
WYNYARD	SK	836	96.5	11.5	712	771	836	901	960	1457	165.2	11.3	1245	1345	1457	1568	1668
YELLOWGRASS	SK	846	94.8	11.2	724	782	846	909	967	1621	171.5	10.6	1401	1505	1621	1736	1841
YORKTONA	SK	819	91.6	11.2	702	757	819	881	936	1435	155.9	10.9	1235	1330	1435	1540	1635
ALTONA	MB	953	121.4	12.7	797	871	953	1035	1108	1841	162.7	8.8	1632	1731	1841	1950	2049
ARBORG	MB	805	89.4	11.1	690	745	805	865	920	1454	145.3	10.0	1268	1356	1454	1552	1640
ASHERN	MB	788	86.8	11.0	677	730	788	847	899	1424	146.5	10.3	1236	1325	1424	1523	1612
BALDUR	MB	860	105.4	12.3	725	789	860	931	995	1592	191.1	12.0	1347	1464	1592	1721	1837
BEAUSEJOUR2	MB	859	107.2	12.5	721	786	859	931	996	1627	177.9	10.9	1399	1507	1627	1747	1855
BINSCARTH	MB	794	131.1	16.5	626	706	794	883	962	1424	197.9	13.9	1170	1291	1424	1558	1678
BIRCHRIVER	MB	775	93.1	12.0	656	712	775	838	895	1371	154.0	11.2	1174	1267	1371	1475	1568
BIRTLE	MB	817	103.4	12.7	684	747	817	887	949	1443	174.8	12.1	1219	1325	1443	1561	1667
BISSETT	MB	785	101.3	12.9	655	716	785	853	915	1469	169.6	11.5	1251	1354	1469	1583	1686
BRANDONA	MB	839	89.7	10.7	724	779	839	900	954	1519	161.7	10.6	1311	1410	1519	1628	1726
BRANDONCDA	MB	865	94.5	10.9	744	801	865	929	986	1591	174.1	10.9	1368	1474	1591	1709	1815
BROADVALLEY	MB	845	94.6	11.2	724	782	845	909	966	1577	153.4	9.7	1380	1473	1577	1680	1773
CHURCHILLA	MB	343	69.8	20.3	254	296	343	390	432	537	124.8	23.2	377	453	537	622	697
CROSSLAKE_JENPEG	MB	746	104.4	14.0	612	676	746	817	880	1319	146.2	11.1	1131	1220	1319	1417	1506
CYPRESSRIVER	MB	881	99.3	11.3	753	814	881	948	1008	1662	174.3	10.5	1439	1545	1662	1780	1886
DAUPHINA	MB	807	101.4	12.6	677	739	807	876	937	1496	161.9	10.8	1288	1387	1496	1605	1703
DEERWOOD	MB	962	110.5	11.5	820	887	962	1036	1103	1794	185.0	10.3	1557	1670	1794	1919	2031
DELORAINE	MB	904	113.9	12.6	758	827	904	981	1050	1683	201.2	12.0	1425	1547	1683	1819	1941
DELTA_UNIVERSITYFS	MB	900	93.7	10.4	780	837	900	964	1021	1590	153.7	9.7	1394	1487	1590	1694	1787
ELMCREEK	MB	885	111.9	12.6	742	810	885	961	1029	1690	199.5	11.8	1434	1556	1690	1825	1946
EMERSON	MB	941	114.2	12.1	795	864	941	1018	1088	1819	154.4	8.5	1621	1715	1819	1923	2017
FALCONLAKE_TCPL45	MB	796	98.2	12.3	670	730	796	862	922	1477	162.2	11.0	1269	1367	1477	1586	1685
FISHERBRANCHS	MB	821	92.1	11.2	703	759	821	883	939	1494	167.4	11.2	1280	1382	1494	1607	1709
FLINFLON	MB	851	83.7	9.8	744	794	851	907	958	1450	136.0	9.4	1275	1358	1450	1541	1624
FLINFLONA	MB	791	82.3	10.4	686	736	791	847	897	1334	132.6	9.9	1164	1244	1334	1423	1504
GILBERTPLAINS	MB	793	79.9	10.1	691	739	793	847	896	1437	136.6	9.5	1262	1345	1437	1529	1612
GILLAMA	MB	524	71.4	13.6	432	476	524	572	615	893	130.7	14.6	725	804	893	981	1060
GIMLI	MB	836	97.3	11.6	711	770	836	901	960	1539	143.8	9.3	1354	1442	1539	1635	1723
GLADSTONE_SOUTH	MB	889	95.8	10.8	766	824	889	953	1012	1653	168.8	10.2	1437	1539	1653	1767	1869
GLENBORO	MB	879	89.6	10.2	765	819	879	940	994	1637	152.6	9.3	1441	1534	1637	1740	1832
GLENLEA	MB	886	103.1	11.6	753	816	886	955	1018	1674	184.6	11.0	1438	1550	1674	1799	1911
GRANDRAPIDS_HYDRO	MB	840	87.5	10.4	728	781	840	899	952	1436	129.7	9.0	1270	1349	1436	1524	1603
GRASSRIVER	MB	868	95.4	11.0	745	803	868	932	990	1605	175.0	10.9	1381	1487	1605	1723	1829
GREATFALLS	MB	913	127.8	14.0	749	827	913	999	1077	1693	165.5	9.8	1481	1581	1693	1805	1905
HAMIOTA	MB	844	110.9	13.1	702	769	844	919	986	1520	176.4	11.6	1294	1401	1520	1639	1746
HODGSON2	MB	724	78.4	10.8	624	672	724	777	825	1324	154.0	11.6	1127	1221	1324	1428	1522

Station Name	Prov	P-Days for Potato								Growing Degree Days for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
INDIANBAY	MB	827	110.7	13.4	685	752	827	902	969	1498	168.5	11.2	1282	1385	1498	1612	1714
ISLANDLAKE	MB	742	82.0	11.1	637	686	742	797	847	1266	135.9	10.7	1092	1174	1266	1358	1440
LANGRUTH	MB	887	103.1	11.6	755	818	887	957	1020	1592	161.0	10.1	1386	1484	1592	1701	1799
LYNNLAKEA	MB	590	79.1	13.4	489	537	590	643	691	1006	124.4	12.4	847	922	1006	1090	1165
MACGREGOR	MB	920	93.9	10.2	800	857	920	984	1041	1699	184.2	10.8	1463	1575	1699	1823	1935
MARQUETTE	MB	939	89.4	9.5	825	879	939	1000	1054	1729	162.8	9.4	1520	1619	1729	1839	1938
MINNEDOSA	MB	755	99.7	13.2	627	688	755	822	883	1331	160.7	12.1	1125	1223	1331	1440	1537
MORDENCDA	MB	984	116.2	11.8	835	906	984	1063	1133	1850	173.6	9.4	1628	1733	1850	1967	2073
MYRTLE	MB	895	108.9	12.2	755	822	895	968	1035	1720	172.0	10.0	1500	1604	1720	1836	1941
NEEPAWAWATER	MB	916	92.6	10.1	797	853	916	978	1035	1613	155.1	9.6	1414	1509	1613	1718	1812
NIVERVILLE	MB	867	105.5	12.2	732	796	867	938	1002	1639	150.1	9.2	1446	1538	1639	1740	1831
NORWAYHOUSEA	MB	715	82.0	11.5	610	660	715	771	820	1216	133.4	11.0	1045	1126	1216	1306	1387
NORWAYHOUSEF	MB	809	90.4	11.2	693	748	809	870	925	1394	132.7	9.5	1224	1304	1394	1483	1564
OAKNER	MB	828	103.1	12.5	696	759	828	898	960	1504	177.8	11.8	1276	1384	1504	1623	1731
PASQUIAPROJ_PFRA	MB	766	81.9	10.7	661	711	766	821	871	1312	126.9	9.7	1149	1226	1312	1397	1475
PEACEGARDENS	MB	797	101.4	12.7	667	729	797	866	927	1430	168.1	11.8	1215	1317	1430	1544	1646
PIERSON	MB	879	98.2	11.2	753	813	879	945	1005	1673	168.0	10.0	1457	1560	1673	1786	1888
PINAWAWNRE	MB	879	98.5	11.2	753	813	879	945	1005	1584	150.3	9.5	1391	1482	1584	1685	1776
PINEDOCK	MB	840	97.3	11.6	715	774	840	906	965	1508	143.6	9.5	1323	1411	1508	1604	1692
PINEFALLS	MB	894	103.2	11.5	762	825	894	964	1027	1594	168.4	10.6	1378	1481	1594	1708	1810
PINEY	MB	883	87.1	9.9	771	824	883	941	994	1588	175.7	11.1	1363	1469	1588	1706	1813
PLUMCOULEE	MB	959	113.5	11.8	813	882	959	1035	1104	1841	176.0	9.6	1615	1722	1841	1959	2066
PORTAGELAPR	MB	925	111.2	12.0	782	850	925	1000	1067	1750	163.2	9.3	1541	1640	1750	1860	1959
PORTAGELAPR2	MB	925	105.1	11.4	790	854	925	996	1060	1687	166.9	9.9	1473	1574	1687	1799	1900
RATHWELL	MB	892	96.8	10.9	768	827	892	957	1016	1674	179.4	10.7	1444	1553	1674	1795	1904
ROSSBURN	MB	768	115.3	15.0	620	690	768	846	916	1359	176.1	13.0	1133	1240	1359	1478	1585
SELKIRK	MB	931	98.7	10.6	804	864	931	997	1057	1747	169.8	9.7	1530	1633	1747	1862	1965
SOMERSET	MB	859	101.0	11.7	730	791	859	927	989	1559	190.0	12.2	1316	1431	1559	1687	1803
SPRAGUE	MB	829	81.1	9.8	725	775	829	884	933	1519	152.1	10.0	1324	1416	1519	1621	1714
STARBUCK	MB	863	99.6	11.5	735	796	863	930	990	1647	175.9	10.7	1422	1529	1647	1766	1873
STEINBACH	MB	890	86.8	9.8	778	831	890	948	1001	1625	166.6	10.2	1412	1513	1625	1738	1839
STONEWALL	MB	851	116.8	13.7	701	772	851	929	1000	1629	211.3	13.0	1358	1486	1629	1771	1900
STONYMTN	MB	895	95.1	10.6	773	831	895	959	1017	1686	177.9	10.6	1458	1566	1686	1806	1914
STRATHCLAIR	MB	796	105.7	13.3	660	724	796	867	931	1378	181.7	13.2	1145	1255	1378	1500	1610
SWANRIVER	MB	840	86.6	10.3	729	781	840	898	951	1474	156.9	10.6	1272	1368	1474	1579	1675
THEPASA	MB	775	87.2	11.2	663	716	775	834	887	1327	133.5	10.1	1156	1237	1327	1417	1498
THOMPSONA	MB	531	84.2	15.9	423	474	531	587	639	945	130.1	13.8	778	857	945	1033	1112
VIRDEN	MB	900	93.4	10.4	780	837	900	963	1020	1622	149.3	9.2	1431	1521	1622	1723	1813
VOGAR	MB	947	103.8	11.0	814	877	947	1017	1080	1631	134.9	8.3	1458	1540	1631	1722	1804
WILSONCRWEIR	MB	887	92.8	10.5	768	825	887	950	1006	1596	162.1	10.2	1388	1487	1596	1705	1804

Station Name	Prov	P-Days for Potato								Growing Degree Days for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
WINNIPEGA	MB	887	101.7	11.5	757	819	887	956	1018	1686	175.1	10.4	1462	1568	1686	1804	1911

VII. Risk of growing season rainfall and crop water demand for wheat

Station Name	Prov	Growing Season Rainfall for Wheat								Crop Water Demand for Wheat							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
ATHABASCA2	AB	266	70.4	26.5	176	219	266	313	356	293	15.4	5.3	313	303	293	282	273
BANFF	AB	234	65.5	28.1	150	189	234	278	318	357	19.8	5.5	383	371	357	344	332
BEAVERLODGE_CDA	AB	226	74.0	32.7	132	177	226	276	321	305	16.1	5.3	326	316	305	294	285
BRIGHTVIEW	AB	293	49.2	16.8	229	259	293	326	356	312	13.5	4.3	329	321	312	303	295
BROWNFIELD	AB	237	61.0	25.7	159	196	237	278	316	328	12.4	3.8	344	337	328	320	312
CALDWELL	AB	222	97.3	43.8	98	157	222	288	347	344	26.9	7.8	378	362	344	326	309
CALGARYA	AB	232	65.1	28.0	149	188	232	276	316	332	14.7	4.4	351	342	332	322	313
CALMAR	AB	271	46.9	17.3	211	239	271	303	331	321	15.1	4.7	341	332	321	311	302
CAMPSIE	AB	275	62.0	22.6	195	233	275	317	354	326	17.7	5.4	349	338	326	314	304
CAMROSE	AB	243	64.5	26.5	160	200	243	287	326	279	33.1	11.8	322	302	279	257	237
CARDSTON	AB	210	113.3	54.0	65	134	210	286	355	353	27.6	7.8	389	372	353	335	318
CARWAY	AB	237	112.0	47.2	94	162	237	313	381	376	13.8	3.7	394	385	376	367	358
CLARESHOLM_WATERW	AB	195	88.8	45.5	81	135	195	255	309	334	15.5	4.6	354	345	334	324	314
CLEARDALE	AB	245	76.9	31.5	146	193	245	296	343	326	19.6	6.0	351	339	326	312	300
COLDLAKEA	AB	213	51.8	24.3	146	178	213	248	279	289	15.2	5.3	308	299	289	278	269
CONNELLY CREEK	AB	232	105.6	45.6	96	161	232	303	367	356	18.0	5.1	379	368	356	344	333
CORONATIONA	AB	212	44.3	20.9	155	182	212	242	269	326	24.0	7.4	357	342	326	310	295
EDMONTONA	AB	265	51.9	19.6	198	230	265	300	331	319	19.6	6.1	344	332	319	306	294
EDMONTONMUN	AB	235	56.6	24.0	163	197	235	274	308	273	10.3	3.8	286	280	273	266	260
EDSONA	AB	355	104.6	29.4	221	285	355	426	489	340	55.8	16.4	412	378	340	303	269
ELKPOINT	AB	222	53.4	24.1	153	186	222	258	290	319	19.5	6.1	344	333	319	306	294
ELMWORTHCDA	AB	243	72.8	30.0	149	194	243	292	336	336	27.2	8.1	371	354	336	317	301
EMPRESS	AB	145	58.0	39.9	71	106	145	184	220	315	12.3	3.9	331	324	315	307	299
EUREKARIVER	AB	244	64.9	26.6	161	200	244	288	327	340	23.0	6.8	369	355	340	324	310
FAIRVIEW	AB	220	71.0	32.2	129	172	220	268	311	273	12.4	4.5	289	281	273	265	257
FOREMOST	AB	148	68.6	46.3	60	102	148	194	236	328	17.5	5.3	350	339	328	316	305
FORESTBURG_PLANT	AB	197	50.9	25.9	132	162	197	231	262	282	10.0	3.5	295	289	282	276	270
FORT_CHIPEWYANA	AB	169	51.1	30.2	104	135	169	204	235	267	19.3	7.2	292	280	267	254	242
FORT_SASKATCHEWAN	AB	236	53.6	22.7	167	200	236	272	305	298	16.8	5.6	319	309	298	287	276
FORTMACLEOD	AB	182	76.2	42.0	84	130	182	233	279	326	38.7	11.9	375	352	326	299	276
FORTMCMURRAYA	AB	224	64.5	28.8	141	180	224	267	306	296	16.9	5.7	317	307	296	284	274
GLEICHEN	AB	169	58.6	34.6	94	130	169	209	244	342	20.4	6.0	368	356	342	328	316
GRANDEPRAIRIEA	AB	220	71.9	32.7	128	171	220	268	312	302	13.7	4.5	320	312	302	293	285
HIGHLEVELA	AB	191	54.3	28.4	122	155	191	228	261	302	17.3	5.7	324	313	302	290	279
HIGHRIVER	AB	273	84.4	30.9	165	216	273	330	381	383	14.5	3.8	402	393	383	373	364
JASPER	AB	218	58.4	26.8	143	179	218	257	293	342	11.4	3.3	357	350	342	334	327
LACOMBECDA	AB	270	56.8	21.1	197	231	270	308	342	336	18.5	5.5	360	349	336	324	313
LETHBRIDGEA	AB	162	80.4	49.6	59	108	162	217	265	330	18.8	5.7	354	342	330	317	306

Station Name	Prov	Growing Season Rainfall for Wheat								Crop Water Demand for Wheat							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
LETHBRIDGECDA	AB	161	74.1	46.0	66	111	161	211	256	322	13.6	4.2	339	331	322	312	304
MANYBERRIESCDA	AB	125	44.7	35.8	67	95	125	155	182	322	15.0	4.7	341	332	322	312	303
MEDICINEHATA	AB	145	57.0	39.4	72	106	145	183	218	314	12.7	4.0	330	323	314	306	298
NOTIKEWINEAST	AB	204	58.8	28.8	129	165	204	244	280	325	19.3	5.9	350	338	325	312	300
OLDS	AB	290	85.2	29.4	180	232	290	347	399	337	14.9	4.4	356	347	337	327	318
OYEN CAPPON	AB	160	44.5	27.8	103	130	160	190	217	316	11.0	3.5	330	323	316	308	302
PEACERIVERA	AB	204	73.9	36.3	109	154	204	254	299	299	14.4	4.8	317	309	299	289	280
PINCHERCREEKA	AB	216	117.8	54.6	65	136	216	295	367	346	18.3	5.3	369	358	346	334	323
QUEENSTOWN	AB	181	68.2	37.6	94	135	181	227	269	324	19.5	6.0	349	337	324	311	299
RANFURLY	AB	225	62.5	27.8	145	183	225	267	305	300	12.8	4.3	317	309	300	292	284
REDDEERA	AB	292	72.9	25.0	198	243	292	341	385	344	17.6	5.1	366	356	344	332	321
ROCKYMTN_HOUSEA	AB	349	90.2	25.8	234	289	349	410	465	358	14.1	3.9	376	367	358	348	340
SION	AB	270	63.7	23.6	188	227	270	313	351	302	20.0	6.6	328	316	302	289	277
STETTLERNORTH	AB	257	65.7	25.6	172	212	257	301	341	322	15.6	4.8	342	332	322	311	302
SUFFIELDA	AB	134	49.9	37.2	70	101	134	168	198	320	13.3	4.2	337	329	320	311	303
TABER	AB	145	70.0	48.1	56	98	145	193	235	320	13.1	4.1	337	329	320	311	303
TROCHU TOWN	AB	221	59.8	27.0	145	181	221	262	298	312	50.5	16.2	377	346	312	278	247
VEGREVILLECDA	AB	229	56.4	24.6	157	191	229	267	301	324	17.7	5.5	346	336	324	312	301
VULCAN	AB	195	79.7	40.8	93	141	195	249	297	338	13.6	4.0	355	347	338	328	320
WANHAMCDAEPF	AB	220	81.6	37.1	115	165	220	275	324	298	19.1	6.4	323	311	298	285	274
WATINO	AB	191	61.0	32.0	113	150	191	232	269	304	12.8	4.2	321	313	304	295	288
WHITECOURTA	AB	351	81.7	23.3	246	296	351	406	455	316	21.0	6.6	343	330	316	302	289
ABBEY	SK	149	47.5	32.0	88	117	149	181	209	310	16.5	5.3	331	321	310	299	289
ALSASKHARDENE	SK	149	56.5	38.0	76	111	149	187	221	323	15.1	4.7	343	334	323	313	304
AMULET	SK	180	76.6	42.6	82	128	180	231	278	309	17.8	5.8	331	321	309	297	286
ANEROID	SK	166	50.4	30.4	101	132	166	200	230	335	19.5	5.8	360	349	335	322	310
ARRAN23N	SK	211	45.0	21.4	153	180	211	241	268	317	21.0	6.6	344	331	317	303	290
ATWATER	SK	202	60.0	29.7	125	161	202	242	279	307	16.4	5.4	328	318	307	296	286
BIGGAR	SK	169	51.9	30.7	103	134	169	204	236	301	15.9	5.3	322	312	301	291	281
BROADVIEW	SK	188	73.1	38.9	94	139	188	237	282	318	18.1	5.7	342	331	318	306	295
CAMEO	SK	215	65.7	30.5	131	171	215	260	299	322	22.7	7.1	351	337	322	307	293
CARLYLE	SK	182	64.6	35.6	99	138	182	225	264	306	17.6	5.7	328	318	306	294	283
CEYLON	SK	180	67.7	37.7	93	134	180	225	267	308	20.1	6.5	334	322	308	295	282
CHAPLIN	SK	165	70.4	42.6	75	118	165	213	256	301	20.1	6.7	326	314	301	287	275
CHOICELAND	SK	218	79.8	36.5	116	165	218	272	321	305	20.9	6.9	332	319	305	291	278
CLAYDON	SK	160	53.6	33.5	91	124	160	196	229	314	55.5	17.7	385	351	314	276	243
CODERRE	SK	176	53.7	30.6	107	139	176	212	244	321	16.9	5.3	342	332	321	309	299
CORONACH	SK	171	71.5	41.9	79	123	171	219	263	309	37.3	12.1	357	334	309	284	261
COTE	SK	204	66.8	32.7	119	159	204	249	290	314	19.0	6.0	339	327	314	301	290
CREELAKE	SK	236	70.9	30.1	145	188	236	284	327	255	21.0	8.2	282	269	255	240	228
DAHINDA	SK	190	83.5	43.9	83	134	190	246	297	309	23.3	7.5	339	325	309	294	279
DAVIDSON	SK	172	66.9	38.9	86	127	172	217	257	315	22.9	7.3	344	330	315	299	286
DUVAL	SK	187	66.4	35.5	102	142	187	232	272	280	14.7	5.2	299	290	280	270	261
ELROSE	SK	181	69.6	38.4	92	134	181	228	271	307	11.3	3.7	321	314	307	299	292
ESTEVANA	SK	181	74.1	40.8	87	132	181	231	276	305	20.4	6.7	332	319	305	292	279

Station Name	Prov	Growing Season Rainfall for Wheat								Crop Water Demand for Wheat							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
FENWOOD	SK	229	85.2	37.2	120	172	229	287	338	281	40.5	14.4	333	308	281	253	229
FERTILE	SK	196	61.1	31.2	117	155	196	237	274	305	19.2	6.3	329	318	305	292	280
GRAVELBOURG	SK	161	56.0	34.8	89	123	161	199	233	319	19.1	6.0	344	332	319	307	295
GULLLAKECDAEPF	SK	184	70.0	38.1	94	137	184	231	273	339	14.8	4.4	358	349	339	329	320
HAFFORD	SK	190	64.7	34.0	107	147	190	234	273	311	19.5	6.3	336	324	311	298	286
HANDSWORTH	SK	194	68.9	35.5	106	147	194	240	282	316	17.9	5.7	339	328	316	304	293
HARRIS	SK	177	74.9	42.3	81	127	177	228	273	316	17.3	5.5	338	328	316	304	294
HUDSONBAYA	SK	197	56.2	28.6	125	159	197	234	269	300	46.5	15.5	359	331	300	269	240
HUMBOLDT	SK	197	83.3	42.2	91	141	197	254	304	301	19.7	6.6	326	314	301	287	275
INDIANHEAD_CDA	SK	216	77.8	36.0	116	164	216	269	316	324	53.6	16.5	393	360	324	288	255
INGEBRIGHT_LAKE	SK	143	47.8	33.4	82	111	143	176	205	326	15.9	4.9	346	336	326	315	305
ISLANDFALLS2	SK	233	67.8	29.1	146	187	233	279	320	267	16.3	6.1	288	278	267	256	246
KELLIHER	SK	212	71.5	33.7	120	164	212	260	303	305	18.5	6.1	328	317	305	292	281
KERROBERT	SK	178	51.2	28.7	113	144	178	213	244	335	21.3	6.4	363	350	335	321	308
KINDERSLEYA	SK	161	49.1	30.6	98	128	161	194	224	311	13.5	4.4	328	320	311	301	293
KIPLING	SK	201	59.8	29.7	125	161	201	242	278	306	17.9	5.9	328	318	306	293	283
KLINTONEL	SK	205	80.2	39.1	103	151	205	259	308	376	22.9	6.1	405	391	376	361	347
KUROKI	SK	205	67.3	32.8	119	160	205	251	292	301	19.7	6.6	326	314	301	288	276
LAKE ALMA	SK	189	66.3	35.2	104	144	189	233	274	306	19.1	6.2	331	319	306	293	282
LEADER2	SK	154	56.7	36.8	81	116	154	192	227	308	57.5	18.7	382	347	308	269	234
LIPTON	SK	201	59.8	29.7	124	161	201	241	278	315	19.5	6.2	340	328	315	302	290
LOONLAKE_CDAEPF	SK	218	52.5	24.1	150	182	218	253	285	315	17.0	5.4	337	326	315	303	293
LOSTRIVER	SK	210	75.1	35.8	113	159	210	260	306	312	21.4	6.9	339	326	312	297	284
LUMSDEN	SK	178	78.6	44.2	77	125	178	231	278	309	16.5	5.3	330	320	309	298	288
MANKOTA	SK	153	62.4	40.9	73	111	153	195	233	340	21.0	6.2	367	354	340	326	313
MAPLECREEK_NORTH	SK	155	54.2	34.9	86	119	155	192	225	325	15.8	4.9	345	335	325	314	304
MARYFIELD	SK	195	68.8	35.3	107	149	195	242	283	301	15.6	5.2	321	311	301	290	281
MEADOWLAKEA	SK	218	55.0	25.2	148	181	218	256	289	314	24.7	7.9	346	331	314	297	282
MELFORTCDA	SK	193	68.2	35.3	106	147	193	239	281	293	17.6	6.0	316	305	293	281	270
MIDALE	SK	167	65.6	39.3	83	123	167	211	251	313	19.4	6.2	338	326	313	300	288
MOOSEJAWA	SK	177	93.3	52.6	58	114	177	240	297	303	14.5	4.8	322	313	303	294	285
MOOSOMIN	SK	213	78.9	37.1	112	160	213	266	314	295	14.6	4.9	314	305	295	285	277
MUENSTER	SK	194	72.4	37.3	101	145	194	243	287	294	19.4	6.6	318	307	294	280	269
NIPAWIN	SK	221	72.2	32.7	128	172	221	270	313	296	19.0	6.4	320	309	296	283	272
NOKOMIS	SK	184	68.3	37.2	96	138	184	230	271	309	17.1	5.5	331	320	309	297	287
NORTH_BATTLEFORDA	SK	177	43.1	24.3	122	148	177	206	232	298	14.0	4.7	316	307	298	288	280
ORMISTON	SK	166	69.2	41.7	77	119	166	213	255	302	18.8	6.2	326	315	302	289	278
OUTLOOKPFRA	SK	160	45.6	28.5	102	129	160	191	219	299	12.6	4.2	315	307	299	290	283
OXBOW	SK	181	62.3	34.4	101	139	181	223	261	306	19.0	6.2	331	319	306	294	282
PASWEGIN	SK	207	81.6	39.4	103	152	207	262	312	300	19.5	6.5	325	313	300	287	275
PELLY	SK	271	82.7	30.5	165	215	271	327	377	321	25.5	8.0	354	338	321	304	288
PENNANT	SK	167	64.4	38.6	84	123	167	210	249	311	19.2	6.2	336	324	311	298	287
PILGER	SK	201	70.9	35.3	110	153	201	249	292	299	18.1	6.0	322	311	299	287	276
PRINCEALBERTA	SK	208	70.5	33.9	118	161	208	256	299	304	27.7	9.1	340	323	304	286	269
REGINAA	SK	179	73.2	40.9	85	129	179	228	273	300	63.3	21.1	382	343	300	258	219

Station Name	Prov	Growing Season Rainfall for Wheat								Crop Water Demand for Wheat							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
REGINACDA	SK	174	68.3	39.3	87	128	174	220	262	315	22.6	7.2	344	331	315	300	287
ROCANVILLE	SK	175	63.0	36.1	94	132	175	217	255	294	17.1	5.8	315	305	294	282	272
ROSETOWN	SK	152	54.3	35.8	82	115	152	188	221	322	18.9	5.9	346	334	322	309	297
SASKATOONA	SK	166	50.5	30.5	101	132	166	200	230	301	15.1	5.0	320	311	301	291	282
SASKATOONSRC	SK	158	53.5	33.9	89	122	158	194	227	304	16.9	5.6	325	315	304	292	282
SCOTTCDA	SK	180	45.0	25.0	123	150	180	211	238	309	13.7	4.4	327	318	309	300	292
SEMANS	SK	184	75.0	40.7	88	134	184	235	280	299	14.9	5.0	318	309	299	289	280
SHAMROCK	SK	163	61.1	37.4	85	122	163	205	242	310	15.2	4.9	330	321	310	300	291
SHAUNAVON2	SK	178	63.3	35.5	97	136	178	221	259	325	16.6	5.1	347	337	325	314	304
SWIFTCURRENT_CDA	SK	168	60.9	36.3	90	127	168	209	246	307	12.9	4.2	324	316	307	298	290
SWIFTCURRENTA	SK	176	73.7	41.7	82	127	176	226	271	316	13.2	4.2	333	325	316	307	299
TREELON	SK	160	63.5	39.6	79	118	160	203	242	332	18.3	5.5	355	344	332	320	308
TUGASKE	SK	176	60.7	34.5	98	135	176	217	254	306	17.4	5.7	328	318	306	294	284
VALMARIE	SK	160	72.1	45.1	67	111	160	208	252	336	17.8	5.3	359	348	336	324	313
WASECA	SK	209	55.7	26.6	138	172	209	247	280	308	16.0	5.2	329	319	308	297	288
WASKESIULAKE	SK	235	80.9	34.5	131	180	235	290	339	295	23.4	7.9	325	311	295	280	265
WATROUS	SK	203	69.6	34.3	114	156	203	250	292	300	15.3	5.1	320	310	300	290	280
WESTPOPLAR_RIVER	SK	170	65.0	38.2	87	126	170	214	253	336	19.6	5.8	362	350	336	323	311
WEYBURN	SK	180	83.6	46.5	73	123	180	236	287	304	18.6	6.1	327	316	304	291	280
WHITESAND_DAM	SK	261	68.0	26.1	174	215	261	307	348	265	17.6	6.7	288	277	265	253	242
WHITEWOOD	SK	210	76.4	36.3	112	159	210	262	308	290	58.5	20.1	366	330	290	251	215
WILLOWCREEK2	SK	150	58.6	39.0	75	111	150	190	225	343	13.8	4.0	361	352	343	334	325
WYNYARD	SK	188	71.2	38.0	96	140	188	236	279	288	15.9	5.5	309	299	288	278	268
YELLOWGRASS	SK	185	69.3	37.5	96	138	185	231	274	317	19.2	6.0	342	330	317	304	293
YORKTONA	SK	215	74.6	34.7	119	164	215	265	310	302	19.1	6.3	326	315	302	289	277
ALTONA	MB	212	60.7	28.6	135	172	212	253	290	283	14.9	5.3	302	293	283	273	264
ARBORG	MB	217	70.3	32.4	127	170	217	264	307	294	17.6	6.0	316	306	294	282	271
ASHERN	MB	206	61.3	29.8	127	164	206	247	284	303	20.0	6.6	329	317	303	290	278
BALDUR	MB	218	82.9	38.0	112	163	218	274	325	308	19.2	6.2	332	321	308	295	283
BEAUSEJOUR2	MB	225	67.9	30.1	138	180	225	271	312	294	20.3	6.9	320	307	294	280	267
BINSCARTH	MB	225	96.7	42.9	102	160	225	291	349	312	20.5	6.6	338	326	312	298	286
BIRCHRIVER	MB	222	64.6	29.0	140	179	222	266	305	304	19.0	6.2	329	317	304	291	280
BIRTLE	MB	209	79.8	38.3	106	155	209	262	311	310	18.7	6.0	334	323	310	298	286
BISSETT	MB	227	73.9	32.5	133	178	227	277	322	296	18.7	6.3	320	309	296	284	273
BRANDONA	MB	201	78.5	39.0	101	149	201	254	302	311	17.4	5.6	333	323	311	299	289
BRANDONCDA	MB	188	78.7	41.9	87	135	188	241	289	344	50.7	14.7	409	378	344	310	279
BROADVALLEY	MB	213	85.6	40.2	103	155	213	270	322	289	18.2	6.3	313	302	289	277	266
CHURCHILLA	MB	246	61.8	25.1	167	204	246	288	325	168	27.3	16.3	203	186	168	149	133
CROSSLAKE_JENPEG	MB	196	64.6	32.9	113	152	196	240	279	244	14.5	5.9	263	254	244	234	225
CYPRESSRIVER	MB	219	68.1	31.1	132	173	219	265	307	295	14.7	5.0	314	305	295	285	276
DAUPHINA	MB	210	69.8	33.2	121	163	210	257	300	301	16.5	5.5	322	312	301	290	280
DEERWOOD	MB	213	68.9	32.3	125	167	213	259	301	280	13.1	4.7	297	289	280	271	263
DELORAINE	MB	186	52.8	28.3	119	151	186	222	254	298	15.8	5.3	318	308	298	287	278
DELTA_UNIVERSITYFS	MB	202	59.2	29.3	126	162	202	242	278	271	15.5	5.7	291	282	271	261	252
ELMCREEK	MB	200	74.3	37.1	105	150	200	250	296	281	64.9	23.1	364	325	281	237	198

Station Name	Prov	Growing Season Rainfall for Wheat								Crop Water Demand for Wheat							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
EMERSON	MB	223	70.7	31.7	132	175	223	270	313	286	15.1	5.3	305	296	286	275	266
FALCONLAKE_TCPL45	MB	254	78.1	30.7	154	202	254	307	355	308	21.4	7.0	335	322	308	293	280
FISHERBRANCHS	MB	208	69.3	33.3	119	161	208	255	297	287	59.1	20.6	363	327	287	247	211
FLINFLON	MB	185	56.8	30.7	112	147	185	223	258	248	15.2	6.1	267	258	248	237	228
FLINFLONA	MB	196	59.3	30.2	120	156	196	236	272	253	13.6	5.4	271	263	253	244	236
GILBERTPLAINS	MB	225	72.2	32.2	132	176	225	273	317	308	18.2	5.9	331	320	308	296	285
GILLAMA	MB	283	92.4	32.6	165	221	283	346	402	257	24.9	9.7	289	274	257	241	225
GIMLI	MB	204	71.6	35.1	112	156	204	252	296	270	13.5	5.0	287	279	270	261	252
GLADSTONE_SOUTH	MB	177	65.5	37.0	93	133	177	221	261	286	51.2	17.9	352	321	286	252	221
GLENBORO	MB	198	71.7	36.1	107	150	198	247	290	303	18.1	6.0	326	315	303	291	280
GLENLEA	MB	230	92.3	40.1	112	168	230	292	348	291	19.7	6.8	316	304	291	278	266
GRANDRAPIDS_HYDRO	MB	199	76.5	38.5	101	147	199	250	297	244	13.0	5.4	261	253	244	235	227
GRASSRIVER	MB	185	57.3	31.1	111	146	185	223	258	300	17.1	5.7	322	311	300	288	278
GREATFALLS	MB	215	65.1	30.3	132	171	215	259	298	259	13.1	5.1	276	268	259	250	242
HAMIOTA	MB	177	62.8	35.4	97	135	177	220	258	314	27.0	8.6	348	332	314	295	279
HODGSON2	MB	229	68.0	29.7	142	184	229	275	317	322	26.4	8.2	356	340	322	304	288
INDIANBAY	MB	258	81.0	31.4	154	204	258	313	362	292	19.0	6.5	316	305	292	279	267
ISLANDLAKE	MB	241	60.6	25.1	164	200	241	282	319	249	15.1	6.0	269	260	249	239	230
LANGRUTH	MB	201	56.6	28.2	128	163	201	239	273	270	15.8	5.9	291	281	270	260	250
LYNNLAKEA	MB	243	73.6	30.3	149	194	243	293	338	261	21.3	8.2	289	276	261	247	234
MACGREGOR	MB	199	71.3	35.9	107	151	199	247	290	296	20.1	6.8	322	309	296	282	270
MARQUETTE	MB	204	65.1	31.9	120	160	204	248	287	281	16.9	6.0	302	292	281	269	259
MINNEDOSA	MB	225	73.6	32.8	130	175	225	274	319	321	21.7	6.8	349	336	321	306	293
MORDENCDA	MB	198	75.0	37.9	102	147	198	249	294	275	12.8	4.6	292	284	275	267	259
MYRTLE	MB	206	69.4	33.6	117	160	206	253	295	299	19.1	6.4	323	311	299	286	274
NEEPAWAWATER	MB	202	84.1	41.6	95	146	202	259	310	281	14.1	5.0	299	290	281	271	263
NIVERVILLE	MB	211	63.9	30.3	129	168	211	254	293	303	20.0	6.6	329	317	303	290	278
NORWAYHOUSEA	MB	217	64.4	29.7	134	173	217	260	299	273	15.0	5.5	293	283	273	263	254
NORWAYHOUSEF	MB	197	57.9	29.4	123	158	197	236	272	240	23.4	9.7	270	256	240	224	210
OAKNER	MB	204	66.1	32.4	119	159	204	248	289	312	21.3	6.8	339	326	312	298	285
PASQUIAPROJ_PFRA	MB	199	67.7	34.0	112	153	199	244	285	287	21.1	7.3	314	301	287	273	260
PEACEGARDENS	MB	258	99.0	38.3	131	191	258	325	385	316	21.0	6.7	343	330	316	302	289
PIERSON	MB	184	62.5	33.9	104	142	184	226	264	308	18.8	6.1	332	320	308	295	284
PINAWAWNRE	MB	229	68.0	29.7	142	183	229	275	316	282	15.8	5.6	302	293	282	271	262
PINEDOCK	MB	233	94.9	40.8	111	169	233	297	354	257	22.5	8.7	286	272	257	242	229
PINEFALLS	MB	222	60.7	27.4	144	181	222	263	300	276	16.9	6.1	298	288	276	265	254
PINEY	MB	272	67.1	24.7	186	227	272	317	358	303	14.3	4.7	321	312	303	293	284
PLUMCOULEE	MB	211	76.1	36.1	113	159	211	262	308	291	18.1	6.2	315	304	291	279	268
PORTAGELAPR	MB	195	60.0	30.8	118	154	195	235	272	284	15.5	5.5	304	295	284	274	264
PORTAGELAPR2	MB	191	64.5	33.8	108	147	191	234	274	274	48.0	17.5	336	307	274	242	213
RATHWELL	MB	202	81.7	40.5	97	147	202	257	306	293	15.6	5.3	313	304	293	283	273
ROSSBURN	MB	210	65.8	31.3	126	166	210	255	295	314	22.0	7.0	342	329	314	299	286
SELKIRK	MB	223	81.5	36.6	118	168	223	278	327	267	18.5	6.9	290	279	267	254	243
SOMERSET	MB	225	83.5	37.1	118	169	225	281	332	293	14.7	5.0	312	303	293	283	274
SPRAGUE	MB	263	69.6	26.5	173	216	263	310	352	307	18.0	5.9	330	319	307	295	284

Station Name	Prov	Growing Season Rainfall for Wheat								Crop Water Demand for Wheat							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
STARBUCK	MB	233	93.6	40.1	113	170	233	296	353	305	20.2	6.6	331	319	305	291	279
STEINBACH	MB	229	64.8	28.4	145	185	229	272	312	298	18.0	6.1	321	310	298	285	275
STONEWALL	MB	215	62.7	29.2	135	173	215	258	296	297	22.3	7.5	326	312	297	282	269
STONYMTN	MB	213	78.0	36.6	113	161	213	266	313	287	20.4	7.1	313	301	287	273	261
STRATHCLAIR	MB	205	66.7	32.5	120	160	205	250	291	308	21.4	6.9	335	322	308	293	280
SWANRIVER	MB	229	73.6	32.2	134	179	229	278	323	291	15.7	5.4	311	302	291	281	271
THEPASA	MB	185	65.7	35.6	101	140	185	229	269	269	15.2	5.7	288	279	269	259	249
THOMPSONA	MB	278	77.6	27.9	179	226	278	331	378	301	24.0	8.0	332	317	301	285	270
VIRDEN	MB	183	72.2	39.5	90	134	183	231	275	295	14.6	5.0	314	305	295	285	276
VOGAR	MB	186	48.4	26.1	124	153	186	218	248	241	10.7	4.4	254	248	241	233	227
WILSONCRWEIR	MB	211	69.6	33.0	122	164	211	258	300	283	15.2	5.4	302	293	283	273	263
WINNIPEGA	MB	209	75.0	36.0	112	158	209	259	305	285	17.1	6.0	307	297	285	273	263

VIII. Risk of growing season rainfall and crop water demand for corn

Station Name	Prov	Growing Season Rainfall for Corn								Crop Water Demand for Corn							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
ATHABASCA2	AB	337	71.5	21.2	245	289	337	385	429	357	39.2	11.0	408	384	357	331	307
BANFF	AB	251	61.0	24.3	173	210	251	292	329	351	31.8	9.1	392	372	351	330	310
BEAVERLODGE_CDA	AB	289	72.1	25.0	196	240	289	337	381	343	41.6	12.1	397	371	343	315	290
BRIGHTVIEW	AB	373	70.8	19.0	282	325	373	421	464	385	31.9	8.3	426	406	385	363	344
BROWNFIELD	AB	312	67.3	21.6	225	266	312	357	398	429	36.6	8.5	476	453	429	404	382
CALDWELL	AB	303	119.3	39.3	150	223	303	384	456	402	48.0	11.9	464	435	402	370	341
CALGARYA	AB	293	66.7	22.8	207	248	293	338	378	415	29.0	7.0	452	435	415	396	378
CALMAR	AB	359	61.7	17.2	280	318	359	401	438	414	35.4	8.6	459	438	414	390	369
CAMPSIE	AB	331	55.7	16.8	259	293	331	368	402	393	38.8	9.9	442	419	393	367	343
CAMROSE	AB	319	77.7	24.3	220	267	319	372	419	362	63.3	17.5	443	404	362	319	281
CARDSTON	AB	297	116.2	39.1	148	219	297	376	446	455	40.6	8.9	507	483	455	428	403
CARWAY	AB	266	115.7	43.5	117	188	266	344	414	403	37.9	9.4	451	428	403	377	354
CLARESHOLM_WATERW	AB	265	81.6	30.9	160	209	265	320	369	463	36.2	7.8	510	488	463	439	417
CLEARDALE	AB	290	71.3	24.6	198	242	290	338	381	362	41.6	11.5	415	390	362	334	309
COLDLAKEA	AB	296	66.2	22.3	211	252	296	341	381	374	33.1	8.9	417	397	374	352	332
CONNELLY CREEK	AB	278	107.3	38.6	140	206	278	350	415	389	49.5	12.7	453	423	389	356	326
CORONATIONA	AB	273	52.4	19.2	206	238	273	308	340	429	30.6	7.1	468	450	429	409	390
EDMONTONA	AB	340	69.0	20.3	252	294	340	387	429	396	32.8	8.3	438	418	396	374	354
EDMONTONMUN	AB	340	64.0	18.9	257	296	340	383	422	376	26.8	7.1	410	394	376	358	342
EDSONA	AB	378	105.2	27.8	243	307	378	449	513	347	69.5	20.1	436	394	347	300	258
ELKPOINT	AB	282	66.1	23.4	198	238	282	327	367	398	37.5	9.4	446	423	398	373	350
ELMWORTHCDA	AB	295	70.6	23.9	205	248	295	343	386	380	45.1	11.9	438	411	380	350	322
EMPRESS	AB	204	56.9	27.9	131	166	204	243	277	500	21.0	4.2	527	514	500	486	473
EUREKARIVER	AB	269	63.3	23.5	188	227	269	312	350	353	44.8	12.7	410	383	353	323	295
FAIRVIEW	AB	295	70.4	23.9	204	247	295	342	385	324	32.3	10.0	366	346	324	303	283
FOREMOST	AB	229	75.2	32.8	133	179	229	280	326	493	33.0	6.7	536	516	493	471	451
FORESTBURG_PLANT	AB	287	56.1	19.6	215	249	287	325	359	402	29.4	7.3	440	422	402	383	365
FORT_CHIPEWYANA	AB	239	53.0	22.1	171	204	239	275	307	319	67.9	21.3	406	365	319	274	232

Station Name	Prov	Growing Season Rainfall for Corn								Crop Water Demand for Corn							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
FORT_SASKATCHEWAN	AB	314	68.6	21.8	227	268	314	361	402	395	35.4	9.0	440	419	395	371	349
FORTMACLEOD	AB	268	72.1	26.9	175	219	268	316	360	475	82.6	17.4	581	530	475	419	369
FORTMCMURRAYA	AB	319	86.9	27.3	207	260	319	377	430	373	36.7	9.8	420	398	373	348	326
GLEICHEN	AB	228	58.8	25.7	153	189	228	268	304	469	34.8	7.4	513	492	469	445	424
GRANDEPRAIRIEA	AB	289	81.7	28.3	184	233	289	344	393	368	36.7	10.0	415	393	368	344	321
HIGHLEVELA	AB	252	60.8	24.1	174	211	252	293	330	356	36.4	10.2	403	381	356	331	309
HIGHRIVER	AB	298	86.8	29.1	187	240	298	357	410	417	40.8	9.8	470	445	417	390	365
JASPER	AB	247	53.9	21.8	178	210	247	283	316	359	32.6	9.1	401	381	359	337	317
LACOMBECDA	AB	320	71.4	22.3	228	272	320	368	411	405	26.8	6.6	440	423	405	387	371
LETHBRIDGEA	AB	248	79.5	32.1	146	194	248	301	350	488	33.4	6.9	531	510	488	465	445
LETHBRIDGECDA	AB	246	67.8	27.6	159	200	246	291	332	478	33.0	6.9	520	500	478	456	436
MANYBERRIESCDA	AB	203	61.5	30.2	125	162	203	245	282	493	35.5	7.2	539	517	493	470	448
MEDICINEHATA	AB	225	73.5	32.7	130	175	225	274	319	493	20.4	4.1	520	507	493	480	467
NOTIKEWINEAST	AB	256	71.2	27.8	165	208	256	304	348	388	32.7	8.4	430	410	388	366	346
OLDS	AB	327	85.6	26.2	218	270	327	385	437	379	31.4	8.3	419	400	379	358	339
OYEN CAPPON	AB	223	41.4	18.5	170	195	223	251	276	455	34.1	7.5	499	478	455	432	411
PEACERIVERA	AB	267	72.9	27.3	174	218	267	316	361	360	37.2	10.3	408	385	360	335	312
PINCHERCREEKA	AB	291	120.2	41.3	137	210	291	373	446	418	37.2	8.9	466	443	418	393	371
QUEENSTOWN	AB	256	65.8	25.7	172	212	256	300	340	460	32.2	7.0	501	481	460	438	418
RANFURLY	AB	296	72.2	24.4	203	247	296	344	388	390	37.9	9.7	439	416	390	365	341
REDDEERA	AB	340	77.1	22.7	241	288	340	392	439	407	33.8	8.3	450	430	407	384	364
ROCKYMTN_HOUSEA	AB	381	91.4	24.0	264	319	381	442	498	380	25.8	6.8	413	397	380	362	347
SION	AB	353	62.1	17.6	274	311	353	395	433	376	33.7	9.0	419	398	376	353	332
STETTLERNORTH	AB	330	71.5	21.7	238	282	330	378	422	409	34.8	8.5	454	433	409	386	365
SUFFIELDA	AB	207	59.8	28.8	131	167	207	248	284	491	24.9	5.1	523	508	491	474	459
TABER	AB	225	67.7	30.1	138	179	225	271	312	484	31.2	6.4	523	505	484	463	444
TROCHU TOWN	AB	290	77.5	26.7	191	238	290	343	390	411	73.7	17.9	506	461	411	362	317
VEGREVILLECDA	AB	297	67.9	22.9	209	251	297	342	384	414	29.8	7.2	452	434	414	394	376
VULCAN	AB	271	71.0	26.2	180	223	271	319	362	466	41.2	8.8	519	494	466	439	414
WANHAMCDAEPF	AB	300	75.1	25.0	204	249	300	351	396	369	34.7	9.4	413	392	369	345	324
WATINO	AB	286	60.5	21.2	208	245	286	327	363	425	31.4	7.4	465	446	425	404	384
WHITECOURTA	AB	400	77.7	19.4	300	347	400	452	499	357	31.4	8.8	398	379	357	336	317
ABBEY	SK	211	46.4	22.0	152	180	211	243	271	469	28.4	6.1	505	488	469	450	433
ALSASKHARDENE	SK	205	55.1	26.9	134	167	205	242	275	482	32.6	6.8	524	504	482	460	440
AMULET	SK	261	76.2	29.2	163	210	261	312	359	458	39.5	8.6	508	484	458	431	407
ANEROID	SK	242	56.0	23.1	170	205	242	280	314	515	43.0	8.3	570	544	515	486	460
ARRAN23N	SK	303	62.0	20.5	223	261	303	345	382	407	29.7	7.3	445	427	407	387	368
ATWATER	SK	300	71.4	23.8	209	252	300	348	392	433	35.4	8.2	479	457	433	409	388
BIGGAR	SK	239	58.0	24.3	165	200	239	278	314	428	31.1	7.3	468	449	428	407	388
BROADVIEW	SK	279	86.6	31.1	168	220	279	337	390	445	32.7	7.4	487	467	445	423	403
CAMEO	SK	291	69.4	23.9	202	244	291	337	380	418	28.9	6.9	455	437	418	398	381
CARLYLE	SK	290	72.5	25.0	197	241	290	339	383	445	36.2	8.1	492	470	445	421	399
CEYLON	SK	264	67.1	25.4	178	219	264	309	350	445	37.3	8.4	493	470	445	420	397
CHAPLIN	SK	240	70.8	29.5	149	192	240	288	331	447	57.5	12.8	521	486	447	409	374
CHOICELAND	SK	325	91.8	28.2	208	263	325	387	443	406	42.9	10.6	461	435	406	377	351

Station Name	Prov	Growing Season Rainfall for Corn								Crop Water Demand for Corn							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
CLAYDON	SK	229	70.7	30.9	138	181	229	276	319	464	85.7	18.5	574	521	464	406	354
CODERRE	SK	249	59.4	23.9	173	209	249	289	325	485	36.2	7.5	531	509	485	461	439
CORONACH	SK	247	74.5	30.2	151	197	247	297	342	460	65.6	14.3	544	504	460	415	376
COTE	SK	303	64.9	21.4	220	260	303	347	387	438	34.3	7.8	482	461	438	415	394
CREELAKE	SK	297	60.2	20.3	220	257	297	338	375	262	32.4	12.4	304	284	262	240	221
DAHINDA	SK	272	79.1	29.1	171	219	272	325	373	460	43.5	9.5	516	489	460	431	404
DAVIDSON	SK	250	68.1	27.3	162	204	250	295	337	454	36.5	8.0	501	479	454	430	407
DUVAL	SK	268	73.1	27.2	175	219	268	318	362	409	33.2	8.1	452	432	409	387	367
ELROSE	SK	255	62.3	24.4	175	213	255	297	335	471	23.5	5.0	501	487	471	455	441
ESTEVANA	SK	287	80.5	28.0	184	233	287	341	390	465	32.4	7.0	507	487	465	443	424
FENWOOD	SK	318	82.2	25.9	212	262	318	373	423	374	59.6	15.9	451	414	374	334	298
FERTILE	SK	310	83.8	27.0	203	254	310	366	417	451	35.7	7.9	496	475	451	426	405
GRAVELBOURG	SK	241	61.5	25.5	163	200	241	283	320	495	28.6	5.8	531	514	495	475	458
GULLLAKECDAEPF	SK	248	77.2	31.2	149	196	248	300	347	475	42.1	8.8	529	504	475	447	422
HAFFORD	SK	263	71.6	27.2	172	215	263	312	355	422	32.0	7.6	463	444	422	401	381
HANDSWORTH	SK	299	77.1	25.8	201	247	299	351	398	464	32.1	6.9	505	485	464	442	423
HARRIS	SK	260	65.7	25.2	176	216	260	305	345	476	36.1	7.6	522	500	476	451	429
HUDSONBAYA	SK	298	77.0	25.9	199	246	298	350	396	387	76.4	19.7	485	439	387	336	289
HUMBOLDT	SK	276	75.6	27.4	179	225	276	327	373	403	38.5	9.6	453	429	403	377	354
INDIANHEAD_CDA	SK	312	80.5	25.8	209	257	312	366	415	460	52.1	11.3	527	495	460	425	393
INGEBRIGHT_LAKE	SK	212	55.3	26.1	141	174	212	249	283	510	29.5	5.8	547	529	510	490	472
ISLANDFALLS2	SK	328	65.8	20.1	244	284	328	372	412	304	32.5	10.7	346	326	304	282	262
KELLIHER	SK	295	67.3	22.8	209	250	295	340	381	406	39.8	9.8	457	432	406	379	355
KERROBERT	SK	245	51.8	21.1	179	210	245	280	311	477	42.3	8.9	531	506	477	448	423
KINDERSLEYA	SK	215	46.8	21.8	155	183	215	247	275	450	32.0	7.1	491	472	450	428	409
KIPLING	SK	291	69.7	24.0	201	244	291	338	380	422	35.6	8.4	468	446	422	398	377
KLINTONEL	SK	258	83.3	32.2	152	202	258	315	365	451	39.9	8.9	502	477	451	424	399
KUROKI	SK	296	72.4	24.5	203	247	296	345	389	399	33.8	8.5	442	421	399	376	355
LAKE ALMA	SK	280	65.4	23.4	196	236	280	324	364	471	28.8	6.1	508	491	471	452	434
LEADER2	SK	225	65.1	28.9	142	181	225	269	309	470	93.1	19.8	589	533	470	407	351
LIPTON	SK	288	60.0	20.9	211	247	288	328	364	449	39.4	8.8	500	476	449	423	399
LOONLAKE_CDAEPF	SK	285	50.5	17.7	220	251	285	319	350	383	38.1	10.0	432	409	383	357	334
LOSTRIVER	SK	297	74.5	25.1	201	246	297	347	392	412	35.1	8.5	457	435	412	388	367
LUMSDEN	SK	260	81.8	31.5	155	204	260	315	364	465	51.9	11.2	532	500	465	430	399
MANKOTA	SK	210	61.3	29.2	131	169	210	251	289	511	34.2	6.7	555	534	511	488	467
MAPLECREEK_NORTH	SK	239	64.8	27.1	156	195	239	283	322	501	30.2	6.0	539	521	501	480	462
MARYFIELD	SK	306	99.6	32.5	179	239	306	373	434	434	29.6	6.8	471	454	434	414	396
MEADOWLAKEA	SK	294	67.9	23.1	207	248	294	339	381	399	36.5	9.2	445	423	399	374	352
MELFORTCDA	SK	278	61.6	22.1	199	236	278	320	357	390	35.7	9.2	435	414	390	366	344
MIDALE	SK	268	66.5	24.8	182	223	268	312	353	473	37.7	8.0	521	498	473	448	425
MOOSEJAWA	SK	262	92.8	35.4	143	199	262	324	381	464	32.3	7.0	505	486	464	442	423
MOOSOMIN	SK	338	99.1	29.4	211	271	338	404	465	418	32.7	7.8	460	440	418	396	376
MUENSTER	SK	271	69.6	25.7	182	224	271	318	360	392	35.0	8.9	437	416	392	369	348
NIPAWIN	SK	314	71.1	22.7	223	266	314	362	405	398	32.4	8.1	439	420	398	376	356

Station Name	Prov	Growing Season Rainfall for Corn								Crop Water Demand for Corn							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
NOKOMIS	SK	261	73.6	28.2	167	211	261	311	355	448	33.8	7.5	491	471	448	425	405
NORTH_BATTLEFORDA	SK	254	55.1	21.7	183	216	254	291	324	422	30.0	7.1	461	442	422	402	384
ORMISTON	SK	241	69.6	28.9	152	194	241	288	330	459	30.8	6.7	498	480	459	438	419
OUTLOOKPFRA	SK	228	42.8	18.8	173	199	228	257	283	449	29.2	6.5	486	468	449	429	411
OXBOW	SK	283	84.3	29.8	174	226	283	339	391	450	37.5	8.3	498	475	450	424	402
PASWEGIN	SK	296	83.5	28.2	189	240	296	353	403	402	35.9	8.9	448	427	402	378	356
PELLY	SK	341	77.9	22.9	241	288	341	393	441	374	31.8	8.5	414	395	374	352	333
PENNANT	SK	232	81.3	35.0	128	178	232	287	337	464	53.5	11.5	533	500	464	428	396
PILGER	SK	289	73.5	25.5	194	239	289	338	383	415	39.2	9.5	465	441	415	388	364
PRINCEALBERTA	SK	297	75.3	25.3	201	246	297	348	394	409	40.5	9.9	460	436	409	381	357
REGINAA	SK	261	87.1	33.4	149	202	261	319	372	449	93.2	20.7	569	512	449	387	330
REGINACDA	SK	249	71.6	28.8	157	200	249	297	340	473	33.9	7.2	517	496	473	450	430
ROCANVILLE	SK	287	87.1	30.4	175	228	287	345	398	432	30.3	7.0	471	453	432	412	393
ROSETOWN	SK	208	55.6	26.8	136	170	208	245	279	472	57.2	12.1	546	511	472	434	399
SASKATOONA	SK	239	48.4	20.3	177	206	239	271	301	441	31.7	7.2	482	462	441	420	400
SASKATOONSRC	SK	230	55.8	24.2	159	193	230	268	302	443	30.0	6.8	482	464	443	423	405
SCOTTCDA	SK	240	46.0	19.2	181	209	240	271	299	418	29.1	7.0	455	437	418	398	381
SEMANS	SK	268	80.8	30.2	164	213	268	322	371	435	32.0	7.3	476	457	435	413	394
SHAMROCK	SK	233	60.9	26.2	155	192	233	274	311	466	31.8	6.8	507	487	466	445	425
SHAUNAVON2	SK	242	63.6	26.3	160	199	242	285	323	473	40.6	8.6	526	501	473	446	421
SWIFTCURRENT_CDA	SK	230	66.2	28.8	145	186	230	275	315	440	38.6	8.8	490	466	440	414	391
SWIFTCURRENTA	SK	245	75.1	30.6	149	195	245	296	342	452	38.2	8.5	501	478	452	426	403
TREELON	SK	229	65.8	28.7	145	185	229	274	314	500	40.3	8.1	552	528	500	473	449
TUGASKE	SK	252	62.0	24.6	173	211	252	294	332	456	36.2	7.9	502	480	456	432	410
VALMARIE	SK	224	72.1	32.2	131	175	224	272	316	509	35.0	6.9	554	532	509	485	464
WASECA	SK	280	57.0	20.3	207	242	280	319	353	406	38.4	9.5	455	432	406	380	357
WASKESIULAKE	SK	306	77.8	25.4	206	253	306	358	406	347	32.2	9.3	389	369	347	326	306
WATROUS	SK	298	76.4	25.6	200	247	298	349	396	430	34.4	8.0	474	454	430	407	386
WESTPOPLAR_RIVER	SK	240	62.3	26.0	160	198	240	282	320	488	41.8	8.6	541	516	488	460	434
WEYBURN	SK	278	89.2	32.1	164	218	278	338	392	463	34.4	7.4	507	486	463	440	419
WHITESAND_DAM	SK	335	64.1	19.2	252	291	335	378	417	287	34.6	12.1	331	310	287	264	243
WHITEWOOD	SK	310	94.8	30.6	188	246	310	374	431	403	84.8	21.1	511	460	403	345	294
WILLOWCREEK2	SK	219	70.5	32.2	129	171	219	267	309	537	38.5	7.2	587	563	537	511	488
WYNYARD	SK	275	76.5	27.8	177	224	275	327	373	395	35.4	9.0	441	419	395	371	350
YELLOWGRASS	SK	283	73.2	25.9	189	234	283	332	377	479	37.2	7.8	527	504	479	454	432
YORKTONA	SK	310	80.5	26.0	207	256	310	364	413	416	35.2	8.5	461	440	416	392	371
ALTONA	MB	337	94.6	28.1	216	273	337	401	458	425	27.7	6.5	461	444	425	406	390
ARBORG	MB	335	93.9	28.0	215	272	335	399	456	391	36.1	9.2	437	415	391	366	344
ASHERN	MB	348	109.4	31.4	208	275	348	422	489	421	39.7	9.4	472	448	421	395	371
BALDUR	MB	348	105.8	30.4	213	277	348	419	484	450	36.2	8.0	496	474	450	425	403

Station Name	Prov	Growing Season Rainfall for Corn								Crop Water Demand for Corn							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
BEAUSEJOUR2	MB	369	84.5	22.9	261	312	369	426	477	418	41.3	9.9	471	445	418	390	365
BINSCARTH	MB	330	106.4	32.2	194	258	330	402	466	423	39.7	9.4	474	450	423	396	372
BIRCHRIVER	MB	336	75.1	22.4	239	285	336	386	432	405	38.5	9.5	454	431	405	379	355
BIRTLE	MB	322	90.4	28.0	207	262	322	383	438	431	34.2	7.9	475	454	431	408	387
BISSETT	MB	365	97.1	26.6	241	300	365	431	490	388	37.3	9.6	436	414	388	363	341
BRANDONA	MB	317	98.1	31.0	191	251	317	383	442	448	30.8	6.9	488	469	448	428	409
BRANDONCDA	MB	327	107.9	33.0	188	254	327	399	465	494	50.7	10.3	559	528	494	459	429
BROADVALLEY	MB	344	118.7	34.5	192	264	344	424	496	404	38.0	9.4	453	429	404	378	355
CHURCHILLA	MB	268	67.4	25.2	181	222	268	313	354	136	28.8	21.2	173	155	136	116	99
CROSSLAKE_JENPEG	MB	291	62.4	21.4	211	249	291	333	371	292	31.9	10.9	333	314	292	270	251
CYPRESSRIVER	MB	353	101.7	28.8	222	284	353	421	483	438	33.6	7.7	481	461	438	416	395
DAUPHINA	MB	346	103.1	29.8	213	276	346	415	478	419	36.0	8.6	465	444	419	395	373
DEERWOOD	MB	357	122.6	34.4	199	274	357	439	514	419	25.4	6.1	452	436	419	402	386
DELORAINE	MB	317	82.2	26.0	211	261	317	372	422	447	26.0	5.8	481	465	447	430	414
DELTA_UNIVERSITYFS	MB	329	89.8	27.3	214	268	329	389	444	393	26.4	6.7	427	411	393	375	359
ELMCREEK	MB	323	118.6	36.7	171	243	323	403	475	412	98.3	23.8	538	479	412	346	286
EMERSON	MB	358	96.6	27.0	235	293	358	424	482	424	29.7	7.0	462	444	424	404	386
FALCONLAKE_TCPL45	MB	389	94.1	24.2	269	326	389	453	510	416	37.7	9.0	465	442	416	391	368
FISHERBRANCHS	MB	333	72.9	21.9	239	284	333	382	426	398	85.1	21.4	507	456	398	341	289
FLINFLON	MB	315	63.9	20.3	233	271	315	358	396	323	30.5	9.4	363	344	323	303	284
FLINFLONA	MB	311	62.1	19.9	232	270	311	353	391	307	27.8	9.1	343	326	307	289	272
GILBERTPLAINS	MB	342	96.5	28.2	218	277	342	407	466	421	31.5	7.5	461	442	421	400	381
GILLAMA	MB	308	90.0	29.2	193	247	308	369	424	247	33.9	13.7	290	269	247	224	203
GIMLI	MB	341	96.7	28.4	217	276	341	406	465	360	30.5	8.5	399	380	360	339	320
GLADSTONE_SOUTH	MB	310	110.9	35.8	167	235	310	384	452	423	89.8	21.2	538	484	423	363	308
GLENBORO	MB	332	112.3	33.8	188	256	332	408	476	451	35.7	7.9	496	475	451	426	405
GLENLEA	MB	360	112.1	31.2	216	284	360	435	503	428	38.1	8.9	477	454	428	402	379
GRANDRAPIDS_HYDRO	MB	320	88.4	27.6	207	260	320	379	433	310	23.8	7.7	340	326	310	294	279
GRASSRIVER	MB	325	103.1	31.7	193	256	325	395	458	444	36.8	8.3	491	469	444	419	397
GREATFALLS	MB	338	78.3	23.2	238	285	338	391	438	360	34.0	9.5	403	382	360	337	316
HAMIOTA	MB	288	87.5	30.4	176	229	288	347	400	447	32.6	7.3	489	469	447	425	405
HODGSON2	MB	351	107.3	30.6	213	278	351	423	488	421	34.5	8.2	465	444	421	398	377
INDIANBAY	MB	393	102.4	26.1	262	324	393	462	524	390	36.4	9.3	437	415	390	365	343
ISLANDLAKE	MB	353	63.5	18.0	272	310	353	396	434	280	26.7	9.5	315	299	280	262	246
LANGRUTH	MB	338	99.5	29.4	211	271	338	405	466	381	30.6	8.0	421	402	381	361	342
LYNNLAKEA	MB	306	75.1	24.5	210	255	306	357	402	265	31.0	11.7	305	286	265	244	226
MACGREGOR	MB	336	111.1	33.0	194	261	336	411	479	437	41.3	9.4	490	465	437	410	385
MARQUETTE	MB	349	94.6	27.1	228	286	349	413	471	415	28.8	6.9	451	434	415	395	378
MINNEDOSA	MB	317	85.1	26.8	208	260	317	375	426	408	37.3	9.1	456	433	408	383	360
MORDENCDA	MB	340	116.0	34.1	192	262	340	418	489	409	25.8	6.3	442	426	409	392	376

Station Name	Prov	Growing Season Rainfall for Corn								Crop Water Demand for Corn							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
MYRTLE	MB	332	91.6	27.6	214	270	332	394	449	448	37.0	8.3	495	473	448	423	400
NEEPAWAWATER	MB	342	119.0	34.8	189	262	342	422	494	405	24.7	6.1	437	422	405	389	374
NIVERVILLE	MB	326	94.2	28.9	205	262	326	389	447	451	34.2	7.6	494	474	451	427	407
NORWAYHOUSEA	MB	310	57.2	18.5	236	271	310	348	383	316	29.3	9.3	354	336	316	296	278
NORWAYHOUSEF	MB	300	70.7	23.6	209	252	300	348	390	293	41.8	14.3	346	321	293	264	239
OAKNER	MB	318	89.0	28.0	204	258	318	378	432	440	33.5	7.6	483	463	440	418	397
PASQUIAPROJ_PFRA	MB	305	67.0	22.0	219	260	305	350	391	370	35.6	9.6	416	394	370	346	324
PEACEGARDENS	MB	373	126.6	33.9	211	288	373	458	535	417	36.2	8.7	464	442	417	393	371
PIERSON	MB	300	79.4	26.5	198	246	300	353	401	471	29.6	6.3	509	491	471	451	433
PINAWAWNRE	MB	369	87.3	23.7	257	310	369	428	481	387	34.1	8.8	430	410	387	364	343
PINEDOCK	MB	382	89.9	23.6	266	321	382	442	497	332	36.0	10.8	378	356	332	308	286
PINEFALLS	MB	378	89.0	23.6	264	318	378	438	492	384	32.8	8.5	426	406	384	362	342
PINEY	MB	427	98.2	23.0	301	361	427	493	553	434	25.9	6.0	467	452	434	417	401
PLUMCOULEE	MB	348	102.0	29.3	217	279	348	416	478	442	32.6	7.4	484	464	442	420	400
PORTAGELAPR	MB	346	103.6	30.0	213	276	346	415	478	425	25.6	6.0	457	442	425	407	392
PORTAGELAPR2	MB	326	119.1	36.5	173	246	326	406	479	404	76.1	18.8	502	455	404	353	306
RATHWELL	MB	334	105.2	31.5	199	263	334	405	469	435	31.6	7.3	475	456	435	413	394
ROSSBURN	MB	329	100.2	30.5	200	261	329	396	457	420	33.2	7.9	463	443	420	398	378
SELKIRK	MB	358	96.9	27.1	233	292	358	423	482	387	33.6	8.7	430	409	387	364	344
SOMERSET	MB	351	106.7	30.4	214	279	351	423	488	409	36.1	8.8	456	434	409	385	363
SPRAGUE	MB	405	89.0	22.0	291	345	405	465	519	424	35.3	8.3	470	448	424	401	379
STARBUCK	MB	364	110.1	30.2	223	290	364	438	505	451	39.3	8.7	501	477	451	424	400
STEINBACH	MB	373	94.8	25.4	252	309	373	437	495	429	28.4	6.6	465	448	429	409	392
STONEWALL	MB	342	90.1	26.3	227	281	342	403	458	435	33.6	7.7	478	458	435	412	392
STONYMTN	MB	341	101.8	29.8	211	273	341	410	472	419	33.1	7.9	461	441	419	397	377
STRATHCLAIR	MB	300	88.3	29.5	186	240	300	359	413	408	35.5	8.7	454	432	408	384	363
SWANRIVER	MB	348	69.5	20.0	259	302	348	395	438	405	31.4	7.7	445	426	405	384	365
THEPASA	MB	294	61.7	21.0	215	252	294	335	373	333	29.6	8.9	371	353	333	313	295
THOMPSONA	MB	333	77.9	23.4	233	280	333	385	432	310	35.9	11.6	356	334	310	286	264
VIRDEN	MB	304	96.7	31.8	180	239	304	369	428	433	29.4	6.8	471	453	433	413	395
VOGAR	MB	325	100.5	30.9	196	257	325	393	454	332	25.2	7.6	365	349	332	315	300
WILSONCRWEIR	MB	367	129.9	35.4	200	279	367	454	533	402	39.6	9.8	453	429	402	376	351
WINNIPEGA	MB	341	94.0	27.6	220	278	341	404	461	416	31.1	7.5	456	437	416	395	376

IX. Risk of growing season rainfall and crop water demand for forage

Station Name	Prov	Growing Season Rainfall for Forage								Crop Water Demand for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
ATHABASCA2	AB	372	79.6	21.4	270	319	372	426	474	586	46.5	7.9	646	618	586	555	527
BANFF	AB	303	63.6	20.9	222	261	303	346	385	605	44.0	7.3	662	635	605	576	549
BEAVERLODGE_CDA	AB	307	77.3	25.2	208	255	307	359	406	570	41.8	7.3	624	598	570	542	517
BRIGHTVIEW	AB	405	66.1	16.3	321	361	405	450	490	615	45.4	7.4	673	645	615	584	556
BROWNFIELD	AB	342	66.3	19.4	257	297	342	386	427	663	57.7	8.7	737	702	663	624	589
CALDWELL	AB	368	123.7	33.6	210	285	368	452	527	641	73.2	11.4	735	690	641	592	547
CALGARYA	AB	332	60.1	18.1	255	292	332	373	409	651	38.3	5.9	700	677	651	625	602
CALMAR	AB	388	61.0	15.7	310	347	388	430	467	655	52.7	8.0	723	691	655	620	588
CAMPSIE	AB	357	61.8	17.3	278	315	357	399	436	627	53.3	8.5	695	663	627	591	558
CAMROSE	AB	346	78.8	22.8	245	293	346	399	447	580	75.1	12.9	676	631	580	530	484
CARDSTON	AB	353	110.4	31.3	211	279	353	427	494	709	54.7	7.7	779	745	709	672	639
CARWAY	AB	318	105.4	33.2	183	247	318	389	453	637	52.6	8.3	704	672	637	601	569
CLARESHOLM_WATERW	AB	296	85.8	28.9	187	239	296	354	406	703	54.3	7.7	772	739	703	666	633
CLEARDALE	AB	297	78.6	26.5	196	244	297	350	398	591	46.5	7.9	651	623	591	560	532
COLDLAKEA	AB	323	62.8	19.4	243	281	323	366	404	598	40.0	6.7	649	625	598	571	546
CONNELLY CREEK	AB	337	105.3	31.3	202	266	337	408	472	634	48.7	7.7	697	667	634	602	572
CORONATIONA	AB	295	48.8	16.6	232	262	295	327	357	649	52.5	8.1	717	685	649	614	582
EDMONTONA	AB	370	71.2	19.2	279	322	370	418	461	627	43.7	7.0	683	657	627	598	571
EDMONTONMUN	AB	369	65.4	17.7	286	325	369	413	453	604	36.3	6.0	650	628	604	579	557
EDSONA	AB	416	112.2	27.0	272	340	416	492	560	592	78.7	13.3	693	645	592	539	491
ELKPOINT	AB	315	66.7	21.2	229	270	315	360	400	623	45.5	7.3	682	654	623	593	565
ELMWORTHCDA	AB	312	78.7	25.2	212	259	312	366	413	627	43.4	6.9	682	656	627	597	571
EMPRESS	AB	223	57.9	26.0	149	184	223	262	297	766	52.6	6.9	834	802	766	731	699
EUREKARIVER	AB	283	85.8	30.3	173	225	283	341	393	591	42.3	7.1	645	620	591	563	537
FAIRVIEW	AB	326	74.4	22.8	231	276	326	376	421	546	32.4	5.9	588	568	546	525	505
FOREMOST	AB	264	80.7	30.6	160	209	264	318	367	767	59.2	7.7	843	807	767	727	691
FORESTBURG_PLANT	AB	322	53.6	16.7	253	286	322	358	390	637	48.4	7.6	699	670	637	605	575
FORT_CHIPEWYANA	AB	245	54.2	22.2	175	208	245	281	314	542	160.3	29.6	747	650	542	434	337
FORT_SASKATCHEWAN	AB	340	75.0	22.1	244	289	340	391	436	621	46.5	7.5	681	652	621	590	561
FORTMACLEOD	AB	300	80.0	26.7	198	246	300	354	403	735	94.7	12.9	857	799	735	672	614
FORTMCMURRAYA	AB	332	87.1	26.3	220	273	332	390	443	606	47.5	7.8	667	638	606	574	545
GLEICHEN	AB	259	62.4	24.1	179	217	259	301	339	716	54.8	7.7	786	753	716	679	646
GRANDEPRAIRIEA	AB	304	81.3	26.7	200	249	304	359	408	595	45.4	7.6	653	626	595	564	537
HIGHLEVELA	AB	251	68.3	27.2	163	205	251	297	338	575	43.2	7.5	630	604	575	546	519
HIGHRIVER	AB	352	82.7	23.5	246	296	352	407	458	659	51.9	7.9	725	694	659	624	592
JASPER	AB	263	57.7	21.9	189	224	263	302	337	615	37.1	6.0	663	640	615	590	568
LACOMBECDA	AB	353	72.8	20.6	260	304	353	403	447	631	45.1	7.1	689	661	631	601	573

Station Name	Prov	Growing Season Rainfall for Forage								Crop Water Demand for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
LETHBRIDGEA	AB	284	102.4	36.0	153	215	284	353	415	748	51.9	6.9	814	783	748	713	681
LETHBRIDGECDA	AB	277	77.6	28.0	177	224	277	329	376	738	59.0	8.0	814	778	738	698	663
MANYBERRIESCDA	AB	230	76.7	33.3	132	179	230	282	329	748	60.0	8.0	825	789	748	708	672
MEDICINEHATA	AB	246	77.9	31.6	146	194	246	299	346	768	51.0	6.6	834	803	768	734	703
NOTIKEWINEAST	AB	256	74.4	29.1	160	205	256	306	351	617	43.9	7.1	673	646	617	587	561
OLDS	AB	372	87.1	23.4	261	314	372	431	484	600	46.6	7.8	660	631	600	569	540
OYEN CAPPON	AB	250	54.4	21.8	180	213	250	287	320	704	50.6	7.2	769	738	704	670	639
PEACERIVERA	AB	284	79.6	28.1	182	230	284	337	386	589	45.4	7.7	647	620	589	558	531
PINCHERCREEKA	AB	349	106.9	30.6	212	277	349	421	486	668	45.9	6.9	727	699	668	637	609
QUEENSTOWN	AB	291	75.9	26.1	193	239	291	342	388	708	48.9	6.9	771	741	708	675	646
RANFURLY	AB	327	66.9	20.5	241	282	327	372	413	622	54.7	8.8	692	659	622	585	552
REDDEERA	AB	379	87.1	23.0	267	320	379	438	491	635	48.5	7.6	697	668	635	602	573
ROCKYMTN_HOUSEA	AB	408	82.5	20.2	303	353	408	464	514	606	47.8	7.9	667	638	606	573	544
SION	AB	392	68.4	17.5	304	346	392	438	480	611	46.1	7.5	670	642	611	580	552
STETTLERNORTH	AB	360	71.1	19.7	269	312	360	408	451	641	61.7	9.6	720	682	641	599	562
SUFFIELDA	AB	229	64.2	28.0	147	186	229	273	312	761	44.3	5.8	818	791	761	731	704
TABER	AB	264	87.7	33.2	152	205	264	323	376	763	46.6	6.1	823	795	763	732	703
TROCHU TOWN	AB	338	71.2	21.1	246	290	338	386	429	666	59.7	9.0	742	706	666	625	589
VEGREVILLECDA	AB	312	55.1	17.7	241	275	312	349	383	630	48.5	7.7	692	663	630	597	568
VULCAN	AB	304	73.9	24.3	209	254	304	354	398	719	55.2	7.7	790	756	719	682	648
WANHAMCDAEPF	AB	317	68.7	21.7	229	271	317	363	405	596	41.9	7.0	650	624	596	568	542
WATINO	AB	300	69.5	23.1	211	254	300	347	389	673	39.9	5.9	724	700	673	646	622
WHITECOURTA	AB	441	74.6	16.9	345	390	441	491	536	597	39.4	6.6	647	623	597	570	546
ABBEY	SK	231	55.8	24.2	159	193	231	268	302	721	48.7	6.8	784	754	721	688	659
ALSASKHARDENE	SK	224	55.0	24.6	153	187	224	261	294	722	52.7	7.3	789	757	722	686	654
AMULET	SK	297	79.3	26.7	195	243	297	350	399	707	62.2	8.8	786	748	707	665	627
ANEROID	SK	263	72.6	27.7	169	214	263	312	356	777	59.4	7.6	853	817	777	737	701
ARRAN23N	SK	315	65.2	20.7	231	271	315	359	398	628	50.8	8.1	693	662	628	593	563
ATWATER	SK	330	71.7	21.8	238	281	330	378	421	668	54.5	8.2	738	705	668	631	598
BIGGAR	SK	265	69.8	26.3	176	218	265	312	355	658	49.5	7.5	721	691	658	625	595
BROADVIEW	SK	305	88.0	28.9	192	245	305	364	417	678	49.3	7.3	742	712	678	645	615
CAMEO	SK	310	80.0	25.8	208	257	310	364	413	642	43.5	6.8	697	671	642	612	586
CARLYLE	SK	318	87.0	27.3	207	260	318	377	430	683	57.2	8.4	757	722	683	645	610
CEYLON	SK	296	81.8	27.6	191	241	296	351	401	682	62.7	9.2	763	724	682	640	602
CHAPLIN	SK	265	81.5	30.8	160	210	265	320	369	694	79.7	11.5	796	748	694	640	592
CHOICELAND	SK	347	89.6	25.8	232	286	347	407	462	636	54.6	8.6	706	672	636	599	566
CLAYDON	SK	257	87.1	33.9	145	198	257	315	368	719	75.8	10.5	817	771	719	668	622
CODERRE	SK	271	77.1	28.5	172	219	271	323	369	736	58.9	8.0	812	776	736	697	661
CORONACH	SK	287	71.6	24.9	195	239	287	335	379	715	67.7	9.5	801	760	715	669	628
COTE	SK	316	66.3	21.0	231	272	316	361	401	665	55.3	8.3	735	702	665	627	594

Station Name	Prov	Growing Season Rainfall for Forage								Crop Water Demand for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
CREELAKE	SK	296	66.7	22.6	210	251	296	341	381	459	34.3	7.5	503	482	459	436	415
DAHINDA	SK	302	80.4	26.6	199	248	302	356	405	703	66.0	9.4	788	748	703	659	619
DAVIDSON	SK	268	71.3	26.6	176	220	268	316	359	684	59.6	8.7	760	724	684	644	608
DUVAL	SK	298	79.6	26.7	196	244	298	352	400	645	44.8	6.9	702	675	645	614	587
ELROSE	SK	278	65.8	23.7	193	233	278	322	362	732	54.6	7.5	802	769	732	695	662
ESTEVANA	SK	316	90.7	28.7	200	255	316	377	432	723	60.1	8.3	800	764	723	683	646
FENWOOD	SK	348	84.9	24.4	239	291	348	405	457	601	58.7	9.8	676	640	601	561	526
FERTILE	SK	339	94.1	27.7	219	276	339	403	460	692	62.1	9.0	772	734	692	651	613
GRAVELBOURG	SK	259	71.2	27.5	168	211	259	307	350	752	48.5	6.5	814	784	752	719	689
GULLLAKECDAEPF	SK	277	94.7	34.1	156	213	277	341	399	706	55.5	7.9	777	744	706	669	635
HAFFORD	SK	291	72.0	24.7	199	243	291	340	384	649	48.1	7.4	710	681	649	616	587
HANDSWORTH	SK	326	78.9	24.2	225	273	326	379	427	708	56.5	8.0	780	746	708	670	635
HARRIS	SK	282	72.3	25.7	189	233	282	330	374	722	54.7	7.6	792	759	722	685	652
HUDSONBAYA	SK	320	72.3	22.6	227	271	320	368	412	612	86.4	14.1	723	670	612	554	501
HUMBOLDT	SK	298	83.2	27.9	191	242	298	354	404	631	51.8	8.2	698	666	631	596	565
INDIANHEAD_CDA	SK	337	82.6	24.5	231	281	337	392	443	701	60.7	8.7	779	742	701	660	623
INGEBRIGHT_LAKE	SK	229	58.0	25.4	154	190	229	268	303	769	55.6	7.2	840	807	769	732	698
ISLANDFALLS2	SK	351	72.2	20.5	259	303	351	400	444	519	40.4	7.8	571	546	519	491	467
KELLIHER	SK	320	77.4	24.2	221	268	320	372	419	632	56.9	9.0	705	671	632	594	559
KERROBERT	SK	263	58.3	22.2	189	224	263	303	338	714	62.2	8.7	793	756	714	672	634
KINDERSLEYA	SK	245	57.2	23.3	172	207	245	284	319	691	51.1	7.4	757	726	691	657	626
KIPLING	SK	322	72.4	22.5	229	273	322	371	415	655	56.2	8.6	727	693	655	617	583
KLINTONEL	SK	271	76.9	28.3	173	220	271	323	370	669	69.1	10.3	757	715	669	622	580
KUROKI	SK	321	73.4	22.8	227	272	321	371	415	619	49.7	8.0	683	653	619	586	556
LAKE ALMA	SK	313	81.0	25.8	210	259	313	368	417	742	62.7	8.4	823	785	742	700	662
LEADER2	SK	246	65.0	26.4	163	202	246	290	329	718	119.8	16.7	871	799	718	637	564
LIPTON	SK	310	75.4	24.3	214	260	310	361	407	683	59.5	8.7	759	723	683	642	606
LOONLAKE_CDAEPF	SK	311	61.8	19.9	232	270	311	353	391	608	54.4	8.9	678	645	608	572	539
LOSTRIVER	SK	314	80.3	25.6	211	260	314	368	417	635	55.0	8.7	706	673	635	598	565
LUMSDEN	SK	276	84.6	30.7	167	219	276	333	384	709	74.2	10.5	804	759	709	659	614
MANKOTA	SK	236	66.8	28.3	150	191	236	281	321	750	67.2	9.0	836	795	750	704	663
MAPLECREEK_NORTH	SK	266	66.6	25.0	181	221	266	311	352	772	56.7	7.3	845	811	772	734	700
MARYFIELD	SK	342	96.6	28.2	218	277	342	407	466	673	51.4	7.6	738	707	673	638	607
MEADOWLAKEA	SK	326	74.4	22.8	230	276	326	376	421	629	51.0	8.1	695	664	629	595	564
MELFORTCDA	SK	302	69.3	22.9	213	255	302	349	391	612	48.9	8.0	675	645	612	579	550
MIDALE	SK	295	78.3	26.5	195	243	295	348	396	729	60.6	8.3	807	770	729	688	651
MOOSEJAWA	SK	293	103.8	35.4	160	223	293	363	426	728	56.9	7.8	801	766	728	690	655
MOOSOMIN	SK	378	103.7	27.4	245	308	378	448	511	656	54.4	8.3	726	693	656	619	586
MUENSTER	SK	294	67.6	23.0	208	249	294	340	381	614	50.0	8.1	678	647	614	580	550
NIPAWIN	SK	334	67.0	20.1	248	288	334	379	419	626	45.9	7.3	685	657	626	595	567

Station Name	Prov	Growing Season Rainfall for Forage								Crop Water Demand for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
NOKOMIS	SK	279	75.4	27.0	183	228	279	330	376	687	48.0	7.0	749	720	687	655	626
NORTH_BATTLEFORDA	SK	276	59.1	21.4	201	237	276	316	352	647	47.6	7.4	708	679	647	615	586
ORMISTON	SK	267	74.7	28.0	171	216	267	317	363	703	49.7	7.1	767	737	703	670	640
OUTLOOKPFRA	SK	253	51.2	20.2	187	219	253	288	319	694	50.1	7.2	758	728	694	660	630
OXBOW	SK	312	84.5	27.1	204	255	312	369	420	698	57.5	8.2	772	737	698	659	624
PASWEGIN	SK	311	82.5	26.6	205	255	311	366	416	618	53.3	8.6	686	654	618	582	549
PELLY	SK	356	83.8	23.5	249	300	356	413	464	590	55.0	9.3	661	627	590	553	520
PENNANT	SK	257	75.3	29.3	161	207	257	308	354	709	65.0	9.2	793	753	709	666	626
PILGER	SK	312	72.5	23.2	219	263	312	361	405	649	54.3	8.4	719	686	649	612	579
PRINCEALBERTA	SK	315	78.9	25.0	214	262	315	368	416	639	49.8	7.8	703	673	639	605	575
REGINAA	SK	286	80.1	28.1	183	232	286	340	388	710	60.9	8.6	788	751	710	669	632
REGINACDA	SK	271	77.3	28.5	172	219	271	323	370	710	62.5	8.8	790	752	710	668	630
ROCANVILLE	SK	315	86.2	27.4	205	257	315	373	425	671	49.0	7.3	734	704	671	638	608
ROSETOWN	SK	228	68.6	30.1	140	181	228	274	315	713	75.4	10.6	809	764	713	662	616
SASKATOONA	SK	260	56.6	21.8	188	222	260	298	333	678	55.5	8.2	749	715	678	641	607
SASKATOONSRC	SK	252	65.7	26.0	168	208	252	297	337	681	53.9	7.9	750	718	681	645	612
SCOTTCDA	SK	263	43.9	16.7	206	233	263	292	319	639	50.6	7.9	704	673	639	605	574
SEMANS	SK	286	90.6	31.7	170	225	286	347	402	671	48.6	7.3	733	703	671	638	608
SHAMROCK	SK	257	72.5	28.2	164	208	257	306	350	711	53.6	7.5	780	747	711	675	643
SHAUNAVON2	SK	266	73.6	27.7	172	216	266	316	360	717	62.8	8.7	798	760	717	675	637
SWIFTCURRENT_CDA	SK	258	71.0	27.5	167	210	258	306	349	678	56.9	8.4	751	717	678	640	605
SWIFTCURRENTA	SK	270	85.6	31.6	161	213	270	328	380	692	45.0	6.5	750	722	692	662	634
TREELON	SK	250	72.1	28.8	158	202	250	299	343	759	65.2	8.6	843	803	759	715	676
TUGASKE	SK	281	72.6	25.9	188	232	281	330	374	698	58.2	8.3	773	737	698	659	624
VALMARIE	SK	243	82.5	33.9	138	188	243	299	349	747	65.7	8.8	831	791	747	703	663
WASECA	SK	306	61.8	20.2	227	264	306	347	385	627	46.3	7.4	687	659	627	596	568
WASKESIULAKE	SK	335	93.1	27.8	215	272	335	397	454	566	52.5	9.3	633	601	566	530	498
WATROUS	SK	326	81.0	24.8	222	272	326	381	430	670	53.1	7.9	738	706	670	635	602
WESTPOPLAR_RIVER	SK	268	58.0	21.6	194	229	268	307	343	726	71.3	9.8	817	774	726	678	634
WEYBURN	SK	305	99.3	32.6	177	238	305	372	432	712	70.4	9.9	802	759	712	664	621
WHITESAND_DAM	SK	360	59.5	16.6	283	320	360	400	436	499	40.3	8.1	551	526	499	472	448
WHITEWOOD	SK	339	88.3	26.0	226	280	339	399	452	634	97.9	15.4	760	700	634	568	509
WILLOWCREEK2	SK	230	90.7	39.4	114	169	230	291	346	794	73.3	9.2	888	843	794	744	700
WYNYARD	SK	297	76.0	25.6	200	246	297	349	395	617	53.3	8.6	685	653	617	581	548
YELLOWGRASS	SK	304	86.9	28.6	193	245	304	363	415	731	67.7	9.3	818	777	731	686	645
YORKTONA	SK	336	84.8	25.2	227	279	336	393	444	647	52.2	8.1	714	683	647	612	580
ALTONA	MB	386	88.3	22.9	273	327	386	446	499	711	50.8	7.1	776	746	711	677	646
ARBORG	MB	363	89.6	24.7	248	302	363	423	478	635	50.1	7.9	699	669	635	601	571
ASHERN	MB	360	96.2	26.7	237	296	360	425	484	654	54.7	8.4	724	691	654	617	584
BALDUR	MB	392	92.9	23.7	273	329	392	454	511	709	57.2	8.1	783	748	709	671	636

Station Name	Prov	Growing Season Rainfall for Forage								Crop Water Demand for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
BEAUSEJOUR2	MB	394	82.0	20.8	289	339	394	450	499	685	56.5	8.2	757	723	685	647	613
BINSCARTH	MB	345	95.0	27.6	223	281	345	409	467	653	57.0	8.7	726	692	653	615	580
BIRCHRIVER	MB	353	71.0	20.1	262	305	353	401	444	639	54.4	8.5	709	676	639	602	569
BIRTLE	MB	342	90.9	26.5	226	281	342	404	459	656	51.0	7.8	721	690	656	622	591
BISSETT	MB	401	80.9	20.1	298	347	401	456	505	645	50.0	7.7	709	679	645	612	581
BRANDONA	MB	343	101.5	29.6	213	274	343	411	473	681	52.8	7.8	749	717	681	646	613
BRANDONCDA	MB	350	113.5	32.4	205	273	350	427	496	744	69.8	9.4	834	791	744	697	655
BROADVALLEY	MB	381	106.4	27.9	245	310	381	453	518	660	51.7	7.8	726	695	660	625	594
CHURCHILLA	MB	244	66.1	27.2	159	199	244	288	328	280	42.2	15.1	334	308	280	251	226
CROSSLAKE_JENPEG	MB	311	65.8	21.1	227	267	311	356	396	492	39.2	8.0	542	519	492	466	442
CYPRESSRIVER	MB	389	91.4	23.5	272	327	389	450	506	698	52.6	7.5	766	734	698	663	631
DAUPHINA	MB	383	86.8	22.6	272	325	383	442	494	666	55.7	8.4	737	703	666	628	594
DEERWOOD	MB	400	109.2	27.3	260	326	400	474	540	687	54.8	8.0	757	724	687	650	616
DELORAINE	MB	353	86.8	24.6	242	295	353	412	465	706	50.3	7.1	771	740	706	672	642
DELTA_UNIVERSITYFS	MB	370	83.7	22.6	262	313	370	426	477	625	46.5	7.4	685	657	625	594	566
ELMCREEK	MB	355	101.0	28.5	225	287	355	423	484	680	117.7	17.3	831	760	680	601	530
EMERSON	MB	403	95.7	23.7	281	339	403	468	526	708	55.4	7.8	779	745	708	670	637
FALCONLAKE_TCPL45	MB	409	86.9	21.2	298	351	409	468	521	672	50.2	7.5	736	705	672	638	607
FISHERBRANCHS	MB	354	70.1	19.8	264	307	354	401	444	649	94.7	14.6	771	713	649	585	528
FLINFLON	MB	347	71.4	20.6	255	299	347	395	438	531	39.9	7.5	583	558	531	504	480
FLINFLONA	MB	338	66.3	19.6	253	294	338	383	423	514	38.0	7.4	563	540	514	489	466
GILBERTPLAINS	MB	370	85.5	23.1	260	312	370	428	480	663	51.2	7.7	729	697	663	628	597
GILLAMA	MB	304	80.8	26.6	200	249	304	358	407	444	44.2	9.9	501	474	444	415	388
GIMLI	MB	378	97.8	25.9	252	312	378	444	503	596	47.6	8.0	657	628	596	564	535
GLADSTONE_SOUTH	MB	344	99.6	28.9	217	277	344	412	472	676	116.0	17.2	824	754	676	598	527
GLENBORO	MB	367	108.2	29.5	228	294	367	440	506	702	59.7	8.5	778	742	702	662	625
GLENLEA	MB	403	109.6	27.2	263	330	403	477	544	696	53.2	7.6	764	732	696	660	628
GRANDRAPIDS_HYDRO	MB	349	94.2	27.0	228	286	349	413	470	517	36.6	7.1	564	542	517	492	470
GRASSRIVER	MB	348	93.9	27.0	227	284	348	411	468	690	65.1	9.4	773	733	690	646	606
GREATFALLS	MB	380	73.5	19.3	286	331	380	430	474	609	42.2	6.9	663	638	609	581	555
HAMIOTA	MB	306	81.1	26.5	202	251	306	361	410	683	51.2	7.5	748	717	683	648	617
HODGSON2	MB	365	104.6	28.7	231	294	365	435	499	664	54.4	8.2	734	701	664	627	594
INDIANBAY	MB	433	93.7	21.6	313	370	433	496	553	639	46.8	7.3	699	671	639	608	579
ISLANDLAKE	MB	368	56.1	15.2	297	331	368	406	440	480	41.7	8.7	533	508	480	452	426
LANGRUTH	MB	383	93.5	24.4	263	320	383	446	503	618	52.4	8.5	685	654	618	583	551
LYNNLAKEA	MB	313	81.9	26.1	208	258	313	368	418	466	38.0	8.2	515	492	466	441	418
MACGREGOR	MB	374	99.8	26.7	246	306	374	441	501	700	62.6	8.9	780	742	700	658	620
MARQUETTE	MB	390	90.7	23.2	274	329	390	451	506	682	51.3	7.5	748	717	682	647	616
MINNEDOSA	MB	345	95.8	27.8	222	281	345	410	468	639	65.1	10.2	722	682	639	595	555
MORDENCDA	MB	396	107.0	27.0	259	324	396	468	533	683	52.9	7.7	751	719	683	648	616

Station Name	Prov	Growing Season Rainfall for Forage								Crop Water Demand for Forage							
		Mean	SD	CV	10%	25%	50%	75%	90%	Mean	SD	CV	10%	25%	50%	75%	90%
MYRTLE	MB	371	89.1	24.0	257	311	371	431	485	726	55.7	7.7	797	763	726	688	654
NEEPAWAWATER	MB	388	111.6	28.8	245	312	388	463	531	644	48.2	7.5	706	676	644	611	582
NIVERVILLE	MB	364	81.3	22.3	260	310	364	419	469	716	48.8	6.8	778	748	716	683	653
NORWAYHOUSEA	MB	312	60.9	19.5	234	271	312	353	390	518	41.5	8.0	571	546	518	490	465
NORWAYHOUSEF	MB	316	64.1	20.3	234	273	316	359	398	485	45.8	9.4	544	516	485	454	427
OAKNER	MB	342	82.2	24.1	236	286	342	397	447	675	57.3	8.5	749	714	675	637	602
PASQUIAPROJ_PFRA	MB	318	76.9	24.2	219	266	318	370	417	590	51.9	8.8	657	625	590	555	524
PEACEGARDENS	MB	415	135.6	32.7	241	324	415	507	589	647	53.9	8.3	716	683	647	611	578
PIERSON	MB	334	91.1	27.2	218	273	334	396	451	733	55.5	7.6	805	771	733	696	662
PINAWAWNRE	MB	414	83.1	20.1	307	358	414	470	520	643	46.0	7.2	702	674	643	612	584
PINEDOCK	MB	412	85.1	20.6	303	355	412	470	522	568	53.4	9.4	637	604	568	532	500
PINEFALLS	MB	418	79.9	19.1	316	365	418	472	521	629	47.1	7.5	689	660	629	597	568
PINEY	MB	438	88.3	20.1	325	379	438	498	551	693	47.2	6.8	754	725	693	662	633
PLUMCOULEE	MB	389	96.0	24.7	266	324	389	454	512	722	58.5	8.1	797	762	722	683	647
PORTAGELAPR	MB	385	90.8	23.6	269	324	385	446	501	696	47.0	6.8	756	727	696	664	635
PORTAGELAPR2	MB	365	108.4	29.7	226	292	365	438	504	662	101.5	15.3	792	731	662	594	532
RATHWELL	MB	372	94.7	25.5	251	308	372	436	493	698	53.3	7.6	767	734	698	662	630
ROSSBURN	MB	353	91.5	25.9	236	292	353	415	470	643	47.5	7.4	704	675	643	611	582
SELKIRK	MB	406	92.9	22.8	287	344	406	469	525	652	40.1	6.2	703	679	652	625	600
SOMERSET	MB	388	103.8	26.8	255	318	388	458	521	650	59.3	9.1	726	690	650	610	574
SPRAGUE	MB	432	101.8	23.6	301	363	432	500	562	674	55.0	8.2	745	711	674	637	604
STARBUCK	MB	392	103.1	26.3	259	322	392	461	524	715	62.2	8.7	795	757	715	673	635
STEINBACH	MB	402	89.0	22.1	288	342	402	462	516	691	44.3	6.4	748	721	691	661	635
STONEWALL	MB	374	86.4	23.1	264	316	374	433	485	703	49.7	7.1	767	737	703	670	640
STONYMTN	MB	376	96.0	25.5	253	311	376	441	499	678	53.5	7.9	747	714	678	642	610
STRATHCLAIR	MB	320	83.9	26.3	212	263	320	376	427	622	58.9	9.5	698	662	622	583	547
SWANRIVER	MB	371	63.6	17.1	289	328	371	414	452	638	49.8	7.8	702	672	638	604	574
THEPASA	MB	315	65.6	20.8	231	271	315	359	399	553	38.6	7.0	603	579	553	527	504
THOMPSONA	MB	322	87.5	27.2	210	263	322	381	434	517	47.8	9.2	578	549	517	485	456
VIRDEN	MB	336	89.8	26.7	221	276	336	397	451	677	48.3	7.1	739	709	677	644	615
VOGAR	MB	371	87.8	23.7	258	312	371	430	483	547	40.3	7.4	599	575	547	520	496
WILSONCRWEIR	MB	409	122.9	30.0	252	327	409	492	567	650	54.7	8.4	721	687	650	614	580
WINNIPEGA	MB	392	89.8	22.9	277	331	392	452	507	690	50.3	7.3	754	724	690	656	626

X. Probablility of moisture stress for wheat, corn, and forage

Station Name	Prov	Wheat				Corn					Forage				
		Probability of stress in excess of				Probability of stress in excess of					Probability of stress in excess of				
		0mm	25mm	50mm	100mm	0mm	25mm	50mm	100mm	150mm	50mm	100mm	150mm	200mm	250mm
ATHABASCA2	AB	0.66	0.04	0.01	0.01	0.66	0.27	0.11	0.02	0.01	0.85	0.51	0.31	0.19	0.11
BANFF	AB	0.94	0.41	0.18	0.03	0.87	0.31	0.11	0.01	0.01	0.99	0.99	0.54	0.29	0.16
BEAVERLODGE_CDA	AB	0.71	0.19	0.05	0.01	0.71	0.28	0.11	0.02	0.01	0.99	0.61	0.37	0.22	0.13
BRIGHTVIEW	AB	0.67	0.11	0.02	0.01	0.88	0.34	0.13	0.02	0.01	0.99	0.61	0.30	0.15	0.07
BROWNFIELD	AB	0.85	0.22	0.06	0.01	0.91	0.57	0.36	0.14	0.05	0.99	0.99	0.66	0.43	0.28
CALDWELL	AB	0.99	0.45	0.19	0.04	0.78	0.52	0.35	0.15	0.07	0.90	0.63	0.44	0.31	0.22
CALGARYA	AB	0.84	0.38	0.17	0.04	0.99	0.76	0.45	0.16	0.06	0.99	0.99	0.99	0.65	0.39
CALMAR	AB	0.76	0.04	0.01	0.01	0.77	0.28	0.11	0.01	0.01	0.99	0.79	0.44	0.25	0.14
CAMPSIE	AB	0.60	0.22	0.08	0.01	0.77	0.41	0.22	0.06	0.02	0.99	0.85	0.53	0.33	0.21
CAMROSE	AB	0.89	0.02	0.01	0.01	0.65	0.26	0.10	0.02	0.01	0.99	0.60	0.36	0.21	0.13
CARDSTON	AB	0.99	0.57	0.30	0.08	0.99	0.88	0.60	0.29	0.14	0.99	0.99	0.70	0.48	0.33
CARWAY	AB	0.99	0.70	0.41	0.14	0.99	0.71	0.47	0.21	0.09	0.99	0.80	0.54	0.37	0.25
CLARESHOLM_WATERW	AB	0.94	0.55	0.32	0.11	0.99	0.99	0.76	0.44	0.25	0.99	0.99	0.99	0.81	0.56
CLEARDALE	AB	0.80	0.40	0.20	0.05	0.87	0.51	0.30	0.11	0.04	0.99	0.89	0.57	0.37	0.24
COLDLAKEA	AB	0.66	0.15	0.04	0.01	0.73	0.39	0.20	0.06	0.02	0.99	0.99	0.63	0.37	0.22
CONNELLY CREEK	AB	0.99	0.48	0.21	0.04	0.99	0.58	0.29	0.07	0.02	0.99	0.67	0.41	0.25	0.15
CORONATIONA	AB	0.99	0.63	0.36	0.11	0.99	0.99	0.91	0.39	0.17	0.99	0.99	0.99	0.80	0.51
EDMONTONA	AB	0.80	0.05	0.01	0.01	0.83	0.33	0.13	0.02	0.01	0.99	0.74	0.45	0.28	0.17
EDMONTONMUN	AB	0.85	0.01	0.01	0.01	0.69	0.09	0.01	0.01	0.01	0.99	0.67	0.35	0.19	0.10
EDSONA	AB	0.73	0.02	0.01	0.01	0.64	0.07	0.01	0.01	0.01	0.65	0.38	0.22	0.13	0.07
ELKPOINT	AB	0.85	0.34	0.13	0.02	0.84	0.57	0.38	0.18	0.08	0.99	0.99	0.77	0.48	0.30
ELMWORTHCDA	AB	0.84	0.28	0.09	0.01	0.98	0.42	0.18	0.03	0.01	0.99	0.84	0.53	0.33	0.21
EMPRESS	AB	0.99	0.99	0.76	0.37	0.99	0.99	0.99	0.99	0.92	0.99	0.99	0.99	0.99	0.99
EUREKARIVER	AB	0.83	0.46	0.26	0.08	0.79	0.50	0.32	0.13	0.05	0.99	0.92	0.62	0.41	0.28
FAIRVIEW	AB	0.76	0.06	0.01	0.01	0.74	0.23	0.07	0.01	0.01	0.87	0.53	0.32	0.20	0.12
FOREMOST	AB	0.99	0.79	0.46	0.16	0.99	0.99	0.99	0.75	0.44	0.99	0.99	0.99	0.99	0.99
FORESTBURG_PLANT	AB	0.67	0.11	0.02	0.01	0.99	0.60	0.35	0.12	0.04	0.99	0.99	0.87	0.53	0.32
FORT_CHIPEWYANA	AB	0.68	0.33	0.16	0.04	0.71	0.47	0.32	0.14	0.06	0.99	0.87	0.57	0.38	0.25
FORT_SASKATCHEWAN	AB	0.71	0.23	0.08	0.01	0.80	0.46	0.26	0.09	0.03	0.99	0.79	0.53	0.35	0.23
FORTMACLEOD	AB	0.99	0.60	0.31	0.08	0.99	0.99	0.81	0.49	0.29	0.99	0.99	0.99	0.88	0.65
FORTMCMURRAYA	AB	0.62	0.23	0.08	0.01	0.72	0.40	0.22	0.07	0.02	0.99	0.84	0.53	0.34	0.22
GLEICHEN	AB	0.99	0.99	0.60	0.22	0.99	0.99	0.99	0.81	0.41	0.99	0.99	0.99	0.99	0.99
GRANDEPRAIRIEA	AB	0.84	0.20	0.05	0.01	0.81	0.43	0.23	0.07	0.02	0.99	0.90	0.55	0.34	0.21
HIGHLEVELA	AB	0.84	0.47	0.27	0.08	0.99	0.70	0.47	0.21	0.10	0.99	0.99	0.88	0.55	0.34
HIGHRIVER	AB	0.99	0.51	0.26	0.07	0.96	0.59	0.36	0.14	0.05	0.99	0.86	0.55	0.35	0.22
JASPER	AB	0.99	0.48	0.21	0.04	0.99	0.52	0.27	0.07	0.02	0.99	0.99	0.99	0.70	0.35
LACOMBECDA	AB	0.99	0.64	0.31	0.07	0.99	0.96	0.56	0.19	0.06	0.99	0.99	0.97	0.53	0.29
LETHBRIDGEA	AB	0.99	0.71	0.47	0.21	0.99	0.99	0.99	0.71	0.43	0.99	0.99	0.99	0.99	0.84

Station Name	Prov	Wheat				Corn					Forage				
		Probability of stress in excess of				Probability of stress in excess of					Probability of stress in excess of				
		0mm	**25mm**	**50mm**	**100mm**	**0mm**	**25mm**	**50mm**	**100mm**	**150mm**	**50mm**	**100mm**	**150mm**	**200mm**	**250mm**
LETHBRIDGECDA	AB	0.93	0.61	0.40	0.17	0.99	0.99	0.99	0.65	0.37	0.99	0.99	0.99	0.99	0.88
MANYBERRIESCDA	AB	0.99	0.81	0.54	0.24	0.99	0.99	0.99	0.80	0.52	0.99	0.99	0.99	0.99	0.95
MEDICINEHATA	AB	0.99	0.82	0.49	0.17	0.99	0.99	0.99	0.99	0.57	0.99	0.99	0.99	0.99	0.99
NOTIKEWINEAST	AB	0.94	0.58	0.36	0.14	0.99	0.81	0.57	0.28	0.14	0.99	0.99	0.99	0.74	0.47
OLDS	AB	0.72	0.12	0.02	0.01	0.74	0.22	0.07	0.01	0.01	0.99	0.56	0.30	0.17	0.09
OYEN CAPPON	AB	0.99	0.68	0.41	0.15	0.99	0.99	0.99	0.64	0.35	0.99	0.99	0.99	0.99	0.99
PEACERIVERA	AB	0.77	0.33	0.14	0.03	0.80	0.53	0.35	0.15	0.06	0.99	0.89	0.59	0.40	0.27
PINCHERCREEKA	AB	0.95	0.44	0.20	0.04	0.96	0.62	0.40	0.16	0.07	0.99	0.80	0.55	0.37	0.25
QUEENSTOWN	AB	0.89	0.46	0.23	0.06	0.99	0.99	0.77	0.40	0.21	0.99	0.99	0.99	0.99	0.69
RANFURLY	AB	0.76	0.21	0.06	0.01	0.87	0.52	0.31	0.11	0.04	0.99	0.84	0.57	0.39	0.27
REDDEERA	AB	0.70	0.20	0.06	0.01	0.81	0.38	0.18	0.04	0.01	0.99	0.76	0.47	0.29	0.18
ROCKYMTN_HOUSEA	AB	0.67	0.15	0.03	0.01	0.74	0.14	0.02	0.01	0.01	0.75	0.41	0.22	0.12	0.07
SION	AB	0.63	0.03	0.01	0.01	0.70	0.22	0.07	0.01	0.01	0.91	0.52	0.29	0.17	0.10
STETTLERNORTH	AB	0.72	0.13	0.02	0.01	0.75	0.40	0.22	0.06	0.02	0.99	0.90	0.55	0.33	0.20
SUFFIELDA	AB	0.99	0.99	0.65	0.24	0.99	0.99	0.99	0.99	0.73	0.99	0.99	0.99	0.99	0.99
TABER	AB	0.99	0.68	0.42	0.16	0.99	0.99	0.99	0.69	0.41	0.99	0.99	0.99	0.99	0.99
TROCHU TOWN	AB	0.64	0.24	0.09	0.01	0.77	0.48	0.30	0.12	0.05	0.99	0.99	0.72	0.46	0.29
VEGREVILLECDA	AB	0.98	0.41	0.17	0.03	0.99	0.71	0.48	0.21	0.10	0.99	0.99	0.87	0.56	0.36
VULCAN	AB	0.99	0.55	0.31	0.10	0.99	0.99	0.81	0.43	0.23	0.99	0.99	0.99	0.99	0.67
WANHAMCDAEPF	AB	0.73	0.16	0.03	0.01	0.67	0.40	0.24	0.09	0.03	0.99	0.73	0.46	0.29	0.18
WATINO	AB	0.99	0.83	0.51	0.19	0.99	0.99	0.95	0.48	0.24	0.99	0.99	0.99	0.99	0.69
WHITECOURTA	AB	0.79	0.01	0.01	0.01	0.77	0.01	0.01	0.01	0.01	0.57	0.26	0.11	0.05	0.02
ABBEY	SK	0.99	0.86	0.49	0.16	0.99	0.99	0.99	0.86	0.48	0.99	0.99	0.99	0.99	0.99
ALSASKHARDENE	SK	0.99	0.99	0.72	0.33	0.99	0.99	0.99	0.95	0.60	0.99	0.99	0.99	0.99	0.99
AMULET	SK	0.72	0.44	0.27	0.11	0.99	0.87	0.68	0.41	0.25	0.99	0.99	0.98	0.72	0.53
ANEROID	SK	0.99	0.84	0.56	0.25	0.99	0.99	0.99	0.95	0.58	0.99	0.99	0.99	0.99	0.99
ARRAN23N	SK	0.63	0.23	0.08	0.01	0.99	0.53	0.28	0.08	0.02	0.99	0.99	0.76	0.44	0.26
ATWATER	SK	0.60	0.28	0.13	0.03	0.95	0.65	0.45	0.21	0.10	0.99	0.99	0.77	0.53	0.37
BIGGAR	SK	0.99	0.69	0.39	0.13	0.99	0.99	0.99	0.52	0.27	0.99	0.99	0.99	0.99	0.73
BROADVIEW	SK	0.96	0.54	0.30	0.10	0.99	0.98	0.73	0.40	0.22	0.99	0.99	0.99	0.78	0.53
CAMEO	SK	0.99	0.91	0.50	0.15	0.99	0.99	0.99	0.38	0.14	0.99	0.99	0.99	0.87	0.48
CARLYLE	SK	0.78	0.42	0.23	0.07	0.99	0.76	0.58	0.34	0.20	0.99	0.99	0.99	0.75	0.53
CEYLON	SK	0.77	0.47	0.29	0.11	0.99	0.91	0.70	0.41	0.25	0.99	0.99	0.99	0.86	0.59
CHAPLIN	SK	0.99	0.88	0.54	0.21	0.99	0.99	0.99	0.69	0.41	0.99	0.99	0.99	0.99	0.95
CHOICELAND	SK	0.65	0.28	0.12	0.02	0.86	0.54	0.33	0.13	0.05	0.99	0.98	0.66	0.45	0.30
CLAYDON	SK	0.88	0.57	0.37	0.15	0.99	0.99	0.91	0.58	0.37	0.99	0.99	0.99	0.99	0.83
CODERRE	SK	0.99	0.88	0.59	0.27	0.99	0.99	0.99	0.90	0.55	0.99	0.99	0.99	0.99	0.99
CORONACH	SK	0.99	0.50	0.25	0.06	0.99	0.99	0.85	0.47	0.26	0.99	0.99	0.99	0.99	0.73
COTE	SK	0.80	0.31	0.12	0.02	0.99	0.78	0.53	0.25	0.12	0.99	0.99	0.99	0.74	0.44
CREELAKE	SK	0.90	0.42	0.20	0.04	0.76	0.37	0.18	0.04	0.01	0.99	0.65	0.35	0.19	0.11

Station Name	Prov	Wheat				Corn					Forage				
		Probability of stress in excess of				Probability of stress in excess of					Probability of stress in excess of				
		0mm	25mm	50mm	100mm	0mm	25mm	50mm	100mm	150mm	50mm	100mm	150mm	200mm	250mm
DAHINDA	SK	0.87	0.55	0.35	0.14	0.99	0.99	0.82	0.52	0.33	0.99	0.99	0.99	0.88	0.66
DAVIDSON	SK	0.99	0.73	0.48	0.20	0.99	0.99	0.99	0.69	0.40	0.99	0.99	0.99	0.99	0.87
DUVAL	SK	0.71	0.37	0.19	0.05	0.99	0.74	0.55	0.30	0.17	0.99	0.99	0.99	0.74	0.49
ELROSE	SK	0.99	0.70	0.43	0.16	0.99	0.99	0.99	0.73	0.41	0.99	0.99	0.99	0.99	0.92
ESTEVANA	SK	0.88	0.54	0.33	0.12	0.99	0.99	0.85	0.49	0.29	0.99	0.99	0.99	0.81	0.60
FENWOOD	SK	0.69	0.20	0.06	0.01	0.80	0.43	0.23	0.07	0.02	0.99	0.71	0.46	0.30	0.20
FERTILE	SK	0.73	0.26	0.09	0.01	0.99	0.75	0.53	0.26	0.13	0.99	0.99	0.76	0.54	0.38
GRAVELBOURG	SK	0.99	0.63	0.40	0.17	0.99	0.99	0.99	0.70	0.42	0.99	0.99	0.99	0.99	0.94
GULLLAKECDAEPF	SK	0.98	0.57	0.33	0.11	0.99	0.99	0.87	0.51	0.30	0.99	0.99	0.99	0.89	0.63
HAFFORD	SK	0.99	0.71	0.38	0.11	0.99	0.99	0.99	0.49	0.24	0.99	0.99	0.99	0.99	0.78
HANDSWORTH	SK	0.84	0.35	0.15	0.02	0.99	0.91	0.63	0.30	0.14	0.99	0.99	0.99	0.73	0.50
HARRIS	SK	0.99	0.76	0.46	0.17	0.99	0.99	0.99	0.70	0.41	0.99	0.99	0.99	0.99	0.78
HUDSONBAYA	SK	0.99	0.47	0.22	0.05	0.99	0.77	0.49	0.20	0.08	0.99	0.99	0.89	0.54	0.33
HUMBOLDT	SK	0.87	0.40	0.18	0.04	0.93	0.69	0.51	0.28	0.16	0.99	0.99	0.83	0.58	0.40
INDIANHEAD_CDA	SK	0.73	0.27	0.10	0.01	0.99	0.68	0.47	0.22	0.10	0.99	0.99	0.99	0.72	0.46
INGEBRIGHT_LAKE	SK	0.99	0.99	0.99	0.68	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
ISLANDFALLS2	SK	0.74	0.05	0.01	0.01	0.74	0.10	0.01	0.01	0.01	0.81	0.43	0.22	0.12	0.06
KELLIHER	SK	0.71	0.30	0.13	0.02	0.90	0.60	0.40	0.17	0.08	0.99	0.99	0.70	0.44	0.28
KERROBERT	SK	0.99	0.99	0.71	0.33	0.99	0.99	0.99	0.93	0.55	0.99	0.99	0.99	0.99	0.99
KINDERSLEYA	SK	0.99	0.67	0.42	0.17	0.99	0.99	0.97	0.59	0.36	0.99	0.99	0.99	0.99	0.73
KIPLING	SK	0.82	0.26	0.08	0.01	0.99	0.71	0.46	0.19	0.08	0.99	0.99	0.78	0.52	0.34
KLINTONEL	SK	0.99	0.67	0.40	0.14	0.99	0.86	0.65	0.37	0.21	0.99	0.99	0.80	0.58	0.41
KUROKI	SK	0.67	0.31	0.14	0.03	0.83	0.54	0.35	0.14	0.06	0.99	0.99	0.71	0.44	0.28
LAKE ALMA	SK	0.68	0.38	0.21	0.07	0.99	0.87	0.68	0.42	0.26	0.99	0.99	0.99	0.90	0.66
LEADER2	SK	0.99	0.67	0.41	0.15	0.99	0.99	0.99	0.72	0.42	0.99	0.99	0.99	0.99	0.92
LIPTON	SK	0.69	0.30	0.13	0.02	0.99	0.78	0.56	0.29	0.15	0.99	0.99	0.99	0.80	0.52
LOONLAKE_CDAEPF	SK	0.79	0.31	0.12	0.02	0.92	0.58	0.37	0.15	0.06	0.99	0.99	0.70	0.46	0.30
LOSTRIVER	SK	0.84	0.39	0.18	0.04	0.99	0.75	0.51	0.24	0.11	0.99	0.99	0.77	0.53	0.36
LUMSDEN	SK	0.93	0.58	0.37	0.15	0.99	0.99	0.86	0.55	0.35	0.99	0.99	0.99	0.94	0.70
MANKOTA	SK	0.99	0.99	0.73	0.33	0.99	0.99	0.99	0.99	0.71	0.99	0.99	0.99	0.99	0.99
MAPLECREEK_NORTH	SK	0.99	0.91	0.49	0.15	0.99	0.99	0.99	0.98	0.52	0.99	0.99	0.99	0.99	0.99
MARYFIELD	SK	0.68	0.32	0.15	0.03	0.99	0.71	0.50	0.24	0.12	0.99	0.99	0.86	0.58	0.39
MEADOWLAKEA	SK	0.68	0.25	0.09	0.01	0.92	0.55	0.32	0.11	0.04	0.99	0.99	0.69	0.45	0.30
MELFORTCDA	SK	0.77	0.24	0.07	0.01	0.95	0.61	0.40	0.17	0.07	0.99	0.99	0.85	0.54	0.34
MIDALE	SK	0.78	0.48	0.30	0.11	0.99	0.97	0.77	0.47	0.29	0.99	0.99	0.99	0.90	0.66
MOOSEJAWA	SK	0.98	0.58	0.34	0.12	0.99	0.99	0.84	0.53	0.34	0.99	0.99	0.99	0.90	0.69
MOOSOMIN	SK	0.72	0.27	0.10	0.01	0.86	0.55	0.35	0.14	0.06	0.99	0.85	0.57	0.39	0.26
MUENSTER	SK	0.70	0.34	0.17	0.04	0.96	0.69	0.49	0.25	0.13	0.99	0.99	0.93	0.60	0.38
NIPAWIN	SK	0.72	0.21	0.06	0.01	0.87	0.54	0.34	0.13	0.05	0.99	0.99	0.67	0.44	0.28
NOKOMIS	SK	0.87	0.60	0.41	0.20	0.99	0.99	0.86	0.54	0.33	0.99	0.99	0.99	0.99	0.80

Station Name	Prov	Wheat				Corn					Forage				
		Probability of stress in excess of				Probability of stress in excess of					Probability of stress in excess of				
		0mm	25mm	50mm	100mm	0mm	25mm	50mm	100mm	150mm	50mm	100mm	150mm	200mm	250mm
NORTH_BATTLEFORDA	SK	0.99	0.42	0.17	0.03	0.99	0.99	0.74	0.35	0.17	0.99	0.99	0.99	0.99	0.61
ORMISTON	SK	0.99	0.79	0.51	0.22	0.99	0.99	0.99	0.78	0.45	0.99	0.99	0.99	0.99	0.94
OUTLOOKPFRA	SK	0.99	0.73	0.45	0.17	0.99	0.99	0.99	0.76	0.42	0.99	0.99	0.99	0.99	0.99
OXBOW	SK	0.74	0.44	0.26	0.09	0.99	0.82	0.62	0.36	0.21	0.99	0.99	0.98	0.71	0.51
PASWEGIN	SK	0.69	0.26	0.10	0.01	0.87	0.56	0.36	0.15	0.06	0.99	0.99	0.68	0.42	0.27
PELLY	SK	0.55	0.28	0.14	0.04	0.70	0.33	0.15	0.03	0.01	0.82	0.52	0.33	0.21	0.13
PENNANT	SK	0.93	0.64	0.44	0.21	0.99	0.99	0.98	0.64	0.41	0.99	0.99	0.99	0.99	0.92
PILGER	SK	0.64	0.35	0.20	0.06	0.98	0.71	0.51	0.27	0.14	0.99	0.99	0.99	0.66	0.44
PRINCEALBERTA	SK	0.99	0.79	0.41	0.11	0.99	0.99	0.87	0.38	0.16	0.99	0.99	0.99	0.75	0.46
REGINAA	SK	0.81	0.43	0.23	0.07	0.99	0.99	0.74	0.42	0.24	0.99	0.99	0.99	0.99	0.68
REGINACDA	SK	0.99	0.67	0.43	0.17	0.99	0.99	0.99	0.68	0.41	0.99	0.99	0.99	0.99	0.99
ROCANVILLE	SK	0.76	0.42	0.23	0.07	0.99	0.81	0.60	0.33	0.18	0.99	0.99	0.99	0.71	0.48
ROSETOWN	SK	0.99	0.99	0.68	0.32	0.99	0.99	0.99	0.93	0.60	0.99	0.99	0.99	0.99	0.99
SASKATOONA	SK	0.99	0.73	0.44	0.16	0.99	0.99	0.99	0.72	0.38	0.99	0.99	0.99	0.99	0.97
SASKATOONSRC	SK	0.99	0.62	0.34	0.10	0.99	0.99	0.99	0.63	0.32	0.99	0.99	0.99	0.99	0.98
SCOTTCDA	SK	0.99	0.62	0.35	0.11	0.99	0.99	0.90	0.46	0.23	0.99	0.99	0.99	0.99	0.66
SEMANS	SK	0.77	0.50	0.32	0.13	0.99	0.87	0.68	0.42	0.26	0.99	0.99	0.99	0.95	0.64
SHAMROCK	SK	0.99	0.77	0.48	0.19	0.99	0.99	0.99	0.71	0.43	0.99	0.99	0.99	0.99	0.96
SHAUNAVON2	SK	0.96	0.57	0.34	0.12	0.99	0.99	0.95	0.55	0.32	0.99	0.99	0.99	0.99	0.74
SWIFTCURRENT_CDA	SK	0.91	0.58	0.37	0.15	0.99	0.99	0.81	0.50	0.31	0.99	0.99	0.99	0.92	0.66
SWIFTCURRENTA	SK	0.92	0.58	0.36	0.14	0.99	0.99	0.79	0.49	0.30	0.99	0.99	0.99	0.86	0.62
TREELON	SK	0.99	0.91	0.62	0.29	0.99	0.99	0.99	0.93	0.61	0.99	0.99	0.99	0.99	0.99
TUGASKE	SK	0.89	0.56	0.35	0.14	0.99	0.99	0.86	0.52	0.32	0.99	0.99	0.99	0.95	0.68
VALMARIE	SK	0.99	0.83	0.59	0.30	0.99	0.99	0.99	0.90	0.60	0.99	0.99	0.99	0.99	0.99
WASECA	SK	0.73	0.24	0.08	0.01	0.96	0.61	0.39	0.16	0.06	0.99	0.99	0.91	0.51	0.28
WASKESIULAKE	SK	0.73	0.36	0.18	0.04	0.79	0.47	0.28	0.10	0.03	0.99	0.75	0.49	0.32	0.21
WATROUS	SK	0.72	0.32	0.14	0.03	0.99	0.74	0.54	0.29	0.16	0.99	0.99	0.99	0.68	0.46
WESTPOPLAR_RIVER	SK	0.99	0.76	0.45	0.16	0.99	0.99	0.99	0.67	0.40	0.99	0.99	0.99	0.99	0.77
WEYBURN	SK	0.74	0.47	0.29	0.12	0.97	0.78	0.63	0.41	0.27	0.99	0.99	0.91	0.70	0.54
WHITESAND_DAM	SK	0.77	0.01	0.01	0.01	0.86	0.01	0.01	0.01	0.01	0.60	0.25	0.10	0.04	0.02
WHITEWOOD	SK	0.61	0.27	0.12	0.02	0.90	0.56	0.34	0.13	0.05	0.99	0.75	0.53	0.37	0.26
WILLOWCREEK2	SK	0.99	0.99	0.73	0.38	0.99	0.99	0.99	0.99	0.79	0.99	0.99	0.99	0.99	0.99
WYNYARD	SK	0.76	0.22	0.06	0.01	0.99	0.65	0.40	0.15	0.05	0.99	0.99	0.76	0.49	0.31
YELLOWGRASS	SK	0.74	0.47	0.29	0.12	0.99	0.84	0.67	0.43	0.27	0.99	0.99	0.99	0.82	0.61
YORKTONA	SK	0.67	0.26	0.10	0.02	0.86	0.57	0.38	0.17	0.07	0.99	0.99	0.85	0.52	0.32
ALTONA	MB	0.77	0.13	0.02	0.01	0.65	0.45	0.31	0.14	0.07	0.99	0.99	0.70	0.48	0.32
ARBORG	MB	0.73	0.07	0.01	0.01	0.67	0.36	0.19	0.06	0.02	0.99	0.97	0.58	0.35	0.21
ASHERN	MB	0.73	0.21	0.06	0.01	0.82	0.57	0.39	0.18	0.09	0.99	0.95	0.64	0.44	0.30
BALDUR	MB	0.67	0.34	0.17	0.04	0.84	0.60	0.42	0.21	0.11	0.99	0.99	0.75	0.51	0.35
BEAUSEJOUR2	MB	0.70	0.09	0.01	0.01	0.74	0.36	0.17	0.04	0.01	0.99	0.87	0.55	0.35	0.23

Station Name	Prov	Wheat				Corn					Forage				
		Probability of stress in excess of				Probability of stress in excess of					Probability of stress in excess of				
		0mm	25mm	50mm	100mm	0mm	25mm	50mm	100mm	150mm	50mm	100mm	150mm	200mm	250mm
BINSCARTH	MB	0.73	0.32	0.14	0.03	0.89	0.58	0.39	0.17	0.07	0.99	0.91	0.63	0.43	0.30
BIRCHRIVER	MB	0.66	0.16	0.04	0.01	0.85	0.38	0.17	0.03	0.01	0.99	0.99	0.55	0.30	0.16
BIRTLE	MB	0.85	0.24	0.07	0.01	0.94	0.65	0.45	0.21	0.10	0.99	0.99	0.75	0.51	0.35
BISSETT	MB	0.73	0.01	0.01	0.01	0.69	0.17	0.04	0.01	0.01	0.99	0.63	0.38	0.22	0.13
BRANDONA	MB	0.78	0.36	0.16	0.03	0.99	0.77	0.54	0.26	0.13	0.99	0.99	0.98	0.64	0.42
BRANDONCDA	MB	0.82	0.46	0.26	0.08	0.99	0.84	0.62	0.33	0.18	0.99	0.99	0.99	0.73	0.52
BROADVALLEY	MB	0.64	0.05	0.01	0.01	0.81	0.37	0.17	0.04	0.01	0.99	0.83	0.54	0.35	0.23
CHURCHILLA	MB	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.09	0.01	0.01	0.01	0.01
CROSSLAKE_JENPEG	MB	0.77	0.01	0.01	0.01	0.73	0.12	0.02	0.01	0.01	0.84	0.46	0.25	0.14	0.07
CYPRESSRIVER	MB	0.74	0.04	0.01	0.01	0.77	0.46	0.27	0.10	0.03	0.99	0.99	0.69	0.43	0.27
DAUPHINA	MB	0.70	0.01	0.01	0.01	0.81	0.38	0.17	0.04	0.01	0.99	0.99	0.63	0.36	0.21
DEERWOOD	MB	0.71	0.21	0.06	0.01	0.73	0.48	0.32	0.14	0.06	0.99	0.87	0.60	0.41	0.28
DELORAINE	MB	0.77	0.23	0.07	0.01	0.99	0.74	0.47	0.20	0.08	0.99	0.99	0.99	0.66	0.44
DELTA_UNIVERSITYFS	MB	0.59	0.15	0.04	0.01	0.82	0.38	0.18	0.04	0.01	0.99	0.87	0.51	0.30	0.18
ELMCREEK	MB	0.60	0.29	0.14	0.03	0.69	0.50	0.37	0.19	0.10	0.99	0.82	0.61	0.45	0.34
EMERSON	MB	0.78	0.03	0.01	0.01	0.76	0.42	0.23	0.07	0.02	0.99	0.92	0.62	0.42	0.29
FALCONLAKE_TCPL45	MB	0.73	0.12	0.02	0.01	0.80	0.38	0.18	0.04	0.01	0.99	0.85	0.50	0.29	0.17
FISHERBRANCHS	MB	0.68	0.13	0.02	0.01	0.90	0.54	0.32	0.11	0.04	0.99	0.99	0.69	0.43	0.27
FLINFLON	MB	0.88	0.35	0.14	0.02	0.99	0.54	0.27	0.06	0.02	0.99	0.99	0.51	0.26	0.13
FLINFLONA	MB	0.89	0.37	0.15	0.03	0.99	0.44	0.20	0.04	0.01	0.99	0.86	0.44	0.22	0.11
GILBERTPLAINS	MB	0.71	0.16	0.04	0.01	0.84	0.39	0.19	0.04	0.01	0.99	0.99	0.58	0.31	0.16
GILLAMA	MB	0.68	0.03	0.01	0.01	0.84	0.01	0.01	0.01	0.01	0.54	0.23	0.10	0.04	0.02
GIMLI	MB	0.83	0.01	0.01	0.01	0.76	0.19	0.05	0.01	0.01	0.88	0.52	0.31	0.18	0.11
GLADSTONE_SOUTH	MB	0.99	0.64	0.36	0.12	0.99	0.95	0.71	0.40	0.22	0.99	0.99	0.99	0.71	0.50
GLENBORO	MB	0.62	0.34	0.19	0.06	0.93	0.68	0.50	0.27	0.15	0.99	0.99	0.87	0.61	0.43
GLENLEA	MB	0.66	0.04	0.01	0.01	0.75	0.44	0.26	0.09	0.03	0.99	0.87	0.59	0.40	0.28
GRANDRAPIDS_HYDRO	MB	0.75	0.01	0.01	0.01	0.76	0.10	0.01	0.01	0.01	0.76	0.39	0.20	0.10	0.05
GRASSRIVER	MB	0.81	0.20	0.05	0.01	0.99	0.67	0.45	0.21	0.09	0.99	0.99	0.91	0.60	0.40
GREATFALLS	MB	0.90	0.01	0.01	0.01	0.69	0.09	0.01	0.01	0.01	0.99	0.76	0.43	0.24	0.14
HAMIOTA	MB	0.89	0.51	0.29	0.09	0.99	0.99	0.72	0.37	0.19	0.99	0.99	0.99	0.82	0.55
HODGSON2	MB	0.74	0.26	0.09	0.01	0.86	0.51	0.30	0.11	0.04	0.99	0.99	0.68	0.41	0.25
INDIANBAY	MB	0.82	0.01	0.01	0.01	0.75	0.26	0.09	0.01	0.01	0.93	0.54	0.31	0.18	0.11
ISLANDLAKE	MB	0.82	0.01	0.01	0.01	0.85	0.01	0.01	0.01	0.01	0.48	0.16	0.05	0.02	0.01
LANGRUTH	MB	0.59	0.14	0.03	0.01	0.71	0.33	0.15	0.03	0.01	0.99	0.69	0.41	0.24	0.14
LYNNLAKEA	MB	0.82	0.30	0.11	0.01	0.72	0.22	0.07	0.01	0.01	0.99	0.53	0.26	0.13	0.06
MACGREGOR	MB	0.91	0.58	0.37	0.15	0.99	0.93	0.70	0.40	0.23	0.99	0.99	0.99	0.82	0.56
MARQUETTE	MB	0.62	0.15	0.04	0.01	0.75	0.43	0.25	0.08	0.03	0.99	0.99	0.68	0.42	0.27
MINNEDOSA	MB	0.72	0.26	0.09	0.01	0.88	0.52	0.31	0.11	0.04	0.99	0.98	0.64	0.41	0.27
MORDENCDA	MB	0.70	0.25	0.09	0.01	0.79	0.53	0.35	0.16	0.07	0.99	0.91	0.62	0.42	0.29
MYRTLE	MB	0.73	0.13	0.02	0.01	0.70	0.49	0.34	0.16	0.08	0.99	0.99	0.83	0.56	0.37

Station Name	Prov	Wheat				Corn					Forage				
		Probability of stress in excess of				Probability of stress in excess of					Probability of stress in excess of				
		0mm	**25mm**	**50mm**	**100mm**	**0mm**	**25mm**	**50mm**	**100mm**	**150mm**	**50mm**	**100mm**	**150mm**	**200mm**	**250mm**
NEEPAWAWATER	MB	0.99	0.66	0.37	0.11	0.99	0.98	0.68	0.32	0.16	0.99	0.99	0.99	0.61	0.37
NIVERVILLE	MB	0.68	0.14	0.03	0.01	0.84	0.60	0.43	0.22	0.11	0.99	0.99	0.86	0.61	0.43
NORWAYHOUSEA	MB	0.74	0.02	0.01	0.01	0.74	0.11	0.02	0.01	0.01	0.91	0.48	0.25	0.13	0.07
NORWAYHOUSEF	MB	0.73	0.01	0.01	0.01	0.69	0.05	0.01	0.01	0.01	0.87	0.42	0.20	0.10	0.05
OAKNER	MB	0.62	0.30	0.15	0.04	0.99	0.68	0.44	0.18	0.07	0.99	0.99	0.88	0.56	0.35
PASQUIAPROJ_PFRA	MB	0.80	0.11	0.02	0.01	0.80	0.44	0.24	0.07	0.02	0.99	0.99	0.63	0.37	0.22
PEACEGARDENS	MB	0.61	0.21	0.07	0.01	0.77	0.43	0.24	0.08	0.02	0.82	0.56	0.38	0.26	0.18
PIERSON	MB	0.66	0.38	0.22	0.07	0.99	0.85	0.65	0.38	0.23	0.99	0.99	0.99	0.84	0.60
PINAWAWNRE	MB	0.63	0.02	0.01	0.01	0.81	0.22	0.06	0.01	0.01	0.99	0.73	0.41	0.23	0.13
PINEDOCK	MB	0.81	0.19	0.04	0.01	0.65	0.16	0.04	0.01	0.01	0.60	0.34	0.19	0.11	0.06
PINEFALLS	MB	0.67	0.02	0.01	0.01	0.75	0.27	0.09	0.01	0.01	0.99	0.77	0.44	0.25	0.14
PINEY	MB	0.99	0.59	0.25	0.05	0.99	0.99	0.68	0.29	0.13	0.99	0.99	0.88	0.56	0.35
PLUMCOULEE	MB	0.70	0.22	0.07	0.01	0.79	0.56	0.40	0.20	0.10	0.99	0.99	0.79	0.56	0.39
PORTAGELAPR	MB	0.59	0.33	0.18	0.06	0.73	0.47	0.31	0.13	0.05	0.99	0.99	0.73	0.49	0.33
PORTAGELAPR2	MB	0.66	0.18	0.05	0.01	0.78	0.48	0.29	0.11	0.04	0.99	0.99	0.74	0.48	0.31
RATHWELL	MB	0.61	0.31	0.16	0.04	0.88	0.61	0.42	0.20	0.10	0.99	0.99	0.80	0.54	0.37
ROSSBURN	MB	0.79	0.27	0.09	0.01	0.93	0.58	0.36	0.14	0.05	0.99	0.99	0.71	0.44	0.27
SELKIRK	MB	0.62	0.25	0.10	0.02	0.59	0.35	0.21	0.08	0.03	0.99	0.85	0.54	0.35	0.22
SOMERSET	MB	0.70	0.18	0.05	0.01	0.73	0.45	0.28	0.11	0.04	0.99	0.73	0.49	0.33	0.22
SPRAGUE	MB	0.69	0.24	0.08	0.01	0.91	0.52	0.29	0.09	0.03	0.99	0.82	0.50	0.31	0.19
STARBUCK	MB	0.58	0.29	0.14	0.04	0.73	0.53	0.38	0.20	0.10	0.99	0.94	0.67	0.48	0.34
STEINBACH	MB	0.81	0.28	0.10	0.01	0.99	0.68	0.43	0.17	0.07	0.99	0.99	0.94	0.55	0.33
STONEWALL	MB	0.79	0.02	0.01	0.01	0.83	0.49	0.29	0.10	0.04	0.99	0.99	0.80	0.53	0.35
STONYMTN	MB	0.69	0.16	0.04	0.01	0.77	0.49	0.32	0.13	0.05	0.99	0.99	0.65	0.43	0.28
STRATHCLAIR	MB	0.71	0.32	0.15	0.03	0.99	0.66	0.42	0.17	0.07	0.99	0.99	0.76	0.48	0.31
SWANRIVER	MB	0.99	0.44	0.20	0.04	0.99	0.78	0.49	0.19	0.07	0.99	0.99	0.74	0.43	0.24
THEPASA	MB	0.72	0.05	0.01	0.01	0.74	0.22	0.06	0.01	0.01	0.99	0.80	0.41	0.21	0.11
THOMPSONA	MB	0.74	0.04	0.01	0.01	0.81	0.01	0.01	0.01	0.01	0.64	0.31	0.15	0.08	0.04
VIRDEN	MB	0.93	0.48	0.24	0.06	0.99	0.92	0.63	0.30	0.14	0.99	0.99	0.99	0.67	0.44
VOGAR	MB	0.87	0.01	0.01	0.01	0.74	0.16	0.04	0.01	0.01	0.92	0.50	0.27	0.14	0.08
WILSONCRWEIR	MB	0.70	0.06	0.01	0.01	0.77	0.34	0.15	0.03	0.01	0.99	0.77	0.47	0.28	0.17
WINNIPEGA	MB	0.64	0.27	0.12	0.02	0.68	0.40	0.24	0.08	0.03	0.99	0.99	0.70	0.45	0.28