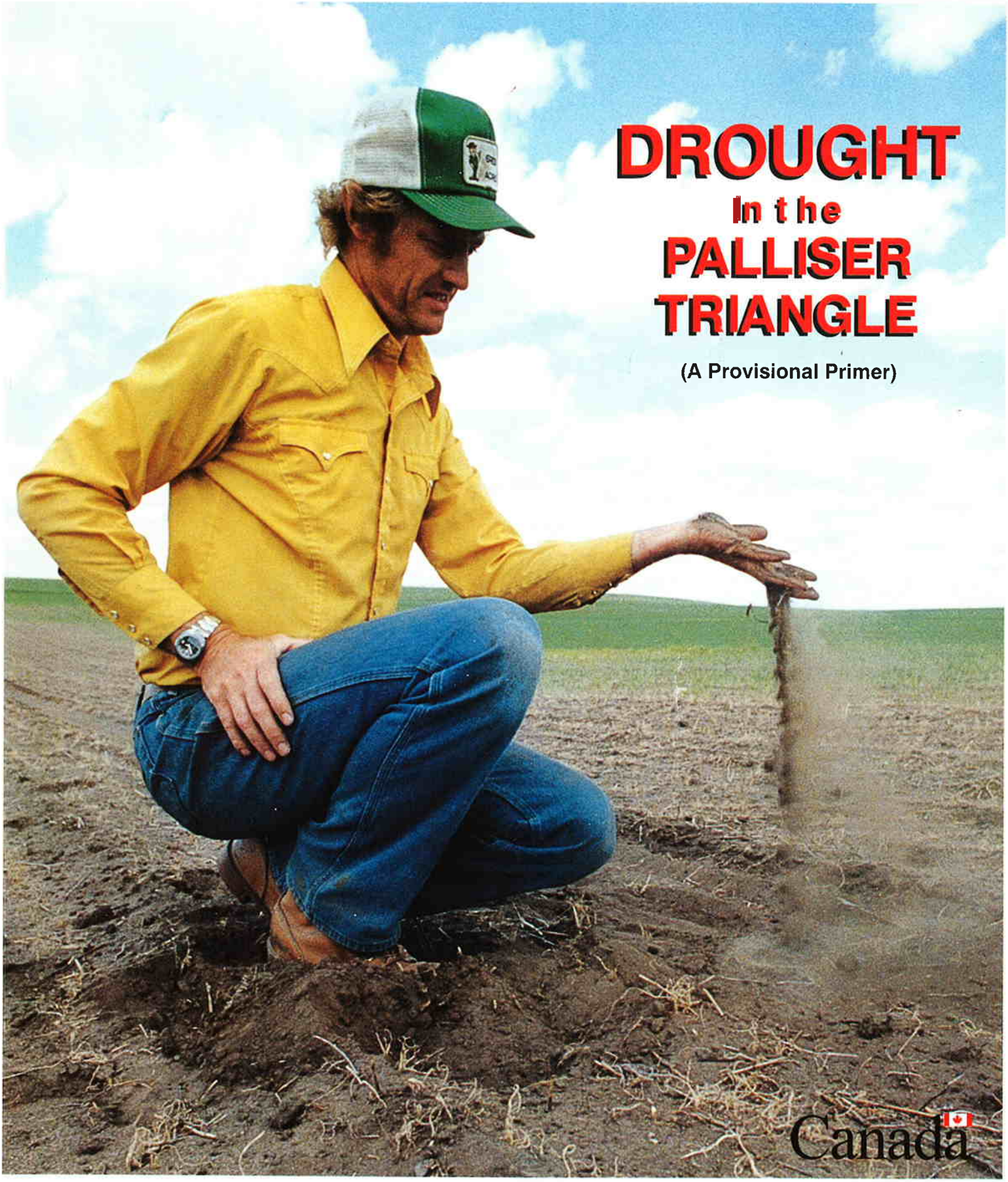
PFRA

Prairie Farm Rehabilitation Administration



DROUGHT
In the PALLISER TRIANGLE

(A Provisional Primer)

Canada

D R O U G H T

in the

PALLISER TRIANGLE

(A Provisional Primer*)

January, 1998

* This Primer was prepared by Walter Nemanishen, P.Eng., formerly a Planning Engineer with PFRA, and author of a number of papers relating to Prairie droughts and floods. The work was sponsored by PFRA's Drought Committee, with the intent to foster education and awareness among the Prairie people of the causes and drivers of historic droughts. This Primer is intended to be a compendium of historic data, analysis and trends to expand the body of knowledge on this subject. Although the information in this Primer is deemed to be accurate, the opinions and interpretations are those of the author and do not necessarily represent those of the PFRA Drought Committee.

The Drought Committee welcomes feed-back from the readers of this Primer.

Signed, PFRA Drought Committee:

Andrew J. Cullen, Regional Director, South Alberta Region
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Preface

The international focus on climate change, and the adverse impacts of recent Prairie droughts, has alerted agricultural climatologists, soil scientists and water resource managers to the vulnerability of our agricultural sector in terms of weather extremes. The super El Niño now in progress has caused serious droughts in Australia, Indonesia and Papua New Guinea. Using the 1982-83 El Niño as a template, oceanographers and climatologists predict more severe storms and droughts.

Profitable farming businesses in the Palliser Triangle are just as vulnerable to drought, soil erosion and pests as they were in the 1920's and 1930's. The recent droughts have served to demonstrate that all Federal and Provincial agencies with a vested interest in drought mitigation and soil rehabilitation must be knowledgeable of the causes of historic drought and be vigilant in anticipating their future recurrence. In 1988, Gilson and Hill[1] admitted that governments were not heeding some of the historic lessons, particularly in farm credit and soil conservation. Conceded Dr. Hill: "We forgot a lot of those things."

In the past 15 years there have been an equal number of Prairie conferences, workshops and other initiatives relating to climate change, drought and water resource management. Also, an international conference was held in Australia in 1991, on the physical causes of drought, especially the role of El Niño. These convocations provided forums for experts to describe some of their research relating to climate change and droughts. It appears that many of the pieces of the drought jig-saw puzzle are known. These pieces now fit together to create a partial picture. The gaps indicate where research effort is still required.

Table 1: A Partial List of Recent Prairie Initiatives Relating to Climate Change & Drought

Date	Location	Initiative	Primary Sponsor(s)
1983	Regina	Drought Workshop	PFRA, Cdn Climate Pl'ng Brd
1983	Hanna	WATER: The Prairie's Hope	PAWM*
1986	Calgary	Moisture Management in Crop Production: Managing Drought	Alberta Agriculture
1986	3 Provinces	Prairie Drought Study	PFRA
1986	Edmonton	Impact of Climate Variability & Change: Cdn Prairies	CCC*, EC*, Alta,
1986	Regina	DROUGHT: The Impending Crises?	NRC*, Univ. of Regina (UofR)
1988	Saskatoon	Prairie Drought Workshop	PFRA, NHRI*, SRC* & CCC*
1990	Calgary	Impact of Climate Change & Variability on the Great Plains	CCC, IWD*, NOAA*, USDC*, Univ. of Nebraska
1992	Calgary	Palliser Triangle Global Change Project	EC, GSC*, PFRA, UofCalgary, UofR, UofMan., UofWaterloo
1993	Saskatoon	1st meeting of the Long-Range Weather & Crop Forecasting (LRW&CF) Work Group	CWB*, EC, CGC* & PFRA
1993	Regina	Palliser Triangle Global Change Project	EC, GSC*, PFRA, UofC, UofR, UofM, UofWestern Ontario
1995	Winnipeg	2nd meeting of the LRW&CF Work Group	CWB, EC, CGC & PFRA
1995	Edmonton	Prairie Climate, Landscape & Vegetation Change	CFS & Geog Dept, UofAlberta
1996 & 1997	Saskatoon	Canadian Association of Geographers (CAG)	CAG, UofSask., & others
1996	Edmonton & Saskatoon	Prairie Climate Workshops (Prairie Adaptation Study)	EC, AEP*, PFRA, SRC, UofLethbridge
1997	Wpg, Regina, & Calgary	Climate Prediction Workshops	Cdn Inst Climate Studies & PFRA
1997	Montreal	3rd meeting of the LRW&CF Work Group	CWB, EC, CGC & PFRA

*PAWM denotes Prairie Association for Water Management: CCC, Canadian Climate Centre: EC, Environment Canada: NRC, National Research Council: UofR, Univ. of Regina: NHRI, National Hydrology Research Institute: SRC, Sask. Research Council: NOAA, National Oceanic, Atmospheric Administration: USDC, United States Dept. of Commerce: GSC, Geol., Survey of Canada: UofC, Univ. of Calgary: CWB, Canadian Wheat Board: CFS, Canadian Forest Service: CGC, Canadian Grains Commission: AEP, Alberta Environmental Protection:

This report is intended to be a primer on Palliser Triangle droughts. It draws extensively upon the climatological research results of the investigators associated with the various Canadian agencies who have contributed to the initiatives listed in Table 1. Since it is now apparent that Palliser Triangle droughts are caused by teleconnections to global ocean temperatures and to atmospheric circulation patterns, the drought research results of many international scientists are also highlighted in a attempt to coherently and scientifically illustrate and explain:

- the vulnerability of Palliser Triangle agriculture to drought;
- the drought driving forces: El Niño, Southern Oscillation and solar radiation;
- the primary drought areas of the Canadian Prairies and their climate;
- the suspected origin of historical droughts, their link to the drought drivers and the threat posed by global warming; and
- the technical feasibility of drought prediction in the Palliser Triangle.

Although it has been the scourge of mankind for millennia, only in the last two decades has science been able to identify and explain how distant ocean temperature anomalies, like the El Niño, and atmospheric processes, like the Southern Oscillation, interact to create droughts in the Palliser Triangle of the Canadian Prairies. To effectively summarize and communicate this scientific understanding in a short technical report is a daunting task. Faced with a somewhat similar and difficult assignment in 1995, that of reporting on global warming, Dr. Gordon McBean[2], (Assistant Deputy Minister of Atmospheric Environment Services) cautioned:

"Perhaps one of the most difficult tasks facing the science community is not that of reducing uncertainty, but of properly assessing what we do and do not know and communicating such assessments to politicians and decision makers (and society in general) in a language that they can understand. Communication of this kind is also a risky business, since it often draws the ire and scorn of those who feel the science has been over simplified and uncertainties trivialized, while still confusing, even paralysing decision makers with scientific jargon."

Throughout the Primer, I use the term "average" rather then the term, "normal", being in full agreement with Gribbin's and Lamb's[3] conclusion that, "The first and most important lesson of the historical record is that there is no such thing as a climate 'normal' in the sense that the word was used 50 or more years ago".

Acknowledgements

Many scientific and technical experts contributed to the preparation of this Primer. The format and general contents were established by the PFRA Drought Committee members identified on the title page. Copies of recent reports and articles on global warming, climate change, droughts, El Niño, the Southern Oscillation, the Pacific North America index and solar cycles were provided by Ted O'Brien (PFRA), Allan Stewart (PFRA), Gord Bell (PFRA), Paula Brand (PFRA), Dick Bennett (AEP), Dick Hart (AEP), Rodney Jones (AEP), Ray Garnett (CWB), Dr. Madhav Khandekar (AES), Dr. Amir Shabbar (AES), Dr. Barry Bonsal (AES), Dr. S.M. McGinn (AAFC), Herb Cutforth (AAFC), Virginia Wittrock (SRC), Larry Romaniuk (WeatherTec), Tim Goos (AES), Prof. Louis Thompson (Iowa State Univ.), Dr. Laurence G. Riddle (Scripps Institute) and Dr. David Enfield (NOAA).

CICS officials, Dr. Kirk Dawson and Rick Lee, offered timely advice on drought forecasting. Ted O'Brien, Dr. Dave Sauchyn (Univ. of Regina) and Dr. Scott Stine (Calif. State Univ.) contributed the information on tree stump graveyards. Prof. Brian Luckman (Univ. W. Ont.), Dr. Don Lemmon (GSC), Dick Allison (AEP), and Dr. Alwayne Beaudoin (Prov. Museum of Alberta) supplied the paleoenvironmental data. Dr. J. A. Eddy and Dr. R. L Gilliland (NCAR) contributed the solar information. Discussions with Harvey Hill (Texas A&M Univ.) helped to resolve some teleconnection problems. Brian Bell (PFRA) expertly performed the Palliser Triangle data analyses. Bob Parkinson desktop published the document and conducted the Internet searches (the first time that this new mode of communication has been invoked to report on the factors contributing to Palliser Triangle droughts). Historical information was supplied by Fred Kraft (PFRA), Joan Pugh (PFRA), Bill King (PFRA), Jay Slemp (Chairman, SAB), Ab Grover (former Chairman, SAB) and James Martin (JQ Public). Charlene Dusyk, Barb Senkow and other PFRA Library staff rendered timely assistance by locating long forgotten drought documents. The report illustrations were skilfully prepared by Alain Lee (PFRA). Kelly Sander, Richard Powley and Mark Wonneck rendered valuable assistance on word processing. Regular consultations with the PFRA Drought Committee members—Andrew J. Cullen, Erminio Caligiuri and Brian Abrahamson— guided the Primer to completion.

Contents

Cover Photo: *"DREAMS TURNED TO DUST"*: Claresholm (Alberta) farmer, Glen Roemmele sifts bone-dry topsoil from a cultivated field that would have yielded 30 to 35 bu/ac had it not been for extreme drought conditions in 1983 (Glenbow Archives' Photo: #5A, 86/06/13-21-PK).

1 Drought: Nemesis of Palliser Triangle Farmers

The Palliser Triangle, named after the British explorer Captain John Palliser, is part of the Northern Great Plains outlined in Figure 1. This vast region lies in the "rain-shadow" of the massive Rocky Mountains. The Rockies, in conjunction with the Coast Mountains, the Cascade Range and the Sierra Nevada Range, form lofty barriers to the flow of moisture from the Pacific Ocean. Moisture-laden clouds from the Pacific Ocean are stripped of much of their precipitation due to cooling induced by orographic uplift as the cold lows are thrust upwards by the mountains. During winter months, the process is usually so efficient that the air masses are essentially dry by the time they skim over the final barrier, the Rockies. Rather than bringing needed moisture, the dry air mass creates only warm chinook conditions across the western portion of the Palliser Triangle.

About 35 years before Captain Palliser's exploration of the Canadian Prairie's, the American cartographer and explorer, Stephen Long, had mapped the desert region of the continental interior. Captain Palliser was familiar with this work having led an expedition through South Dakota and Wyoming, prior to his Canadian assignment. It is, therefore, not surprising that Captain Palliser correctly surmised that the semi-arid Prairie region was the northern extension of the notorious "Great American Desert". Since his 1857-1859 exploration coincided with a severe drought period, Captain Palliser cautioned that the dry region, which now bears his name, was not suitable for agricultural settlement. The research of Professor David C. Jones[4] into the settlement of this dry region, reveals that a number of later, but observant, Canadians supported Palliser. Commissioner G. A. French of the North-West Mounted Police, described the region southwest of Suffield (Alta) as "little more than a desert." Thus the Canadian government was adequately forewarned of the hazards dryland agriculture would face in this semi-arid region, particularly the notorious "Dry Belt" within the heart of the Palliser Triangle. Historian, Jack Gorman, aptly described this region as one of perpetual drought. Gable, a cartoonist with the Regina Leaderpost, portrayed farming in the southern Palliser Triangle as a no-win poker game against an experienced and sarcastic "Mother Nature". In one of his cartoons (Figure 2), the old lady has not only won all the farmer's money, she has even stooped to take his pitch fork and pants.

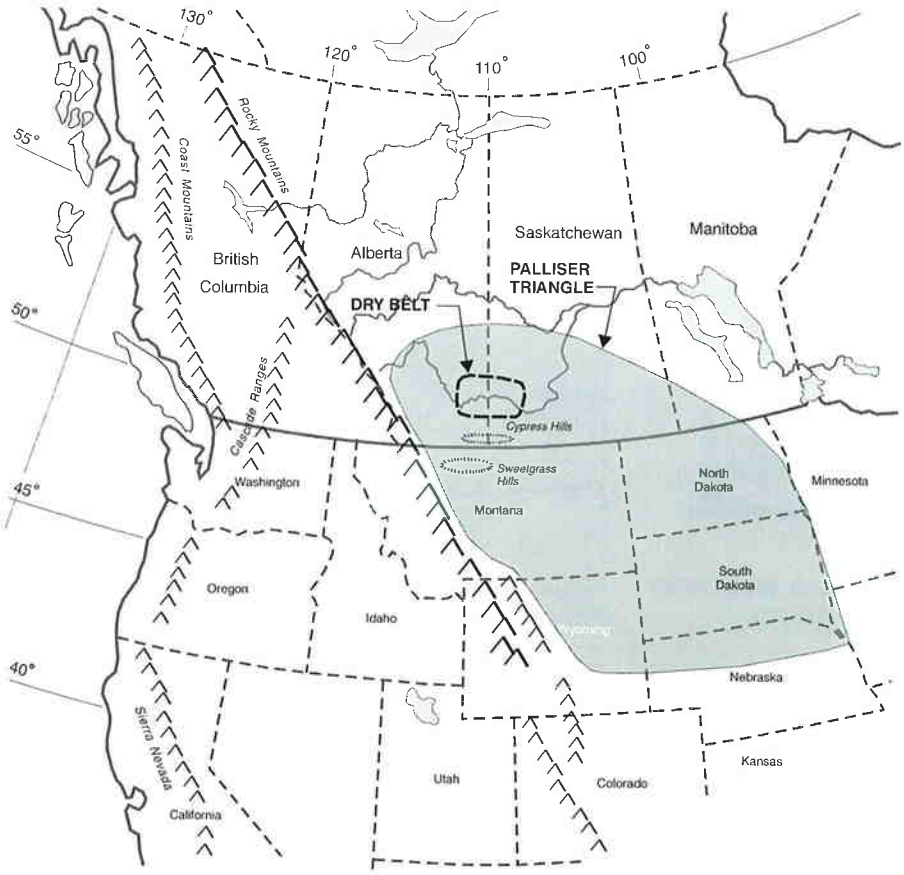


Figure 1: The Northern Great Plains (shaded area): Palliser Triangle is within Canada

Figure 2: The perils of gambling against Mother Nature in the Palliser Triangle.

In another cartoon (Figure 3), Gable features an ex-farmer preparing to step into a lion's cage. He expresses relief for having abandoned a much more hazardous profession—farming.

Figure 3: Lion Taming: a profession safer than farming. (Figures 2 & 3 courtesy Brian Gable)

THREE DESTRUCTIVE DROUGHT PERIODS

By the start of the 20th century, a number of modern cropping practices and early maturing wheat strains had been developed by the network of Dominion Experimental Farms. The summer fallow system allowed the fields to bank moisture for next year's wheat crop. Even if precipitation was below average in the crop year, a good yield could be expected. But summer fallowing could not help farmers if the drought persisted into the second, and even the third, growing season. This was the terrible situation which Palliser Triangle farmers were to endure three times in the 20th century.

1. The Destructive Dry Belt Droughts: 1917-1926

Canadian geographer, Villimow[5], has assigned the name, "Dry Belt" to the interior of the Palliser Triangle (Figure 4). It lies in the rain shadow of the tall Rocky Mountains, the Cypress Hills, and the Sweet Grass Hills of Montana. The average annual precipitation within this notoriously drought-prone region, is less than 325 mm. Moisture losses are high due to winter chinooks and summer heat waves. In drought years, excessive heat constantly evaporates moisture from the soil. This high loss, added to the below average return of moisture in the form of precipitation, marks the Dry Belt as a region of double misfortune. Archie McKellar, who homesteaded near Bingville, (90 km north of Medicine Hat), poetically recalled the dryness of the region[6]:

"Come and I'll tell you a story of life on the plains, sixty miles from the Hat as the crow flies, in a land where it never rains."

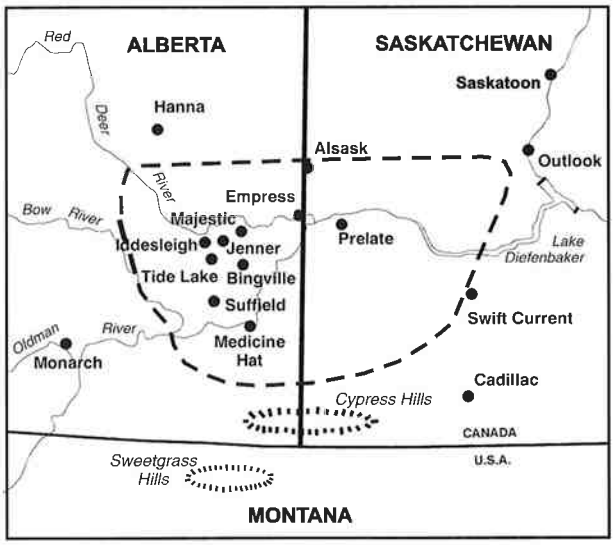


Figure 4: The Dry Belt: a region of double misfortune.

Captain Palliser's warnings were ignored by the government and railway officials in their zeal to settle the Dry Belt, a decision which sowed the seeds for "the nightmare in western Canada," according to an eyewitness of the sufferings created by the 1917-1926 droughts in the Dry Belt. Caligiuri[7] provides a brief description of the promotional campaigns designed to attract settlers, the consequences of the massive droughts and PFRA's efforts to rehabilitate the drought-ravaged areas within the Palliser Triangle.

In all fairness to the government and railway promoters, the land and the deceptively benign climate in the Palliser triangle were attractive to settlers. Fertile and easily broken by steam engines and powerful tractors (Figure 5), the fields initially yielded bountiful harvests. Mother Nature showered her blessings with timely rainfalls in four of the six years in the period, 1911 to 1916 (Figure 6). Bumper crops were threshed throughout the Dry Belt in 1915. In many districts, yields exceeded 40 bushels/acres. The following year was nearly as good. Farmers experienced prosperity as wheat prices soared due to overseas demands in World War 1.

Figure 5: Two Marshall gas tractors[8] (35-70 HP) breaking sod on the Canadian Wheatlands Company Limited holdings near Suffield, in 1913 (Glenbow Archives, NA-587-8).

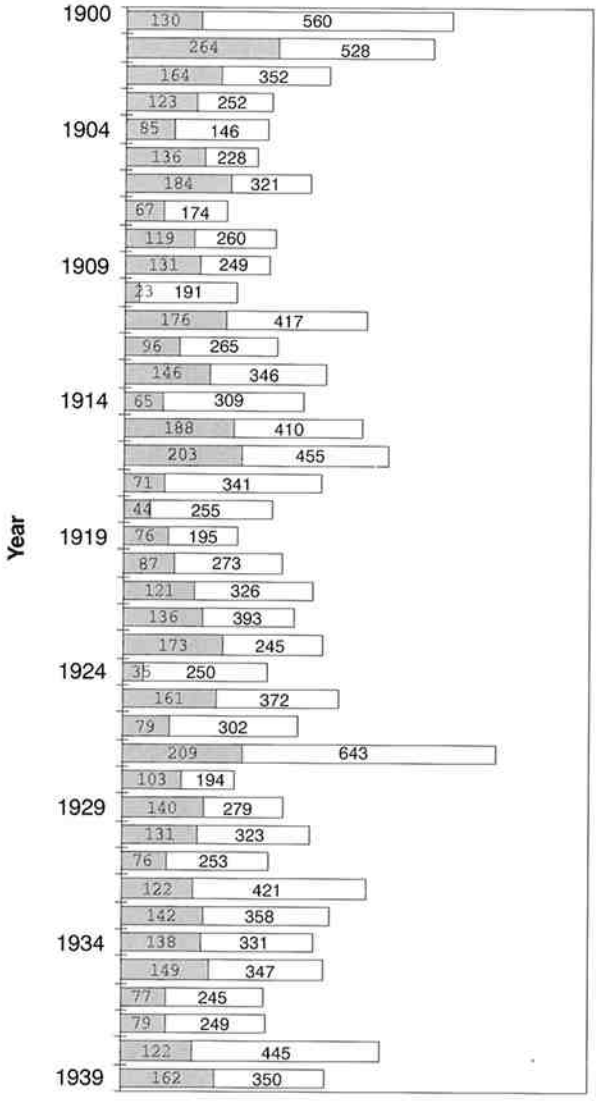


Figure 6: Growing season (Apr-June) and annual precipitation (in millimetres) recorded at Medicine Hat, 1900 to 1939. (Graph replotted from the MEDICINE HAT NEWS, Thursday, March 24, 1988).

Mother Nature's "Jekyll & Hyde" Personality

In 1917, the rains became mere sprinkles in the Dry Belt south of the Red Deer River. Severe drought conditions persisted until 1926. During six years, in the ten-year drought period, the April to June local rainfall did not exceed 100 mm (Figure 6). Fortunately, precipitation north of the Red Deer River was somewhat better.

Wheat yields within the Dry Belt fell. Jones[9] records that in the Medicine Hat district, only 7 bushels/acre was threshed in 1917; in 1918 it was down to 1 bushel/acre and zero in 1919. The next two years were hardly better; yields only averaged 5 and 3 bushels/acre respectively.

Four years into the drought, desperate Medicine Hat area farmers and agricultural officials agreed to retain California rainmaker, Charles M. Hatfield (Figure 7). Jones gleaned accounts from the local newspapers to piece together a description of several of the secret methods employed at Chappice Lake, 60 km northeast of the city. Hatfield's apparatus included a tower, the height of which one reporter compared to the legendary Tower of Babel. His operations encompassed several Dry Belt localities in Saskatchewan according to Jones. In 1921, the Secretary Treasurer of Village of Prelate wrote to the Minister of Agriculture in Regina, of the hope Hatfield had brought to drought-weary farmers:

"... I might say that regardless of what people think of Hatfield I really thought that his coming here this year has kept some people in this country who would otherwise have pulled out."

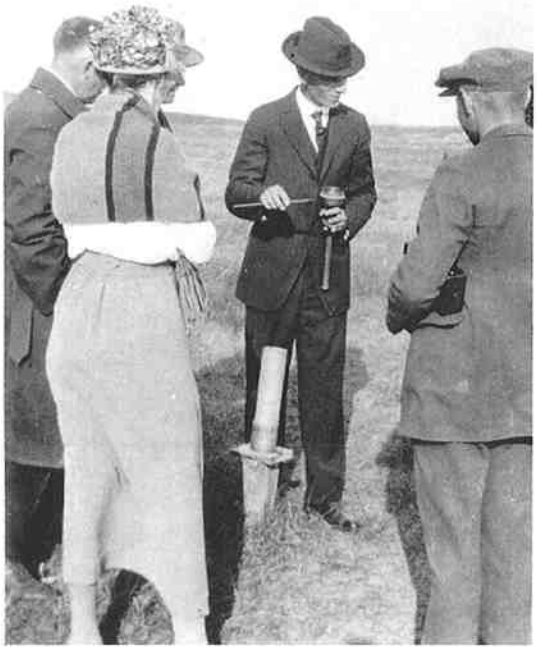


Figure 7: California rainmaker, Charles Hatfield, explains some of his techniques to drought weary farmers at Chappice Lake, June 5, 1921 (Glenbow Archives, NA-2003-67).

The early drought years in southwest Saskatchewan prompted some naive, but high ranking, government officials to attribute the crop failures to bad farming. One such official boasted that he was convinced drought was a controllable factor in crop production and that there was no necessity for complete failure. Some "experts" recommended excessive surface tillage of summer fallow fields to create a dust-mulch to reduce evaporation. Farmers who adopted this unscientific advice, were the first to see their topsoil blown away by the unrelenting dust storms.

Wheat Farming Ends in the Southern Dry Belt

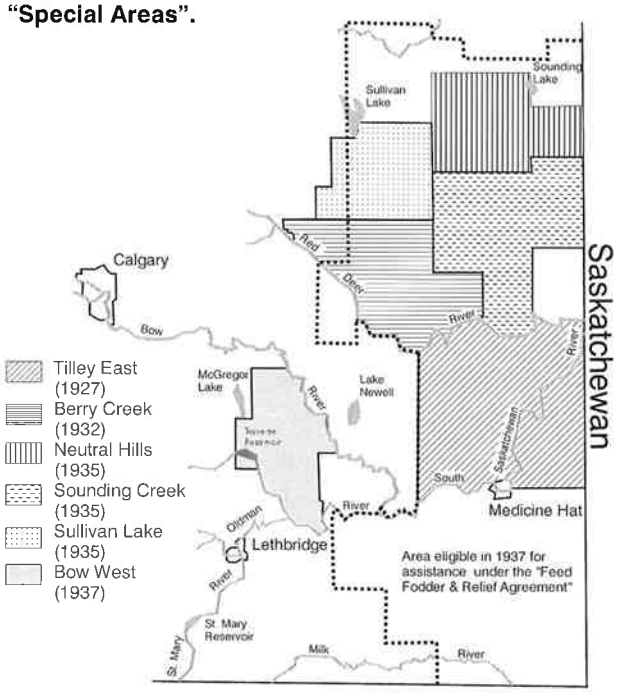
Ben Russell, an engineer with the Reclamation Service of the Department of the Interior, (and later, PFRA's first Chief Engineer) carefully documented the Dry Belt drought conditions in a 1924 report[10].

But he made no attempt to suggest any cause for the severe drought period. He does however deserve credit for admitting that the government, and others, had knowledge of the dry nature of the region prior to promoting settlement:

"It has long been recognized that throughout extensive areas in Southern Alberta the precipitation is insufficient for the growth of crops. From a study of the precipitation records during the past thirty five years and the financial condition of the large majority of the farmers living throughout the dry belt,it must be conceded that much of the area is more suitable for ranching than farming purposes. Due to continued drought many farmers have already been forced to abandon their farms and the prospects are that this general abandonment by farmers of the semi-arid lands will continue."

By the time he had completed his report, Russell states that only 645 farmers were still surviving (within the survey area) of the original 2386 homesteaders. Local municipal government had ceased to function. Gorman[11] describes the subsequent events leading in 1927 to the passage of "An Act Respecting the East Tilly Area" (Figure 8). Only a scant four years later, this Act became the basis of the Special Areas legislation enacted to cope with the devastation wrought north of the Red Deer River by the droughts of the Dirty Thirties.

Figure 8: The Alberta "Special Areas".



2. The "Dirty Thirties" Droughts: 1929-1937

In his memoirs, Moose Jaw district farmer, Leslie Ashton[12], recalls the exact month when the drought started: "In retrospect, we must now recognize that the GREAT DROUGHT ACTUALLY STARTED IN JULY 1928". A year later, the Stock Market collapsed, ushering in the Great Depression. International trade barriers contributed to a ruinous decline in wheat prices. The ten year nightmare was about to begin in all of the Palliser Triangle. It was to be Canada's worst calamity.

James H. Gray[13] provides thumbnail sketches of conditions farm families were enduring and of the drought blasted and drifting landscape existing on February 11, 1937, when the Parliament debated a bill to amend the Prairie Farm Rehabilitation Act, passed two years earlier to establish PFRA:

"The people of the West had just survived the worst year, climatically, within living memory. Not only had 1936 been the coldest bitterest winter ever recorded but the torrid summer had seen high temperature records shattered between Winnipeg and the Rockies. Even as Mr. Gardiner spoke, the winter of 1937 had started in where the winter of 1936 had left off, presaging worse disasters to come.

Life on the dust bowl farms might have been tolerable for the 200,000 farmers and their families on dried-out relief if they had been well housed and well clothed. For the most part they shivered or sweltered in shack-houses with paper thin walls, without modern conveniences, comatosely holding to a fading hope, that next year had to be better; and for seven years each year had been worse than the one before.

The desert, which had begun in 1929 with the swirling up-drafts on the parched summer-fallow from Hanna to Monarch to Cadillac to Melita, now threatened the entire Palliser Triangle. Blowing topsoil drifted like snow across the railway tracks in Alberta.It blew from the poor land onto the good land in Saskatchewan and kept Regina, Moose Jaw and Swift Current coated with dust inside and out. It bathed Winnipeg in perpetual yellow overcast. Roads made impassable by snowdrifts in winter were drifted into impassability again with blowing topsoil in the summer. The drifts built up till they covered the fences, choked out shelterbelts and gardens, reached the roofs of the chicken houses, blew through the cracks around farmhouse windows and under farmhouse doors to drive the inhabitants out of their houses and out of the country."

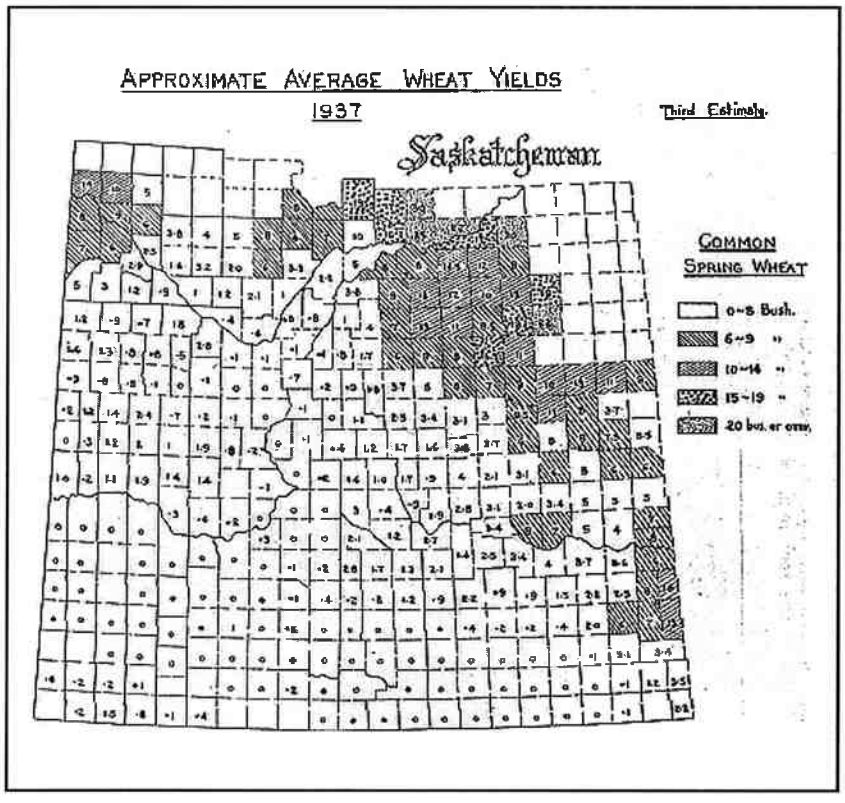


Figure 9: Average wheat yields in Saskatchewan in 1937 (reproduced from the Stapleford Report[14]).

Despite drought conditions in the Palliser Triangle, the opposite conditions existed in the northern fringes of the Parklands, and wheat yields were good—even in the worst drought year, 1937. That year, the southern third of the Saskatchewan wheat growing area had zero yield (Figure 9). Many destitute farmers trekked north to grub-out a new life in the bush country (Fig. 10 & 11).

Jack Gorman[15] recalls vividly the demise of dryland farming in the northern Dry Belt. Thousand of destitute farm families were forced to abandon their homes, a tragedy he calls, "The Exodus." Many of the destitute farmers loaded their meagre belongings on wagons, old trucks and even "Bennett Buggies", named after then Canadian Prime Minister, Rt. Hon. R.B. Bennett. The