THE IMPACT OF AGRICULTURE ON WATER QUALITY IN THE SOUTH SASKATCHEWAN RIVER SUB-BASIN

SEAWA Watershed Report 2010-7 Draft

SEAWA Web-based State of the Watershed Report

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Overview

Agricultural activities take place on most of the land within the South Saskatchewan River Watershed in both Alberta and Saskatchewan. General public perception is that agriculture may pose the greatest threat to both surface and ground water quality. Potential agricultural point sources include runoff from intensive livestock operations, manure storage, and livestock wintering areas; direct cattle access to streams; drift from chemical application or improper storage and disposal, leaching from septic systems; and improper fuel storage. Nonpoint source agriculture threats include runoff from livestock grazing and wintering sites; and surface runoff and leaching of pesticide residues, fertilizer and manure .

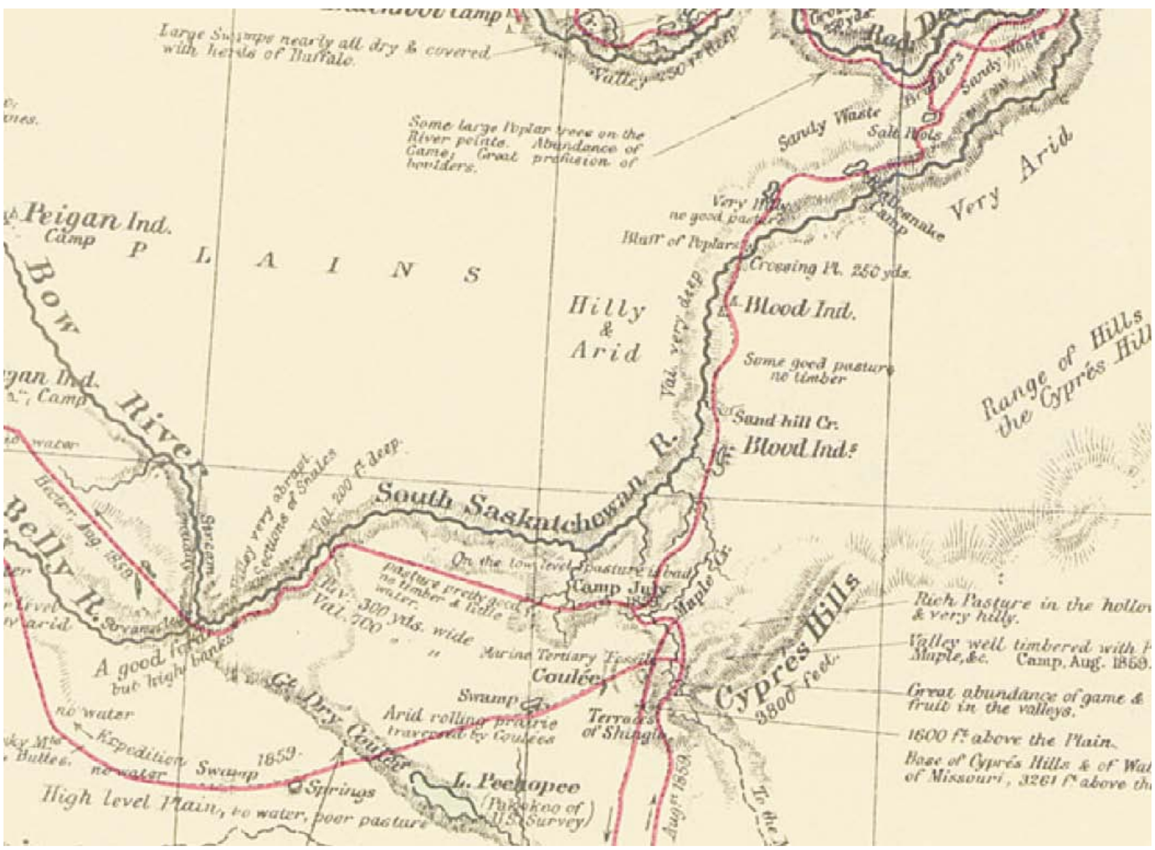
Extensive research studies have been conducted by a variety of government and other agencies to monitor the quality and quantity of water throughout the South Saskatchewan Watershed as well as the other major watersheds in Alberta and Saskatchewan. At the same time a variety of best management practices have been implemented to address agriculture's impact on these watersheds.

The purpose of this report is to address a number of important questions with regard to the South Saskatchewan River Sub-basin (SSRSB). What components of water quality within the sub-basin are affected by agriculture? What is the current state of water quality as it relates to agricultural activities within the SSRSB? Have the implemented agricultural best management practices had any impact on improving water quality in the SSRSB? Are there agricultural issues or trends that may affect future water quality or quantity in the SSRSB? To provide background to these questions, a brief history of the development of agriculture in southern Alberta has also been provided.

PART A. BACKGROUND

Palliser’s Triangle

The significance of water in the development of agriculture within the South Saskatchewan River Basin has been recognized even since the first scientific expeditions through the area between 1857 and 1859 by Captain John Palliser (Spry 1968- cited by Anderson and Dale-Burnett , 2003)). In his final 1863 report to the National Geographic Society and British government investors , the area which became known as Palliser’s triangle was deemed unsuitable for agriculture and described as “desert, or semi desert in character, which can never be expected to become occupied by settlers” (Anderson and Dale-Burnett, 2003)



Section of Map from John Palliser Expedition 1857-1860

University of Saskatchewan, Millennium project, 1999

http://www.sasksettlement.com/assets/archive_map/pg40.pdf

Another scientific expedition led by Toronto naturalist and geologist Henry Youle Hind, searching out reliable transportation routes through the river valleys of southern Manitoba and southern Saskatchewan came to a much more positive conclusion about the agricultural potential of the area. While Hind echoed Palliser's findings regarding the extreme south-east corner of Alberta to be essentially sterile, his 1860 account to the Legislative Assembly of Upper Canada in 1859 described a northerly fertile belt outside of Palliser's triangle which could maintain ranching and agriculture. While the existence of a semi-arid region was recognized, the possibility of agriculture and settlement in the prairies was seized upon by both Government and business investors and bolstered their desire to annex the region. (Milne,1972)

An optimistic view of the potential of the prairies was also emphasized by Dominion government botanist, John Macoun. On a trip in 1879, Macoun noted that there was "nothing to be seen but grass and flowers across the Prairies". (McLeod, 2009). Macoun argued that the absence of trees in the south-western Canadian prairies did not reflect soil deficiencies but instead indicated the area was particularly well suited for agriculture. Department of Agriculture pamphlets of the time even suggested that the absence of trees was a farmer's blessing since it made land-clearing unnecessary.

Promotion of Southern Alberta to potential homesteaders by the Department of Agriculture releases further announced that "no better place to grow crops existed than southern Alberta". The virtues of the Alberta prairies were painted in such glowing colours by immigration agents that people were led to believe that "...free land, where a man might become rich overnight awaited their plows, a land of temperate climate with the blessing of the Chinook, luscious grass belly-high to a tall horse, sod just waiting to be turned" (Milne, 1972).

Glenbow Museum Archive ca. 1920 ACCESSION: 1990-119-1

Other sections of these government pamphlets geared more toward attracting investment stated that because the land was so ideal for raising livestock, start up capital was minimal.   Unfortunately the resulting belief that settlers would require little assistance at the pioneering stage would lead to much hardship and undermine federal homestead policy. (McLeod, 2009).

The Era of the Big Cattle Ranches

In 1873 the Canadian government formed the North-West Mounted Police (NWMP) to secure and control the vast North-West Territories which would later be divided into Alberta and Saskatchewan. The primary duties of the Mounted Police were to establish friendly relations with the First Nations, eradicate the whiskey trade, and maintain law and order. (Demsey, 1974)

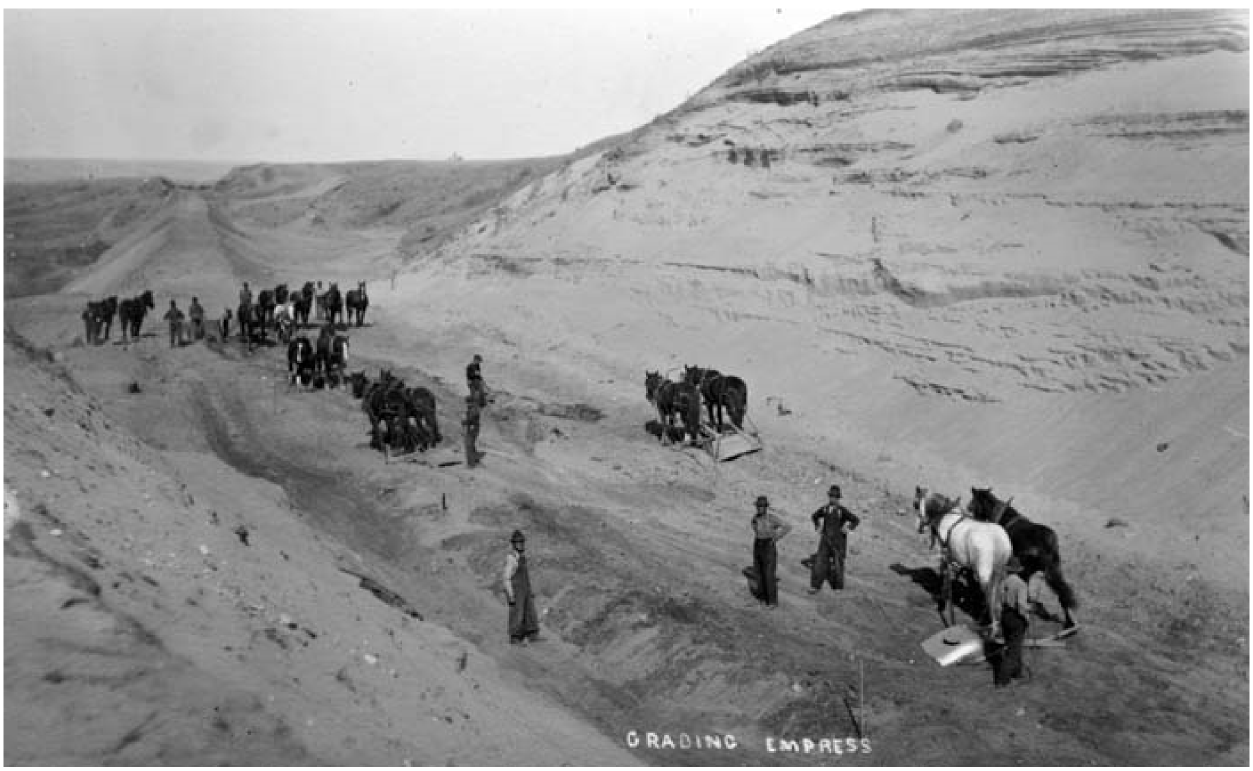
Group of uniformed police in front of log building at Fort Walsh (ca. 1885) From Esplanade Archives. Accession Number: 0404.0015

By 1874, NWMP reports of abundant native grasses and the promise of year-round grazing in a climate moderated by occasional Chinook winds in the winter came to the attention of British and eastern Canadian investors. Federal government policies to establish large-scale cattle businesses were put in place to promote investment in lands thought to be ill-suited for agriculture. (Demsey, 1974). Sir John A. MacDonald's federal system allowed the leasing of 100,000 acres for up to twenty-one years at an annual rental of one cent per acre.

Keeping capital expenditures to minimum encouraged entrepreneurs to invest heavily. The ranching industry expanded rapidly into Alberta and by 1884, the territory was home to an estimated 40,000 head of mostly longhorn cattle. (Alberta Texas Longhorn Association). By 1885, four cattle companies alone controlled 42 percent of the total leased acreage in southern Alberta. By 1886 there were 58 ranchers in Southern Alberta leasing over 2 million acres and the average size of the grazing leases in the Suffield-Medicine Hat area was 13,000 acres. (Cypress County History). A decade later, some two hundred large-scale cattlemen controlled the entire region.

Cattle round-up "bunching" between Greeley and Parson's ranches south of Maple Creek (1897). From the Esplanade Archives. Accession Number: 0395.0085

From 1883 to the early 1900's the range was open and cattle drifted from the South Saskatchewan River at Medicine Hat northeast to Many Island Lake district, east to Maple Creek and south to the Cypress Hills (Cypress County History). In the fall, ranchers would send out roundup crews to gather and separate the herds. This form of low-overhead, low-maintenance ranching however was not economically productive. Without feeding, fencing and sorting, huge numbers of animals were lost to cold, starvation, fire, wolves, disease and rustlers. Availability of water and suitable shelter became critical to the success of these early ranches. The Cypress Hills and creeks such as the Ross, Box Elder, Bullshead and the McKay became the home locations for many of the early ranches. (Cypress County History).



This photo is described by Edgar Potts: "The making of a railroad, a very dusty job on a windy day." The image looks down on a team of horse and men plowing the dirt for the railroad. [ca.1912 - 1913] From the Esplanade Archives. Accession Number: 0817.0008

With the arrival of the railway in 1883 and free market opening of the American Eastern markets such as Chicago, the ranching industry in southern Alberta boomed. Cheaply produced western beef was shipped to rapidly expanding British markets leading to a "beef bonanza" for the great cattle companies that dominated the Canadian range. (Breen, 1975). However the railway also meant that a tide of immigration to southern Alberta was underway. With settlement came the installation of barbed wire fences and the beginning of the end to free-range ranching. Emotions raged as the ranchers were determined to keep out the "sod-busters" where as the settlers were equally determined to break into the huge land holdings of the grazing leases. (Breen,1975). Finally yielding to the interests of settlement the federal government gave notice that all grazing leases would be cancelled in 1896.

The ranchers did not release control of their vast grazing leases without a fight arguing that southern Alberta was too dry for cereal agriculture. The ranchers also recognized the strategic role of water access and persuaded Ottawa to protect the cattle industry by setting up a system of public stock-watering reserves by major springs, rivers and creek fronts. With establishment of these stock-watering reserves most choice settlement sites became inaccessible and the ranchers hold on the land was maintained. (Breen, 1975)

In 1896 a change in federal government brought with it a reversal in settlement policy. With a strong belief that farming practices could overcome the obstacle of moisture deficiencies in the southern Alberta, the elaborate stock-watering reservations were auctioned off. Between 1897 and 1911, Clifford Sifton, Canadian minister of the Interior, actively promoted immigration to Western Canada. Immigrant farmers could apply for homestead title to a quarter section of land (160 acres) for just $10 if they managed to stay on the land for three years and improve it by clearing, planting and building a house. The land rush was on and even marginal land in southern Alberta and Saskatchewan was homesteaded. Between 1901 and 1905, 40,000 homesteads were granted. (History of Agriculture, Report to AB Legislature)

CPR Depot, Medicine Hat. View of track side of old depot, with a few people on the platform. Immigration hall in background. (ca. 1880's)

Accession Number: 0525.0093

The ultimate blow to the era of the huge cattle ranches was dealt by nature itself. Above-average rainfall had assisted the homesteaders with their crops but severe spring storms in 1903 along with major snow blizzards and freezing cold temperatures with no Chinooks in the winter of 1906-07 resulted in massive 70-80% stock losses for the large-scale ranchers. (Cypress County History).

An end to homesteading

During the period 1917 to 1921, the prairies suffered a prolonged drought forcing many people from their dryland farms into the growing cities and towns. Others returned to the United States from where they originated. In certain areas including the arid south-east corner of Alberta, farm abandonment reached levels of 80%. For comparison purposes these rates exceeded those of the Great Depression following the 1929 stock market collapse. It is ironic that the region known as the Prairie dry belt or Palliser's triangle (southern Alberta/Saskatchewan) had produced a mammoth harvest in the preceding years of 1915-1916.

To add to the suffering, in March of 1918 a new virulent type of flu virus appeared in American army training camps. The flu is believed to have spread to England and then to Spain where it was renamed the Spanish flu. Claiming more than twenty one million lives worldwide between 1918 and 1920 the death rate in Alberta is 4300 with another 38,000 people becoming sick. Many small communities in Alberta are devastated by the flu and without access to good medical care, deaths are common especially amongst young adults. (http://albertajasper.com/Alberta-History-1915-1918.html)

In 1922 the Homestead Act was revoked by the Canadian government. Throughout the arid dryland areas of southeast Alberta and southwest Saskatchewan homesteaders between 1922 to 1927 were offered a free "ticket-out" and the opportunity to farm on better land elsewhere in the province. In the heart of Palliser's triangle, the population of the Suffield block dropped from a high of 2386 in 1920 to 645 (by what year?). Some 70 years after Palliser's first pronouncement that the area was unfit for agriculture, the remaining farmers of the Suffield block were ordered, under the War Measures Act, to vacate their property by June 30 1941. (Cypress County History)

Dryland Farming in Southeast Alberta

For early homesteaders in southern Alberta, the main crop planted was wheat. Drought, frosts, plant diseases and epidemics of pests such as grasshoppers were common and wiped out their fields. Finally plant breeders from the Dominion Department of Agriculture developed a new breed of early-maturing wheat called Marquis which significantly improved yields. Diversification into mixed operations including dairy, hogs, poultry and other field crops became a strategy to successfully weather the challenges of dryland farming. (Cypress County History)

Four men standing in wheat field. Dry farming in Medicine Hat - Ginther Syndicate Farming (old Canada Wheatlands), NW of Medicine Hat (1915). Esplanade Archives. Accession Number: 0055.0918

Most of the first fields in southern Alberta were broken using horse-drawn ploughs, discs and cultivators. With the arrival of the mechanical revolution, how farming was to be carried out became profoundly changed. Huge steam tractors pulling multi-blade ploughs ripped through acres of previously unbroken native prairie. Steam threshers moved from farm to farm assisting with harvest of bumper crops in 1915-1916.

Unfortunately these bumper crops were followed by widespread drought especially in the arid Palliser's triangle area from 1917 to 1921.

"A threshing scene, Canada's western prairies." An early harvest scene showing horse-drawn and steam-driven threshing equipment (undated), From the Esplanade archives.

Accession Number: 0260.0007

With the end of the First World War came increased demands for food, increased prices for wheat but a shortage of manpower. Steam tractors were replaced by lighter and more reliable gasoline powered tractors. New implements for cultivation appeared. The horse was replaced and threshing crews gave way to swathers and combines. Harvesting was now a two-man operation instead of community wide. Immigration remained strong and new acreage was being broken even in marginal areas that would later contribute to the disastrous era of the "Dirty Thirties" in Alberta.

The “Dirty Thirties”

Agriculture in southern Alberta suffered a major setback in the 1930’s due to a combination of the stock market crash of 1929, closing of the European market for food imports and the major economic depression that followed. Wheat prices plunged and railway lines cut back or were abandoned leaving many small prairie communities without the lifeline for transportation they had come to rely on. Based on bumper 1925 crops, many Alberta farmers had been encouraged by banks and mortgage companies to go heavily into debt.

View of the prairie landscape during the dirty thirties. Shows the soil drifting, thistles, fence posts and the blown earth (ca. 1935). Image from the Esplanade Archives.

Accession Number: 0100.0001

Unable to make payments on their loans, many families lost their farms as banks foreclosed. People abandoned their homes and whole towns disappeared across the prairies. (http://www.ucalgary.ca/applied_history/tutor/calgary/onottawa.html)

Drifts in yard against buildings and machinery. Ca. 1930 From the Esplanade archives. Accession Number: 0136.0007

To add to this perfect storm, severe drought conditions returned and continued for almost a decade. The many years of drought, hordes of grasshopper infestations, wind storms, and fires left much of south-eastern Alberta a barren landscape. When the rain did fall, the eroded or fire-scorched land could not absorb the water, which caused major flooding. Summer fallowing, the practice of letting land lie unplanted for a summer and cultivating to control weeds, had been introduced in the 1880's as a method to conserve moisture. Unfortunately, the dry, improperly tilled soils drifted badly. With no vegetation to anchor soil in place, massive dust storms picked up

topsoil and blew it in huge dark clouds eastward and southward, creating huge drifts against homes and fences.
(http://www.absoluteastronomy.com/topics/Dust_Bowl)

The Prairie Farm Rehabilitation Administration (PFRA) was established by an Act of Parliament in 1935 in response to the widespread drought, farm abandonment and land degradation of the 1930s. From 1935 to 1946 the Indian Head Experimental Farm administered the PFRA program and was responsible for reclamation projects. In 1936, the PFRA financed the Swift Current Experimental Station Soil Research Laboratory that was to carry out studies into soil fertility, moisture conservation, and wind erosion control. Earthen farm reservoirs and dugouts are created to store water. Irrigation projects in southwest Saskatchewan are constructed and farm families are re-settled near the projects. Community Pasture projects are seeded and fenced and open for grazing. (PFRA History 2007 http://www4.agr.gc.ca/AAFC-AAC)

A farm shelterbelt of red osier dogwood and poplar showing snow captured.

http://www.na.fs.fed.us/spfo/pubs/uf/treeguidehtm/images/p98pic1.jpg

Irrigation Development in Southern Alberta

Beginning in the early 1880's William Pearce, Surveyor for the Department of the Interior, set out to prove that irrigation would work in Southern Alberta. While a demonstration project outside of Calgary proved unsuccessful the federal Government passed the *North West Irrigation Act* in 1894 which meant that settlers would no longer be able to divert water without a license. (Larmour, 1957). At the same time the federal government also instituted a topographical survey of the arid south of Alberta, Saskatchewan and Manitoba to determine when and where potential irrigation systems could be built. As Larmour describes in her 1957 book "Laying down the Lines", the basic objective of these first irrigation schemes in Western Canada was to map potential areas for the diversion and storage of spring run-off for use during the summer dry months.

Several smaller scale irrigation projects were initiated however most were plagued with the problem of high costs and an unpredictable climate that fluctuated between drought and excess moisture. Finally in 1898 a combination of a strong economy, the desire to protect Canadian interests and secure adequate water supplies and the negotiation skills of Elliot Galt all worked together to bring the first large scale irrigation project to fruition in southern Alberta. Water from the St. Mary River was diverted into a network of canals and storage reservoirs through to the community of Stirling and finally Lethbridge. Another federal act – *the Irrigation Districts Act* was passed in 1915 which authorized farmer owned and operated irrigation co-operatives. With capitalization and operating expenses shared by the provincial and federal governments a total of 13 irrigation districts were established and by 1919 more than 7500 hectares of land were in irrigated production. Editors note: for additional information see http://www.aipa.ca/files/21st_Century_Vol_01_Chp_02_Irrigation _Development.pdf

The principles of "first-in-time, first-in-rights" regarding appropriation of water within these irrigation districts contributed greatly to further settlement of southern Alberta and establishment of irrigation infrastructure. Despite the setbacks of re-occurring drought, disease and war, optimism for the potential for agriculture in Southeast Alberta was widespread by 1920. Coupled with this optimism was the recognition that irrigation would further allow the development of additional acreage and overcome reliance on precipitation to produce crops.

Farmers at a demonstration of surface irrigation using syphon tubes.
http://www.assembly.ab.ca/lao/library/egovdocs/alard/2000/130166.pdf

By 1954 water from the SMRID finally reached Medicine Hat via 220 miles of the newly constructed Main Canal (SMRID History). Another significant milestone was the replacement of the federal North West Irrigation Act and the Irrigation Districts Act with the Irrigations Districts Act (2000) and the comprehensive and now provincially managed *Water Act* of 1999 . September 4, 2000 marked a milestone in irrigation history as the SMRID celebrated 100 years of delivering water to croplands throughout southern Alberta. The irrigation development in Alberta now totals in excess of 1.6 million acres and represents two-thirds of all irrigation development in Canada (AAFRD, 2004). About 1.3 million acres are located within the 13 organized irrigation districts of Alberta with a further 300,000 acres controlled within private irrigation developments. The value of the irrigated lands are estimated to return 300% of the yield of non-irrigated acres.

It has been repeatedly shown that irrigation is a necessity for the consistent production of high value crops, forage and livestock production within south-east Alberta. In a 2004 AAFRD report the increase in land productivity in southern Alberta because of irrigation is estimated to be 300 percent compared to dryland production.

Good quality livestock drinking water is crucial to a successful feedlot, ranch or dairy industry, and obtaining this water from irrigation systems is more reliable, more economical, and of generally higher quality than the limited groundwater resources within south-east Alberta. According to Alberta Agriculture and Rural Development production manuals, a 10,000-head feedlot requires as much as 380,000 litres a day for the animals' drinking supplies, plus additional water for other purposes. While this is a significant quantity of water, this is still less than the water needed to irrigate 65 hectares of crop land.

The 2006 Statistics Canada Census of Agriculture reports state that total irrigated areas across Canada increased by 7.7% in 2005. Alberta accounted for 63.5% of the national total of acreage under irrigation with the majority of water used to produce field crops, irrigated hay and pasture. A 2002 study prepared by the Alberta Irrigation Producers Association (AIPA) states that the highest levels of irrigation management were in the Medicine Hat and Bow Island regions where long-term normal heat units are highest and normal precipitation is lowest. Within the South Saskatchewan River sub-basin, the largest single irrigation district is the St. Mary's River Irrigation District (SMRID). Data from the Alberta Irrigation Producers Association and the SMRID in 2010 indicates that irrigation in the SMRID provided water to some 359,887 acres.

Further water allocation for all uses from the entire Oldman, Bow and South Saskatchewan Sub-basin was halted in 2006 – a decision which will undoubtedly have significant impact further expansion and management practices for Agriculture in the future.

Irrigation districts such as the St. Mary's River Irrigation district (SMRID) are investing with support from the provincial government into infrastructure upgrades to reduce water losses from seepage, evaporation and return flows. Meanwhile, Alberta Sustainable Resources Development (ASRD) is closely monitoring the salinization of soils and the the quality of surface and ground waters associated with public lands.

The Modern Era of Agriculture

As the 1930's drew to a close the drought that had so severely impacted agriculture in southeast Alberta ended. Prosperity returned as farm crops and livestock were in demand to supply troops fighting in the Second World War. Improved methods of soil conservation were implemented including strip farming, minimum tillage cultivation and planting of shelterbelts. Federal and provincial governments invested in expanding and improving irrigation projects throughout southern Alberta.

Since World War 2 typical agricultural operations in south east Alberta have become larger in size, more diverse, specialized and required significant capital investment and technical expertise. According to an Alberta Agriculture report to the legislature, today's farmers tend to be better educated than their homesteading forbearers and implement high technology innovations such as automated feeding or manure management systems plus computerized electronic monitoring on farm equipment and irrigation systems. (http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex2)

The 2006 Statistics Canada Census of Agriculture shows that in the last decade the number of farms in Canada has steadily declined. Between 2001 and 2006 alone the rate of decline was 7.1% representing the loss of some 229,373 farms since 2001. Meanwhile the number of larger farms, with gross farm receipts of $250,000 or more (at 2005 constant prices), have increased 13.8% since 2001 while those with less than $250,000 in receipts declined by 10.5%. Significantly, as the farm numbers drop, the average size of a Canadian farm has increased from 676 acres to 728 acres or approx. 7.7%.

In the 2010 Alberta Agricultural Research Institute report (AARI, 2010)), agriculture is described as fundamental to strengthening Alberta's economic potential. In 2001 alone, Alberta's agricultural economy produced $8.2 billion in primary product sales, and $9.9 billion in value-added product sales. The AARI estimates that the Value-Added Agri- Food and Health Products sector represents an opportunity of $7.6 billion in growth for the province by 2010 and beyond. Bio-products priorities identify a $2.5

billion opportunity for industry growth due to new opportunities in biomaterials, bioenergy, and bio-industrial chemicals.

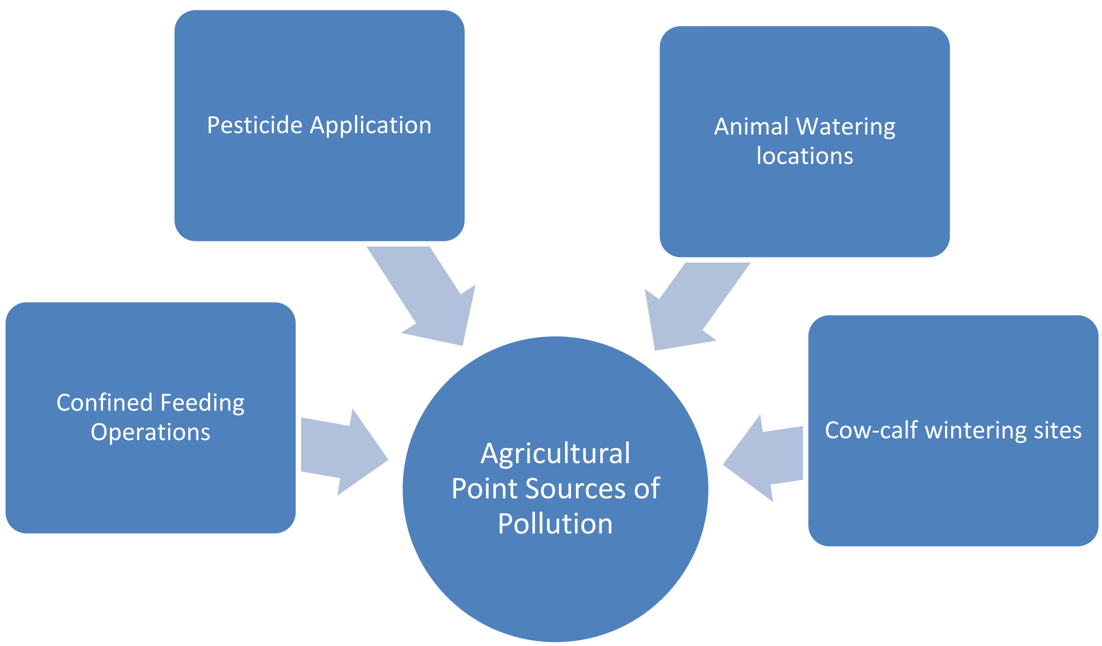
Based on these projections, a healthy agricultural sector can clearly be seen as significant for the economy of Alberta, second only in dollar value to Oil and Gas . Agriculture also directly employed about 50,400 Albertans in 2007 compared to some 88,700 people in 1997 representing a decrease of some 43%. Despite these trends, the agricultural industry is expected to grow by a yearly average of 0.5 per cent, employing about 51,600 by 2012.

A focus on production and value-added processing of specialty crops and livestock was adopted beginning in the 1990's by government agencies. For example, the 2010 research summary contained within the AIPA report "The South Saskatchewan River Basin in the 21st Century", predicts a continued decrease in the number of acres in the production of cereal crops and traditional farming. Instead and for south-eastern Alberta in particular the higher corn heat units for plant growth and dependable supply of irrigation should see more acreage planted to canola, sugar beets and potatoes. The report also suggests that with the shift towards higher value crops there will be an increase in water-demand for irrigation in the range of 1.8% over current levels and that this increase in demand can be absorbed by the increases in efficiency and reduction in evaporation and seepage loss resulting from infrastructure upgrades within the irrigation districts. The AIPA report detailed that the average on-farm application efficiency of irrigation water in Alberta in 1999 within the irrigation districts was estimated to be only 71% however continued technology and management improvements could reasonably see this application efficiency increase to 75%. (AIPA 2010)

http://www.aipa.ca/files/21st_Century_Vol_01_Chp_04_Key_Research_Findings.pdf

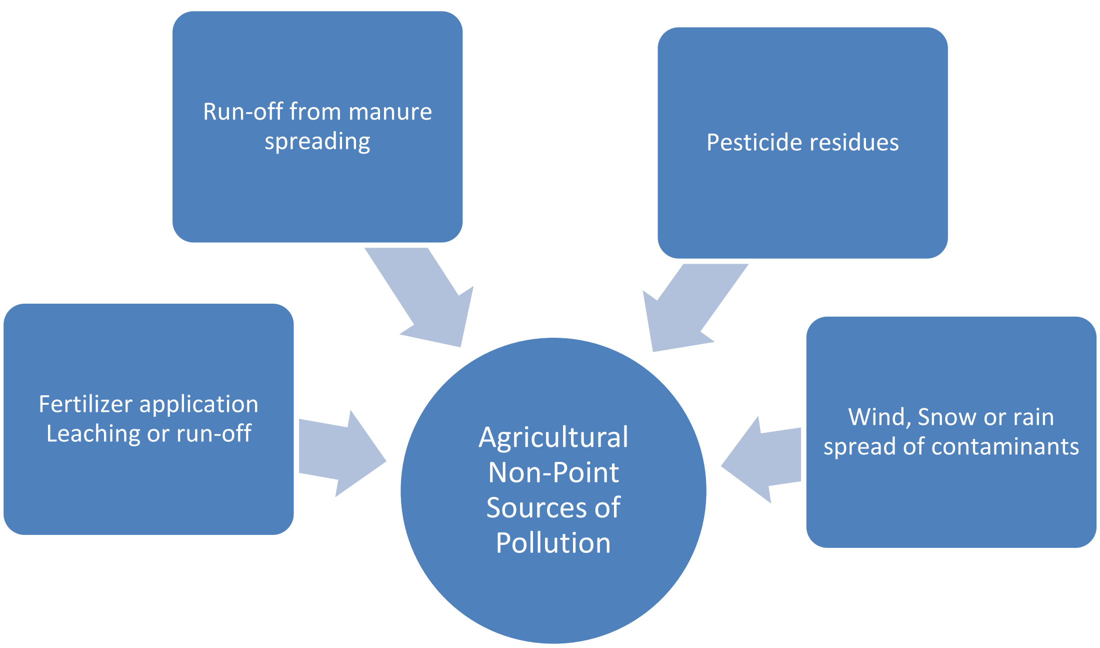
PART B. THE CURRENT STATUS OF WATER QUALITY

Agriculture activities take place on most of the land within the South Saskatchewan River Watershed. Although water quality is affected by a range of activities and sectors, agriculture in south east Alberta is perceived as one of the major contributors to reduction in water quality and quantity.



Agriculture contaminants to source water can be categorized as either **point source** or **non-point source**. Potential point source threats from agriculture activities can include intensive or confined livestock feeding operations, manure storage, livestock wintering areas, chemical storage and disposal areas, septic systems, and fuel storage. As water from rainfall and snowmelt flows over and through the landscape, it picks up and carries contaminants from many different sources producing what is classified as Non-Point Source pollution.

Some potential nonpoint source agriculture threats include livestock grazing and wintering sites, chemical, fertilizer and manure application, which can adversely affect surface water or groundwater. Many of these potential point and non-point pollution sources can be identified and addressed on individual farms through the adoption of best management practices and completion of an Environmental Farm Plan. Cumulative effects from non-point sources are of the greatest potential concern because they largely come from activities that, by themselves, have a limited impact. However, when these activities occur collectively within a significant portion of the watershed, they can have major effects on water quality.



Run-off from agricultural land, especially from lands receiving manure applications, can add nitrogen and phosphorus to waterways; there can be residues or drift from pesticides; contamination by potentially harmful bacteria from manure production, and disturbance of riparian areas by livestock all of which can adversely affect surface water quality. Pollution of groundwater can occur when irrigation or precipitation leaches nutrients, pesticides and bacteria through the soil. (Ag Canada, 1996). Elevation of levels of nutrients and bacteria in water above safe limits can occur depending upon the type and intensity of the agricultural operation; irrigation intensity; crop and land management practices; type and amounts of fertilizers and other agrichemicals applied; weather, soil characteristics and regional hydrogeology (Reynolds et al, 1995).

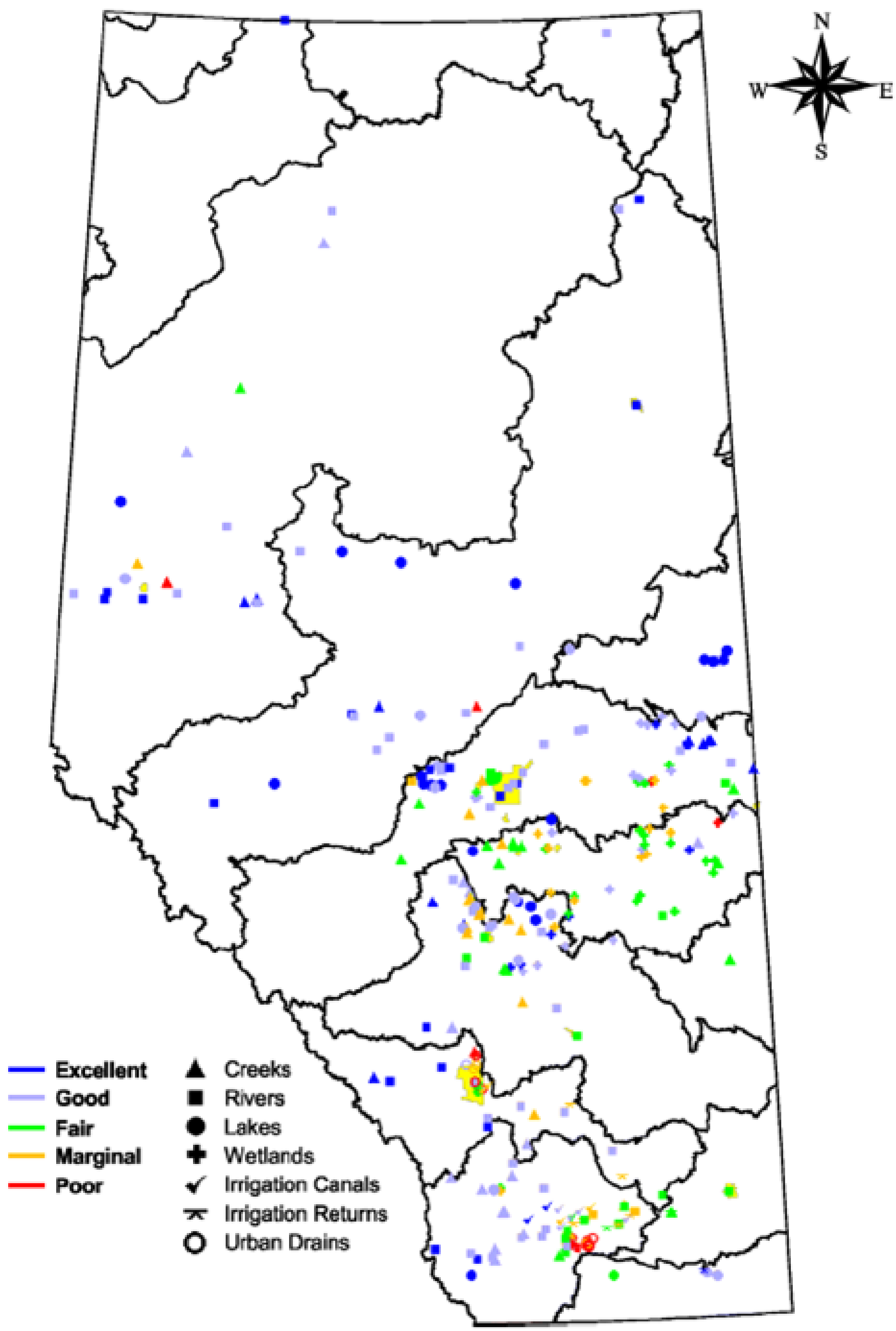
In the 2008 publication prepared by Palliser Environmental for Alberta Agriculture and Rural Development entitled "Assessment of Environmental Sustainability in Alberta's Agricultural Watershed" the significance of quality water for agriculture is described. According to this publication agricultural water quality is determined by measurement of the chemical, physical and biological parameters of water samples and then comparison of the results against the Agricultural Surface Water Quality Guidelines for Use in Alberta. Higher crop yields, prevention of soil salinization and improved animal health and weight gain have been demonstrated in a number of scientific studies. For example, Willms' yearling heifer study in 2002 found that an average weight gain of 23% was achieved for animals provided quality water versus water rated as of poor quality.

http://www4.agr.gc.ca/resources/prod/img/terr/images/cattle-drink.jpg

Access to safe and adequate quantities of water has been consistently identified by surveys conducted by both Alberta Agriculture and Rural Development and Agriculture Canada as a major concern and priority to farm families both for domestic water supply and to provide for a wide assortment of livestock from cattle to poultry to swine operations. Research studies of agricultural practices in Europe and other parts of North America have identified agriculture in these areas as being a prime contributor to the degradation of ground and surface water quality.

Due to the drier climate, lower intensity of agriculture, types of soils and lower use of inputs such as fertilizers and other agrichemicals, the risk of water pollution from agriculture in the south east corner of Alberta is considered less of a risk than for other farming areas of Alberta and Canada. (PFRA 1996). The risk of surface and ground water being adversely affected however was found to be significant where high-density feedlots existed or where soils were heavily fertilized and irrigated. In particular the potential for nitrates to enter ground water in these situations was found to be high (Chang and Entz,1996; Chang and Janzen, 1996; Hill et al.,1996; Miller et al., 1994).

http://www4.agr.gc.ca/resources/prod/img/terr/images/1237218783751_1.jpg



Pesticide index for all sites sampled from 1995 to and including 2002

Alberta Environment monitors the levels of nutrients, bacteria and pesticides within surface waters within Alberta on an on-going basis. Summary of the data collected in

2007 - 2008 from the South Saskatchewan River monitoring station upstream of the City of Medicine Hat produced ratings of:

Metals (97/100) - good

Nutrient levels (79/100) – fair

Pesticide levels (76/100) – fair

Bacteria levels (90/100) – good

OVERALL RATING: 86/100 GOOD

In comparison of these sample ratings to the other sample site the overall rating of 86 is equivalent to the average of all samples. (See Appendix for complete table of samples.) A 1997-2000 Sampling of the South Saskatchewan River at the AB/SK border by the Saskatchewan Watershed Authority (SWA) gives an overall CWQI rating of 88/100 indicating a slight improvement in quality as water travels into Saskatchewan.

South Saskatchewan River at the AB/SK border

http://www.southsaskriverstewards.ca/galleryfiles/SSRWest27.gif

Beginning In 2004 and with regular five year updates, the benchmark Canada-Alberta Environmentally Sustainable Agriculture (CAESA) Water Quality study was conducted to determine the impact of primary agriculture on water quality in Alberta. The study gathered a wide range of data about the current status of water quality in agricultural areas and produced a baseline of information which could be used for comparison against future studies. (CAESA 2004,) (http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/wat2442)

In the 1990s, the Canada-Alberta Environmentally Sustainable Agriculture Agreement investigated the impacts of agriculture on the environment, including the status of agricultural streams, groundwater, and domestic sources (wells and dugouts). A major finding of the CAESA reports was that agricultural practices were indeed contributing to degradation of water quality. In particular, higher than maximum recommended guideline levels of nutrients and bacteria were detected in both the surface and ground waters of agricultural areas. A range of pesticides were also detected in these tests although the concentrations detected with some exceptions fell below minimum water quality guidelines. Subsequent to this study, the long-term stream monitoring network of 23 agricultural streams were examined through the Alberta Environmentally Sustainable Agriculture program (1999-2007). The AESA program showed that nutrient concentrations were greater in streams with greater agricultural intensity in their watersheds.

An extensive monitoring of deep groundwater wells across the province indicated that contamination of the wells was normally associated with poor well design or improper maintenance rather than contamination from agricultural activity.

Additional Study Findings:

The following is extracted from the 2010 CAESA study and outlines additional details about the compliance of surface and groundwater in Alberta's agricultural areas with quality guidelines.

Nutrients

- In general, nutrient levels did not exceed the guidelines for human and livestock drinking water.

- Nitrogen and phosphorus concentrations often exceeded water quality guidelines for the protection of aquatic life in streams, especially in high and moderate intensity agricultural areas.

- Phosphorus concentrations often exceeded guidelines for the protection of aquatic life in small lakes located in high intensity agricultural areas, and in irrigation canals.

  High levels of nitrogen and phosphorus in surface waters are a significant environmental problem because they cause excessive aquatic plant growth. When these plants decay, they cause oxygen levels in the water to drop. The lack of oxygen affects the ability of fish and other aquatic life forms to survive.

  Runoff associated with livestock operations and crops was identified as a major source of phosphorus, but the study did not specifically evaluate which agricultural activities caused the buildup of other nutrients.

- Nitrate in shallow groundwater occasionally exceeded drinking water quality guidelines. High levels of nitrate-nitrogen were also found in shallow farmstead water wells, but the specific source was unclear.

- Groundwater research indicates that continuous, heavy applications of manure and fertilizer are likely to result in detections of nitrate in shallow groundwater. Shallow groundwater aquifers without a protective layer of impermeable material above them are at greatest risk.
- For nutrients, most of the primary source water met the Alberta environment guideline for the protection of aquatic life (around 80%), this dropped to (around 62%) for irrigation return flows. Ammonia-N concentrations also exceeded

CCME guidelines for the protection of aquatic life in around 15% of samples. Other forms of nitrogen never exceeded water quality guidelines.

Bacteria

- Approximately 90% of water samples from streams in low intensity areas, and 94% of samples from streams in high intensity agricultural areas, exceeded the bacterial guidelines for human drinking water. All samples from irrigation systems exceeded drinking water guidelines for bacteria.

  NOTE: Agriculture is one of the causes of bacterial contamination, but wildlife and other human activities contribute to the problem.

- Excedences of guidelines for bacteria in dugouts were generally high. The dugout study showed that 92 per cent of samples had detectable levels of coliform bacteria. Depending on the time of year and location, anywhere from 20 to 71 per cent of dugout samples contained faecal coliform bacteria levels that exceeded the *Guidelines for Canadian Drinking Water Quality* (Health Canada 1996). This study also found that 42 per cent of farmers surveyed didn't treat their dugout drinking water and many (27 per cent) had never had their water quality tested.

- Human drinking water guidelines were exceeded more often in southern Alberta, than in the Peace River area of northern Alberta.

- Fecal coliform bacteria levels met irrigation water quality guidelines more often for source water than in the return flows, where the irrigation water returns to the river.

- The CAESA Farmstead Water Quality project showed a significant number of rural families do not test or treat their water supplies.

Because bacterial contamination of surface water is widespread and derives from a variety of sources, public health officials strongly recommend all water be tested and treated before human use.

Pesticides

- Based on water quality guidelines for human and livestock consumption, and for the protection of aquatic life, pesticide residues from agricultural sources were not a significant problem.

- Very low level herbicide detections were frequently found in many surface waters and some ground water. Most of the samples with herbicide detections were well below water quality guidelines. In surface waters, most detections were related to spring snowmelt events.

- Samples from irrigation canals showed residues of two of the herbicides tested, MCPA and dicamba in the majority of samples tested. The levels of MCPA exceeded guidelines 72% of the time while dicamba was identified in excess of guidelines for irrigation 47% of the time. 2,4-D was also detected in the majority of samples and was present in concentrations that exceeded irrigation guideline thresholds in 100% of the samples. In general, herbicide levels were higher in irrigation canals than in other water sources in the province. These results are of concern because of limited studies into the effect of the release of these herbicides into water bodies.

  Levels of MCPA and dicamba exceeded irrigation guidelines in streams and lakes in high intensity agriculture areas. This may have negative impact on some crop yields since canal water is ued to irrigate a variety of crops.

- Herbicide levels in canals increased from upstream to downstream. The highest levels were found in irrigation return flows.

- A few low-level pesticide detections were found in farmstead wells. However, research studies conducted in central and southern Alberta indicate that over a long period, herbicides can leach into shallow ground water.

Other water quality concerns:

- The study results showed that 32 per cent of the 448 farmstead wells across Alberta tested exceeded at least one health related contaminant such as fluoride, arsenic, zinc, selenium, manganese, lead or nitrate. Also, 93% of the well samples exceeded at least one aesthetic or physical guideline such as taste, odour, color or staining. (CAESA 2004, 2010)

In February 2010 another study was completed by the Irrigation and Farm Water Division, Alberta Agriculture and Rural Development regarding entitled “Assessment of Water Quality in Alberta’s Irrigation Districts”. The objective of this study was to assess the quality of source water used for irrigation from a food production perspective; to assess changes in water quality as water travels through the irrigation infrastructure from source water to return flow; determine if there are differences between the irrigation districts in terms of water quality; and determine if there are differences in water quality between types of conveyance systems. (IFWD of AARD, 2010)

Within the SSRSB most irrigation water is supplied through the St Mary’s River Irrigation District. A communication from J. Little, Water Quality Specialist, Water Resources Branch Alberta Agriculture and Rural Development summarized information relating to the SSRSB:

“The following information is from the 15 sites in the entire SMRID (which goes beyond your SSRSB study area). In terms of pesticides, they were detected in all samples from the SMRID, including primary and source water sites. Of the 25 pesticides analyzed for, five were detected. The most frequently detected pesticide was 2,4-D (100%), followed by MCPA (72%) and dicamba (47%). Only 1 of the 118 samples exceeded the protection of aquatic life guideline for 2,4-D. The irrigation guideline for dicamba was exceeded in all samples for which it was detected, as the guideline is actually below the limits of detection. The irrigation guideline for MCPA was also exceeded in 80 of the 85 samples it was detected in. Dichlorprop and bromoxynil were also detected in a few samples."

(J. Little, Personal communication, May 2010)

Sub-Index Values for Northern and Southern Rivers (2007-2008)
This table shows the River Water Quality Sub-Index values for Northern and Southern Rivers for 2007-08 summarized by Alberta Environment:

Southern Rivers: 2007-2008

River Location	Sub-Index Values (0-100) Metals	Nutrients	Bacteria	Pesticides	Overall Index (Average)
Red Deer R. upstream of Red Deer (Hwy 2)	100	80	51	80	78
Red Deer R. at Nevis Bridge	100	79	96	73	87
Red Deer R. at Morrin Bridge	100	77	74	75	82
Bow R. at Cochrane	100	90	62	96	87
Elbow R. at 9th Ave. Bridge	96	81	44	73	74
Bow R. at Carseland Weir	97	78	79	96	87
Bow R. at Cluny	100	79	92	76	87
Bow R. at Ronalane	97	69	96	73	84
S. Saskatchewan R. upstream of Medicine Hat	97	79	90	76	86
Oldman R. near Brocket	100	100	100	100	100
Oldman R. upstream of Lethbridge (Hwy 3)	95	89	97	96	94
Oldman R. downstream of Lethbridge (Hwy 36)	97	80	92	79	87
Milk River at Hwy 880	95	70	94	100	90

Index Ratings

Excellent	Good	Fair	Marginal	Poor
96-100	81-95	66-80	46-65	0-45

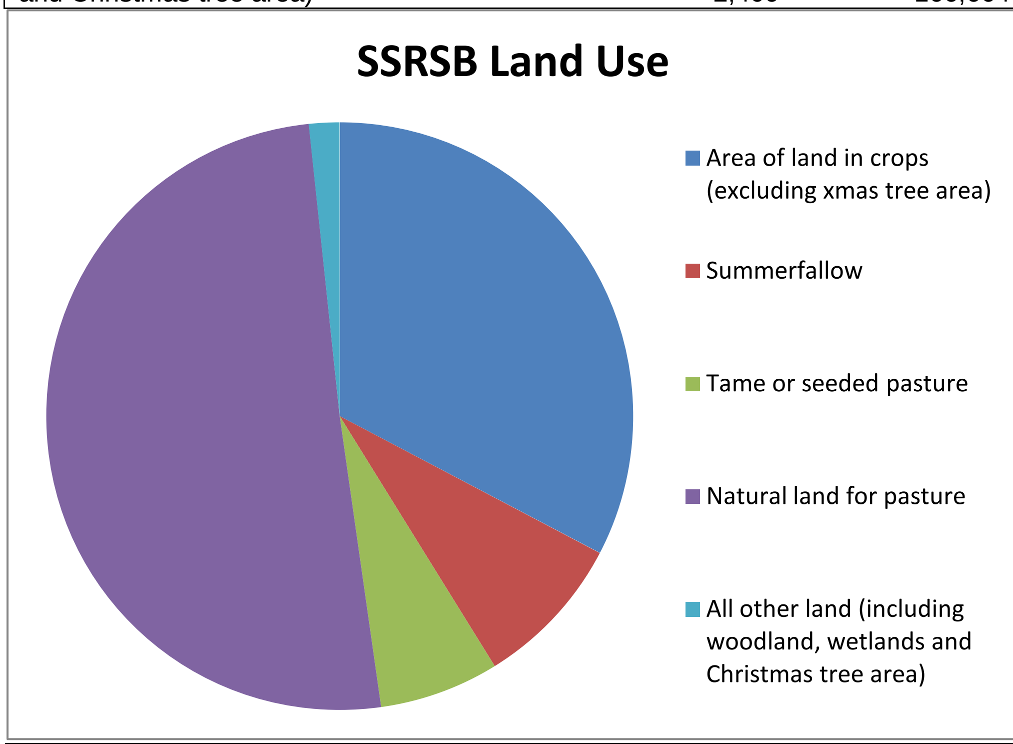
http://environment.gov.ab.ca/info/library/7683.pdf

PART C. BEST MANAGEMENT PRACTICES AND AGRICULTURAL WATER QUALITY

Livestock in the SSRSB

Within the SSRSB, due to the historical development of the area, the climate, availability of water and types of soils, the largest agricultural land use is that of native pasture for cattle ranching.

Land Use	Number of Farms Reporting	Acres
Area of land in crops (excluding xmas tree area)	3,572	3,229,821
Summerfallow	1,510	836,165
Tame or seeded pasture	1,688	649,512
Natural land for pasture	2,268	4,994,128
All other land (including woodland, wetlands and Christmas tree area)	2,409	166,664



Adapted from Agriculture and Agri-Food Canada and Statistics Canada, customized tabulations, Census of Agriculture CGC Base 1996, 2001, Census of Agriculture Regular Base 2006.

Statistics Canada reports that as of January 2, 2010, the Canadian farm inventories of cattle had reached their lowest levels in 15 years while inventories of hogs were at a 12-year low. The 1990's had been a period of expansion for Canadian cattle with strong foreign markets and exports, expansion in processing facilities and correspondingly higher prices. This dramatically changed beginning in 2001 when another two years of drought affected water and forage supply and damaged pastures. The discovery of the first case of Bovine Spongiform Encephalopathy (BSE) in May 2003 and the subsequent identification of an additional eight more cases of BSE over the next four years severely damaged the cattle industry in Alberta.

Within the SSRSB, data collected by Statistics Canada show that the number of livestock operations dropped between 2001 and 2006 by 9%. Continued economic pressures on the cattle industry will undoubtedly contribute to a continued steady decline in numbers of operators. For those remaining live-stock producers, the numbers of animals per producer Stats Canada data actually showed an increase between 2001 and 2006 probably related to efficiencies of scale to produce profit. Changes in the number of pork producers in the SSRSB have been even more dramatic between 2001 and 2006 with the number of producers declining by just under 50%. Again those producers remaining in the industry have slightly increased their herd size. Increases in herd size and intensity of operations puts additional pressure on environmental management practices to ensure non-point pollution does not result in surface and ground water contamination. (Statistics Canada 2006)

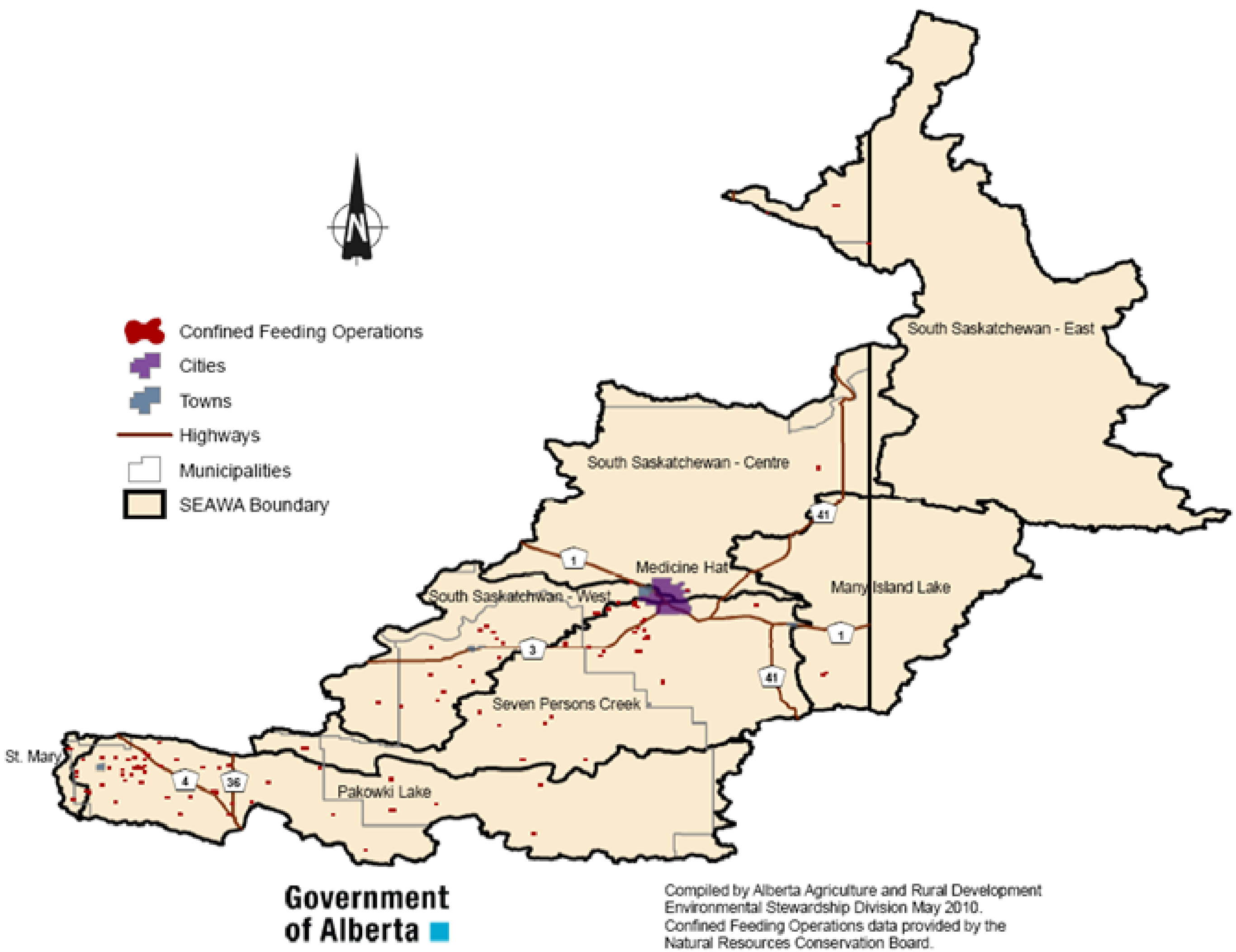
Beginning in 2007 the cost of a barrel of oil surged upwards, making the production of ethanol using feed corn and grains economically viable. Unfortunately this meant that the price of feed for livestock operation soared as well. BSE tracking regulations had re-opened cattle markets to the USA but the stronger Canadian dollar limited return to the export numbers seen previous to BSE. (Statistics Canada 2010)

Appropriate management practices are a top priority to livestock producers as healthy and productive pastures produce healthy animals and reduce costs and reliance on feeding. The Alberta Cattle Producers Association, Alberta Agriculture and Rural Development,   Agriculture and Agri-Food Canada – Prairie Farm Rehabilitation Administration, and the Alberta Environmentally Sustainable Agriculture Program, along with the Alberta Beef Producers Association have worked together with producers to provide education and develop best management practices.   Decisions about both wintering sites and striving for healthy riparian areas can reduce adverse impacts on water quality such as nutrients and bacteria contaminating surface water.

Cows and calves on edge of dry wetland.
http://www.cowsandfish.org/photo_gallery/land_uses/GRAZGEN0019.html

Since 2004 the nonprofit organization “Alberta Riparian Habitat Management Society” better known as Cows and Fish has carried out riparian assessments; established demonstration projects and made recommendation about riparian management.
Within the Cypress/ Forty Mile County area, a total of 128 representative areas have been inventoried including Battle Creek, Elkwater Lake, Graburn Creek, Grant Creek, Lodge Creek, MacKay Creek, Nine Mile Creek, Murray Lake, Seven Persons Creek, Nine Mile Coulee, Reesor Lake, Ross Creek, Storm Creek, Spruce Coulee Reservoir, Thelma Creek, South Saskatchewan River and the Bow River. In 1999, the Milk River was inventoried in 2002 and 2003.   Results of these inventories are confidential so details are only available in an aggregated format. Overall, in Alberta since 1995, Cows and Fish has assessed over 1000 sites representing 2000 km of riparian area on 150 waterways. Results show that 11% of Alberta’s riparian areas are healthy, 49% are healthy but with problems and 40% are unhealthy. This indicates that some issues need to be addressed to ensure that the riparian areas continue to sustain us, by storing, filtering and buffering water.
In addition, agricultural producers receive support to develop Environmental Farm Plans that build awareness of environmental risks that they may be facing on their operations. Within the Counties of Cypress and Forty Mile almost 70 farms have participated in the workshops and training since 2004.

http://www.cypress.ab.ca/agricultural_services/Soil_and_Water/ASBPartnership.pdf



Intensive Livestock Operations in the SSRSB

Intensive livestock operations and especially Confined Feeding Operations (CFO's) have been linked as having the greatest potential to detrimentally affect surface and ground water. As indicated in the map of the SSRSB below the majority of these CFO's are located in the southwest corner of the SSRSB.

Manure

As detailed in Alberta Agriculture and Rural Development production manuals, manure from intensive feeding operations is routinely spread onto adjacent fields. The potential for bacteria from spreading of this manure to enter surface waters can be significant given the correct combination of topography and precipitation. In addition, unless off stream stock-watering is provided, surface water can be polluted by manure and riparian areas damaged by trampling. Data provided by Alberta Agriculture Calculations utilizing the 2006 Agricultural Statistics for the SSRSB this means that just over 87,000 acres of land had manure added either as compost, noncomposted or through fertigation.

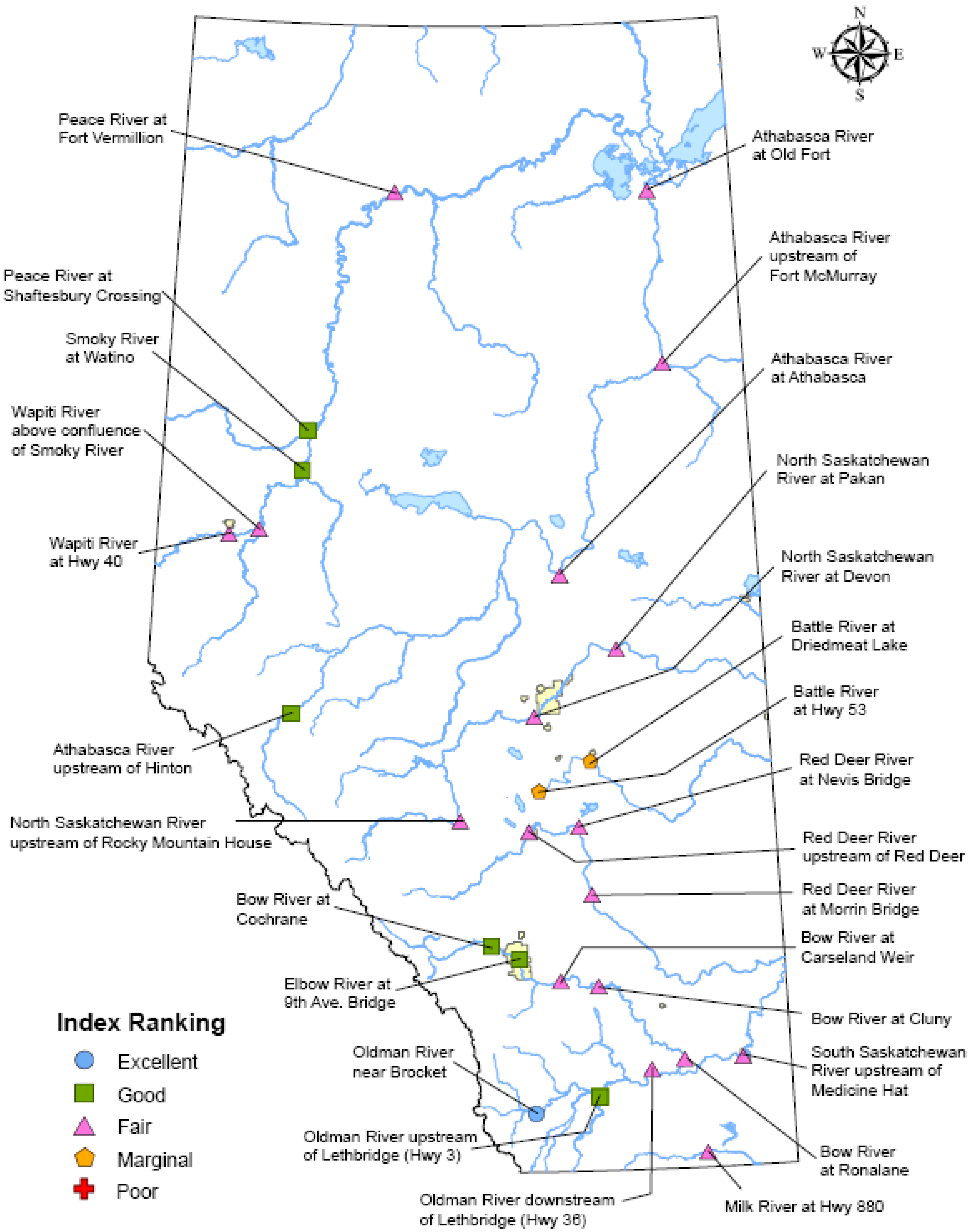
Manure is a valuable nutrient and soil-conditioning agent by-product of livestock production. According to Statistics Canada in 1996, Canadian livestock produced an estimated 361 million kilograms of manure daily. This translated to over 132 billion kilograms of manure for the year. One beef cow alone can produce up to 2.1 tonnes of manure per year. In 1996, Alberta as a whole produced an estimated 6.3 million tonnes of manure. In the SSRSB, the approximately 832,616 head of cattle in all categories reported to Statistics Canada in 2010 are generating 1.75 million tonnes of manure annually.

Avoiding run-off, pollution and undesirable odours from manure requires further research, education, enforcement and consistent application of management practices. Within Canada, solid or composted manure was spread on 5,670,918 acres representing just over two-thirds of the total area on which manure was applied. Beef cattle operations, the majority of which are in western Canada, applied a larger area of solid or composted manure than any other type of farm. It is mainly the steer and feed heifer feedlots that are mechanically applying solid manure, whereas the western cow-calf operations are shifting towards year-round pasturing where no spreading is required. Poultry, sheep, goat, and horse operations are also associated with solid manure application. Hog and dairy operations are most likely to spread liquid manure.

According to 2006 statistics, the average area of liquid manure application in Canada increased, now accounting for just under one-third of the land, or 2,729,391 acres, on which manure is spread. Farm operators are spreading manure over larger acreages, reflecting a trend towards better nutrient management planning partly due to the requirements of various provincial regulations. The practice of applying liquid manure using irrigation equipment decreased and amounted to only 0.6% of the land on which manure was spread in 2005. Liquid manure applied by irrigation, sometimes referred to as fertigation, has the highest risk of run-off, nutrient loss and odour.

Data received for the SSRSB from Statistics Canada indicates that for 2006 some 6.7 million tonnes of manure was being produced by farms including cattle, swine, poultry, sheep and horses. This same data indicates that manure within the SSRSB is being spread on almost 88,000 acres. This represents a total of almost 37 million kg of nitrogen being applied or approx. 420 kg of nitrogen per acre.

Alberta River Water Quality Index - Nutrients (2007-2008)



Chemical Fertilizer Application

Statistics Canada (2006) Agricultural Census data indicates that the use of fertilizers has increased within Alberta in the last two decades. In the south-eastern brown soils zone of the province, Anhydrous Ammonia and Liquid Nitrogen is more commonly applied versus granular forms. Another trend indicated was an increase in the use of 21-0-0-24 which may correspond with the increases in area seeded to Canola and other speciality crops that require sulphur.

Within the SSRSB 54% of the farms in the Statistics Canada 2006 census reported use of commercial fertilizers.

Agricultural Inputs	Number of Farms Reporting	Acres
Use of commercial fertilizer	2,270	2,409,135
Use of herbicides	2,240	2,717,658
Use of insecticides	446	188,937
Use of fungicides	417	281,035

The National Land and Water Information Service Interpolated Census of Agriculture to Soil Landscapes of Canada v3.0 and Water Survey of Canada Sub-Sub Drainage Areas v5.0

Cereal and other crops

From statistics completed by Alberta Agricultural and Rural Development (see table 1 and 2 following) the general trend for crop production within Alberta is for less acres planted to traditional cereal crops (wheat, oats, barley, rye) and more acres planted to alternative, higher value crops.

Table 1: Alberta Crop Production ('000 tonnes)									
							10-year	% change	
Crops	2004	2005	2006	2007	2008r	2009p	Average	09 vs 08	09 vs avg
Winter Wheat	196.0	190.5	167.4	175.5	386.5	266.7	156.0	-31%	71%
Spring Wheat	6,392.9	7,160.3	6,678.7	5,230.6	7,272.0	6,180.6	5,793.5	-15%	7%
Durum Wheat	982.5	1,020.6	657.3	670.0	1,077.7	993.4	850.4	-8%	17%
All Wheat	**7,571.4**	**8,371.4**	**7,503.4**	**6,076.1**	**8,736.2**	**7,440.7**	**6,799.9**	**-15%**	**9%**
Oats	828.2	829.7	706.3	627.4	541.3	308.4	664.3	-43%	-54%
Barley	5,628.2	5,231.9	4,404.6	5,114.3	5,447.5	3,840.7	4,867.8	-29%	-21%
Fall Rye	68.6	79.0	57.2	36.8	76.2	38.1	55.0	-50%	-31%
Mixed Grains	44.9	40.8	65.9	24.1	30.6	23.0	41.9	-25%	-45%
Flaxseed	29.2	53.3	36.3	16.3	33.0	28.4	28.0	-14%	1%
Canola	2,925.7	3,651.4	3,424.6	3,401.9	4,322.7	3,161.5	2,779.8	-27%	14%
Dry Beans	34.2	52.8	60.8	54.4	34.9	49.9	48.0	43%	4%
Dry Peas	642.3	617.5	552.6	527.5	731.4	666.7	545.7	-9%	22%
Mustard Seed	51.2	31.1	25.6	27.0	37.1	47.7	28.3	29%	69%
Triticale	27.9	21.8	15.0	17.8	19.4	12.7	23.5	-35%	-46%
Tame Hay	7,393.6	8,754.3	8,142.0	9,276.0	9,344.0	5,352.4	6,912.3	-43%	-23%
Fodder Corn	340.2	453.6	952.5	839.1	571.5	938.9	541.3	64%	73%
Sugar Beets	743.9	607.8	870.9	762.0	344.7	657.7	635.5	91%	3%
Total	**26,329.5**	**28,796.4**	**26,817.7**	**26,800.7**	**30,270.5**	**22,566.8**	**23,971.1**	**-25%**	**-6%**

Table 2: Alberta Crop Area and Yield									
Crops	2008 Seeded	2008 Harvested	2008 Yield	2009 Seeded	2009 Harvested	2009 Yield	10-year Avg Yld	Yield % change 09 vs 08	Yield % change 09 vs avg
	('000 acres)		(bu/acre)	('000 acres)		(bu/acre)			
Winter Wheat	270.0	270.0	52.6	260.0	260.0	37.7	45.9	-28%	-18%
Spring Wheat	5,700.0	5,655.0	47.3	5,875.0	5,525.0	41.1	40.5	-13%	1%
Durum Wheat	930.0	920.0	43.0	930.0	900.0	40.6	36.0	-6%	13%
All Wheat	**6,900.0**	**6,845.0**	**46.9**	**7,065.0**	**6,685.0**	**40.9**	**40.1**	**-13%**	**2%**
Oats	850.0	500.0	70.2	835.0	300.0	66.7	67.9	-5%	-2%
Barley	4,150.0	3,750.0	66.7	3,960.0	3,030.0	58.2	58.1	-13%	0%
Fall Rye	70.0	70.0	42.9	40.0	40.0	37.5	37.2	-13%	1%
Mixed Grains	130.0	25.0	60.0	185.0	20.0	56.3	54.5	-6%	3%
Flaxseed	45.0	45.0	28.9	50.0	40.0	28.0	23.6	-3%	18%
Canola	5,200.0	5,170.0	36.9	5,000.0	4,520.0	30.8	30.8	-17%	0%
Dry Beans	40.0	35.0	36.7	55.0	53.0	34.7	36.4	-5%	-5%
Dry Peas	710.0	700.0	38.4	800.0	750.0	32.7	34.1	-15%	-4%
Mustard Seed	110.0	105.0	15.6	120.0	115.0	18.3	14.4	17%	27%
Triticale	35.0	14.0	54.6	40.0	10.0	50.0	40.5	-8%	24%
			(tons/acre)			(tons/acre)			
Tame Hay	6,200.0	5,585.0	1.8	6,200.0	5,015.0	1.2	1.3	-33%	-11%
Fodder Corn	70.0	40.0	15.8	90.0	60.0	17.3	16.6	9%	4%
Sugar Beets	18.0	17.0	22.4	30.0	27.0	26.9	22.2	20%	21%
Total	**24,528.0**	**22,901.0**	---	**24,470.0**	**20,665.0**	---	---	---	---

Note: Totals may not add up due to rounding. 10-year average refers to 1999 to 2008.
--- Not applicable bu - Bushels Avg - Average Yld - Yield
Source: Statistics Canada; and Alberta Agriculture and Rural Development

This trend is most apparent when viewing statistics showing crop production trends for 2002 to 2008 again compiled by Alberta Agriculture and Rural development as extracted from the Agricultural Statistics Yearbook, 2008. The most significant change is seen in the number of acres planted to Canola and other oilseeds – a 237% increase in only six years. (See table next page for full details). As indicated by the table on the next page, the crop area assessment within Alberta Irrigation Districts, 2002-2008 shows a general trend toward increased acreage in higher value crops. With the increased value in crops follows an increase in the use of agricultural pesticides in particular glyphosate. The reason for this trend probably relates to an increase in the total number acres planted to glyphosate tolerant canola.

Crop Area Assessment in Alberta Irrigation Districts, 2002-2008

	2002	2003	2004	2005	2006	2007	2008
	Acres						
Cereals	397,162	393,967	408,586	408,107	419,554	416,925	456,907
Forages	669,550	636,214	607,514	612,699	613,246	585,966	516,321
Oilseeds	58,076	103,043	128,044	118,425	104,359	129,990	195,962
Specialty Crops	166,282	162,107	169,155	173,452	178,431	175,668	153,961
Other	32,033	30,107	26,462	29,790	28,726	47,696	36,002
Total Crops	1,323,103	1,325,438	1,339,761	1,342,473	1,344,316	1,356,245	1,359,153

Cereals: Barley, CPS Wheat, Durum, Grain Corn, Hard Spring Wheat, Malt Barley, Oats, Rye, Soft Wheat, Triticale, and Winter Wheat.
Forages: Alfalfa Hay and Silage, Barley Silage, Brome Hay, Corn Silage, Grass Hay, Green Feed, Milk Vetch, Millet, Native Pasture, Oats Silage, Sorghum/Sudan Grass, Tame Pasture, Timothy Hay, Triticale Silage.
Oilseeds: Canola, Flax, Mustard.

Specialty Crops: Alfalfa Seed, Canary Seed, Caraway Seed, Carrots, Dill, Dry Beans, Dry Peas, Faba Beans, Fresh Corn (sweet), Fresh Peas, Grass Seed, Hemp, Lawn Turf, Lentils, Market Gardens, Mint, Monarda, Nursery, Onions, Potatoes, Safflower, Seed Potatoes, Small Fruit, Soy Beans, Sugar Beets, Sunflower.
Other: Miscellaneous, Non Crop, Summerfallow, Unknown (not reported).

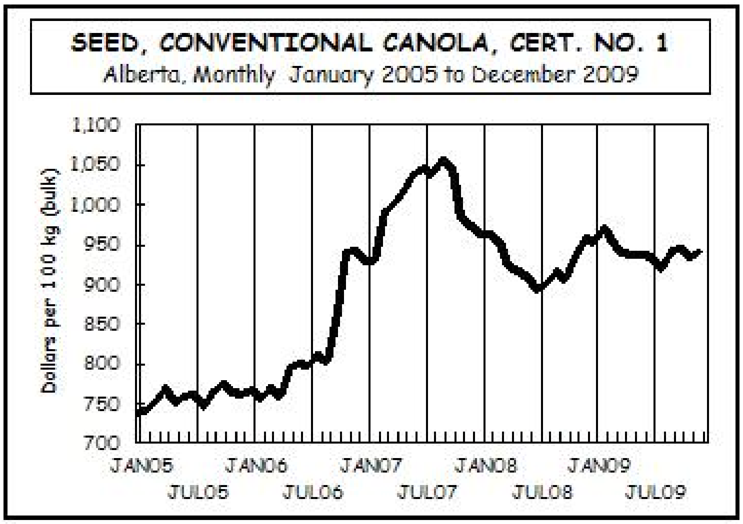
Source: Alberta Agriculture and Rural Development, Irrigation and Farm Water Division

ALBERTA AGRICULTURE STATISTICS YEARBOOK, 2008

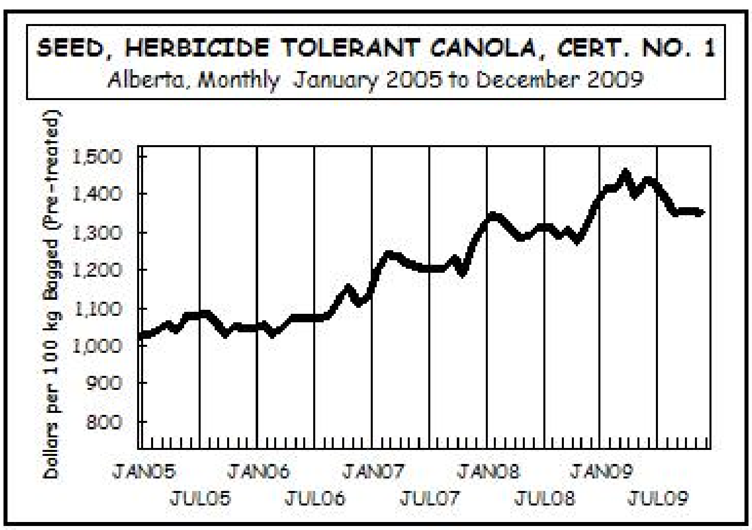
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sdd12891/$file/cropsection.pdf

The following graph from Alberta Agriculture and Rural Development's Agricultural Statistics Yearbook for 2008 shows the historical price of canola during the January 2005-July 2009 time period:

Seed; Canola



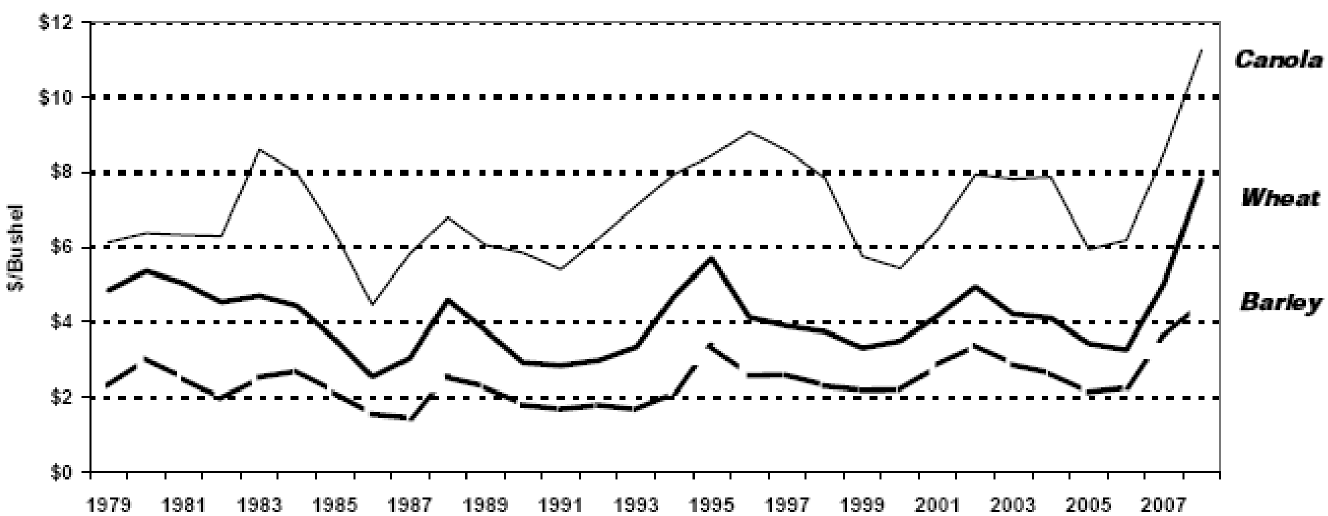
Seed, Canola (herb-tol)



http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sdd4206

The Alberta Agriculture and Rural Development Statistics Yearbook, 2008 provides a very good explanation for the changes in the number of acres planted to Canola versus wheat or barley. As can be seen in the graph below, the $/bushel value of Canola in 2008 was almost $12 while barley was just over $4. With greater dollar return the % cost of agricultural inputs such as fertilizer or pesticides are much less per acre and the relative return for dollar invested are higher.

Price of Alberta Wheat, Barley and Canola, 1979-2008



Source: Statistics Canada; and Alberta Agriculture and Rural Development, Statistics and Data Development Branch

ALBERTA AGRICULTURE STATISTICS YEARBOOK, 2008

The significance of the trends in terms of planting of canola and especially the Herbicide Tolerant Canola is that farmers are able to use glyphosate herbicide rather than other herbicides that produce residues in surface or groundwater including 2,4-D or MCPA. Unfortunately, while the risk of herbicide residues are reduced, the use of other pesticides to control insects or disease is increased.

Area of commercial fertilizer, herbicides, insecticides and fungicides applied, by province (Census of Agriculture, 1996 to 2006)
(Alberta)

	1996	2001	2006	1996 to 2006	2001 to 2006
	number			% change	
Alta.					
Commercial fertilizer					
Area in hectares[1]	7,031,430	6,700,045	6,965,231	-0.9	4.0
Farm reporting	32,642	27,075	23,443	-28.2	-13.4
Percentage of total farms	55.3	50.5	47.4	-14.3	-6.1
Average area in hectares per farm reporting	215	247	297	38.1	20.2
Herbicides[2]					
Area in hectares[1]	6,049,680	6,623,945	6,417,539	6.1	-3.1
Farm reporting	27,198	25,019	20,482	-24.7	-18.1
Percentage of total farms	46.1	46.6	41.4	-10.2	-11.2
Average area in hectares per farm reporting	222	265	313	41.0	18.1
Insecticides[2]					
Area in hectares[1]	299,558	342,903	493,226	64.7	43.8
Farm reporting	2,187	2,607	2,895	32.4	11.0
Percentage of total farms	3.7	4.9	5.9	59.5	20.4
Average area in hectares per farm reporting	137	132	170	24.1	28.8
Fungicides[2]					
Area in hectares[1]	543,377	541,789	653,146	20.2	20.6
Farm reporting	2,329	2,198	2,309	-0.9	5.1
Percentage of total farms	3.9	4.1	4.7	20.5	14.6
Average area in hectares per farm reporting	233	246	283	21.5	15.0

Note: The data for land management practices are reported for the year preceding the census year.
1. Conversion factor: 1 hectare equals 2.471 054 13 acres.
2. Since 1996, the area of land that was treated with herbicides, insecticides and fungicides was under-reported. Some respondents reported chemical expenses but not any corresponding areas to which these chemicals were applied. Telephone follow-up with a sample of these respondents confirmed that some respondents had mistakenly reported for the current year instead of the previous year as requested and, when they completed their questionnaires for 1996 to 2006, the chemicals purchased had not yet been applied.
Source: Statistics Canada, Census of Agriculture.
Last modified: 2008-10-06.

Statistics Canada 2006 http://www40.statcan.ca/l01/cst01/agrc05j-eng.htm

The table above summarizes the Statistics Canada, Census of Agriculture data for the decade of 1996 to 2006 for Alberta. The area to which commercial fertilizer was applied decreased by just under 1% while the area that was treated by insecticides **increased** by 64.7% and fungicides by 20.2%.

Within the SSRSB, like the rest of Alberta, farms have become increasingly diversified within the past decade – no longer relying on traditional livestock or cereal production. A major advantage to crop production in the SSRB is the availability of irrigation, longer growing season and higher heat units not found elsewhere in the province. For example In the vicinity of Bow Island and Seven Persons specialty crops such as mint, monarda, dry beans, , sunflowers and lentils are produced as well as processed .

Crops	Number of Farms Reporting	Farms Acres
Total Wheat	1,887	1,592,366
Oats	528	79,554
Barley	1,211	500,326
Total Rye	136	4,729
Total Corn	113	15,548
Triticale	170	25,315
Other Grains	110	19,249
Flaxseed	90	10,420
Canola	562	211,901
Mustard Seed	109	31,890
Other Oilseed	11	329
Total Pulses	545	200,273
Alfalfa and Alfalfa mixtures	1,794	357,460
Forage Seed for Seed	82	10,218
All other Tame Hay and Fodder Crops	688	98,001
Potatoes	73	19,497
Sugar Beets for Sugar	93	15,673
Canary Seed	6	940
Other Field Crops	31	6,503

The National Land and Water Information Service Interpolated Census of Agriculture to Soil Landscapes of Canada v3.0 and Water Survey of Canada Sub-Sub Drainage Areas v5.0
Citation Sourcing for the Interpolated Census of Agriculture is as follows: Interpolated Census of Agriculture: Adapted from Agriculture and Agri-Food Canada and Statistics Canada, customized tabulations, Census of Agriculture CGC Base 1996, 2001, Census of Agriculture Regular Base 2006.

These higher value crops bring with them greater economic return but also require higher agricultural inputs in terms of irrigation, fertilizer, herbicides, insecticides and fungicides.

Agricultural Use of Herbicides, Insecticides, Fungicides in the SSRSB according to Statistics Canada 2006 Census of Agriculture data:

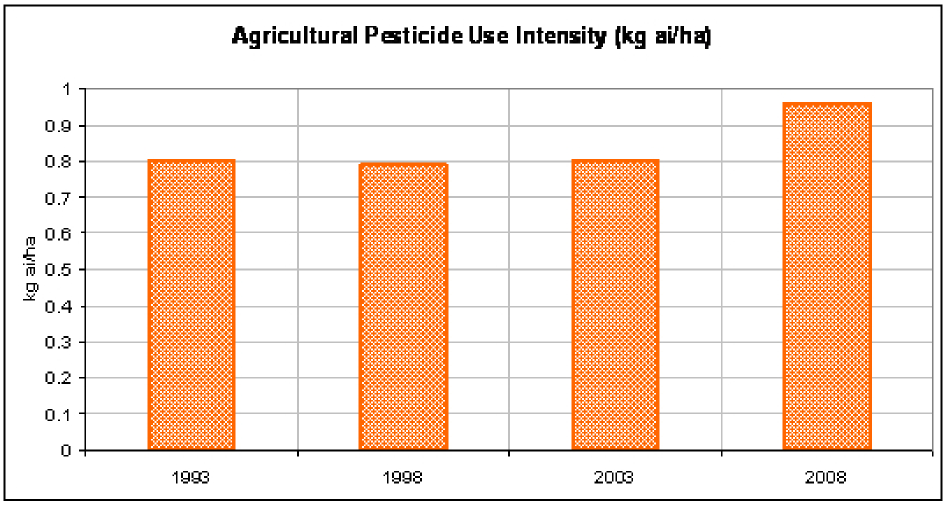
Agricultural Inputs	Number of Farms Reporting	Acres
Use of commercial fertilizer	2,270	2,409,135
Use of herbicides	2,240	2,717,658
Use of insecticides	446	188,937
Use of fungicides	417	281,035

The National Land and Water Information Service Interpolated Census of Agriculture to Soil Landscapes of Canada v3.0 and Water Survey of Canada Sub-Sub Drainage Areas v5.0
Citation Sourcing for the Interpolated Census of Agriculture is as follows: Interpolated Census of Agriculture: Adapted from Agriculture and Agri-Food Canada and Statistics Canada, customized tabulations, Census of Agriculture CGC Base 1996, 2001, Census of Agriculture Regular Base 2006.

As shown in the above pesticide usage table compiled for the SSRSB a total of just over 3 million acres had herbicides, insecticides or fungicides applied in 2006. Increased use of agriculture pesticides increases the potential for contamination of surface or ground water.

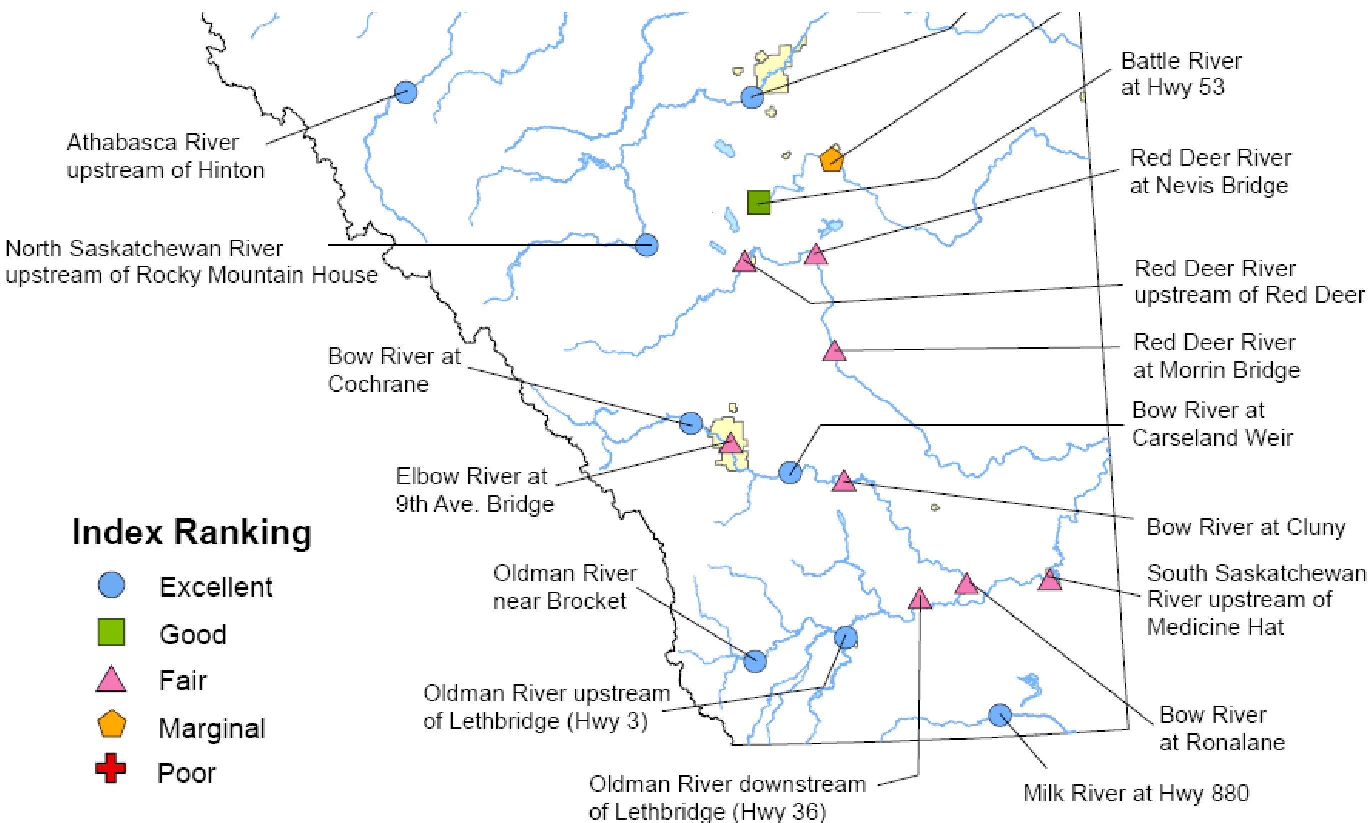
Pesticide use is an indicator of the quantity of chemicals that potentially can be released into the air, water or land. Alberta Environment carries out tracking of pesticide use intensity to provide a standard unit of measurement for various sectors including agriculture that can be used in comparison with other regions of Canada. Overall use and use intensity is also a valuable tool to show the effects of changes in management practices. According to the Alberta Environment indicators for sales of pesticides in Alberta's agricultural, commercial/industrial and domestic sectors during the period 1993 to 2003, pesticide sales remained substantially unchanged. In 2008 however, pesticide sales have increased especially in the agricultural sector.

Another measurement of pesticide useage is the calculation of intensity of pesticide usage in terms of kilograms of active ingredient per hectare of land. According to Alberta Environments data the intensity of usage in Alberta remained relatively constant between 1993 and 2003 however showed a significant increase in 2008 particularly in the amount of glyphosate applied.



http://environment.alberta.ca/02860.html

Alberta River Water Quality Index for Pesticides:



http://environment.gov.ab.ca/info/library/7715.pdf

The previous page includes a map for southern Alberta from the Alberta Environment website showing an index rating for pesticides. According to this map, the South Saskatchewan River has an index rating of “Fair” within the SSRSB.

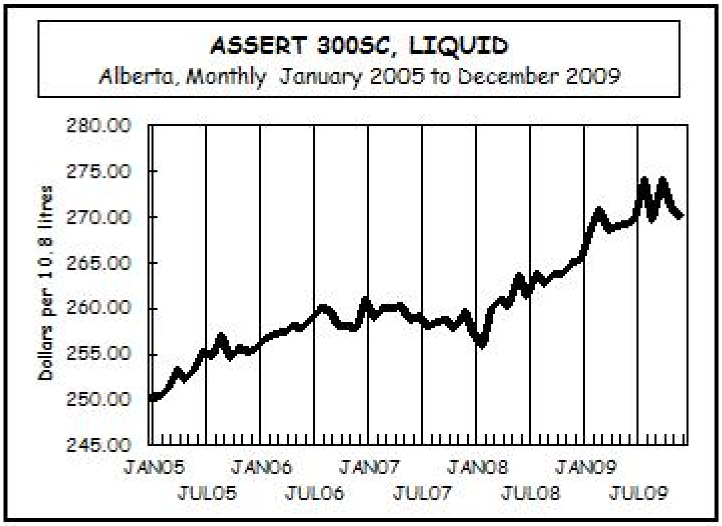
The following table details the number of pesticide measurements that exceeded surface water quality guidelines for drinking, irrigation, livestock and freshwater aquatic life. Within the South Saskatchewan River these guidelines were exceeded for irrigation both for dicamba and MCPA herbicides.

Table 4c Summary by basin of the number of pesticide measurements that exceeded surface water quality guidelines (1995 to 2002) (continued)

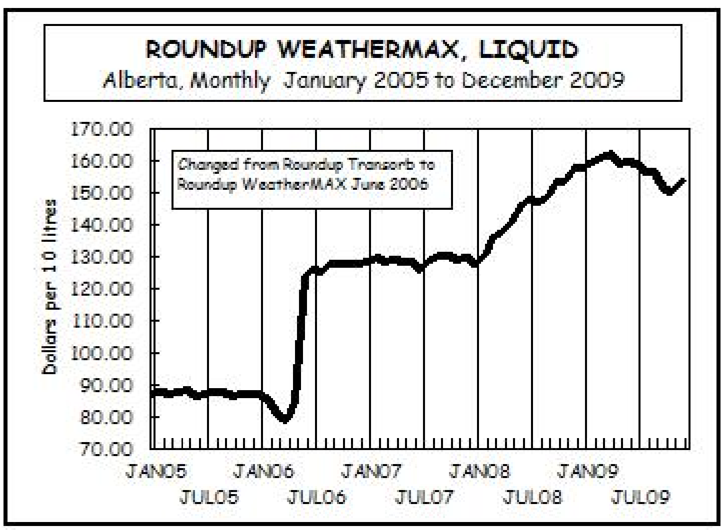
	2,4-D	ATRAZINE	BROMACIL	BROMOXYNIL	CARBATHIIN	CYANAZINE	DICAMBA	DIURON	GLYPHOSATE	MCPA	PICLORAM	SIMAZINE	TRIALLATE	TRIFLURALIN	AZINPHOS-METHYL	CHLORPYRIFOS-ETHYL	DIAZINON	LINDANE	MALATHION	METHOXYCHLOR	TERBUFOS
Sounding	*(2 sites, 15 samples)*																				
Drinking	0	0		0		0	0	0	0		0			0	0	0	0		0	0	0
Irrigation		0	0	0		0	1			1											
Livestock	0	0	0	0		0	0		0	0	0		0	0		0		0			
Freshwater Aquatic Life	0	0	0	0		0	0		0	0	0		0	0		0		0			
Bow	*(30 site, 406 samples)*																				
Drinking	0	0		0		0	0	0	0		0			0	0	0	0		0	0	0
Irrigation		0	1	1		0	113			65											
Livestock	0	0	0	0		0	0		0	0	0		0	0		0		0			
Freshwater Aquatic Life	4	0	0	0		0	0		0	0	0		1	0		4		3			
Oldman River	*(74 sites, 781 samples)*																				
Drinking	1	0		0		0	0	0	0		0			0	0	0	0		0	0	0
Irrigation		0	15	6		0	309			157											
Livestock	1	0	0	0		0	0		0	0	0		0	0		0		0			
Freshwater Aquatic Life	22	1	0	0		0	4		0	5	0		0	0		16		14	1[1]	1[1]	
South Saskatchewan River	*(2 site, 65 samples)*																				
Drinking	0	0		0		0	0	0	0		0			0	0	0	0		0	0	0
Irrigation		0	0	0		0	21			9											
Livestock	0	0	0	0		0	0		0	0	0		0	0		0		0			
Freshwater Aquatic Life	0	0	0	0		0	0		0	0	0		0	0		0		0			
Milk River	*(4 sites, 6 samples)*																				
Drinking	0	0		0		0	0	0	0		0			0	0	0	0		0	0	0
Irrigation		0	0	0		0	0			0											
Livestock	0	0	0	0		0	0		0	0	0		0	0		0		0			
Freshwater Aquatic Life	0	0	0	0		0	0		0	0	0		0	0		0		0			

Notes:
Guidelines used are Alberta/CCME guidelines unless otherwise stated
[1] USEPA (2002) criteria
Only pesticides that were detected and have guidelines are listed here
Number of sites and samples applies to the basin as a whole and may, in some cases, be larger than the number of samples analyzed for a given pesticide

Assert



Roundup



http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sdd4206

Tillage and Cropping Practices

Traditional or conventional tillage practices in combination with severe drought produced the era known as the "dirty thirties" in the prairies. Conservation tillage also known as no-till or minimum tillage methods was first investigated in the 1960`s as a means to conserve both soil and water and prevent erosion. Conservation tillage will also reduce runoff volumes as well as particulate phosphorus and nitrogen losses. Finally, the additional surface trash helps to maintain the soil moisture increasing the potential crop yield. (Davey, 2006) Conservation tillage includes both limited soil disturbance and leaving crop residue on the soil surface. Greater phosphorus and nitrogen losses were found in situations where there was limited surface residue crop cover. (Johnes 1996)

Tillage data has only been collected since the 1991 Statistics Canada Agriculture Census, meaning that only three years of data is available to determine adoption trends. As well it is significant to note that there has been a decrease of over 20% in the total number of farms in the Prairie Provinces between 1991 and 2001, which resulted in a net decrease in the total number of farms using minimum tillage technology even though as a percentage of total farms the use of minimum tillage technology has increased. By 1991, 31% of producers in the Prairie Provinces used minimum tillage technology. Between 1991 and 1996 there was a significant increase in the use of minimum tillage technology so that by 1996 42% of Prairie Producers were using minimum tillage technology. By 2001 the use of minimum tillage technology had increased once again and 48% of Prairie Producers were using minimum tillage technology. The adoption of minimum tillage technology will never reach 100% because the technology is not suited to all agriculture regions in the Prairie Provinces. As well, a significant capital cost is involved with purchasing the technology; therefore the farm must be large enough to justify the capital cost to purchase it. Between 1996 and 2001 Alberta alone experienced ar significant increase in the use of minimum tillage technology, increasing 10 percentage points to 44%.

Within the SSRSB, almost 77% of the total acres are zero or minimum tillage based on the same Statistics Canada 2006 Agricultural census data.

Tillage Practices	Number of Farms Reporting	Acres
Tillage retaining most of the crop residue on the surface (Minimum Tillage)	944	694,443
No-till seeding or zero-till seeding	1,126	1,527,382
Tillage incorporating most of the crop residue into soil (Conventional Tillage)	1,427	672,771

The National Land and Water Information Service Interpolated Census of Agriculture to Soil Landscapes of Canada v3.0 and Water Survey of Canada Sub-Sub Drainage Areas v5.0
Citation Sourcing for the Interpolated Census of Agriculture is as follows: Interpolated Census of Agriculture: Adapted from Agriculture and Agri-Food Canada and Statistics Canada, customized tabulations, Census of Agriculture CGC Base 1996, 2001, Census of Agriculture Regular Base 2006.

SUMMARY

The purpose of this report was to take a ``snap-shot `` of the current state agriculture within the South Saskatchewan River Sub-basin and how agriculture affects water quality.

The first question to be asked was: ``What components of water quality within the South Saskatchewan River Sub-basin are affected by Agriculture``?

Agriculture contaminants to source water can be categorized as either **point source** or **non-point source**. Potential point source threats from agriculture activities can include intensive or confined livestock feeding operations, manure storage, livestock wintering areas, chemical storage and disposal areas, septic systems, and fuel storage. As water from rainfall and snowmelt flows over and through the landscape, it picks up and carries contaminants from many different sources producing what is classified as Non-Point Source pollution.

Another important relationship of Agriculture and the SSRSB is in regards to quantity of water. Increasingly farms are becoming diversified and require irrigation. Within the St Mary`s River Irrigation District there has been a steady increase in acres irrigated. Assuming a 0.52% increase it is predicted that by 2020 there will be some 380,000 acres of land within the SSRSB under irrigation. Efficiencies and upgrades to infrastructure should be sufficient to allow this expansion however eventually the maximum water allocation amounts will be reached. At this point there will be competition between municipal, industrial and agricultural users for irrigation water. One option is for agriculture to tap into aquifer and ground water sources however this comes for additional risks of salinization of soils, contamination of ground water and depletion of reserves in an area where regeneration of ground water may require very long periods of time.

The next question asked was: ``What is the current state of water quality as it relates to agricultural activities within the SSRSB`` ?

Studies reviewed for this report indicate that for the most part water quality within the South Saskatchewan River Sub-basin, with the exception of irrigation returns, exceeded water quality guidelines for irrigation, livestock, fresh water organisms and recreation.

Another question asked within this report was: ``Have the implemented agricultural best management practices had any impact on improving water quality in the SSRS?``

Through government programs, education, support from grower associations and agencies such as ``Cows and Fish`` awareness about how agriculture can affect water quality has increased. The Environmental Farm Management Plan program has also significantly increased awareness of how agriculture can affect water quality. The higher than provincial average number of farms using minimum tillage cropping demonstrates the success of these initiatives within the SSRSB.

The last question to be answered in this report was to determine if there are agricultural issues that may affect future water quality in the SSRSB.

To survive in the current economy, ranchers and farmers alike in the SSRSB have had to become more diversified and seek economies of scale. More intensive livestock operations increase the risk of point and non-point water pollution both to surface and groundwater. Speciality crops require both higher applications of irrigation water and agricultural inputs such as fertilizer, herbicides, insecticides and fungicides. Increased agricultural inputs have been shown through a number of scientific studies to increase the risk of contamination of water.

APPENDIX:

Detailed Agricultural Profile for the South Saskatchewan River Sub Basin - 2010

The National Land and Water Information Service Interpolated Census of Agriculture to Soil Landscapes of Canada v3.0 and Water Survey of Canada Sub-Sub Drainage Areas v5.0

	Number of Farms Reporting
Numbers of Farms	4,169

Crops	Number of Farms Reporting	Farms Acres
Total Wheat	1,887	1,592,366
Oats	528	79,554
Barley	1,211	500,326
Total Rye	136	4,729
Total Corn	113	15,548
Triticale	170	25,315
Other Grains	110	19,249
Flaxseed	90	10,420
Canola	562	211,901
Mustard Seed	109	31,890
Other Oilseed	11	329
Total Pulses	545	200,273
Alfalfa and Alfalfa mixtures	1,794	357,460
Forage Seed for Seed	82	10,218
All other Tame Hay and Fodder Crops	688	98,001
Potatoes	73	19,497
Sugar Beets for Sugar	93	15,673
Canary Seed	6	940
Other Field Crops	31	6,503

Fruit	Number of Farms Reporting	Farms Acres
Total area (producing and non-producing) of fruits, berries and nuts	54	283

Vegetables	Number of Farms Reporting	Farms Acres

Total Vegetables	82	4,544

Greenhouse	**Number of Greenhouses Reporting**	**Square Feet**
Total greenhouse area under glass, plastic other protection	60	3,948,917

Land Use	**Number of Farms Reporting**	**Acres**
Area in land in crops (excluding xmas tree area)	3,572	3,229,821
Summer fallow	1,510	836,165
Tame or seeded pasture	1,688	649,512
Natural land for pasture	2,268	4,994,128
All other land (including woodland, wetlands and Christmas tree area)	2,409	166,664

Inputs	**Number of Farms Reporting**	**Acres**
Use of commercial fertilizer	2,270	2,409,135
Use of herbicides	2,240	2,717,658
Use of insecticides	446	188,937
Use of fungicides	417	281,035

Use of Manure/Compost	**Number of Farms Reporting**	**Acres**
Composted manure incorporated into soil	351	24,230
Composted manure not incorporated into soil	181	9,715
Solid manure incorporated into soil	623	63,022
Solid manure not incorporated into soil	272	19,706
Liquid manure injected or incorporated into soil	92	0
Liquid manure not incorporated into soil	29	1,472
Liquid manure applied by irrigation	10	420

Manure Production (As calculated by AAFC)	**Number of Farms Reporting**	**Tonnes**	**Kilograms**

Production of Manure	2,806	6,658,173	-
Nitrogen in Manure	2,806	-	36,736,535

Soil Conservation Practices	**Number of Farms Reporting**
Crop rotation	2,718
Rotational grazing - Soil conservation practices	1,483
Winter cover crops	253
Windbreaks or shelterbelts	1,334
Ploughing down green crops - Soil conservation practices	89
Buffer zones around water bodies - Soil conservation practices	502

Tillage Practices	**Number of Farms Reporting**	**Acres**
Tillage retaining most of the crop residue on the surface (Minimum Tillage)	944	694,443
No-till seeding or zero-till seeding	1,126	1,527,382
Tillage incorporating most of the crop residue into soil (Conventional Tillage)	1,427	672,771

Summer fallow Practices	**Number of Farms Reporting**	**Acres**
Weed control on summer fallow land, chemical only	750	507,735
Weed control on summer fallow land, tillage only	553	162,476
Weed control on summer fallow land, tillage and chemical combination on the same land	381	135,032

Irrigation (As reported on Census)	**Number of Farms Reporting**	**Acres**
Total use of irrigation	1,567	582,155

Livestock	**Number of Farms Reporting**	**Total Animals**
Total cattle and calves	2,427	763,936

Total pigs	152	334,290
Total hens and chickens	295	1,297,297
Total sheep and lambs	162	21,662
Horses and ponies	1,252	763,936

Cattle Categories*	**Number of Farms Reporting**	**Total Animals**
Dairy cows	107	7,342
Beef cows	2,129	232,359
Steers - 1 year and over	881	128,396
Calves - under 1 year	2,176	254,131
Total heifer - 1 year and over	1,508	90,273
Heifers for beef herd replacement - 1 year and over	1,219	32,658
Heifers for dairy herd replacement - 1 year and over	80	2,901
Heifers for slaughter or feeding - 1 year and over	560	84,821

* Categories do not match total cattle and calves due to census reporting criteria (privacy)

Citation Sourcing for the Interpolated Census of Agriculture is as follows: Interpolated Census of Agriculture: Adapted from Agriculture and Agri-Food Canada and Statistics Canada, customized tabulations, Census of Agriculture CGC Base 1996, 2001, Census of Agriculture Regular Base 2006.

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The **South East Alberta Watershed Alliance (SEAWA)** was formed in 2007, incorporated as a non-profit society in 2008, and designated as the WPAC (Watershed Policy and Advisory Council) for the South Saskatchewan River sub-basin.

SEAWA Vision: *A healthy watershed that provides balance between social, environmental and economic benefits.*

SEAWA Mission: *South East Alberta Watershed Alliance brings together diverse partners to plan and facilitate the sustainable use of the South Saskatchewan River Watershed for present and future needs.*

SEAWA Members include interested individuals throughout the watershed along with our communities, ranchers, farmers, industries, companies, governments, conservation groups and educational institutions. We are proud to include the following among our founding members:

Government Sector: Alberta Government, City of Medicine Hat, Government of Canada, Cypress County, Palliser Health Region, Town of Redcliff, Town of Bow Island, and Special Areas Board.

Land Resource - Industry and Agriculture Sectors: St Mary River Irrigation District, Murray Lake Ranching, GG Bruins Farms, Short Grass Ranches, Canadian Fertilizers Limited, Redcliff Technology Enterprise Centre, Box Springs Business Park, and Canadian Centre for Unmanned Vehicles.

Academic, Research and Non-Governmental Organizations Sectors: Medicine Hat College, Alberta Research Institute, Red Deer River Watershed Alliance, and Hyperion Research.

Tourism and Conservation Sectors: Grasslands Naturalists, Canadian Badlands, and Medicine Hat Interpretive Program.

SEAWA Web-based State of the Watershed Report is managed by the *SEAWA State of the Watershed Committee (2010 members)*:

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