WATSAVE Innovative Water Management Award 2018

Irrigation Districts in Alberta, Canada Water Savings through Technology Innovations

1.0 Describe the Innovation

Irrigation in Alberta began in the 1890s, and steadily expanded to about 708,000 ha in 2016 (AAF, 2017), and represents almost 70% of Canada's irrigated area (AARD, 2014). About 98% of Alberta's irrigation is in southern Alberta (Figure 1). About 82% of the total irrigated area is in the 13 irrigation districts of southern Alberta, and 18% in private irrigation projects located throughout Alberta (Figures 1 & 2). More than 50 different irrigated crops are grown within the irrigation districts (AAF, 2017).

Water is diverted from three rivers (Oldman, Bow and St. Mary rivers) and delivered to about 6,000 irrigation district producers through an inter-connected system of about 50 storage reservoirs, and 7,900 km of canals and pipelines. Groundwater is not used for irrigation in Alberta. About 7,600 km of the canals and pipelines are owned and operated by the irrigation districts, and about 300 km by the Government of Alberta (GoA). The water storage and distribution network owned by the irrigation districts is valued at about CDN $3.7 billion (AAF, 2017).

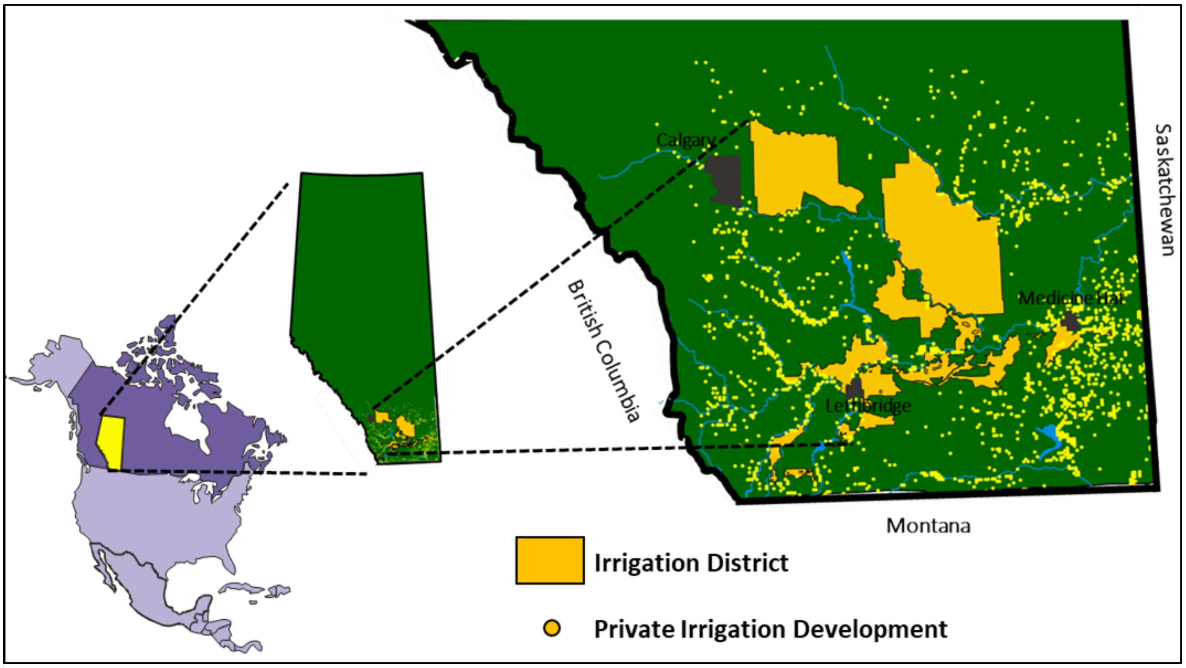

Figure 1. General location of irrigation development in southern Alberta

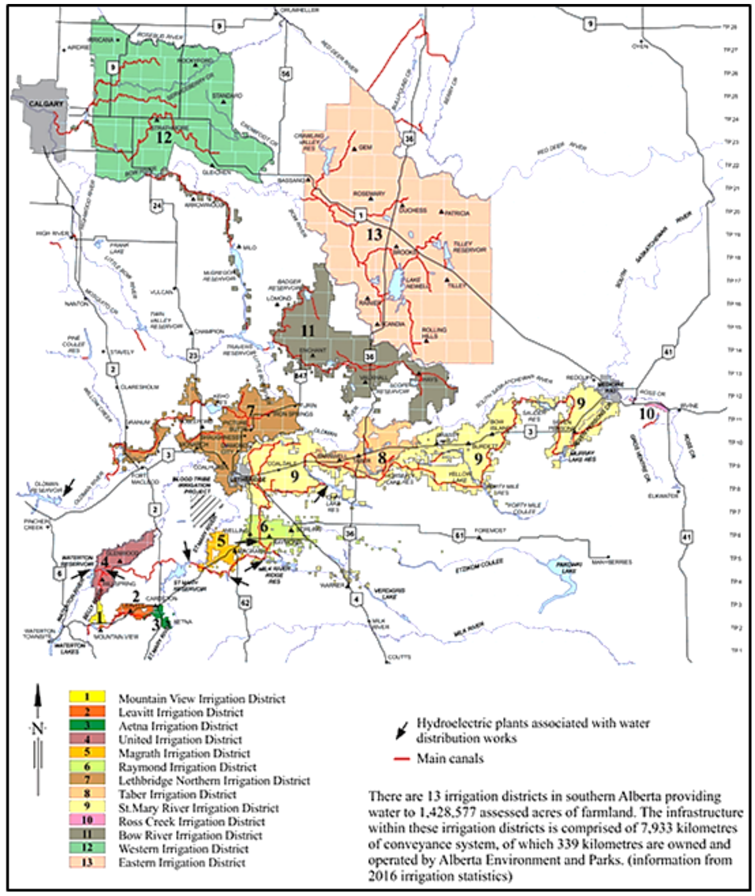

Figure 2. Detailed map of irrigation districts

About 2 billion m^3 of water is supplied annually to the irrigation districts, with about 67% (1.4 billion m^3) of that volume diverted to irrigation producers and 20% returned to a river (AAF, 2017). This infrastructure also provides water to about 50 towns and villages, numerous food processors, intensive livestock operations, wildlife habitat areas, and recreation facilities throughout southern Alberta.

Development and implementation of technologies related to rehabilitation of water supply infrastructure and on-farm irrigation within the irrigation districts have saved significant volumes of water through reduction of distribution system losses (seepage, evaporation) and improvements in on-farm water use efficiency and productivity. Salinity and waterlogging, which affected about 20% of the irrigated area throughout the irrigation districts in the 1970s, was essentially eliminated because of the irrigation rehabilitation program and improvements in on-farm irrigation technologies.

1.1 Rehabilitation of Water Supply Distribution System

Since 1969, the irrigation districts have partnered with the GoA to implement a cost-shared canal rehabilitation program to improve the efficiency and effectiveness of the irrigation water distribution system, and reduce salinity and waterlogging problems on adjacent irrigated lands. To date, the GoA and irrigation districts have invested more than CDN 1$ billion in support of the rehabilitation program (Bennett et al., 2015). Irrigation districts have invested additional funds to escalate the speed of the rehabilitation program. Beginning in the 1980s, there an increased focus on replacement of surface canals with underground pipelines.

1.1.1 Surface Canal Rehabilitation

Rehabilitation of surface canals is currently focused on the larger canals, which cannot be replaced with underground pipelines. Priority is given to canals where seepage has been a problem, and where additional canal capacity is required to meet expanding irrigation development. Rehabilitated canals are designed to optimize water delivery effectiveness, and incorporate armour on the canal banks to protect against erosion (Figure 3). If necessary, buried plastic membrane is installed in the canal bottom and banks to prevent seepage losses.

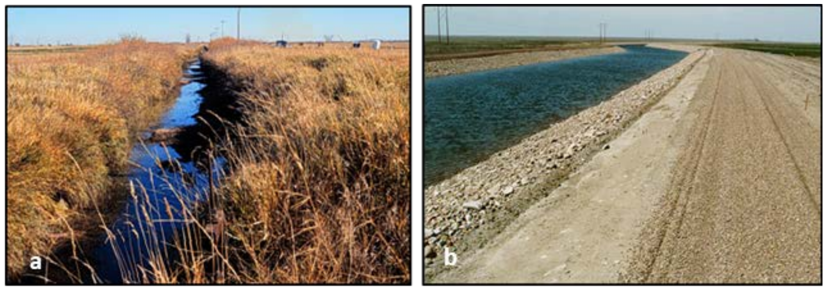

Figure 3. Unrehabilitated (a) and rehabilitated (b) canal

Automation and remote flow control of water in the canals continues to be an integral part of the irrigation rehabilitation program to improve irrigation water supply management and efficiency. This includes pump control, reservoir control, upstream level control, downstream flow control, and water ordering by irrigation producers (Figure 4).

Figure 4. Automated check/drop structure

1.1.2 Replacing Surface Canals with Underground Pipelines

Pipeline installation

Irrigation districts began to replace surface canals with buried polyvinyl chloride (PVC) pipelines in the early 1980s (Ring et al., 2006). Currently, about 4,100 km (54%) of the 7,600 km of irrigation districts-owned water distribution system are in underground pipelines. These pipelines eliminate seepage, evaporation and operational spills; reduce soil salinity and waterlogging on adjacent lands; improve water distribution efficiency and water delivery effectiveness to irrigation producers; and free up valuable land for irrigation development. The maximum pipeline size currently being installed is about 1520 mm diameter, with up to 1980 mm diameter pipelines being installed in special cases. Irrigation districts continue to work closely with pipeline manufacturers to develop increased pipeline sizes that can replace larger surface water supply canals.

1.2 On-Farm Irrigation Technology Improvements

Successful implementation of the irrigation rehabilitation program, over time, has increased the confidence of irrigation producers that sufficient irrigation water will be delivered in a timely manner to

Low pressure drop tube pivot

allow for optimum crop production. This was a critical prerequisite for irrigation farmers to invest in newer irrigation technologies, such as low pressure drop-tube pivot systems, and production of higher value specialty irrigation crops. Many of these crops are now being processed in southern Alberta.

1.2.1 Upgrading Irrigation Systems

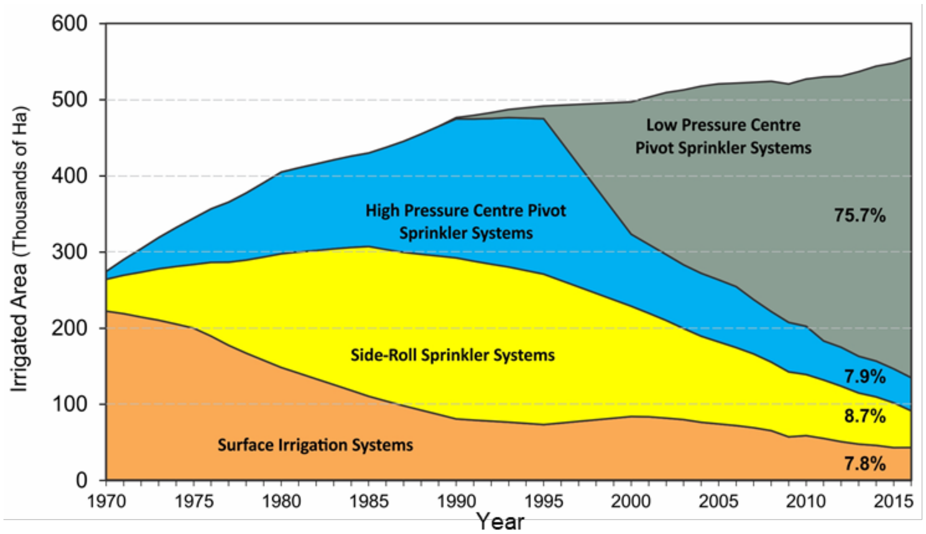

Figure 5. On-farm irrigation systems in Alberta's irrigation districts

Irrigation producers have and continue to replace less efficient irrigation systems with more technically advanced and efficient on-farm irrigation systems. Between 1999 and 2012, irrigation producers within the irrigation districts invested about CDN $375 million in irrigation systems upgrades (Bennett et al., 2015). The total replacement value of all on-farm irrigation systems within the irrigation districts is about CDN $1 billion. Figure 5 shows the changes in on-farm irrigation systems within the irrigation districts between 1970 and 2016.

Currently, about 76% of the on-farm irrigation in the irrigation districts are carried out using low pressure, drop-tube pivot irrigation systems (AAF, 2017), which have an efficiency rating of about 84% (AAF, 2016).

1.2.2 Irrigation Demand Model

Alberta Agriculture and Forestry (AAF) developed the Irrigation Demand Model (IDM) in 2002 to allow irrigation districts more accurately assess long-term water supplies relative to expected irrigation demand. This allows the irrigation districts to make more informed water allocation and expansion decisions, and ensure all irrigation producers and other water users receive a fair share of their water allocation. The IDM is used to determine the on-farm water demand for each irrigated parcel of land within each irrigation district, using historic and current weather data and annually updated cropping and on-farm irrigation system data. The model links this data with the irrigation district water distribution Network Management Module, which is used to estimate conveyance losses (return flow, evaporation, and seepage). The IDM was updated in 2017 to provide more accurate assessment of ongoing water demand within the irrigation districts.

1.2.3 Alberta Irrigation Management Model

To assist irrigation producers better manage their irrigation water application efficiency and optimize crop production, AAF developed the Alberta Irrigation Management Model (AIMM). This decision support software package can be accessed by all irrigation producers to help them make more informed irrigation scheduling. The AIMM software acquires the necessary climate parameters required to calculate evapotranspiration and irrigation recommendations from a comprehensive network of automated weather stations located throughout the irrigation districts. Producers can choose the closest weather station for their information requirements.

2.0 Describe How the Innovation Saves Water

From 1999 to 2012, improvements to the irrigation conveyance infrastructure resulted in annual water savings of about 50 million m^3. In addition, ongoing advances in sprinkler irrigation technology resulted in significant improvements in on-farm irrigation efficiency, which increased from about 35% in 1965 to about 78% in 2012. (AARD, 2011, 2013). This reduced the mean on-farm irrigation demand, based on a 10% chance of exceedance, from about 474 mm in 1999 to about 419 mm in 2012 (Bennett et al., 2015). On-farm irrigation efficiency is expected to increase to 85% by 2025 as irrigation farmers continue to upgrade their on-farm irrigation systems (AARD, 2014).

From 1999 to 2012, changes in irrigation systems and water conveyance infrastructure reduced gross demand by 74 mm, which includes a 55-mm reduction in on-farm demand and a 19-mm decrease in conveyance losses, at a 10% chance of exceedance. During this period, rehabilitation of the canal distribution infrastructure, combined with improvements in the on-farm irrigation systems, reduced annual gross irrigation demand by 170 to 200 million m^3, even including about 30,300 ha of irrigation districts' expansion during that time (Bennett et al., 2015).

3.0 Describe How the Innovation was Introduced and Spread

During the 1960s, the Government of Alberta and the irrigation districts recognized the need to rehabilitate the existing irrigation water supply infrastructure to sustain and grow the irrigation industry in the province. Implementation of a cost-shared funding program, specifically for the rehabilitation and upgrading of existing irrigation water supply infrastructure, was initiated in 1969.

Between 1969 and 1980, the rehabilitation work focused on upgrading surface water supply canals. With the introduction of PVC pipe technology in the early 1980s, the focus of the program shifted to the replacement of surface canals with underground pipelines. Irrigation districts and producers quickly recognized the long-term advantages of this technology, even though the capital costs of pipelines during the early years of development were relatively high compared with surface canal rehabilitation costs.

Total pipeline installation within the 13 irrigation districts averaged about 105 km/year from 1999 to 2012, and during the past 5 years represented almost 90% of the total annual rehabilitation work carried out by the irrigation districts (AAF, 2017a). Irrigation districts continue to work with pipeline manufacturers and contractors to improve pipeline design and installation technologies to increase their effective operational life. As technologies improve, pipe manufacturers will be able to supply increasingly larger pipe sizes, which will allow irrigation districts to replace more surface canals with underground pipelines.

4.0 Describe the Scope for Further Expansion of the Innovation

Irrigation districts recently authorized a further expansion of their total irrigated area to about 612,000 ha because of the water savings resulting from: improvements to the water supply infrastructure; automation of water conveyance systems; upgrading on-farm irrigation systems to more efficient drop tube low-pressure centre pivots; and improved technologies to more effectively link on-farm water supply with crop water needs (Bennett et al., 2015). This expansion represents an increase in the irrigated area by about 57,000 ha from 2012 levels, and about 34,000 ha from 2016 levels.

Irrigation producers are expected to upgrade to more efficient irrigation systems on an additional 160,000 ha of irrigated land to reduce energy and labour costs, increase water use-efficiency, and improve management of available irrigation water for higher value crop production. Increasing use of higher efficiency sprinkler nozzles and variable-rate irrigation technologies by irrigation producers on low pressure centre pivot irrigation systems, as well as improved irrigation management, will also enhance on-farm efficiency gains in the future. Irrigation districts are committed to continuing the replacement of surface canals with underground pipelines wherever possible, and rehabilitation of an additional 1,600 km of un-rehabilitated surface water conveyance infrastructure. These combined actions will provide additional water savings.

5.0 Describe the Roles of the Individual Nominees

Richard Phillips is the current Chair of the Alberta Irrigation Projects Association (AIPA), and is also the manager of the Bow River Irrigation District. The AIPA, which was formed in 1946, represents the interests of the 13 irrigation districts and more than 6,000 irrigation producers. The AIPA promotes the value of Alberta’s irrigation industry to the Province of Alberta and encourages progressive water management practices. AIPA is headquartered in Lethbridge, Alberta, and is actively engaged in research, policy and governance issues, and activities related to public education and outreach.

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