Irrigation Issues, Perceptions, Constraints & Knowledge Gaps

Irrigation development in Saskatchewan has not proceeded smoothly. After the initial spurt of irrigation after entry into Confederation, irrigation development slowed. With the Dirty Thirties, a new appreciation emerged for the benefits of irrigation and the federal government became active in assisting the sector develop through the Prairie Farm Rehabilitation Administration. Completion of the Gardiner Dam and Lake Diefenbaker in the 1960s introduced another phase of irrigation expansion that continued into the 1990s, when once again irrigation development slowed.

Perceptions

Today there remains a large number of constraints to irrigation development in Saskatchewan. As recently as 2005, the Brace Centre for Water Resources Management at McGill University identified a number of barriers to irrigation development in the Province. The Brace evaluation identified Saskatchewan as the Western province with the most potential for irrigation expansion, but the lowest provincial government priority towards development of the sector. The difference between potential and priority represents a barrier itself to development. When government priorities for irrigation align with the irrigation opportunity it is more likely that development will proceed. In the past this has not been the case in Saskatchewan.

Table 54 Index of Provincial Perceptions on Irrigation Expansion Potential and Provincial Priority for Irrigation Development, 2005

Western Province	Perceived Irrigation Expansion Potential from Soil, Water and Economic Perspectives	Perceived Priority of Government Priority towards Future Irrigation Development	Difference Between Potential and Government Priority
	Index on a Scale from 1 (low) to 5 (High)		
Manitoba	3.5	2.8	0.7
Saskatchewan	**4.0**	**1.8**	**2.2**
Alberta	3.5	3.3	0.2
British Colombia	3.3	2.4	0.9
Canadian Average	3.5	2.5	1.0
Source: Brace Centre (2005)			

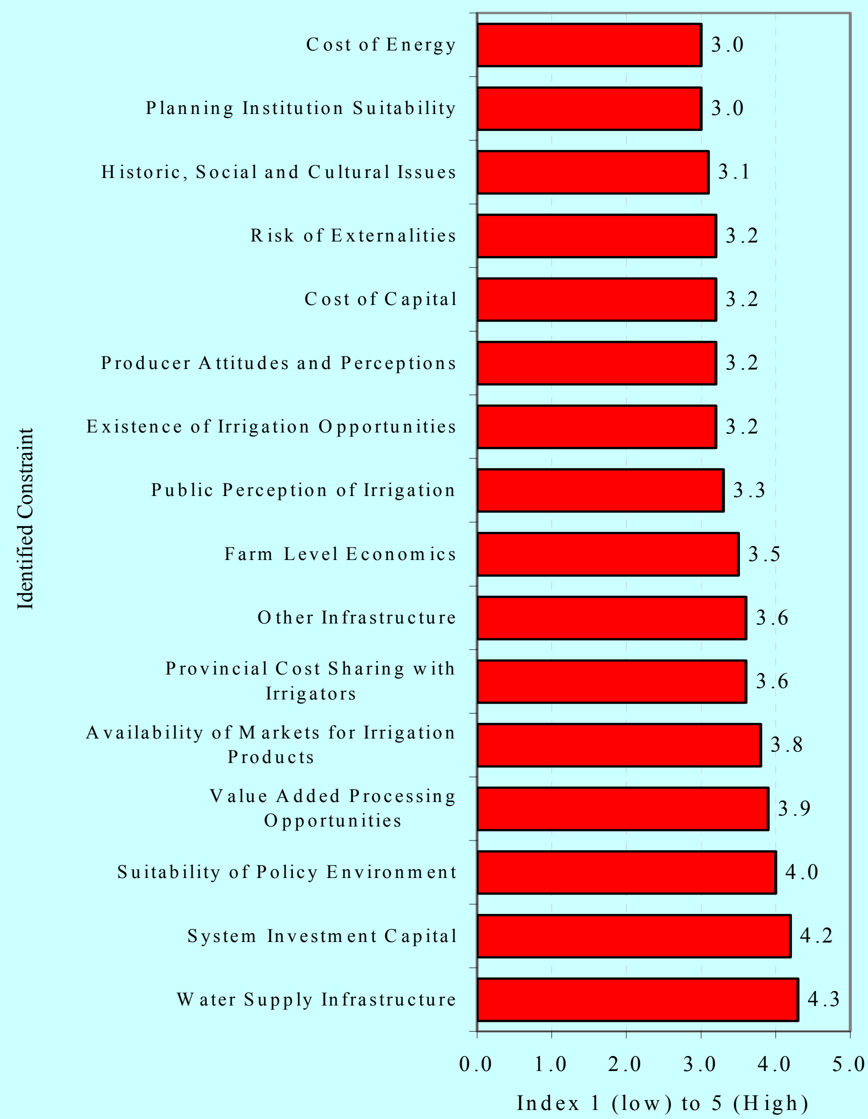
Sixteen specific barriers were identified in Saskatchewan by the Brace Centre that are summarized in Figure 30. This identifies the absence of water supply infrastructure, its financing requirement and the related public policy environment as the three largest constraints to development. The Centre notes: *Few economic benefits will be realized in the short run as long as there is not much change in the level of infrastructure investment. However, with new investment, irrigation-based* *economic development could grow over the long run (i.e. 40 – 50 years) and should become much more important to the provincial economy.*[62]

[62] Brace Centre (2005) p. 49.

The results of barrier identification workshops held in connection with the Brace evaluation identified irrigation development as:

1. the only proven sustainable way to revitalize rural economies that have reasonable access to sufficient water resources, and
2. a means of drought proofing the agricultural area of Saskatchewan in anticipation of global warming and climate change.

Figure 30 Constraints to Irrigation in Saskatchewan, 2005



Source: Brace Centre (2005)

Constraints

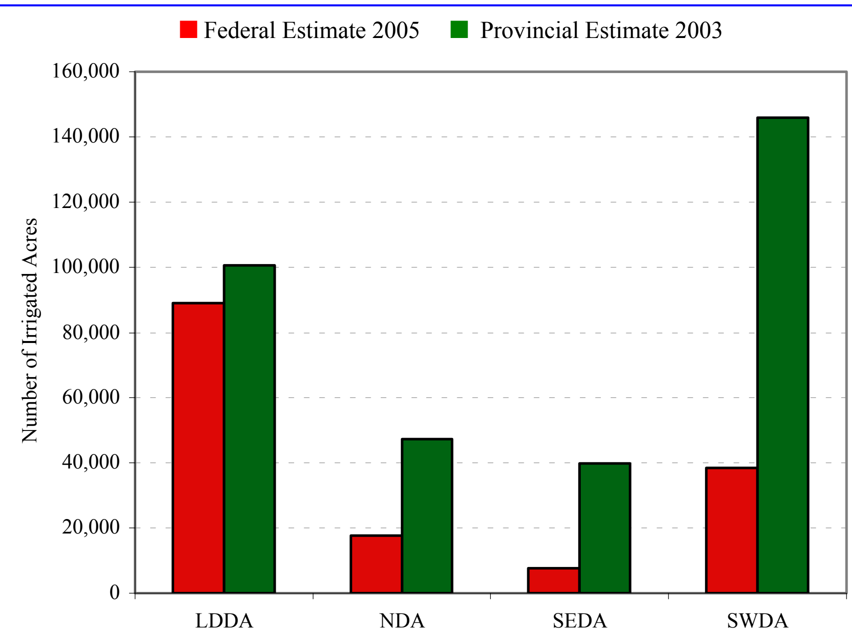
The constraints to irrigation development in Saskatchewan are to be found in nearly all areas of the province and can be seen in the context of five main sets of issues or constraints to development. They are:

1. Irrigation Information and Regulatory Frameworks
2. Use, Value and Allocation of Water
3. Infrastructure for Development
    a. Economic Infrastructure
    b. Demographic Foundations
    c. Critical Mass
    d. Promotion and Marketing
4. Science Technology and Agronomy
5. Planning and Institutional Frameworks for Irrigation Development

Irrigation Information and Regulatory Frameworks

How much irrigation is actually undertaken in Saskatchewan? The answer to this question is a matter of considerable debate and there are large differences between estimates made by the Provincial Government and Statistics Canada. Federal estimates reveal approximately one half the number of irrigated acres in Saskatchewan compared to provincial estimates.

Figure 31 Federal and Provincial Estimates of Irrigated Acreage in Saskatchewan



Source: Statistics Canada, Saskatchewan Agriculture, Food and Rural Revitalization.

The differences in irrigated acres are largest in the southeast (81%) and the southwest (74%) and closest in the Lake Diefenbaker area where federal estimates are only 11% lower than the provincial estimates. In total there is a difference of some 180,000 acres.

Table 55 Differences In Federal and Provincial Estimates of Total Irrigated Acres in Saskatchewan Irrigation Development Areas

Irrigation Development Area	Federal Estimate Statistics Canada 2005	Provincial Estimates 2003	Difference between Federal and Provincial Estimates	
			Acres	%
LDDA	89,137	100,622	11,485	-11%
NDA	17,542	47,139	29,597	-63%
SEDA	7,540	39,759	32,219	-81%
SWDA	38,395	145,913	107,518	-74%
Saskatchewan	**152,614**	**333,433**	**180,819**	**-54%**
Sources: Statistics Canada (2005); SAFRR (2003)				

Differences in irrigation estimates have significance for the development of the sector in several areas:

1. Water allocations and water use estimates based on acres irrigated would vary by large amounts depending on the level of acres selected. As a result the amount of water that might be available for future irrigation development can limit future development.

2. The estimate of irrigated acreage is a basic foundation for estimates of crop supply from that irrigated acreage. This is turn represents the commodity input requirement for agricultural value added activities that can generate so much additional wealth in an irrigated value chain.

Resolving the irrigated acres issue is an important pre-requisite for widespread irrigation development in the province. However, the solution to irrigated acre differentials probably lies in other parts of the regulatory structure for irrigation that are also in need of reform if they are not to constrain irrigation development in the province. These are the areas of irrigated water use value and allocation of water.

Information, Use, Value and Allocation of Water

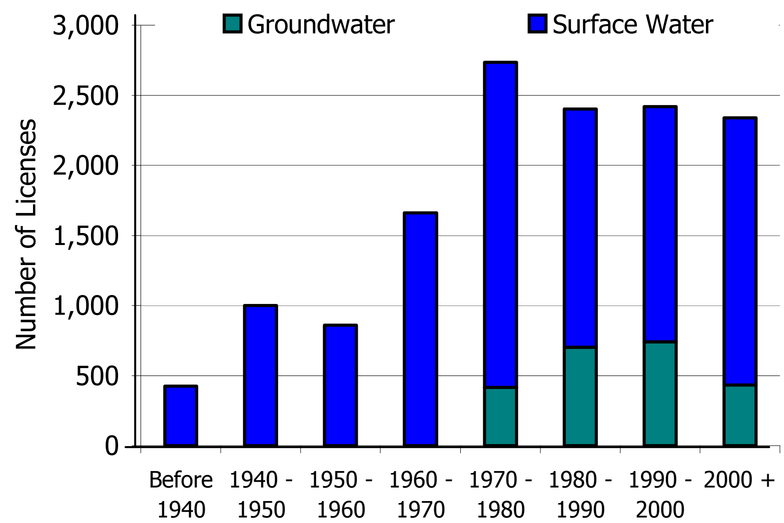
How much water is used for irrigation? How much water is available for irrigation expansion? The answers to these questions are important for the development of the industry. However, the information base is particularly weak and can be seen in three critical areas related to the water licensing system, water use and water consumption estimates.

Water Licensing and Water Rights

Water rights in Saskatchewan have been issued over a long period of time (see Figure 32). Rights issued for agricultural purposes in the early years were issued on the basis of relatively inefficient water application technologies such as flood or furrow irrigation with high evaporation losses and the potential for adverse salinisation of the soils. In contrast, the more water efficient sprinkler technologies that have developed in recent decades cannot be introduced in parts of the province like the southwest where all available waters have been allocated through licenses.

In many cases, since about 20% of provincial water licenses were issued prior to 1960 and are now over fifty years old, it is probable that although the water licenses have been issued they are no longer being used. Such licenses have to be taken into account in water availability estimates, although in reality they do not contribute to water consumption. The absence of any requirement for all license holders to accurately report their water use becomes a further element in the water licensing system that undermines the water information base for irrigation. All of these elements contribute to a water licensing system that forms a constraint on the efficient use of water and the development of the irrigation resource.

Figure 32 Surface and Groundwater Rights in Saskatchewan by Decade to 2004



Source: Saskatchewan Agrivision Corporation Inc. (2003)

The allocation and use of water based on historic allocations may or may not bear any relationship to current demands and values. The valuation of "rights" is common in most parts of our society. Mineral rights are commonly traded and valued through a registration and auction process supported by the government. Oil exploration rights are commonly bought, sold and traded through the marketplace. Governments in many jurisdictions have moved towards providing for specific water rights in order to provide realistic values for the water within their jurisdiction. Thus, as long ago as 1980 and modified in 1988, Chile established secure, transferable water rights with the freedom to buy and sell or rent water. Experience with the process has given farmers greater flexibility to shift crops according to market demand. Efficiency in the provision of urban water and sewage services has increased without any increase in prices.

More recently, Australia has concluded a series of major water policy reforms that started in 1994 and continue to the present day. These reforms were aimed initially at improving water use efficiency in the Murray Darling Basin and re-assigning waters for the environment to maintain natural flows in the centre of Australia's main irrigation economy. Water reforms included full cost pricing, metering, water entitlements and trading and securing basic environmental in-stream river flows as a physical requirement. The effect of these developments on irrigators has been to replace uncertainty over water supplies with certainty and to increase pressure for more efficient water use technologies and thereby reduce operating costs. In most normal years, only five percent of the water entitlements have traded, although during the scarcity of a drought, this share of entitlements trading rose as high as 24%.[63]

Water trading can have important efficiency effects in agriculture and its value added chain. Australia's experience has seen water use shifting from low value crops on poor soils to high value crops on better soils. Many of the water entitlements traded and purchased are to provide water security for both farmers and processors, even though waters are not always used. Water trading is shifting unused water rights into active use and providing a new rural revenue stream.

[63] Bjornlund, H., (2004)

Past investigations of water short regions in Saskatchewan's southwest found that potential high value irrigation on good soils could greatly enhance irrigation productivity, but implementation of these changes progressed only slowly due in part to traditional water rights limitations.

While agriculture and irrigation are one of the largest users of water in the province, as Saskatchewan grows there are increasing demands for the water resource from other users. Reform of the Saskatchewan water management system could, therefore, remove these regulatory constraints to irrigation development in the province and improve the efficiency of water allocation.

Water Use, Allocation, Conservation and Consumption

Water use and allocation remain critical areas for irrigation development. Provincial water management practices do not provide for a detailed measurement of the impacts of usage on the available water resource. Estimates of actual water consumption based on the license information are inflated as a result of the deficiencies in the water licensing systems.

For example, it is estimated that the annual inflow to Lake Diefenbaker could range from 18 million cubic decameters in wet years to as low as 2.4 million decameters in a year of extreme drought such as 1988. Three million cubic decameters is commonly used as an estimate of available supply that would have been available in 90% of the years on the basis of the historical record. The increased precipitation that may accompany global warming may increase the inflow potential. Existing licenses for private irrigators and irrigation districts drawing from Lake Diefenbaker currently provide for irrigators to withdraw between 8%, in an extreme drought year, and 1%, in a wet year, from the available storage (Table 56).

In practice, the record of water extraction for irrigation between 1988 and 2006 shows a much lower level of extraction that is commonly as much as 50% below the available license. This suggests, for example, the available licenses around the Lake would provide for a little over 200 thousand cubic decameters of withdrawal if actual use was about one half the available licenses. Actual use has therefore been between 4% and 1% of the available supply in drought and wet years. In most years irrigation is currently accounting for 3% or less of the available water supply.

Table 56 – Existing and Expanded Irrigation Water Demands, Estimated Annual Supply, Lake Diefenbaker

Lake Diefenbaker Available Live Storage		Lake Diefenbaker Estimated Existing Annual Water Use			Lake Diefenbaker Estimated Future Annual Irrigation Water Use	
Type of Year	Millions of Cubic Decameters	Irrigated Acres (Thousands)	As % Available Annual Supply		Irrigated Acres (Thousands)	Probable Use Based on Existing Use As a % Available Annual Supply
			Licensed	Actual		
Extreme Drought	2.4	100	8%	4%	603	22%
Normal in 90% of the Years	3.0	100	7%	3%	603	18%
Wet Years	18.0	100	1%	1%	603	3%

After water extraction, a certain amount of water on irrigation districts will be returned to the river or lake. In some cases these returns can be large and are not taken into account in measuring water use and lead, therefore, to overestimates of levels of water consumption by the sector. In Alberta, field data from 1997 to 2000 showed that return flow expressed as a percentage of actual gross water diversion ranged from 7.2% to as high as 56.6% on individual irrigation districts. Significantly, in five of the six largest districts, average unit return flows were substantially higher than those assumed in establishing the 1991 provincial regulation license volumes.[64] The volumes of water involved in return flows can be very large and affect water allocation decisions. Return flow volumes from all southern Alberta irrigation districts consistently totaled around 600,000 cubic decameters per year between 1985 and 2000. Clearly, improved information from monitoring and measuring actual water use in irrigation and other sectors of the economy and society could provide an improved foundation for water allocation decisions. As Professor John Pomeroy, the Canada Research Chair in Water Resources and Climate Change, notes: *With appropriate planning, innovative water management and a strong scientific base informing decision making, Saskatchewan should be able to allocate and distribute its water effectively for economic development.*[65]

Irrigation expansion will increase the demands for irrigation water. Irrigation district water use since the 1970s has shown a steady and declining trend in water use per acre as irrigators have adopted improved water conservation and management practices. In the late 1960s at the start of major irrigation about 1.6 acre-feet of water was applied on a per acre basis. By 2007 this had fallen to below 0.8 acre feet-per acre. Water conservation and efficiency technologies in the form of pipelines, canal lining, pivot, self propulsion, low pressure and pivots with drop sprinkler tubes have all made major gains in water use efficiency (See Table 57). New irrigation districts developed later than the earlier districts incorporated many of these practices into their operations. Thus Luck Lake and Riverhurst Irrigation Districts show water use levels of about one half of the first irrigation districts in the Lake Diefenbaker area. Similarly, the conversion of federal irrigation projects in southwestern Saskatchewan from flood to pivot irrigation would be expected to lead to both water conservation and improved agricultural productivity.

Table 57 Irrigation Water Conservation Practices

Irrigation Practice System Type	**Water Use Efficiency Range**	**Average Efficiency**	**Gross Delivery***	**Water Saving***
Contour Flood	25% - 30%	30%	1000 mm	n.a.
Leveled Surface	40% - 65%	55%	545 mm	455 mm
Hand-Move	55% - 65%	60%	500 mm	45 mm
Wheel-Roll	60% - 70%	66%	455 mm	45 mm
High Nozzle Centre Pivot	70% - 75%	72%	415 mm	40 mm
Drop Tube Centre Pivot	75% - 85%	79%	380 mm	35 mm
Average	**25% - 85%**	**74%**	**405 mm**	**595 mm**
*Assumes an average net application of 33mm (12 inches)				
R.Hohm (2008)				

The new irrigation development areas can expect to incorporate the best water conservation technologies within their operations. This would suggest, for example, that the total irrigation water demands from the 600,000 existing and new irrigation acres around Lake Diefenbaker would require some 595,000 cubic decameters that could amount to about one fifth of the available water supply in a year of extreme drought and only 3% in a wet year. Future developments in water conservation involving pipelines, climatic and humidity controlled computer monitoring and further advanced in water application practices can be expected to further reduce water demands on a per acre basis. The shift from contour flood irrigation to more efficient centre pivot irrigation systems would show an average saving of 595 mm (23.4 inches) on the basis of a 300 mm (12 inch) application. Improved levels of irrigation application efficiency can, therefore, provide large water savings for application to expanded irrigated acres.

[64] Irrigation Water Management Committee Study Committee (2002a) p. 86.
[65] Pomeroy (2007) p.85.

Studies of water use efficiency in the southern Alberta irrigation districts have shown that the average water use efficiency rose from 34% in 1965 to 71% by 1999. These gains were made in part by the shift from surface to wheel move to pivot irrigation, but also by reducing losses from canal systems, recycling and returning waters and by improved information, management and monitoring of their water supply systems. Notably the studies found that regulatory standards for water allocation also required modification to meet the new water management realities. Thus, it was estimated that farmers were irrigating to meet, on average, about 84% of the water required to obtain optimal crop yields.[66] This was well below the provincial regulatory requirement for 100%.

A significant element in the reform of water rights lies in the improvement of information related to actual water use under the water right. Accurate, reliable and timely information are central to the efficient allocation of resources. That is, decisions on use are predicated upon accurate information. Commonly the designation of a right also carries an obligation to regularly report on the use of the right. Such information provides an ongoing information base for the development of effective and efficient policies with respect to water allocation.

A number of significant environmental concerns have traditionally been associated with water development projects. These have involved concerns over loss of habitat for fauna, flora and fish, an expansion of saline soils and the adverse effects of storage facilities. Saline soils are a naturally occurring feature of the prairies. It is true that soils with high levels of salts can reduce agricultural productivity by as much as 50%. It has been estimated that in the three Prairie Provinces saline soils with the potential to reduce agricultural productivity by 25% and were 0.65 million hectares in Alberta, 1.34 million hectares in Saskatchewan and .25 million hectares in Manitoba. Significantly, however, improved water management and application practices associated with modern irrigated agriculture are better able to address these problems than many of the old style flood irrigation approaches or even some traditional dryland farming practices.

The central issues for water development in the province are in reality founded around whether it is a choice between development or conservation, or perhaps more realistically development with conservation. The realities of global warming are markedly changing the basic nature of the environment as we have come to know it in Saskatchewan. Maintaining water flows for environmental and riparian reasons may require that we develop more water storage simply to meet the basic flow needs of our rivers, wetlands and lakes. The environment should no longer be seen as a barrier to irrigation development, but rather an essential beneficiary and component of a water management framework that includes expanded irrigation and water storage components.

Water Value and Allocation

Water use for irrigation must compete with other water demands in the economy, society and the environment, including the potable drinking requirements of the population, the demands from industry and power generation as well as the in-stream needs of the natural environment. Commonly, water is allocated between competing uses on the basis of the perceived value of the water to the economy and society. These can show large differences in the value of water depending on methods of estimation and the value within the sector. Water is not traded in the marketplace and thus estimates are made based upon willingness to pay principles contained in methods of non-market goods valuations. Recent estimates of some of these are shown below in Table 58.

Similarly, water for irrigation within agriculture also shows wide variations in value. In the United States, Resources for the Future made estimates in 1996 of the value of freshwater.[67]

[66] Pomeroy (2007) p.85.
[67] Frederick, K.D., VandenBerg, T., and Hanson, J., (1996)

Their study compared the values for withdrawal uses (domestic use, irrigation, industrial processing and thermoelectric power generation) and in-stream uses (hydro power, recreation/fish and wildlife, navigation and waste disposal). The study of nearly 500 water value estimates for each of the uses throughout the United States concluded that: *Nationally, withdrawal water uses, especially industrial processing and domestic, tend to have higher estimated values than instream uses. However, recreation/fish &wildlife habitat and irrigation which together account for nearly 80% of all the estimates, have the highest individual estimated water values. Water values tend to be higher in the drier, more water scarce areas of the country.*[68]

Table 58 - Value of Water in Irrigation and Other Alternative Uses

Type of Use	Author and Year	Valuation Method Used	Long-run Value of Water per dam³
Irrigation in Alberta	Samarawickrema and Kulshreshtha (2008a)	Gain in Producer surplus under irrigation over dryland	$17 to $25
Irrigation in Saskatchewan	Samarawickrema and Kulshreshtha (2008a)		$10 to $62
Drought Mitigation	Samarawickrema and Kulshreshtha (2008b)	Water production functions for a drought year over and above dryland	$41*
Livestock Production	Kulshreshtha (2006)	Cost of alternative source of water	$9.22
Residential	Bruneau (2004)	Willingness to Pay based on demand functions	$1,270 to $2,040
Commercial and Industrial	Bruneau (2004)	Willingness to Pay based on demand functions	$1,410 to $2,170
Industrial	Bruneau (2004)	Willingness to Pay based on demand functions	$80 to $49,000
Thermal Power Generation	Bruneau (2004)	Willingness to Pay based on demand functions	$1.27 to $627
Hydroelectric Power Generation	Bruneau (2004)	Willingness to Pay based on demand functions	$0.11 to $0.24
	Dybvig and Kulshreshtha (1989)	Cost of alternative technology (dry cooling)	$7 to $18
Recreation	Dybvig and Kulshreshtha (1989)	Travel cost method	$0 to $790

* Value during a drought year. No adjustment for the frequency of droughts has been made.

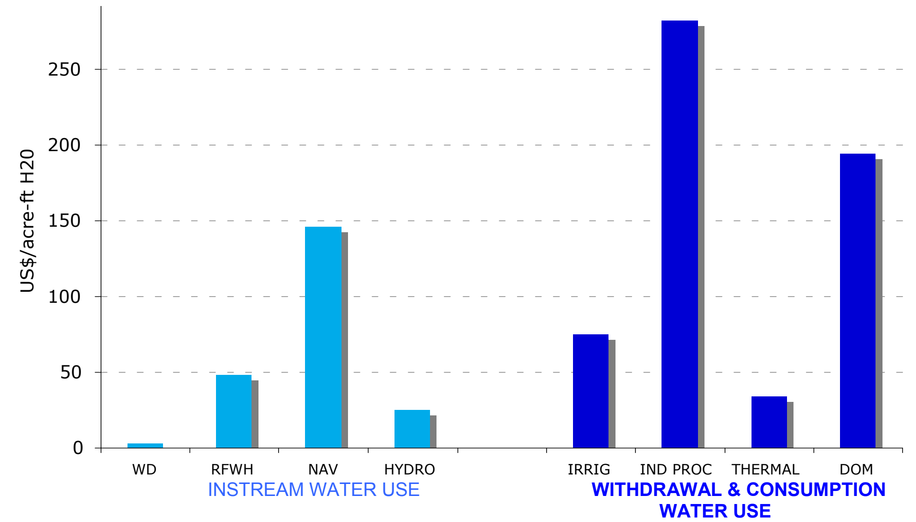
Figure 33 shows the results from the study for the average water values for major water uses by both instream and withdrawal uses. This identifies industrial processing as the highest value user followed by domestic uses, navigation and irrigation. Irrigation uses of water were identified as more valuable than the use of water for both hydro electric and thermo electric power generation uses.

Virtual Water High Value Irrigation Dependent Goods

Photo Credit

[68] Frederick et al(1996), p37.

Figure 33 National US Water Values by Use in US$/acre-foot of Water, 1996



LEGEND: WD= Waste Disposal; RFWH=Wildlife, Fish & Wildlife Habitat; NAV=Navigation; HYDRO= Hydropower; IRRIG= Irrigation; IND PROC= Industrial Processing; THERMAL= Thermoelectric Power; DOM= Domestic Uses

Source: Frederick et al. (1996), p9.

Table 59 - Estimated Water Values by Selected Field, Vegetable and Fruit Crops in US$s per Acre Foot, 1996

Crop	Value Per Acre Foot of Water in US$s		
	Average	Maximum	Minimum
Field Crops			
Barley	33	62	9
Hay	36	49	23
Alfalfa	51	173	18
Wheat	51	104	14
Safflower	53	69	26
Corn	91	134	44
Cotton	114	292	28
Soybeans	121	178	60
Sugar Beets	121	253	39
Vegetables			
Onions	40	40	40
Beans	58	72	44
Lettuce	208	208	208
Carrots	550	550	550
Tomatoes	686	686	686
Potatoes	710	1228	46
Fruits			
Melons	54	70	37
Pears	137	137	137
Apples	151	151	151
Source: Derived from Kendrick, et. al. (1996), p.32			

Irrigation is the largest consumer of water in the United States withdrawing 40% of all water withdrawn nationally and 77% in the seventeen western states. Irrigation water is valued most highly in the Lower Colorado and Pacific Northwest systems where water is valued in excess of US$1,000 per acre foot. Irrigation water values are highest when used for higher value crops and lower for grains and hay. Average water values for potatoes stood at US$710 per acre foot compared to a much lower US$33/acre foot for barley and US$51/acre foot for wheat. Irrigated water values commonly exceeded one hundred dollars when used for vegetables (Carrots - US$550/acre foot; tomatoes - US$686/acre foot, etc.) see Table 59.

It should also be noted that the very high values that were identified for industrial processing are also often directly related to irrigated agriculture through the food processing industries. This industrial processing sector showed an average value of $282/acre foot and ranged as high as $802/acre foot. These effectively increase the value of water for irrigation. Within these averages, however, that cover all major regions of the United States, there are very large variations.

The real value of water for irrigation should be estimated in its multifunctional context that recognizes the wider roles that water plays in the environment, society and economy. Thus to value water for irrigation solely on the basis of an increased crop yield, will exclude the value also created in value added food processing of the irrigated crop, the forward and backward linkages around the irrigation economy, the drought proofing agriculture, environmental contributions from irrigation storage for a watershed and their combined effects of regional economic development and transformation.

A precise definition of multifunctionality is not available, since it is usually defined in a local context. Giebe (2003) defines it to include food security, food safety, animal welfare, cultural landscape, biodiversity, and rural development. Groenfeldt (2006) has argued that value of water must be looked beyond food production and ecosystem services. In fact, he has argued for recognition of four categories of functions: (1) economic and productive, (2) environmental, (3) socio-cultural, and (4) rural development. Economic and productive functions feed into food security issues and as well provide the needed economic income to producers. The environmental value of water depends on its impact on the environment and the benefit to society. Some of these values may be negative, although many would seem positive. Bio-diversity, ecotourism, and habitat values are included among the positive values for water. Sociocultural and religious values of water are very location and culture specific. Aesthetics, landscape values, and cultural heritage values are typically recognized by the society.

Rural development values of water go beyond the production of food and non-food products. Forward-links between water users and other sectors of the economy create a plethora of economic activity, which would not be possible without use of water. Estimating the value of irrigation water in a multifunctional context is not simple. Conceptually it requires measuring: (1) The direct value of water in irrigation; (2) The value of water in drought mitigation; (3) The value of water in diversifying farm level activities; (4) The value created from forward-linkages; (5) The positive and negative environmental values of irrigation; (6) The socio-cultural value of irrigation water and its associated infrastructure.

When one compares the nominal value of water in non-irrigation water uses, municipal water use – residential, commercial, and industrial, all show higher values than irrigation. However, the amount of water used for these purposes is very small, and does not compete directly with irrigation water use. There is a direct trade-off between use of water for irrigation and hydroelectric power generation. However, the value of water in the latter use is relatively lower (less than one dollar one dam^3) than most other uses of water. However, water used for thermal electric power generation is relatively more valuable than in hydroelectric power generation. Irrigation regional water supply systems can also be power generators in their own right as they are in Alberta with Irrican Power – a generating utility created by three irrigation districts to harness the hydro power from their water supply systems.

Water allocations should therefore be based on uses that can generate the highest value streams for society, the economy and the environment. Comprehensive irrigation development that extends beyond the farm gate into value added production, municipal water supply and other energy generation, recreational and environmental uses can be shown to have such high value uses for a limited available water supply. Water value comparisons based upon these more extensive value chains associated with the multiple uses to which irrigated water storage and use makes possible places irrigation waters amongst the highest value uses of water.

The value of water in irrigation is founded on two key factors: the crop mix and the water volumes needed to irrigate. These factors are interlinked, since the nature of crop being irrigated determines the amount of water needed. However, water use for irrigation is also influenced by the changing technologies of water application, methods of delivery of water from source to farm gate (canals vs. pipelines), and return flow from irrigated lands. The estimated value of water is different across the province, in part, due to these two factors. Thus water value varies from $10 to $62 per dam^3 across the South Saskatchewan River basin. The value of water in Saskatchewan's Lake Diefenbaker Development Area was higher than for Alberta basins, partly resulting from a higher proportion of the area in Saskatchewan being devoted to specialty crops. The lower values of water were estimated for southwest Saskatchewan's small plot irrigation areas.[69]

In addition, during periods of drought, irrigation adds even more value to the farm business, protecting both farmers and society from the adverse impacts of the drought. The value for irrigation in a drought year is estimated at $41 per dam^3 for Alberta. If one takes into account a drought frequency of 15% over the past 50-year period, this value in the long-run is estimated at $6 per dam^3. Thus, in the South Saskatchewan River Basin, the value of water used for irrigation is $16 to $68 per dam^3, which is equivalent to the gain in producer surplus from the application of the water to crops. It must also be noted that irrigation also brings other benefits to society through associated economic linkages and other non-economic water uses.

Water rights systems in Saskatchewan and around the world have been established primarily in the context of rural agricultural economies. Increasingly reform of water rights systems is being undertaken in other jurisdictions to ensure that all water users (agricultural, ecological and non-agricultural) in both the economy and the environment have equitable access to water supplies. It is important to provide regulatory instruments to allow for the efficient reallocation of water use between multiple water users, particularly during times of drought and scarcity.

Infrastructure for Development

Beyond the essential water supply infrastructure required for irrigation development, both throughout the region and on the farm, there are other areas of infrastructure development normally associated with successful irrigation economies. The move from a dryland agricultural economy to a diversified irrigation economy places new demands on the overall economy and the society at large.

Economic Infrastructure

The transformation from a dryland export grain economy to a diversified irrigation economy will require an upgrade of the infrastructure for the new economy. Increased road traffic will move at primary weights and over longer distances to export markets across the Prairies and into North America. The lack of a commercial primary weights network of roads and bridges within irrigation areas has become a constraint on local movement and the attraction of processing activities. Efficient truckload weights for many irrigated or processed commodities commonly reach primary weight highway standards. A widespread and accessible network of primary weight secondary roads and bridges is therefore required to allow both farmers and processors access to competitive low cost truck transportation.

[69] Bruneau, J. (2004).

Power supply is essential infrastructure for irrigation economies, particularly for three pin service, often cited as a major constraint to opening up new areas to irrigation. This has not been available as a part of normal rural power service and has only been provided by SaskPower at rates that are prohibitive to the farmer for widespread irrigation use and application. It is possible that a higher volume of power demand through the increased acreage associated with the five projects might lower the cost of service provision. Alternatively, it is also possible that the design of the irrigation regional water works could incorporate power generation facilities to offer power to irrigators at the cost of production. In southern Alberta the Irrican Power Company is the third largest power utility in the province and is owned by three of the larger irrigation districts. SaskPower rates have been consistently removing subsidies for agricultural power and therefore increasing rates. Power costs are the major single cost of operation for Irrigation Districts and private irrigators. The constantly increasing power utility rates have, therefore, become a constraint to most forms of irrigation development.

Promotion and Marketing

Irrigation expansion and development will require promotion and marketing to both dryland farmers in the local area and to investors and prospective irrigators inside and outside of the province and even outside of Canada. In many respects, Saskatchewan's irrigation development potential has been a great secret. Yet the undeveloped irrigation acreage, secure supplies of water and strategic market location provides the foundation for what can become one of the largest concentrations of irrigation development in North America.

Promotion and marketing cannot be limited to the agricultural production elements of the value chain, but also directed toward each of the building blocks that create value from the on-farm irrigation investments.

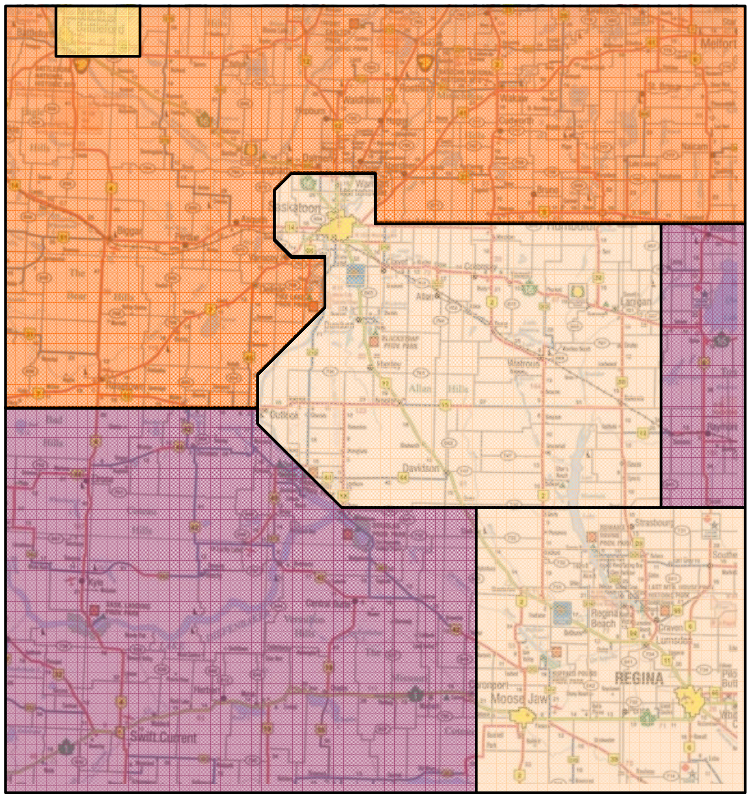
Saskatchewan irrigation lacks any detailed information base through websites at the local irrigation district level or the provincial SIPA level. This information is critical to attract new farmers to irrigation and to promote and market Irrigation Districts as processing centres. It is important to note that in the context of attracting investment for farm, irrigation and processing investment the information available from Saskatchewan sources competes directly with information developed for other irrigation areas in Alberta, Manitoba and in the United States. The absence of a developed and competitive information environment for SIPA, irrigation districts and the major processing communities within them, leaves the region at a locational disadvantage with other regions.

Demographic Foundations

Rural Saskatchewan is aging. The sustained out-migration from the farm, rural communities and the province has left a rural population pyramid that is no longer sustainable. The median age in most villages and towns around Lake Diefenbaker, for example, was 46 in 2006 and 25% of the total population was older than 65. The aging population with a declining employment base as agriculture restructures has also created a high dependency ratio between the working and the non-working population (Map 28) increasing the requirement for sustainable economic development opportunities in the area.

The aging population can also become a critical factor in making the changes required for a large scale irrigation economy that requires new agricultural practices, new investment and marketing. It is far less likely that an elderly population will wish to make these changes from dryland to irrigated agriculture than would a more youthful population.

Map 28 Old Age Dependency Ratios, in the Lake Diefenbaker Area, 2000



Legend % of Population over the Age of 65

Low (12.00% – 16.99%)	High (22.00% – 26.99%)
Medium (17.00% – 21.99%)	Very High (27.00% – 40.60%)

Source: Atlas of Canada, 2008.

Targeted immigration initiatives will be required and must be closely tied to the investment and development requirements of the area. There remains potential to attract offshore irrigation farmers from other areas in the Prairies, North America and Europe. Such immigrants will bring with them not only agronomic skills, but also market contacts and capital.

To be successful, however, immigration initiatives must target not only the incoming immigrant populations but also the existing provincial irrigation community that provides the social environment for the new irrigation farmers. New immigrants need to be welcomed and accepted.

The aging structure of Saskatchewan's farm ownership requires that these places change ownership, since any change in cultural practice at a late stage in life is unlikely. Both inter-generational transfer at home and purchase by new entrants will become a part of the new irrigation economy. These ownership transfers could be facilitated by immigration from other provinces and abroad, although provincial land ownership regulations and procedures have also been a deterrent to this occurring in any large scale. Many of the techniques developed at the turn of the 19th century to attract immigrants and investors to the west will have continued application in the 21st Century. These involved a much wider range of immigrant support services than has been the case in recent years.

Critical Mass

Saskatchewan's irrigated acreage is diverse. It is split between irrigation districts and private irrigators. It is further distributed across the province and throughout the Lake Diefenbaker region in a large number of often very small irrigation districts. This widespread fragmentation of irrigation acreage reduces the capacity of the industry to obtain economies of scale in many aspects of the irrigation value chain including the management of the water supply within irrigation districts, the purchase of equipment, the financing of development, the marketing of goods and the attraction of value added processers.

Irrigation development in provinces to the east and the west have had more success in developing irrigation from a base of larger irrigation districts and more concentrated irrigated acreage. Accordingly, the piecemeal development of the irrigation districts represents a start at expanding the irrigation acreage, but the full benefits of the large scale investments can only be fully realized with the full development of irrigation projects under larger irrigation districts and over a wider regional area, particularly to capture the full benefits of the larger irrigation value chain.

Science, Technology and Agronomy

Irrigation is increasingly paying more attention to science, technology and agronomy. Water conservation, cost management and other related best farm management practices require continued access to agricultural research and demonstration practices of governments, universities and research centres. These agencies were effective in building the province through the last century and will once again have continued and growing relevance to the coming century. They are part of the essential competitive economic infrastructure of a growing irrigation economy. Federal and provincial initiatives working in partnership with universities and irrigation farmers have created a solid foundation for this type of work at the Canada Saskatchewan Irrigation Diversification Centre at Outlook and the industry led Irrigation Crop Diversification Corporation. Major expansions of the irrigated acreage in the province will require the reach of these initiatives to extend into all regions of the province where new irrigation developments are underway.

The era of global warming will require new crop varieties and increased attention to water management, including the monitoring and measurement of water use at all stages of the irrigation value chain. Water conservation practices will be required to reduce losses to the atmosphere and to provide plants with optimal water supplies for growth. Effective water management practices will also reduce the irrigation demand for water. The movement from flood irrigation, to pivot to drop pivot to drip irrigation systems all reduce and conserve critical water supplies. The use of pipelines and covered canals can reduce water losses to the atmosphere. The continuous development and application of water saving and conservation technologies will be important to reduce irrigation water supply costs and to make the most of the available water.

Research, Information and Monitoring

Around the world, there is an increasing focus on the research capacities in water. New research institutes are being founded with the objective of applying resources to the resolution of water problems through pure and applied research. Information is central to the effective management of the province's water resources.

The amount of information available for water monitoring is steadily decreasing as the number of measurement sites is reduced and research funding declines. Information management through metered water is likely to become an essential requirement for effective water control in both a hydrological and an agronomic sense. In many respects irrigators have become essential sources of information for effective water management strategies in all regions of the province.

Global warming and the natural volatility of surface water flows in the Prairies are making reliable information increasingly valuable for water management in rivers and on the farm. The choice of crop is always heavily dependent on meeting its optimal moisture requirements. Even irrigated crops can incur significant pumping charges and reducing water requirements therefore results in financial savings to farmers. There are a growing number of agronomic forecasting systems directly related to water availability including the Crop Condition Assessment Program (CCAP) developed and maintained by Statistics Canada; the Drought Watch and National Land and Water Information Service (NLWIS) of Agriculture and AgriFood Canada and the National Agroclimate Information Service (NAIS) . These information systems rely on satellite imagery, geographic information systems and thematic small area data to make estimates of anticipated water and crop conditions. They become essential information requirements for irrigation district water conservation and management.

Reservoir and stream flow management are expected to become increasingly complicated as demands for a finite supply of water increase which the volatility in water supply continues. Improved information therefore will be a primary requirement to resolve conflicts in use.

Planning, Institutional and Financial Frameworks for Irrigation Development

The government planning frameworks for irrigation development in Saskatchewan can be best described as uncertain. There has been no long term planning framework in place that would match the long term nature of the irrigation developments. At the local level, the institutions in place to develop Saskatchewan waters for irrigation and the agricultural water value chain are both too small in size, capacity and scope to address the economic development requirements.

Irrigation districts in Saskatchewan are small and have not historically had the financial capacity to either development their water resources or to become economic development vehicles, nor did their legislation envisage them doing so. In Alberta, the Irrigation Districts are now major water management and promotional vehicles for the whole water based agricultural value added chain. Websites, financing, investments, marketing and management target a wider objective aimed at drought proofing, rural economic diversification, environmental protection and value added employment. Saskatchewan has not developed all of the critical elements that are central to successful regional development.

Since the 1960s, governments have made continuing change in their organizational responsibilities for irrigation. Federally, the Prairie Farm Rehabilitation Administration, the primary point of authority for federal support for irrigation became a part of Agriculture and AgriFood Canada and pursued a policy of divesting assets and programs to local or provincial authorities. Provincially, the responsibility for irrigation since the 1980s has regularly shifted, like a yo-yo, back and forth between the Departments of Agriculture, the Saskatchewan Water Corporation and the Saskatchewan Watershed Authority.

These government programming frameworks have been seen around the world as essential pre-requisites for the development of a successful irrigation economy. The Brace Centre noted in 2007 *"direct federal funding is viewed as important because the irrigation of private agricultural land initiates the development of a water based economy that provides jobs and wealth creation far beyond the farm gate. New markets and secondary agricultural industries, established because of a reliable supply of irrigated crops, sustain livelihoods in rural areas and improve the economic competitiveness of Canada's agricultural sector. All of these factors contribute to more economically vibrant rural communities." (Brace Centre, 2007, p.i)*

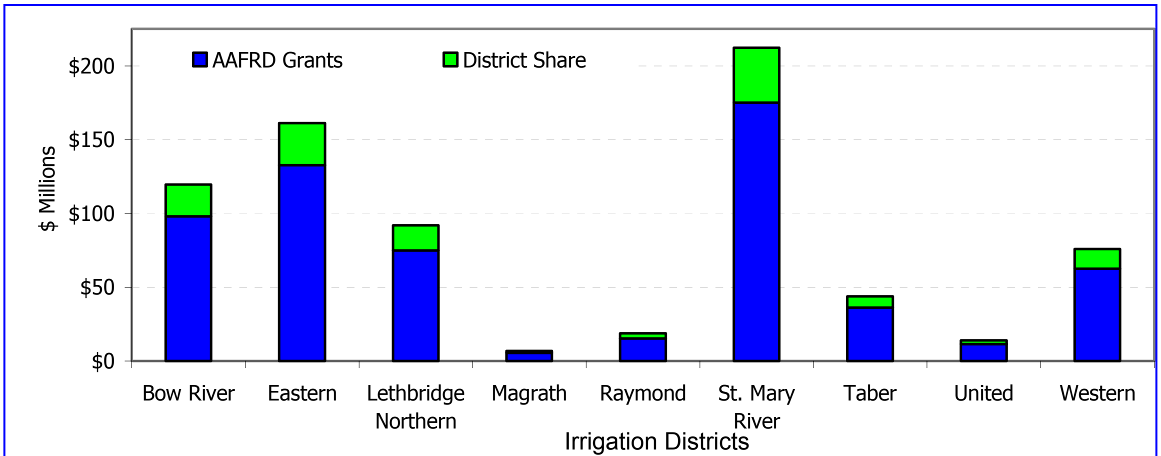
However, in Saskatchewan, as programs for irrigation have started and then stopped, the results on the ground have been predictable. The expansion of acreage following the completion of the Gardiner Dam was supported by irrigation funding for farmers. As governments changed the programs were stopped, started again and then stopped. The uncertainty created by this stop go practice of irrigation reduced farmer interest in investing in irrigation equipment and led governments to abandon major investments that had already been made in canals and other regional water infrastructures. Public monies invested in regional water supply infrastructure was not maintained, equipment deteriorated and in some cases the abandoned irrigation canals became environmental tragedies with trees rather than water lining the canals.

The water financing model in Saskatchewan has not been stable or consistent through the years. Water development for irrigation around Lake Diefenbaker was developed initially in the context of the South Saskatchewan River Project. Early initiatives provided on-farm assistance and built much of the regional water works. By the end of the 1970s these programs were no longer major priorities of the government. Entering into the 1980s, the government initiated development of the Luck Lake and Riverhurst Irrigation projects and once again both on-farm and off-farm programs were introduced as provincial programs. Federal/Provincial agreements for water development were entered into with the Subsidiary Agreement on Irrigation Based Economic Development (SIBED) as a ten year program that was followed in 1991 with the Canada Saskatchewan Partnership Agreement on Water Based Economic Development (PAWBED). However, in the 1990s the priority for provincial assistance to irrigation was reduced, and provincial funding steadily reduced through the decade. The cost shared financial contribution of these programs was small and has averaged less than $2 million a year over the last decade.

This level of financial support differs markedly from the experience in Alberta where since 1969, Alberta Agriculture Food and Rural Development (AAFRD) and Alberta Environment (AENV) have cost-shared with the districts the rehabilitation of infrastructure. As of May 2002, over 4,400 km of canals had been rehabilitated, representing about 59% of the district conveyance works. The benefits of the investments were seen in water conservation and increased irrigation. Grants for system rehabilitation in Alberta up to and including 1993/94 were under an 86:14 cost share ratio. This ratio recognized the wider economic and financial benefits received by the rest of society from the water investments. Until 1974/1975, costs were shared between AAFRD and the Irrigation Districts.

In 1974/1975, other grants from Federal-Provincial Agreement monies totalling $4.2 million were distributed for PFRA water charges ($149,000), the BRID operating fund ($1.9 million), and $2.1 million to all districts for system rehabilitation. Beginning in 1976/1977, the Alberta Heritage Savings Trust Fund (AHSTF) began providing grants under the same cost-sharing ratio. In 1994/1995, the cost-share ratio between AHSTF and the Irrigation Districts was revised to 80:20. Funding from the AHSTF ceased in 1994/1995. In 1994/1995, the Irrigation District Rehabilitation Endowment Fund (IDREF) contributed funds to the Irrigation Districts under a cost-sharing ratio of 86:14. Funding from the IDREF ceased in 1996/1997. Research grants were available between 1976/1977 to 1990/1991. Work on the infrastructure growth and improvement is continuing under the 1995 cost-sharing formula (75:25) with AAFRD. Collective grants since 1969/1970 total $619 million. Under the various cost-sharing formulas, the Irrigation Districts have contributed $134 million. Further, total research funds are $4.2 million. The current overall cost for the system rehabilitation program is $757 million. Figure 34 illustrates the total of cost-shared support for infrastructure rehabilitation between AAFRD and the Irrigation Districts. On average, grants have been administered proportionate to the expansion limits for each district. For instance, the three largest districts, St. Mary River Eastern, and Bow River have received 28%, 21% and 16% of the total grants, respectively.

Figure 34 Distribution of Irrigation System Rehabilitation Financing, Alberta 1969/70 – 2004/05



Source: Saskatchewan Agrivision Corporation Inc. (2004) p.177.

Financing has not been limited to the agricultural sector. For many years in Alberta, there has been a sustained focus to support the developments along the value added chain with a series of provincial and federal provincial programs of support for private sector investment and development. These included, for example, the Canada-Alberta Nutritive Processing Agreement in the 1970s and a continuing set of federal, provincial and federal-provincial programs since that date. Similarly, in Manitoba, government assistance programs have been critical in developing infrastructure in support of food processing investments. The first McCain french fry plant at Portage la Prairie was complemented by a federal Agricultural Rehabilitation and Assistance grant to upgrade the town's water supply and treatment plant. The continuity of funding is an essential pre-requisite for the development of effective development projects. The sustained cost sharing in Alberta has been a major factor in the growth of the agricultural irrigation and processing industry in the south of the province.

The financial requirements of the regional water supply elements of each of the projects identified in Saskatchewan involve a capital requirement of some $3 billion that stretches over a 20 year period and with benefits that extend well beyond that date. Assuming that this development took the form of a long term federal provincial agreement that was equally cost shared, irrigation development in the province would require an annual contribution from the federal and provincial governments of $75 Million each. In the past, governments have not been able to achieve this kind of long term funding that forms the basis for successful irrigation development strategies. Without investment in the major regional water supply systems, expanded irrigation will not become a reality.

Financing requirements are not limited to regional water supply systems. The planned restructuring of the economic infrastructure for regional economic development would increase financing requirements. Comprehensive irrigation development has in most jurisdictions required incentives for farmers to make the initial on farm investments in irrigation equipment, to attract and assist value added processors to the region and to improve infrastructure for municipal water supply and transportation and to promote irrigation development and investment for the area.

Commonly government irrigation incentive programs have assisted farmers with 50% of the capital cost of new irrigation farm investments. Assuming that nearly 600,000 new infill and expansion irrigated acres were brought into production over a forty year period and cost shared equally between federal and provincial governments this would require about five million dollars annually. On the basis of the cost benefit evaluations the returns to government would more than cover these investments from both the agricultural and the wider economies and their fiscal returns.

Alternative Financing Models

The irrigation financing model in Saskatchewan has also differed from Alberta in the financial strength of its local institutional framework to administer and manage the funds at the local level and the involvement of the private sector. Irrigation Districts and their representatives in the Alberta Irrigation Projects Association have both seen substantial financial support over the years. With stronger local institutions, the districts have become both active in economic development and in other related economic development activities, including the formation of the Irrican Power Company.

The development financing model pursued in Saskatchewan has been one of public sector direct action and investment, in contrast to creating an environment for private sector investment. Similarly, legislation governing the operation of Irrigation Districts has generally constrained their development to the narrow focus on their water infrastructure. New hydro development for any electricity to supply Saskatchewan is fully dependent on the SaskPower capital plan. Indeed, the very development of major water infrastructure through a Crown Corporation differs markedly from models for utility development that exist in other parts of the world.

Privately financed water utilities are common features of irrigation development and water management. Financing is always one of the greatest barriers to water development projects. The risk profile of water projects decreases over time as project approvals, environmental assessments, construction and start up risks are concluded. Water projects once in place are attractive investments for those looking for stable longer-term low-risk investments, a characteristic of Saskatchewan investors. Risks can be low on water projects and returns are generally fixed given that the projects have high income certainty through take or pay contracts and a monopoly over local water supplies while operating costs are fixed.

A variety of funding sources is usually required for water development projects of all forms, including seed capital funding, venture capital, equity financing and debt financing. The ability to secure project financing is heavily dependant upon investor expectations of revenue certainty, credibility and return. The uncertainty of public program and financing frameworks for water development has therefore contributed to the weakness of capital markets for water development investment in Saskatchewan. For water development projects to realize private funding sources will require long term take or pay water supply contracts with customers, affordability of water users in the region to meet take or pay commitment and security over long term access to the water. Build to Own Operate and Transfer (BOOT) or Public Private Partnerships (P3) models of development have been successful for infrastructure development around the world.

The ability to conclude these kinds of investments, however, is heavily dependant on the tax structure of a jurisdiction and the flexibility of the regulatory framework to accommodate the development. Thus, recent changes in electrical supply rules to allow the export of electricity and the supply of private electricity to SaskPower would facilitate the formation of a revenue stream for some water projects. However, the ability of the project to supply local irrigators with power from the project at preferential rates under current SaskPower supply rules remains unclear. Extending the electrical partnership model into water development would allow SaskWater and the Saskatchewan Watershed Authority to access a broader financing base for the rehabilitation and development of its water systems beyond currently approved levels. These approaches, however, represent significant departures from the practices of the past.

It is interesting to note that some of the earliest proposals for the South Saskatchewan River project anticipated the dam and its hydro electrical generating capacity being owned by the local farmers to provide low cost power as an incentive for irrigation, with the balance of the power being sold to SaskPower. This scenario did not materialize.

New financing instruments may also be required to build the capital market in Saskatchewan as they have been used elsewhere. In the early 1990s, Community Bonds provided a means of securing private investment with public guarantees. Cheaper than direct grants for infrastructure, they required that the eligible investments could generate a return and raised capital for value added processing activities. The structure of the legislation could easily be modified to accommodate much safer water utility investments. Similarly, Tax Incremental Financing (TIF) has been used in the United States to help finance distressed areas. TIF's have been authorized in forty-seven states, but used most frequently in California, Colorado, Florida, Wisconsin, Minnesota, Illinois and Indiana. Designated projects have their local tax streams based on the original assessment and the increases derived from the investment. The incremental tax stream is then assigned to a fund to help subsidise the development of the project. After all project costs have been recovered, the project reverts to a normal tax base. The TIF designation is used to attract capital into bond issues to finance the projects.

Photo Credit: Parsons

These constraints to irrigation development in Saskatchewan are all well known and have been repeated consistently in separate surveys and workshops for twenty years. The successful work that has been completed in developing irrigation research and demonstration, has not been accompanied by a supportive framework for the commercial or value added infrastructure.

Saskatchewan's experience with comprehensive irrigation development to create a water based agricultural value chain for the province has not been good. For better or worse, the system has not worked and the pace of rural revitalization has not kept up with other jurisdictions. Major reforms are required in the institutional framework for irrigation and value added development in the province. It is time to try new approaches.