ECONOMIC STUDY OF THE FEDERALLY DEVELOPED WATER SUPPLY SYSTEMS IN SOUTHWEST SASKATCHEWAN

WAYNE D. THOMPSON

2003

ECONOMIC STUDY OF THE FEDERALLY DEVELOPED WATER SUPPLY SYSTEMS IN SOUTHWEST SASKATCHEWAN

A Thesis Submitted to the College of Graduate Studies and Research

in Partial Fulfillment of the Requirements

for the Degree of Master in Science

in the Department of Agricultural Economics

University of Saskatchewan

Saskatoon

By

Wayne D. Thompson

In presenting this thesis in partial fulfillment of the requirements for a post graduate degree from the University of Saskatchewan, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis or, in their absence, by the Head of Department or the Dean of the College in which this work was done. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis.

Requests for permission to copy or to make use of material in this thesis in whole or part should be addressed to:

Head of Department Agricultural Economics
University of Saskatchewan
51 Campus Drive
Saskatoon, Saskatchewan.
S7N 5A8

ACKNOWLEDGMENTS

With sincere gratitude, I wish to thank Dr. Suren Kulshreshtha whose contribution was instrumental to this work. His guidance and counsel supported me through the challenges and difficulties which arose through out my studies. I also thank the other members of my committee, Bill Brown and Rose Olfert, as well as Larry St. Louis, for their time and assistance.

I would like to thank PFRA for their financial support for this study.

Unfortunately I am unable to adequately express my appreciation to the many kind and thoughtful people of the Department of Agricultural Economics. Throughout my graduate work, I have encountered many good friends who I will always remember for their support. Finally a big thank you to my family, natural and adopted, for their words of encouragement and support.

ABSTRACT

Thompson, Wayne D., M.Sc., University of Saskatchewan, Saskatoon, March, 2002.

Economic Study of the Federally Developed Water Supply Systems in Southwest Saskatchewan

Supervisor: S.N. Kulshreshtha.

In 1935 the Prairie Farm Rehabilitation Administration (PFRA)was created by the Canadian government. The purpose of the PFRA was to provide programs to parts of the Canadian Prairies to alleviate the result of years of drought and depression. One of the ways PFRA attempted to do this was the Water Development Program, a part of which involved the construction of a series of dams and associated irrigation works in southwest Saskatchewan.

Formulation of sound public policy requires that publicly funded programs are evaluated to determine social impacts of the program. Such was recommended by the Auditor General of Canada in 1986, asking for an evaluation of various PFRA programs, including the infrastructure developed in southwest Saskatchewan under the Water Development Program.

This study evaluated the PFRA infrastructure in southwest Saskatchewan using an input-output model. Using this model, the economic impacts on output (sales), GDP (market prices), income, and employment were determined. Since some of these impacts are felt by those that are not direct water users, some regional development benefits are

also created. Such benefits become the basis for estimating economic value of water for regional development. Regional development benefits were measured for three regions, 1)southwest Saskatchewan, 2) Province of Saskatchewan, and 3) the Prairie Provinces.

Since an input-output model specific to the southwest Saskatchewan region had not been built previous to this study, it was developed using the provincial transactions table, and non-survey technique of location quotient. Furthermore, since the major focus of the study was on agriculture, this sector was further disaggregated.

The data used in this study included information about PFRA activities, forage production using irrigation, cattle production, cattle slaughter and processing, drought mitigation, recreation, wildlife infrastructure, domestic water use, municipal water use and industrial water use, and flood control.

The economic activities resulted in a total economic output impact of $108.6 million in southwest Saskatchewan, $136.4 million in Saskatchewan and $367.1 million in the Prairie region. The results of the study show that cattle production has the largest contribution to the economic activity in southwest Saskatchewan caused by the southwest Saskatchewan water supply systems. The Prairie region benefits from the cattle feedlots related activities and slaughter and processing that occurs outside of southwest Saskatchewan.

Using the indirect and induced impacts of various activities, value of water for regional economic development was estimated for the three regions. The value of water for regional development for southwest Saskatchewan was estimated at $65 per dam^3 (cubic decameters) of water used. When all impacts on the province of Saskatchewan

were included, this value increased to \$111 per dam^3, extending various impacts of these projects on the Prairie provinces resulted in a value of \$394 per dam^3.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

The purpose of this study is to provide an economic analysis of the water supply systems developed by the Prairie Farm Rehabilitation Administration (PFRA) in southwest Saskatchewan for the year 2000. This was done by taking into account both water development and sourcing, as well as associated economic activities. The reason and objectives for this study are provided in this chapter.

1.1 Background

In April of 1935, the Parliament of Canada passed the Prairie Farm Rehabilitation Act. The act was enacted "to provide for the rehabilitation of the drought and soil drifting areas in the Provinces of Manitoba, Saskatchewan and Alberta", through the creation of the PFRA. In the immediate period following, PFRA introduced measures to carry out the "most economical utilization of the limited supply of soil moisture for crop production, the prevention of (soil) drifting, the reclamation of farmland, abandoned or otherwise, and to promote its most suitable use in either crop production or grazing" (Queen's Printer, 1985).

To achieve the purpose of the Act, the PFRA developed several programs. These

included community pastures, cultural activities[1] related to farming practices and water development. Part of the Water Development Program consisted of constructing a series of dams and associated conveyance infrastructure in southwest Saskatchewan.[2] The southwest Saskatchewan water supply systems was designed "to develop and promote within those areas systems of farm practice, tree culture, water supply, land utilization and land settlement that will afford greater economic security" (Queen's Printer, 1985). In the year 2000, the southwest Saskatchewan water supply systems supplied water that was used for a variety of purposes. These uses included irrigation for forage production, stock watering, recreation, wildlife habitat, and domestic, municipal and industrial consumption. The water supply systems also provide drought mitigation for cattle producers and flood control for a major urban center.

1.2 Need for Study

Undertaking of water development projects by PFRA can be defended on the grounds of market failure. According to Gramlich (1990) government intervention is appropriate if it is in the public interest. Musgrave and Musgrave (1980) divided government activities into those affecting allocation of resources, distribution of income, and stabilization of regional (or national) economies. Several situations, if present, could justify such

1 Cultural Activities consisted of finding ways to help farmers combat drought and soil drifting by adopting different cropping practices, regrassing or planting trees.

2 In this study the PFRA dams and related infrastructure will be referred to as the southwest Saskatchewan water supply systems.

intervention. Among these are the presence of public goods[3], externalities[4], or natural monopolies[5]. The government will likely interfere in a situation where the private sector is unable to develop a socially optimum allocation of resources. This may be because the private firms can not capture all the economic benefits and therefore will not recover the cost of the investment. Therefore, when government (or public) resources are used for a specific purpose it is expected that society at large will receive at least some of the benefits from the activity.

The southwest Saskatchewan water supply systems were built on the assumption of a market failure, caused in part by the presence of externalities, and in part due to production of public goods. Since the externalities created by such a system could not be captured by a private firm, use of public funds was required to achieve a social optimum. In addition, government involvement in constructing the southwest Saskatchewan water supply systems was also due to the large[6] size of the projects, considered to be too large to be constructed by individuals, municipalities or small communities (Dominion of Canada, 1937b).

When an investment is made using public funds, it is conventional to assess the social desirability of such activities. A part of this assessment involves economic appraisal of the project(s). This is reenforced by the 1986 report by the Auditor General of Canada (Supply and Services Canada, 1986) which stated:

---

3 Public goods are goods that no matter how much one consumes there is still enough for others. Furthermore, it is virtually impossible for one to be excluded from enjoying it.

4 An externality occurs when an action taken by one party affects other parties.

5 A natural monopoly occurs when only one firm can exist to supply the good or service.

6 This points to a situation where a natural monopoly would be able to survive.

> "PFRA has only partially determined and analyzed the benefits and costs of the program and not yet developed appropriate performance indicators. Current performance indicators address basic requirements such as number, type, location and value of contributions. As measures of efficiency and effectiveness, these need to be improved to provide managers with meaningful information on the manner and degree to which program objectives are being met." (Supply and Services Canada, 1986).

One of the original objectives of various PFRA programs, including development of water supply systems, was to bring economic security to the southwest Saskatchewan region. This may create new economic activities that would not otherwise exist without the development of the systems. These activities help the region in terms of further economic development.

A study of economic contributions made by the southwest Saskatchewan water supply systems has yet to be undertaken. Such a study would take into account economic impacts of the water sourcing and development, by all direct and related activities that are induced by the systems in the region.

A study of the type noted above is also warranted on another ground. In 1997, the Auditor General of Canada stated that "it was expected that the PFRA would have clearly defined strategies of cost recovery for services, based on user profiles and a pricing rationale" and " would have identified opportunities to generate revenue" (Supply and Services Canada, 1997). Such a cost recovery basis cannot be developed without the knowledge of economic activities associated with the southwest Saskatchewan water supply systems.

Past studies undertaken related to water activities have focused on the direct impacts

(Cicchetti, Smith and Carson, 1975; Cox, Grover and Siskin, 1971; and Howe, 1968). The study by Hamilton et al. (1991) discusses the role of forward linkages in creating indirect and induced impacts but does not determine these impacts. There have been several studies that do determine the economic impacts of a water activity, such as irrigation development (Findeis and Whitllesey, 1984), but there has not been a comprehensive study for a water supply system, particularly for southwest Saskatchewan.

The creation of economic security by the water supply systems may also give the water value in the context of regional economic development. According to Veeman (1985) "water and water projects may be important vehicles through which regional distribution of income and wealth within provinces may be altered" (pp. 48-49). However, as above, such a value has not been estimated for the southwest Saskatchewan water supply systems. The question remains whether the value of water for regional economic development created by regional household income and wealth is significant and should be considered.

1.3 Problematic Situation

Regional economic studies can be used to determine positive and negative impacts caused by a new economic activity. These results can be used to help determine public policy through prioritizing various programs using regional development as the major criteria. In order to undertake any prioritization exercise, decision makers must know, besides the objectives to be attained through undertaking projects, how a given project would fulfill the stated objective. In the context of the southwest Saskatchewan water supply systems, the stated objective, as envisioned under the PFRA Act, is to bring economic

security to southwest Saskatchewan. The major question, therefore, that needs to be answered is 'how does a water supply system contribute to the economic security of a region?'

Economic security of a region can be measured through changes in several attributes of a region. The most obvious ones would include (1) level of economic activity in the region, (2) change (positive) in the level of economic activity in the region, and (3) stability in the regional economic activities. The first attribute would require identification of activities that lead to creation of economic wealth in the region, and estimation of their contribution.

Typically, identification of economic activities related to a water supply system is limited to direct water uses. How appropriate is this in the context of regional economic security? Economic development of a region can be a result of direct water users as well as indirect users. An interesting question remains, 'should these indirect users be included in the context of regional security?' If the answer to this question is affirmative, a related issue is that of the process to identify them. Change in the level of economic development of a region and the measurement of variability requires a dynamic approach involving over time comparison/estimation of trends and fluctuations.

A related issue in the measurement of linkages between a water supply system and economic security is the delineation of the region of incidence. Although the water supply system may be physically situated in a given region, due to trade and related links, impacts related to economic activities could be realized in a much broader region.

If all direct and related economic activities in the water supply system regions are

included in the study of economic security, water is likely to have an economic value in activities beyond direct water activities. Is the value of water in indirect water use related activities a legitimate economic value?

The above discussion typifies a number of issues in the study of economic security as related to water resource development such as the federally developed southwest Saskatchewan water supply systems.

1.4 Objectives

Although a broad study of economic security enhancement resulting from the southwest Saskatchewan water supply systems would be desirable, this study is limited to the economic contributions of the southwest Saskatchewan water supply systems. In particular the specific objectives of the study are:

i) to determine the total economic impact of the southwest Saskatchewan water supply systems for southwest Saskatchewan, the province of Saskatchewan and the Prairie region.[7]

ii) to determine a value of water for regional economic development created by the southwest Saskatchewan water supply systems for each region.

1.5 Scope of Study

The period of this study is limited to the year 2000. Although a study from the initial period, since the projects were constructed, would have been desirable, it was considered

[7] The regions and why they were chosen is discussed in Section 5.3.

beyond the scope of this study. In this study all water supply system infrastructure and associated activities are included. The associated activities include various water users in the region as well as all economic activities induced by the water supply systems.

1.6 Organization

The rest of the report is presented in five chapters. Chapter Two gives the relevant background about the region. Chapter Three provides a review of the literature related to economic impacts and economic valuation. In the fourth chapter a review of relevant economic theory, in particular as it is related to economic impact models and economic value, is provided. The fifth chapter explains the analytical framework and study methodology and in Chapter Six is followed by the results for economic impacts and economic value of water for regional development for the regions. In conclusion Chapter Seven contains the summary, conclusions and areas for further research.

CHAPTER TWO

BACKGROUND

The water supply systems that are the focus of this study are located in southwest Saskatchewan. There are many activities associated with the southwest Saskatchewan water supply systems. The region and activities are described in this chapter.

2.1 Geographic Definition of Southwest Saskatchewan Region

The southwest Saskatchewan region, in this study, is defined as the area that houses all the water supply systems developed by the PFRA. This area is bounded by the Alberta-Saskatchewan border to the west, the Montana-Saskatchewan border to the south, the 106° longitude line to the east, and a general line along the South Saskatchewan River to the north. The major water ways in the area are Battle Creek, Frenchman River, Wood River and Swift Current Creek. The Battle Creek and the Frenchman River both flow south into the United States, while the Wood River flows northeasterly into Old Wives Lake, and the Swift Current Creek flows north into the South Saskatchewan River. All of these waterways get their water supply from the spring snow melt or small tributaries fed by natural springs. Figure 2.1 shows the southwest Saskatchewan region of this study.

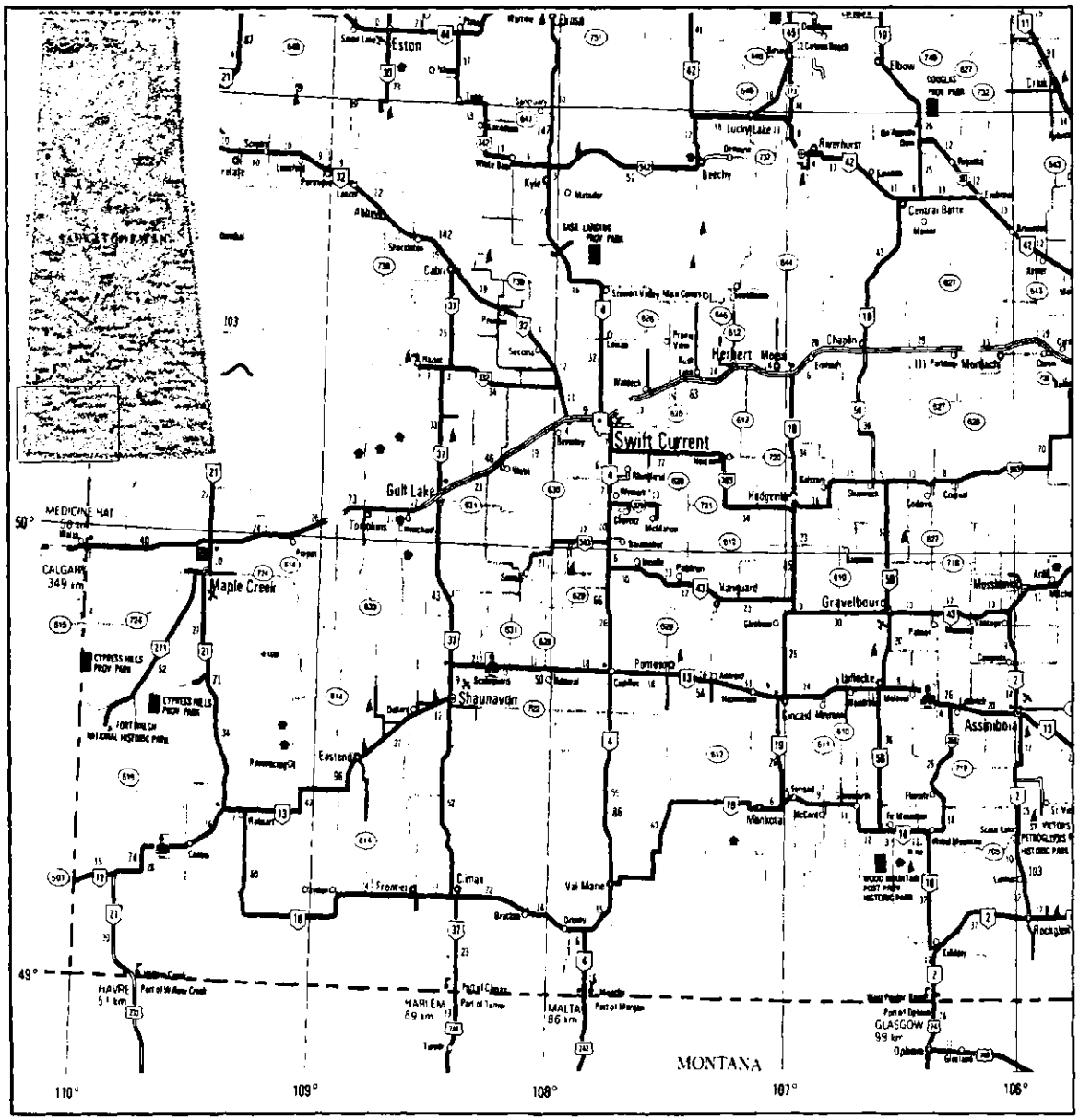


Figure 2.1 Southwest Saskatchewan Region

2.2 PFRA Water Development Program

The drought that occurred in the Palliser Triangle during the 1930's had a devastating effect on agriculture. The crop failures of 1933 to 1938 had a severe negative impact on the producers in southwest Saskatchewan. As noted in Chapter 1, the response by the federal

government to the situation was the establishment of the PFRA, which began to develop the water supply systems.

The Water Development Program was made up of three sizes of water development projects to provide water to various users. These included individual projects, small community and municipal projects, and large water supply projects. The individual projects were made up of dugout, stock watering dams and irrigation works for a single producer. The small community and municipal projects consisted of projects that provided a second source of water if the individual projects were to run dry. The large projects were to "provide the facilities to distribute water for irrigation to very considerable tracts of land, or to store large quantities of the spring run-off, which would otherwise run to waste, and thus supplement the normal stream flow for irrigation, domestic supplies and other purposes" (Dominion of Canada, 1937a). These large dam and irrigation projects are inter-connected and are operated as five separate water supply systems in the region.

2.3 Southwest Saskatchewan Water Supply Systems

The infrastructure built for the southwest Saskatchewan water supply systems included hundreds of small dams and other small scale structures[1], in addition to 26 major dams and canal infrastructure for irrigation. Of these 26 dams originally constructed by the PFRA, in 2000, only 22 of them are operated and maintained by the PFRA, while the other

1 These structures were subsequently transferred to producers.

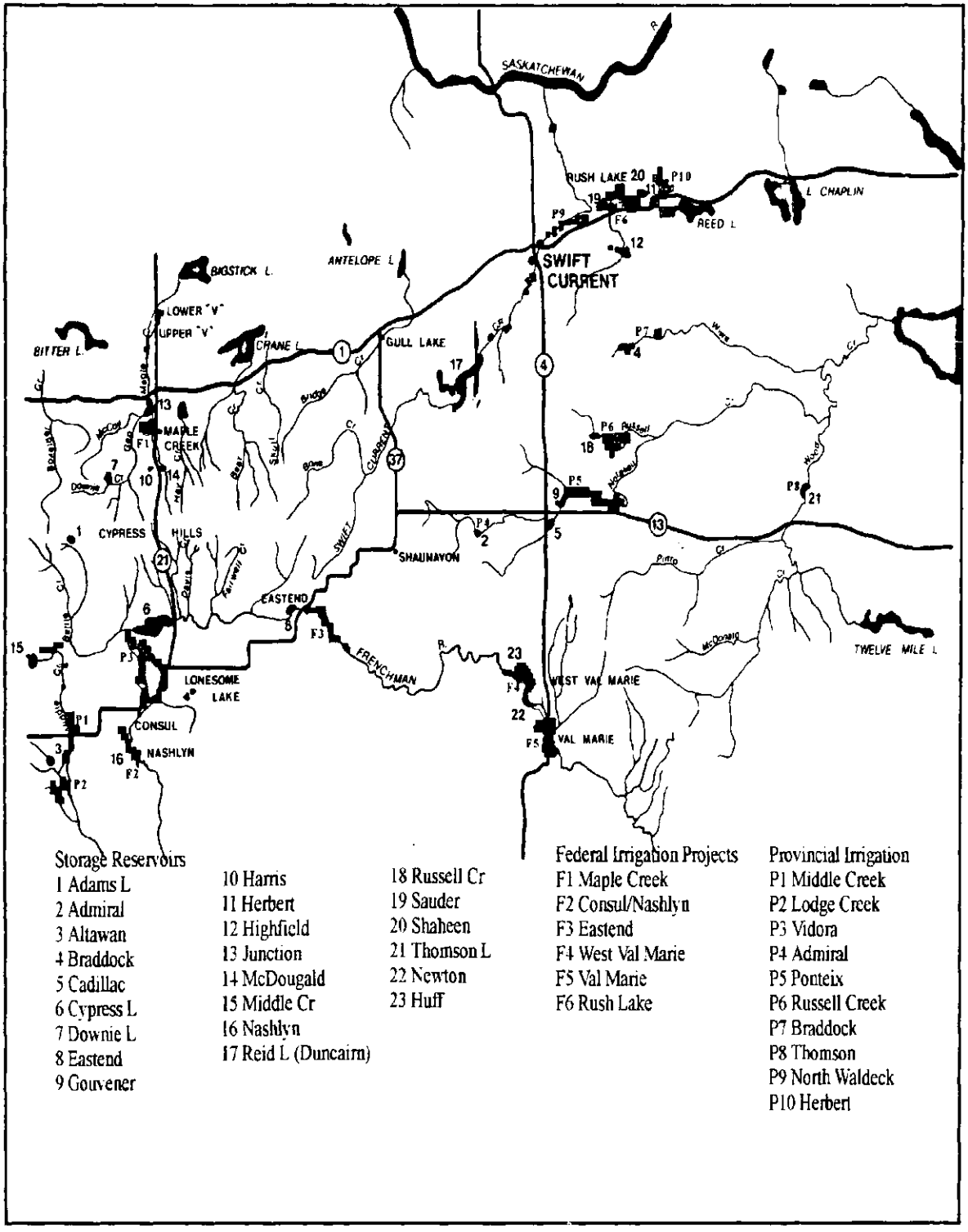
four have been transferred to the Provincial authorities[2] or other groups. The 22 major dams operated by the PFRA in 2000 are listed in Table A.1 (Appendix A). There are six PFRA irrigation projects (22,133 acres) and ten provincial projects (11,877 acres) along with 42,021 acres of private irrigation associated with the water supply system totaling 75,231 acres in the year 2000. The PFRA and provincial projects are shown in Table A.2 and Table A.3 (Appendix A). Figure 2.2 shows the location of the dams and irrigation projects in the region.

2.4 Socio-Economic Description of Southwest Saskatchewan Region

In the 1930's, southwest Saskatchewan, along with much of the Prairies, was going though a severe drought. The drought caused consecutive years of crop failure and the lack of moisture had resulted in soil drifting. The end result was a disaster for agriculture in the region. Since agriculture was the basis for the southwest Saskatchewan economy at the time, the result was a shrinking economy with serious consequences for the people of the region. One of the indicators was the movement of people out of the region during the 1930's, as shown in Figure 2.3. The population of the region for census years since 1936 can be seen in Figure 2.3 with a split between town and rural municipalities shown.

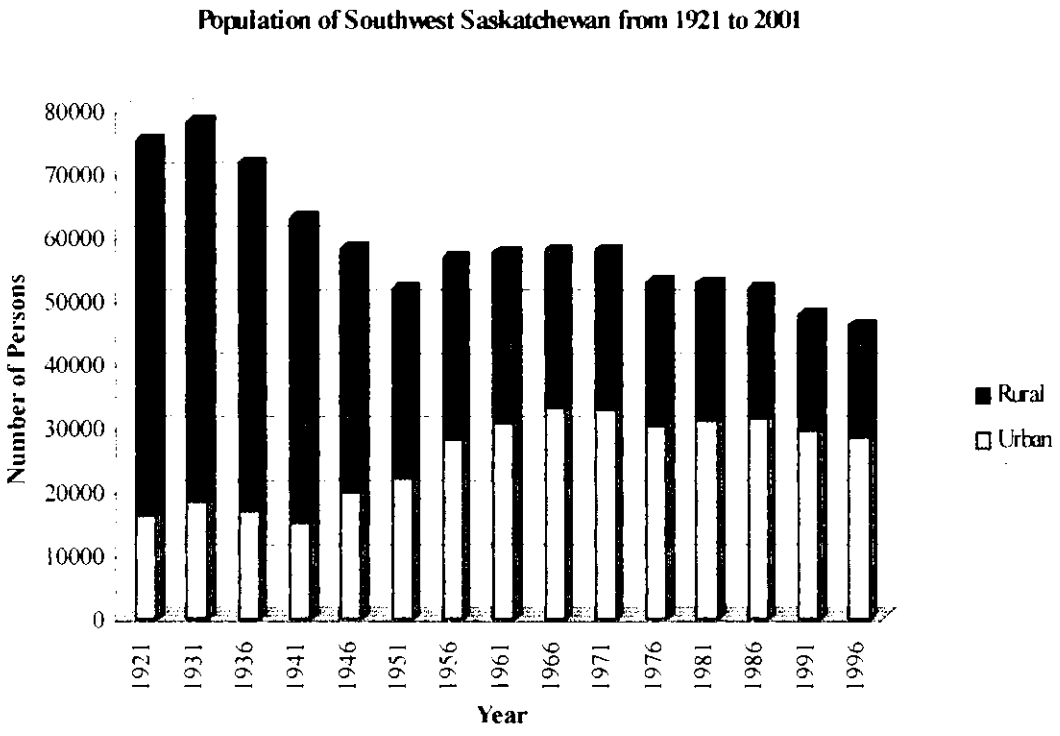
Even in 1996 the major source of employment in the region was agriculture. Other industries in the region are important in terms of employment but are small compared to the

2 Some provincial projects are supplied from the PFRA owned and operated structures. These are not included here.



Source: PFRA, (undated)

Figure 2.2 Southwest Saskatchewan Dams and Irrigation Projects



Source: Statistics Canada, (various census years)
Figure 2.3 Population of Southwest Saskatchewan by Urban Rural Split

agriculture industry (Table 2.1).

The major center of the region for several decades has been the city of Swift Current. The city of Swift Current was established in 1880. There are several other towns in the region. These towns include Eastend, established in 1895, Maple Creek, in existence since 1883, Shaunavon, incorporated as a village in 1913, Gravelbourg, founded in 1906, Lafleche, incorporated in 1911, and Gull Lake, which was incorporated in 1908. In addition to the towns, there are several villages in the region, including Val Marie, Consul, Vanguard, and Herbert.

Table 2.1 Employment by Industry in Southwest Saskatchewan for 1996

Industry	Number of Employees
Agriculture and Related Services	8,305
Fishing and Trapping	0
Forestry	10
Mining, Quarrying, and Oil Wells	655
Manufacturing	765
Construction	790
Transportation and Storage	890
Communications and Other Utilities	525
Wholesale Trade	1,320
Retail	2,365
Finance and Insurance Services	665
Real Estate Services	215
Business Services	415
Government Services	835
Educational Services	1,470
Health and Social Services	2,200
Accommodation, Food and Beverage	1,340
Other Services	1,050
Total	32,950

Source: Statistics Canada, 2001

2.5 Water Use in Southwest Saskatchewan

The water stored and supplied by the southwest Saskatchewan water supply systems in the year 2000 has several consumptive uses. Table 2.2 shows the uses and the relative distribution for the year 2000. As shown here irrigation is the biggest withdrawal use of the

water. International apportionment is the amount of water that flows into the United States based on the agreement with the United States.

Table 2.2 Distribution of Water Intake in Southwest Saskatchewan, by Use

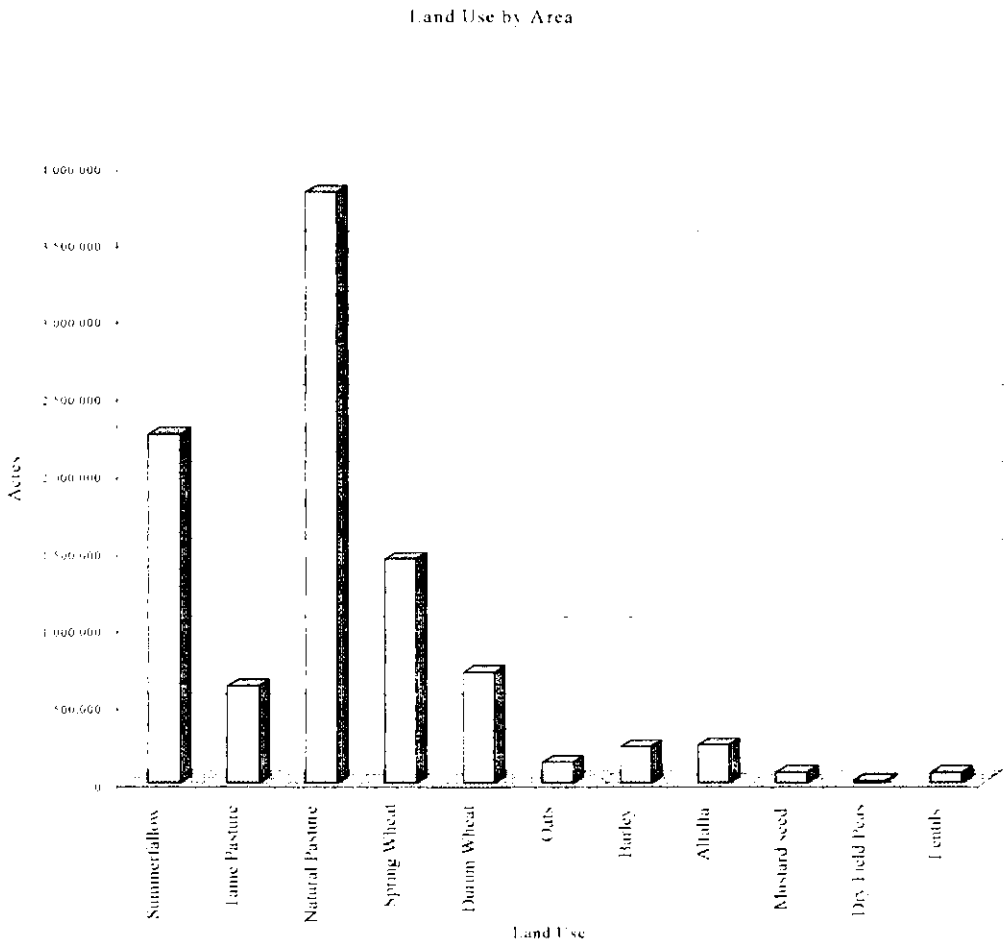
Water Use	Amount of Water (dam^3)
Irrigation	147,184
Domestic	10,164
Municipal	5,516
Industrial	7,632
Other	4,078
Total in Region	174,574
International Apportionment	174,574
Total	336,826

Source: PFRA, special tabulation

2.6 Agricultural Practices in Southwest Saskatchewan

Southwest Saskatchewan is dominated by the Brown soil zone with an area of Dark Brown soil south of Swift Current. The dominant cropping practice is half summer fallow and half cropped area. The dryland crops grown in the region have expanded from cereals, such as wheat and barley in the 1930's, to wheat, durum wheat, barley, oats, chick peas, lentils, canola, and a small area of other crops. The irrigated land is used exclusively for forage production, which is either brome grass or alfalfa. There are a small number of irrigated acres used to grow other crops, although this is usually on a trial basis possibly for research or is used as green feed for cattle. Figure 2.4 shows the various uses of agricultural

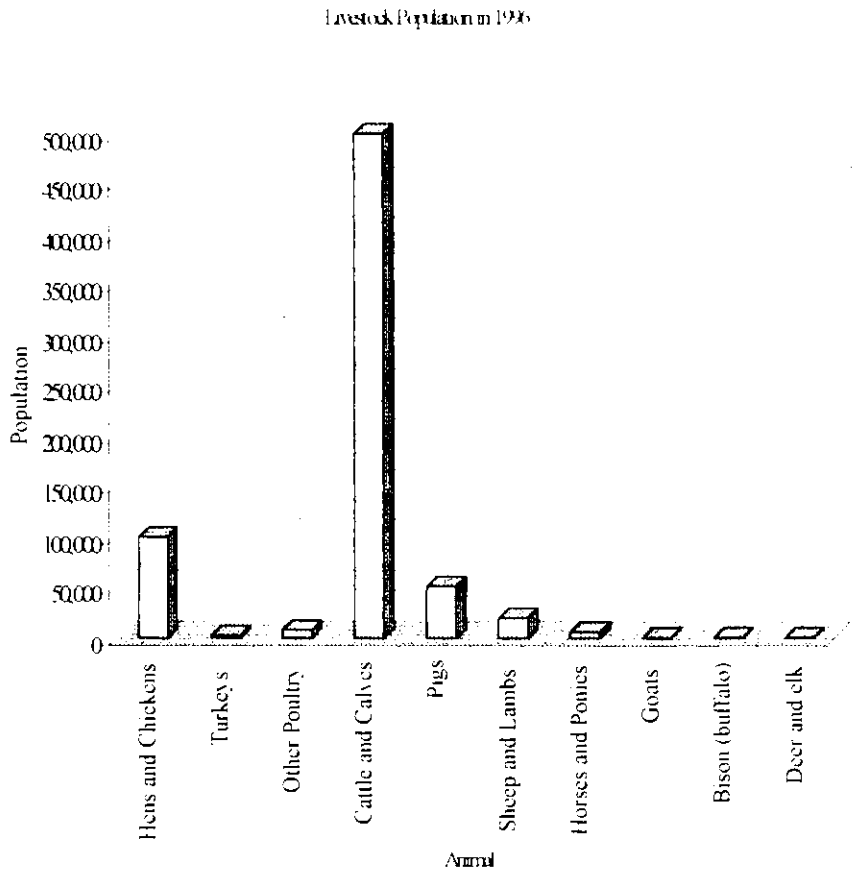
land by area in southwest Saskatchewan. Figure 2.4 shows that there are over 4 million acres of natural and tame pasture in southwest Saskatchewan and wheats are the next major crop in the region.



Source: Statistics Canada, 2001
Figure 2.4 Agricultural Land Use in Southwest Saskatchewan in 1996

Cattle production is extensive in southwest Saskatchewan. There were 499,438 head of cattle on farms in southwest Saskatchewan in 1996. As can be seen in Figure 2.5, cattle production in southwest Saskatchewan is the single largest enterprise in terms of the

number of animals on farms.



Source: Statistics Canada, 2001
Figure 2.5 Livestock Population in Southwest Saskatchewan in 1996

2.7 Economic Activities Associated with the Southwest Saskatchewan Water Supply Systems

There are several economic activities that are associated with the southwest Saskatchewan water supply systems. These activities include PFRA operations, irrigation, cattle production, cattle slaughter and processing, drought mitigation, recreation, wildlife,

domestic water use, municipal water use, industrial water use, and flood control. Each of these is described below.

2.7.1 PFRA Operations

PFRA owns and operates 22 dams that store water for activities associated with the water supply systems. This includes operations and maintenance of the dams and canal structures used to move water to the associated irrigation.[3]

2.7.2 Irrigation

Irrigation is the largest water user of the southwest Saskatchewan water supply systems. There are three distinct groups that manage irrigation in the region: the PFRA management, provincial water user district management, and individual private management. The PFRA manages six irrigation projects, the provincial water user districts

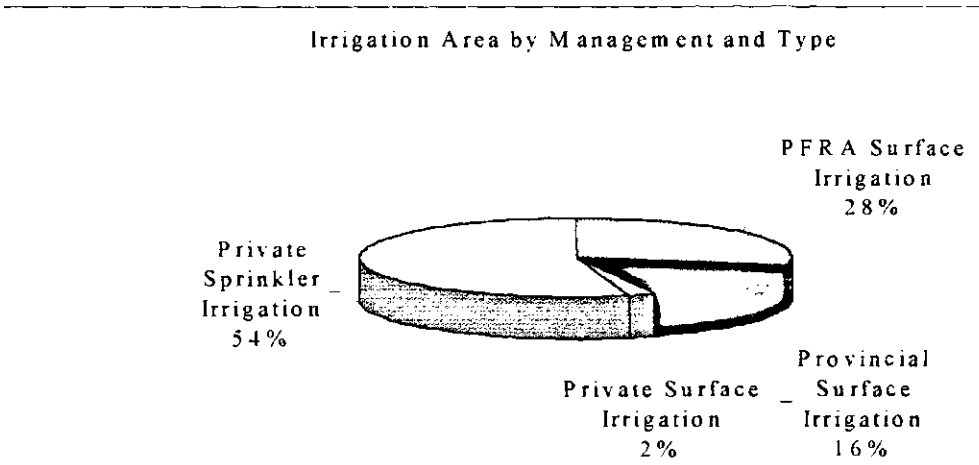


Figure 2.6 Share of Irrigation Area by Management and Type

[3] In some years, the PFRA has also spent money on rehabilitation of various structures.

operate ten irrigation projects and the remaining area is managed by individual private irrigators. The total area of these projects is 75,231 acres. Figure 2.6 shows the share of irrigation area by management and type.

2.7.3 Cattle Production

Although not a large direct user of water, cattle production is linked to irrigation water use in the region . This is because the forage produced by the irrigators is used by cattle producers. In this study the forage irrigators and cattle producers are considered to be one and the same producer. Although the number of cattle on irrigated farms is not known, as explained in Section 5.7.3, the irrigated forage production would support an estimated average of 74,066 head of cattle.

2.7.4 Cattle Slaughter and Processing

Cattle slaughter and processing does not use water from the southwest Saskatchewan water supply systems but is a result of the cattle production induced by irrigated forage production. The additional cattle which are produced have an impact on cattle slaughter and processing in southwest Saskatchewan. In southwest Saskatchewan the cattle slaughter and processing is reported to take place at small local abattoirs. There may also be additional cattle slaughter and processing outside the region because of the additional feeder calf supply from the region.[4] This cattle slaughter and processing is said to take place in

4 This cattle slaughter and processing was said to take place in slaughter and packing plants outside of southwest Saskatchewan.

slaughter and packing plants in Saskatchewan and Alberta.

2.7.5 Domestic Water Use

The domestic water use data pertains to the households in the rural area of the study region. Major sources of water for this use consists of groundwater wells and off-stream storage. The total domestic water use per year from the southwest Saskatchewan water supply systems is 10,164 dam^3 (cubic decameters).

2.7.6 Municipal Water Use

Before the southwest Saskatchewan water supply systems existed, various urban centers relied on groundwater or surface run-off for their water supply. When the PFRA developed the water supply systems, some of these communities started to source their water supply from the nearest PFRA reservoir. In the year 2000, the city of Swift Current sources water from Reid Lake created by Duncarin Dam; Eastend which withdraws water from the Eastend reservoir; Gravelbourg and Lafleche both source their water from Thomson Lake, and Herbert sources water indirectly out of Reid Lake and the Highfield reservoir. According to PFRA data the total municipal use is 5,516 dam^3 per year.

2.7.7 Industrial Water Use

The only industrial user of water in the study region is the Saskatchewan Mineral Sodium Sulphate Mine located at the village of Chaplin on Lake Chaplin. The mine uses water to dissolve sodium sulfate into solution. From the solution, sodium sulfate is extracted

for sale. The mine relies on precipitation and surface water. The mine diverts water from the Wood River down Chaplin Creek to the mine area. The diversion is just upriver of Old Wives Lake and the Ducks Unlimited Delta Project. The mine diverted a total of 7,632 dam^3 of water in the year 2000 out of the Wood River. This water mostly comes from spring runoff from the Wood River basin.

2.7.8 Recreation

One of the non-consumptive uses of water in the region is recreation. When the southwest Saskatchewan water supply systems was first constructed, recreation was not a factor considered in its development. However in the year 2000 recreation has become a very common use of the reservoirs in the water supply systems. These reservoirs are used for water activities such as fishing, swimming and boating. Most of the reservoirs do not have any associated recreation facilities. The one exception to this lack of developed recreation infrastructure is the Thomson Lake Regional Park near Lafleche. The Thomson Lake Regional Park uses water from Thomson Lake to maintain its facilities. The facilities here include cottages, camping sites, a golf course, and a swimming pool. The only other developed recreation area is at Lac Pelltier south of Swift Current; however Lac Pelltier does not rely on the southwest Saskatchewan water supply systems.

2.7.9 Wildlife

Another non-consumptive use of water from the southwest Saskatchewan water supply systems is wildlife activity. The wildlife activity here consists of wildlife habitat.

The expenditures on wildlife habitat associated with the southwest Saskatchewan water supply systems are through Ducks Unlimited who create and maintain waterfowl habitat. Ducks Unlimited also operate and maintain one of the dams built by PFRA that were turned over to this organization.

2.7.10 Drought Mitigation

Drought mitigation does not create a direct impact. It adds to the value of water for regional development through economic security. This is done by having a more stable forage production under irrigation. This results in a more stable level of cattle production relative to a dryland situation. Without the southwest Saskatchewan water supply systems cattle producers would need to follow dryland forage production practices.

2.7.11 Flood Control

Another benefit from the southwest Saskatchewan water supply systems is through the operation of dams for flood control for area(s) downstream of the dams. In southwest Saskatchewan, Duncarin Dam provides flood control for the city of Swift Current. The other urban centers in the region do not receive any measurable flood protection from upstream dams. There is also a potential for rural flood protection for agricultural land, but on account of flexibility on farms, benefits are almost negligible.

2.8 Summary

The southwest Saskatchewan region for this study is a very specific region based on

a set of rural municipalities. Within this region there are several economic activities such as agriculture and mining. The PFRA developed water supply systems in the region around which several activities that were planned and unplanned have occurred. These activities include: PFRA operations, irrigation, cattle production, cattle slaughter and processing, domestic water use, municipal water use, industrial water use, recreation, wildlife, drought mitigation, and flood control.

CHAPTER THREE

REVIEW OF RELEVANT ECONOMIC LITERATURE

The literature on regional economic development and value of water is discussed in this chapter.

3.1 Theory of Regional Development

Neoclassical economics explains the functioning of a simple and homogenous economy. It assumes that all economic transactions occur with full information and within one location. In other words, the notion of space is ignored. Siebert (1969) defined regional economics to be "the study of man's economic behavior in space." This translates into studying a region using the neoclassical economic theory framework but relaxing the assumption of a single location.

Consideration of space explicitly has it's roots in the work of Von Thünen, Launhardt, Weber, and Palander and their ideas for location theory according to Nijkamp (1986). The work of these economists has established that location should not be ignored, but should be incorporated into neoclassical economic theory. There are several reasons that a region may develop or decay. These reasons include economics, social and political. For each of these reasons there may be several factors that affect regional development. The

factors that may have an impact on regional development include location (Lee and Zang, 1998), labor or available natural resources (Howe, 1968).

Much of the literature related to the economy of a region is very recent, dating back only to the late 1940's (Isard, 1975). Prior to the 1940's the economic region usually considered was a nation or possibly a smaller region but using data from the national level. Regional economic studies can be used to determine the positive and negative impacts caused by a new economic activity. Various modeling approaches to study a region include economic base methods, gravity-type models, shift-share analysis, econometric models, input-output models, and programming models.

Input-output models are based on the General Equilibrium theory proposed by Walras in 1874. Walras said "that the maximizing behavior of consumers and producers, can and under certain conditions, will result in an equilibrium between amounts demanded and supplied in every product and factor of the economy" (Blaug, 1992). The idea of General Equilibrium is important in analyzing the transactions of an economy. If General Equilibrium was not assumed then the transactions between sectors of the economy would not reach a point of equilibrium and any economic leakages would not equal zero.

From the idea for general equilibrium by Walras that all transactions in an economy are related, the next step was to quantify these transactions. This initial work was done by Leontief in the early 20th century and culminated with the publishing of the transactions tables for the 1919 and 1929 United States economy in 1936. The Leontief transaction tables separated the economy into several industrial and commodity sectors. The economic transactions between these industries for various commodities showed the trade that

occurred in that commodity. The next step from the transaction tables was to develop the input-output model for the economy. The purpose of the input-output model was to show the impact of an economic transaction on the economy. The first work by Leontief was at the national level. Regional economic modeling for regions smaller than the nation did not become firmly established until the late 1940's (Isard, 1975). The reason for this was that creating a national transaction table and input-output model was very data intensive and time consuming. Therefore, regional models were not a priority. As the data sets became better and computing technology improved, the transaction tables and input-output models for smaller economic regions were developed.

Any of these models can be used to analyze the impacts of an activity on a region. Furthermore, determination of regional development caused by an activity can be made using alternate indicators. There are several economic indicators that could be used to determine the impact on regional development. These include household income, employment, GDP, total output, population, or environmental factors. The indicators are generally selected on the basis of the activity being analyzed and the purpose of the study.

3.2 Role of Water Resources in Regional Development

One of the earlier studies on water resource project evaluation is reported by Howe (1968). Howe's study looked at the impact of natural waterways on regional development in the United States. Howe stated that water availability is dependent on location, quantity, quality, reliability, cost and legal status. These factors may affect the ability of a region to develop and grow. Howe's final conclusion for water and regional development is that

"water did not constitute a bottleneck to rapid economic growth in the water deficit areas". Cox, Grover, and Siskin (1971) expanded Howe's study by looking at "water resource development projects on economic growth in small regions." The Cox et. al. study looked at the impact of large multipurpose projects built in the northeastern United States between 1948 and 1958. The authors came to the conclusion that it could not be proven that water resource projects helped a rural area to grow economically. Cicchetti, Smith, and Carson (1975) expanded the literature further. The Cicchetti et. al paper started by pointing out the debate about the contribution of water resources to regional development. The paper studied the water resource projects built by the United States Bureau of Reclamation from 1930 to 1970.

Economic impact assessment of a new activity in a region has now developed into a full-fledged area of analysis. Such analysis have been reported for establishment of new processing plants such as a corn processing plant in North Dakota by Leistritz (1997) and for energy development (Leitstritz et al., 1981). Other applications have included irrigation development (Kulshreshtha and Grant, 2002), drought proofing and export activity (Gould and Kulshreshtha,1985). Analysis for water projects and irrigation in particular has also been carried out by Hamilton and Gardner (1986). These studies have considered the impact of a new activity on various factors of the economy.

One of the water projects that has been analyzed with the objective of measuring its impact on regional economic development is the Tennessee Valley Authority (TVA) by Moore (1967). The TVA created regional economic development through the creation of hydro-electricity (Moore, 1967). Regional development occurs when an activity in a region

induces new activity or expanded activity that otherwise would not have occurred. In the case of water projects, if the water project creates regional development there would be an economic value of water for regional economic development.

From these studies any one conclusion is not clear. Water resource projects have been shown to have an economic impact on a region. Yet the factor which creates the economic impact has not been clearly shown. The studies do not answer the question(s) about whether the direct impacts or indirect and induced impacts are more significant and should the indirect and induced impacts be ignored in a study of this type?

3.3 Establishing the Value of Water for Regional Development

The value of any resource is created by the limited availability or scarcity of the resource relative to demand. If a resource was endless in supply, its value would be zero as no one would be willing to pay for such a resource. However most resources that we use are limited in their supply, if not globally, at least locally. Water is a good example of a limited resource in the local context. Although water can be transported from one region to augment the supply in the importing region, it is often possible only at a great cost. Another characteristic of water is that it has many uses. Depending on which use water is allocated to, it has an opportunity cost. An opportunity cost is the cost of forgone alternative uses.

The value of the water for different uses can be compared to determine if the water is being used in it's *pareto optimal* economic use. If it is not a *pareto optimal* economic use, there is an opportunity cost of using the water in the lower value activity.

In Canada the topic of the value of water in regional development is not widely

discussed. The three notable studies related to Western Canada are: Brown (1991), Veeman (1985), and Russell, Craig, and Kulshreshtha (1993). Brown (1991) determined direct benefits created by the southwest Saskatchewan water supply systems. This study included PFRA irrigation projects, domestic water use, municipal water use, drought mitigation, and recreation. However, it did not specifically determine the value of water for regional economic development or indirect and induced impacts. The Veeman (1985) study looked at the role of water in regional economic development. Veeman stated that the availability of water does not "appear to be neither a necessary nor sufficient condition for regional economic development". While Veeman said that water does not stop regional economic growth he also stated that "water and water projects may be important vehicles through which the regional distribution of income and wealth within provinces may be altered" (pp. 48-49). The Russell et al. (1993) study considered that a link between water resource development and the development of a region does exist, but only in a qualitative manner.

The studies that discuss the value of water for regional economic development show that the topic is still open to interpretation. This is because the value of water for regional economic development that includes direct, indirect and induced impacts has not been determined in any available study found. Therefore a study that determines a value for water in regional economic development with all of these impacts would be beneficial to the literature and other studies for use and comparison.

3.4 Summary of Literature

The literature for regional economic development and value of water suggests that

there is much to be studied. The regional economic development literature is wide ranging in determination of the causes of regional economic development. The topic of the value of water for regional economic development has not been studied extensively.

CHAPTER FOUR

CONCEPTUAL FRAMEWORK

This chapter explains the conceptual framework that was chosen and explains why this method is appropriate according to economic theory.

4.1 External Effects of Water Use

Externalities are those effects on a third party that are a result of a decision made by another party. There are four types of externalities: 1) technical, 2) public goods, 3) ownership, and 4) pecuniary. Technical externalities are a result of a change (shift) in the long run average cost curve over a range of output. If the good or service is privately owned the result will be a natural monopoly. The public goods externality comes from the idea that no one can be excluded from the consumption of a given good or service. Because of this, the owner of the good cannot charge for its use, resulting in a lack of incentives for a private party to provide the good. The ownership externality occurs when the actions of one user are felt by a second user. The first user does not take into account the impact on the second user who incurs a cost, or receives a benefit. The pecuniary externality occurs when the activities of one user affects another user through the market (van Kooten, 1993).

The southwest Saskatchewan water supply systems creates several externalities.

There may be some technical externalities associated with water quality, water availability to other users and other externalities, but this is not included in this study. The ownership externalities are not created by the southwest Saskatchewan water supply systems as the water is not owned by any firm or individual.

The externalities are a result of the indirect[1] and induced[2] economic activities that are a result of the direct water use. The direct water use is not an externality since the water user can be charged a fee based on a per unit of water use. The secondary activities do not use the water but do use the output of the direct water users as an intermediate input. As a result they cannot easily be charged a fee for their activities. Charging the direct water user for all the externalities would not be possible as they do not receive the external benefits.

4.2 Economic Impact Assessment to Measure External Effects

The external effects of water use may be measured within an economic impact assessment framework. This means that the external effects have an impact on the regional economy. By measuring the economic impacts of the water use activities the economic impact on the regional economy may be calculated

4.3 Measurement of Economic Impacts

The economic impacts created by the externalities should be measured because a

1 Indirect impacts are caused by the purchase of inputs for the direct water use.

2 Induced impacts are caused by the expenditures made due to the increased household income that result for additional wages and salaries.

more complete picture of the economic activities can be determined when compared to an analysis that only considers the direct impacts such as a benefit-cost analysis. The measurement of economic impacts may be reported in several different contexts. Economic impacts can be measured in terms of output, GDP, imports, labor income, and employment. The output measures the value of goods and services produced by industries in the region. The GDP measures the wages, profits and includes inventory valuation and grain transactions adjustments. Imports include foreign and interprovincial imports into the region. Labor income measures the wages and supplementary income, net income of farm operators and the income of unincorporated non-farm businesses. The employment measure gives the number of full-time equivalent workers as a result of the economic activity.

4.4 Approach to Measurement of Economic Impacts

There are several approaches that have been developed for the purpose of measuring economic impacts. These approaches include: economic base, input-output, gravity type, shift share, econometric, and programming.

The economic base approach uses the basic sector of the economy for the driving force and service sectors are a derivative. The economic base model focuses on the basic sector of the economy using macro Keynesian analysis and trade multipliers from international trade theory. The problem with an economic base model is that different product markets can not be shown. Therefore an economic base model is usually conceptual. The further development of economic base theory to include interregional and intersectoral linkages results in the more complex input-output analysis (Nijkamp, 1986).

The input-output model can be used to find the regional impacts of external activities. The input-output approach is based on the double accounting of transaction tables used for national accounts. Input-output models that are an extension of economic base theory have been used in studies by Robison, and Mack (1996) and Hewings, Okuyama and Sonis (2001). The input-output model focuses on interregional trade, factor mobility and technological choice. The problems with an input-output model are: fixed linear coefficients with time, homogeneous input and pure quantity adjustment.

The purpose of a gravity type model is to include the impact of industrial location for transport flows of inputs and outputs. The gravity type approach is an integration of several multi-regional economic models. The gravity type model is often combined with other models such as multi-regional input-output model or econometric models. Leontief and Stout (1963) developed a useful gravity-type model that has been used in multi-regional input-output models such as Smith (1987) and Doyle, Mitchell and Topp (1997).

The shift-share approach is used to analyze regional economic activity with minimal data. The shift-share analysis compares the difference in growth rates for a study region and a control region. This method has been used in studies by Dinc, Hayes and Anderson (1998), Dinc and Hayes (1999), and Graham and Spence (1998 and 2000). The problem with this approach is that differential shifts are not stable with time and the approach is descriptive so the reasons for location advantage are not always clear.

Econometric models can provide a very detailed regional analysis. The econometric model may include variables for production, consumption, investment, and employment. Econometric models have been developed to include gravity-type analysis and input-output

models. An example of an econometric model may be seen in Czamanski (1968).

Programming models are a mix of regional economics and operations research. The special feature of programming models is that the number of equations can be different from the number of variables, so that a unique solution is not found, but rather a set of feasible solutions (Nijkamp, 1986). The limitation of this approach is the assumption of constant values for reaction coefficients, therefore there are problems when dealing with structural change.

All of these approaches have been developed and used in regional economics. Of these approaches the input-output model will provide the best approach for this study. The input-output model disaggregates the regional economy to the level of detail desired for this study. The input-output model may also be used to determine employment impacts of the southwest Saskatchewan water supply systems.

4.5 Role of Multipliers in Economic Impact Assessment

The purpose of the multiplier is to show the "change in the level of expenditures on total income" (Richardson, 1972). The Keynesian income multiplier in macroeconomic theory is useful in regional economics in terms of determining regional income and economic base multipliers. The economic base multiplier for a region contains leakages that a national multiplier does not contain due to interregional imports.

4.5.1 Keynesian Multiplier

The Gross National Product (GNP) is defined as "the total market value of all final

goods and services produced in the economy in one year" (McConnell and Pope, 1984). The GNP provides a measure of the money value of the goods and services which are available to the nation from economic activities. Economic activities included in this measure are those producing market goods, which does not include the transactions for intermediate goods or goods that do not enter into the marketplace.[3]

There are two approaches to the national income accounting of GNP. The first approach is to look at expenditures, which is called the Gross National Expenditures (GNE) approach. The second approach is to look at income created by production or the GNP. The result is that GNP equals GNE because total income will equal total expenditures for a given year.

Using the GNE approach to determining GNP involves estimation of four types of expenditures: personal consumption expenditures by households (C), investment (I_g), government expenditures (G), net exports [exports (E) minus imports (M)]. The GNP is estimated as shown in equation (4.1).

$$GNP = C - I_g - G - (E-M) \tag{4.1}$$

The GNP is not constant; change in it over time is affected by long run growth and cyclical fluctuations. Also, the equilibrium of the GNP is affected by consumption and savings by consumers or the marginal propensity to consume (MPC) and marginal propensity to save (MPS) and other exogenous changes. The MPC and MPS result in the

[3] The former set of goods is excluded on grounds of avoiding double counting.

Keynesian multiplier effect.[4] Using the average propensity to consume (APC) rather than the MPC to determine the Keynesian multiplier, the result is the aggregate or impact multiplier (Hewings, 1985, pp. 13-14). The impact multiplier is used in the economic base and input-output theory to determine the impact of an expenditure on the economy.

4.5.2 Limitations of the Keynesian Multiplier

The Keynesian multipliers described above cannot be directly used in input-output modeling due the problem of leakages. A Keynesian multiplier includes leakages due to savings, imports and taxes. The Keynesian multiplier is an aggregate that may only be determined for income (McConnell and Pope, 1984).

4.5.3 Input-Output Based Multiplier

The input-output multiplier follows the same concept as the Keynesian multiplier. The input-output multiplier is different in that it may be disaggregated to determine multipliers for individual sectors and for economic indicators beyond income to include GDP, imports and employment. In order to understand this concept, it is necessary to review the economic theory behind an input-output model.

4.6 Input-Output Economics

Input-output economics, as stated in Section 4.4, is based on accounting for all economic transactions within the economy. The transactions are made up of activities of

[4] For an algebraic explanation of the Keynesian multiplier effect see McConnell and Pope, (1984).

industries that produce goods and services, as well as consume goods and services from industries. In addition it includes activities between producers and consumers, consumers and consumers, and producers and owners of resources. An input-output model is based on a transactions table. The simple form of an input-output table is the square table, as described below. A slightly more complicated input-output table is the rectangular one.

4.6.1 Conventional Input-Output Model

An input-output model is a method of analysis where the entire economy is represented by a set of linear production functions describing the interrelationships between all sectors. Walras' General Equilibrium theory has provided the framework for this model. A simple input-output transaction table is shown below in Figure 4.1.

From \ To	Purchasing Sectors	Local Final Demand [Consumer (C) Investment (I) Government (G)]	Exports	Total Gross Output
Producing Sectors	X_{11}.....X_{1n} X_{21}.....X_{2n} ..... X_{n1}.....X_{nn}	C_1 I_1 G_1 C_2 I_2 G_2 ..... C_n I_n G_n	E_1 E_2 ... E_n	X_1 X_2 ... X_n
Labor Other Value Added	L_1.....L_n V_1.....V_n	L_C L_I L_G V_C V_I V_G	L_E V_E	L V
Imports	M_1.....M_n	M_C M_I M_G	-	M
Total Gross Outlay	X_1.....X_n	C I G	E	X

Figure 4.1 Simple Input-Output Transactions Table

Where X_{nn} is the firm, C is the consumer, E is export, X_n is the output, L is labor, V is value added, M is imports, I is investment, and G is government demand.

Each row for a producing sector shows the sales of industries to all other purchasing sectors for further production, final consumption, private investment, government spending, and exports. Sales to purchasing sectors for further production are called intermediate demand, which together with final demand (i.e. consumption, investment, government expenditure, and exports) equals total gross output of the industry.

4.6.2 Rectangular Input-Output Model and Impact Estimation

The square input-output model, as described above, is based on each industry producing one commodity. If this assumption is relaxed so that each industry can produce more than one commodity, the result is a rectangular input-output model. The rectangular input-output model adds an output or make matrix [V] to the square input-output model. All accounting in the intermediate demand or use matrix [U] is in terms of commodities. These matrices make it possible to model the sectoral demand or output for commodities. Figure 4.2 shows the rectangle input-output transactions table, based on formulation by Statistics Canada (Statistics Canada, 1979).

4.6.3 Regional and Interregional Input-Output Models

A single region input-output model, as described in the above sections, can be used only to determine impacts within one region. A single region model cannot evaluate impacts

	Commodities	Purchasing Sectors	Final Demand	Total Outputs
Commodities		Intermediate Demand or Use Matrix [U]	Final Demand [F]	Total Commodity Disposition [Q]
Producing Sectors	Output or Make Matrix [V]			Total Sectoral Output [G]
Primary Inputs		Primary Inputs by Sectors [Y]	Primary Inputs by Final Demand [Y^F]	Total Value-Added (GDP) [P]
Imports		Imports by Sector	Imports by Final Demand	Total Imports
Total Inputs	Total Commodity Production [Q']	Total Sectoral Outlay [G']	Total Final Demand [E]	

Figure 4.2 Rectangular Input-Output Transactions Table

of transactions between regions and the feedback effect[5]. This limitation can be overcome by using a multi-regional input-output (MRIO) model or an interregional input-output (IRIO) model. These models capture the transactions between regions. The limitation of the MRIO is that the entire interregional flow and the feedback effect of the transactions between regions is not captured. This is because the MRIO model does not have a matrix to analyze trade between regions. The IRIO captures the interregional flows and feedback effects. However its data requirements are extensive. In Canada only one IRIO model, the

5 The feedback effect refers to the trade flow from region one which needs inputs from region two. As a result region two needs more inputs from other regions including region one (Miller and Blair, 1985).

CANDIDE model developed by Statistics Canada, exists, which models the interprovincial transactions in the country.

The MRIO model was developed by Leontief and Strout (1963). The MRIO model does not distinguish commodities by region. Rather the region's outputs are defined to be a combination of outputs from the economic activities of the region. Therefore, the flow of outputs between regions are pooled so that a commodity's region of origin cannot be determined. The result is the inability to determine the feedback effect and interregional flows with the model.

4.7 Estimation of Economic Impacts Using the Input-Output model

The input-output model is used to estimate impacts of a change in one or more sectors on the entire economy. Impacts are generated by the interdependencies among various sectors. The total economic impact of a change is made up of the direct impacts and secondary impacts. The direct impacts are a result of direct expenditures associated with a given project. These expenditures create further activity in the economy, which are called secondary impacts.

4.7.1 Types of Impacts

The secondary impacts can be made up of four different impacts. The first one is through the purchases of inputs (goods and services) from other sectors of the economy. The second impact is created by the use of factors of production, such as labor and capital in the initial sector, which will be paid for their use and therefore have money to spend on personal

consumption and taxes. The third secondary impact is from the products produced in the initial sector being used as inputs in other sectors within the region. The final secondary impact is through the spending of the payment given to the owners of the factors of production in the sectors included under the third impact.

These four secondary impacts can be identified on the basis of their source of impact and the type of linkage between the initial sector and other sectors. The two sources of secondary impacts are indirect and induced impacts. The indirect impact is created by the purchase of goods and services by a sector. The induced impact is created from the spending of household income. On the basis of linkages, impacts can be divided into two types: forward linkages and backward linkages. Industries that use the output of another industry for further processing (or value added) are deemed to be forward linkages. Those that supply input requirements are called backward linkages. Combining these two criteria the four secondary impacts are referred to as backward-linkage indirect impacts, forward-linkage indirect impacts, backward-linkage induced impacts, and forward-linkage induced impacts. The indirect impacts together with direct impacts are also referred to as Type I impacts. When direct, indirect and induced impacts are added together, the resulting total impacts are called Type II impacts. Equation (4.2) shows the connection between these impacts.

Total Impacts=Direct Impacts + Backward Linkage Indirect Impacts + Backward Linkage Induced Impacts + Forward Linkage Direct and Indirect Impacts + Forward Linkage Induced Impacts (4.2)

In Figure 4.3 the interaction of the expenditures that create the impacts are shown in a flow chart. The figure shows that the direct impacts are created by the project expenditures. The indirect impacts are a result of the purchase of inputs and the induced impacts are a result of the expenditures by households.

4.7.2 Impact Assessment Using a Rectangular Input-Output Model

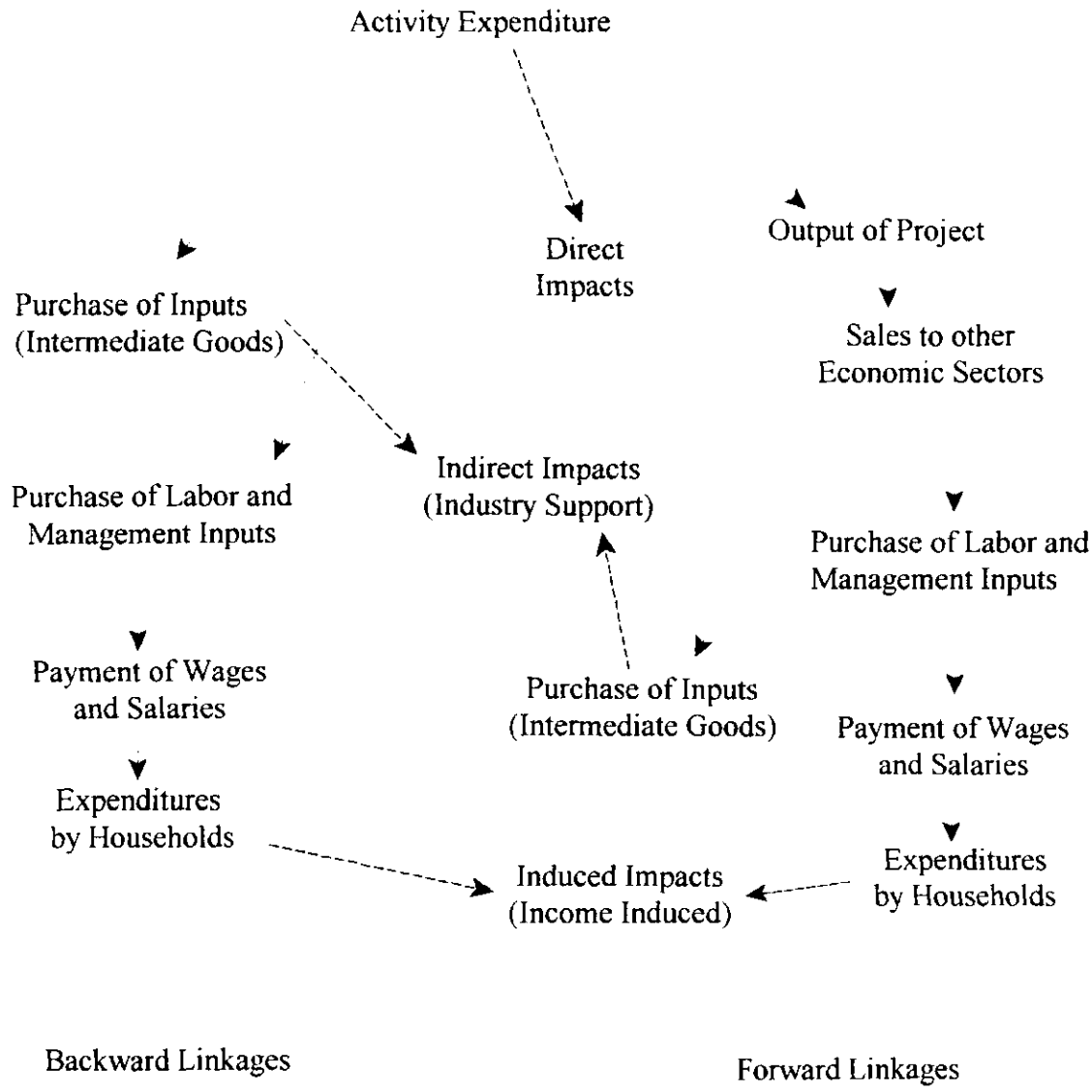
This study follows the Statistics Canada (1979) method for using a rectangular input-output model for impact assessment. This model is based on two assumptions. The first assumption is that "allocation of commodity production among industries is that industries will preserve their observed share of the market for each domestically produced commodity irrespective of the levels of commodity production." This is shown in equation (4.3).

$$g=Dq \tag{4.3}$$

Where the vector g is the value of industry output and q is the value of domestic commodity production. The D matrix is the Domestic Market Share Matrix.

The second assumption is that the value of input for each industry is used in fixed proportions of the value of output for the total industry output and are therefore independent of the output composition. This is also referred to as the industry technology assumption.This assumption is shown in equation (4.4)

$$Ui=Bg \tag{4.4}$$



——— ➤ is the flow of money through the economy.

---------➤ is the type of impact caused by the expenditure.

Figure 4.3 Flowchart of Backward and Forward Linkages

Where U is the intermediate demand matrix, from Figure 4.2, vector i is a column vector for the industries, and B is the matrix of coefficients for industry technology. Vector g is the industry outputs.

The next step is to show the balance between the total supply and total disposition. This is shown in equation (4.5).

$$q-m+a-v=Bg+e-X_D-X_R \tag{4.5}$$

Where m is the vector of the values of imports, a is the vector of the values of government production, v is the vector of values of withdrawals from VPC (physical change in inventory), X_D is the vector of values of exports, X_R is the vector of values of re-exports, and e is the vector of the following final demand categories:

$$e=PE-FCF-VPCA-GGCE \tag{4.6}$$

Where PE is the personal expenditures on goods and services, FCF is the fixed capital formation, for business and government, VPCA is the value of physical change in inventories (additions), and GGCE is the gross government current expenditure on goods and services.

By rearranging equation (4.5), equation (4.7) is formed.

$$q=Bg-e-X_D-X_R-m-a-v \tag{4.7}$$

Since economic impact estimation of the region is the objective, further manipulation for leakages is needed. Hypothesizing each of these as follows:

Imports:

$$m=\mu\,(Bg-e\cdot X_R) \tag{4.8}$$

Inventory withdrawal:

$$v=\beta\,(Bg-e-X_D) \tag{4.9}$$

Equation (4.10) shows the leakage due to government production.

$$a=\alpha\,(Bg-e-X_D) \tag{4.10}$$

The μ, β and α parameters are calculated. By substituting equations (4.8), (4.9) and (4.10) into equation (4.7), equation (4.11) results.

$$q=Bg-e-X_D\cdot X_R-\mu\,(Bg-e-X_R)-\alpha\,(Bg-e-X_D)-\beta\,(Bg-e-X_D) \tag{4.11}$$

By rearranging equation (4.11) the result is (4.12).

$$Q=(1-\mu-\alpha-\beta)Bg-(1-\mu-\alpha-\beta)e-(1-\alpha-\beta)X_D-(1-\mu)X_R \tag{4.12}$$

If equation (4.12) is substituted back into equation (4.3) to allow for leakages out of intermediate and final demand the result is equation (4.13).

$$g=[I-D(I-\mu-\alpha-\beta)B]^{-1}D[(I-\mu-\alpha-\beta)e+(I-\alpha-\beta)X_D+(I-\mu)X_R] \quad (4.13)$$

Then let $D^* = D(I-\mu-\alpha-\beta)$, $X_R = 0$, $X_D = (I-\alpha-\beta)X_D$, and $e^* = (I-\mu-\alpha-\beta)e$. The result is equation (4.14)

$$g=(I-D^*)De^* \quad (4.14)$$

The Inverse matrix (I-D*) in equation (4.14) is the Impact (Multiplier) matrix. These values represent a change in the output of an industry associated with a unit change in the demand of their goods and services.

4.8 Employment Impacts

The input-output model can be used to find the employment impact of an activity. The assumption needed for determining the employment multiplier is that the level of employment for any industry is related to the output of the industry. With this assumption the entries for the input-output system are converted to employment multipliers. According to Richardson (1972) the most common technique for determining the employment impacts is to use linear regression methods. This is shown by equation (4.15)

$$E_i = bX_i \qquad (4.15)$$

Where E is employment, X is output and b is the slope of the employment-production function.

4.9 Value of Water for Regional Economic Development

The concept of value in modern economics is defined by Crane (1980) to be "the quantity of one product or service that will be given or accepted in exchange for another. In this respect, it is a measure of the economic significance of a particular good or service. This value in exchange depends on the scarcity of the good or service and the extent to which it is desired." Valuation of a natural resource or a new economic development activity is generally done using the concept of economic welfare. Economic welfare of the society is commonly estimated as the welfare gains of producers (called producer surplus) and those of consumers (called consumer surplus).

There are two methods needed to explain the welfare gains: 1)using a shift in demand and 2) using a shift in supply. The shift in demand shows the change in welfare created by an increase in demand, in this study due to backward linkages. In Figure 4.4 the change in demand is shown by D_0 shifting to D_1. Since the supplier of inputs can set their prices, assuming a market with many buyers and few suppliers, the result is an increase in price, from P_0 to P_1 and an increase in quantity from Q_A to Q_B. The area '*abcd*' is the increase in producer surplus. Figure 4.5 shows the shift in supply, due to forward linkages, as S_0 to S_1. With additional output due to the increased water supply, the output increases from Q_0 to

Q_1 (Figure 4.5). The demand remains the same at P* since the producer is a price taker for their production. The change in producer surplus is equal to area '*efgh*'. The area '*abcd*' plus '*0efgh*' is equal to the value of water for regional economic development.

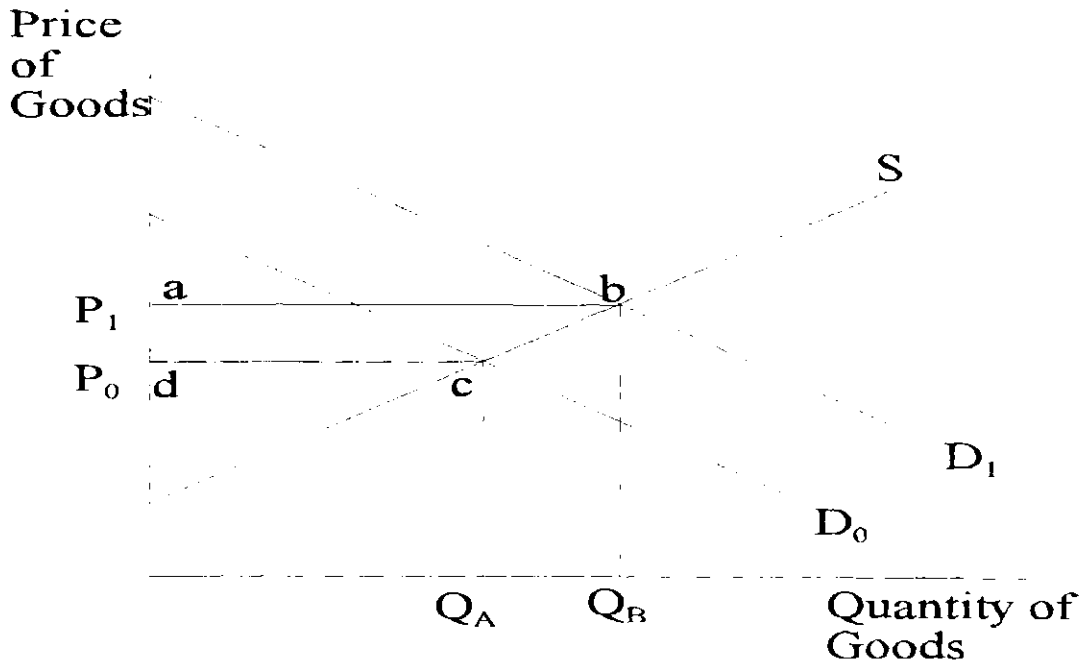


Figure 4.4 Producer Surplus Using a Demand Function Shift

4.10 Summary

The theory presented in this chapter shows that the external effect of water use can be measured through the economic impacts created. The best method for calculating the impacts, for this study, is a rectangular input-output model. The input-output model can be used to determine the economic impacts due to backward and forward linkages that result from water use activities. By using certain impact results of the water use activities the

value of water for regional economic development may be estimated.

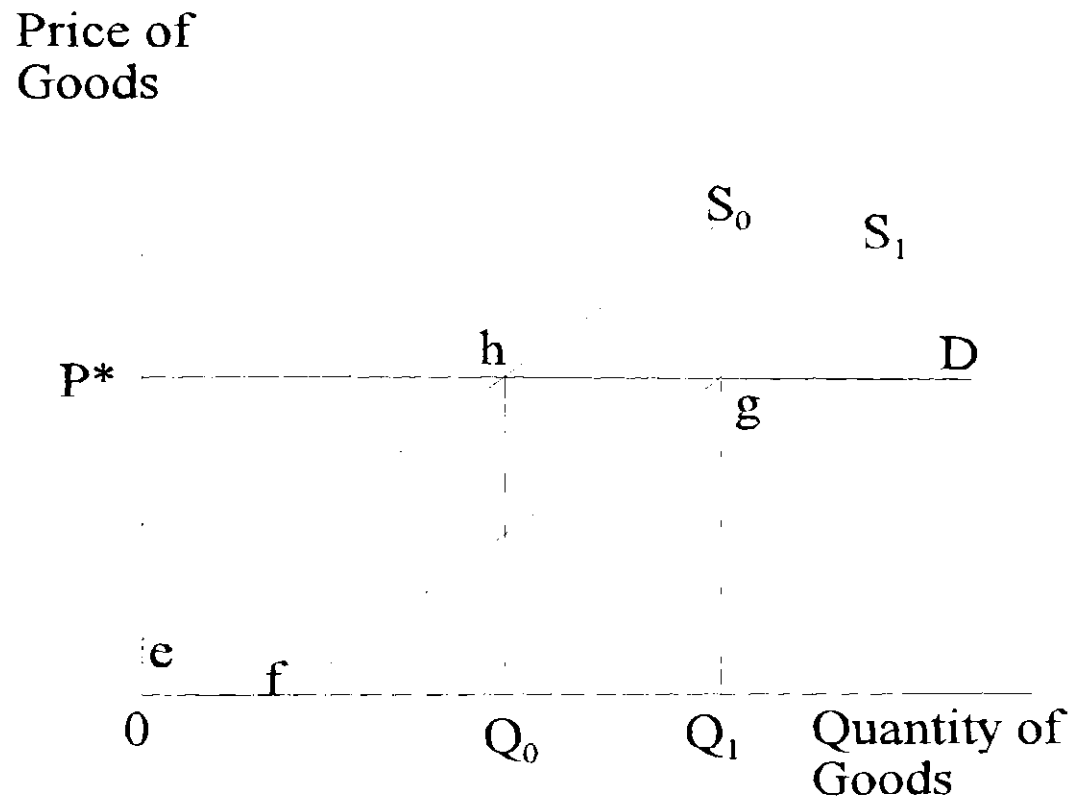


Figure 4.5 Producer Surplus Using a Supply Function Shift

CHAPTER FIVE

ANALYTICAL FRAMEWORK

This chapter applies the economic theory described in Chapter 4. The following methodology describes the analytical framework used to estimate economic contributions of the southwest Saskatchewan water supply systems.

5.1 Considerations for the Development of Study Methodology

Development of the study methodology was based on several considerations. Although the factors described here may appear to be separate entities, the interactions between them also affected the choice of the study methodology.

5.1.1 Accounting Stance

In order to estimate the value of water for the southwest Saskatchewan water supply systems, it is important that the analyst select a proper accounting stance. An accounting stance is simply a criterion which is used to decide the scope of impacts to be included in a given study. Two accounting stances are commonly used: 1) private accounting stance, and 2) social or public accounting stance. If the analyst uses the private accounting stance, those impacts that are included are those borne/experienced by the private investor of the

project. The social accounting stance includes all impacts on the members of society, in commensuration with the interest of the decision maker.

When public funds are used, a social accounting stance is the most appropriate one. Even here, one needs to examine the scope of the society to be included. If one uses the argument that the southwest Saskatchewan water supply systems was initially created to improve economic welfare of southwest Saskatchewan, a local society's accounting stance will be appropriate. However, since some of the impacts of this water use are felt outside the local region, extending the region boundaries to a broader region may be appropriate. Some of the economic impacts of activities in southwest Saskatchewan are felt in other parts of the province, or in other Prairie provinces. Therefore three social accounting stances can be relevant: southwest Saskatchewan region, Province of Saskatchewan, and the Prairie Provinces. In this study three regional accounting stances are used.

5.1.2 Delineation of the Region

The definition of what constituted each region was an important factor. The southwest Saskatchewan region was defined according to the rural municipalities that contained the southwest Saskatchewan water supply systems[1]. The province of Saskatchewan was defined according to its political boundaries. The Prairie region was defined as the provinces of Alberta, Saskatchewan and Manitoba where the PFRA has a mandate to provide programs related to water development.

1 More details are provide in Section 5.3.

5.1.3 Data Availability

Most economic and social data are collected for political regions. The smallest political region for which the data are available is the rural municipality. For the southwest Saskatchewan region, boundaries had to be established using an aggregate of rural municipalities. Although a watershed boundary may be appropriate for water planning and management, such data are rarely available.

5.1.4 Need for Disaggregation

The southwest Saskatchewan water supply systems were developed to assist local producers and the water supplied was used primarily for forage production. Since production technology for forage production is significantly different from that of the general agriculture, the agriculture sector needed to be further disaggregated.

5.2 Overview of Study Methodology

The study methodology consisted of six steps: 1) Determination of regional boundaries; 2) Determination of activities of water users associated with the southwest Saskatchewan water supply systems; 3) Development of a model capable of estimating the change in the indicators selected; 4) Use of the model to estimate impacts; 5) Estimation of initial change in the economy from the water supply systems, and 6) Determination of the value of water for regional development.

The delineation of the region is described in section 5.3. This is followed in section 5.4 by economic activities in the region that are directly or indirectly related to water use.

Salient features of the study's input-output model are the subject of section 5.5, which is followed by impact assessment methodology in section 5.6. Section 5.7 describes the procedure for estimating the initial economic activities. All the economic impacts are then used to estimate the value of water in regional development which is further explained in Section 5.8.

5.3 Regional Specification of the Study

Since the study focuses on a sub-region of the province, a multi-region input-output (MRIO) model was considered more appropriate. This model has three regions: 1) southwest Saskatchewan region with southwest Saskatchewan water supply systems, 2) southwest Saskatchewan region that does not contain southwest Saskatchewan water supply systems, and 3) the Rest of Saskatchewan region.

Boundaries for the southwest Saskatchewan region were selected using several considerations. The first consideration was how PFRA defined the southwest Saskatchewan region. The region was defined by Brown (1991) as containing the PFRA districts of Maple Creek, Shaunavon, Gravelbourg, and Swift Current. Since 1991 these districts have changed. In the year 2001, the region contained three PFRA districts which were Maple Creek, Swift Current, and Gravelbourg. The region the PFRA defined in 1991 and subsequently in 1999/2000 was not used because these PFRA districts include rural municipalities along the South Saskatchewan River. The irrigation along the South Saskatchewan River is not a part of the southwest Saskatchewan water supply systems and therefore were not included. Another factor in deciding the study region was the availability

of data. Most of the data needed for the study was available at the rural municipality[2] level. Therefore, the region could only be an aggregate of various rural municipalities containing the above features. The final factor in deciding the study region was the location of irrigation projects and related infrastructure associated with the southwest Saskatchewan water supply systems.

The study region included all rural municipalities in southwest Saskatchewan that have a PFRA dam and/or irrigated area where water is being supplied by PFRA developed infrastructure. Although all rural municipalities along the South Saskatchewan River were excluded, as stated earlier, two exceptions were made. The rural municipalities of Morse (No.165) and Excelsior (No.166) were included because of the PFRA Rush Lake irrigation project and other provincial water user districts irrigation projects are within them. A complete list of the rural municipalities is presented in Table B.1 in Appendix B. The urban centers of each rural municipality were also included. The study region is shown as the shaded area in Figure 5.1.

5.4 Economic Activities Associated with the Southwest Saskatchewan Water Supply Systems

There are several organizations and groups of individuals that incur expenditures or savings that are directly or indirectly associated with the southwest Saskatchewan water supply systems. These include: the PFRA, forage and cattle producers, the cattle slaughter

2 The use of data from the rural municipality level require more time to collect and process, but using larger areas such as Statistics Canada census regions or census agricultural regions would not define the region to the detail desired for this study.

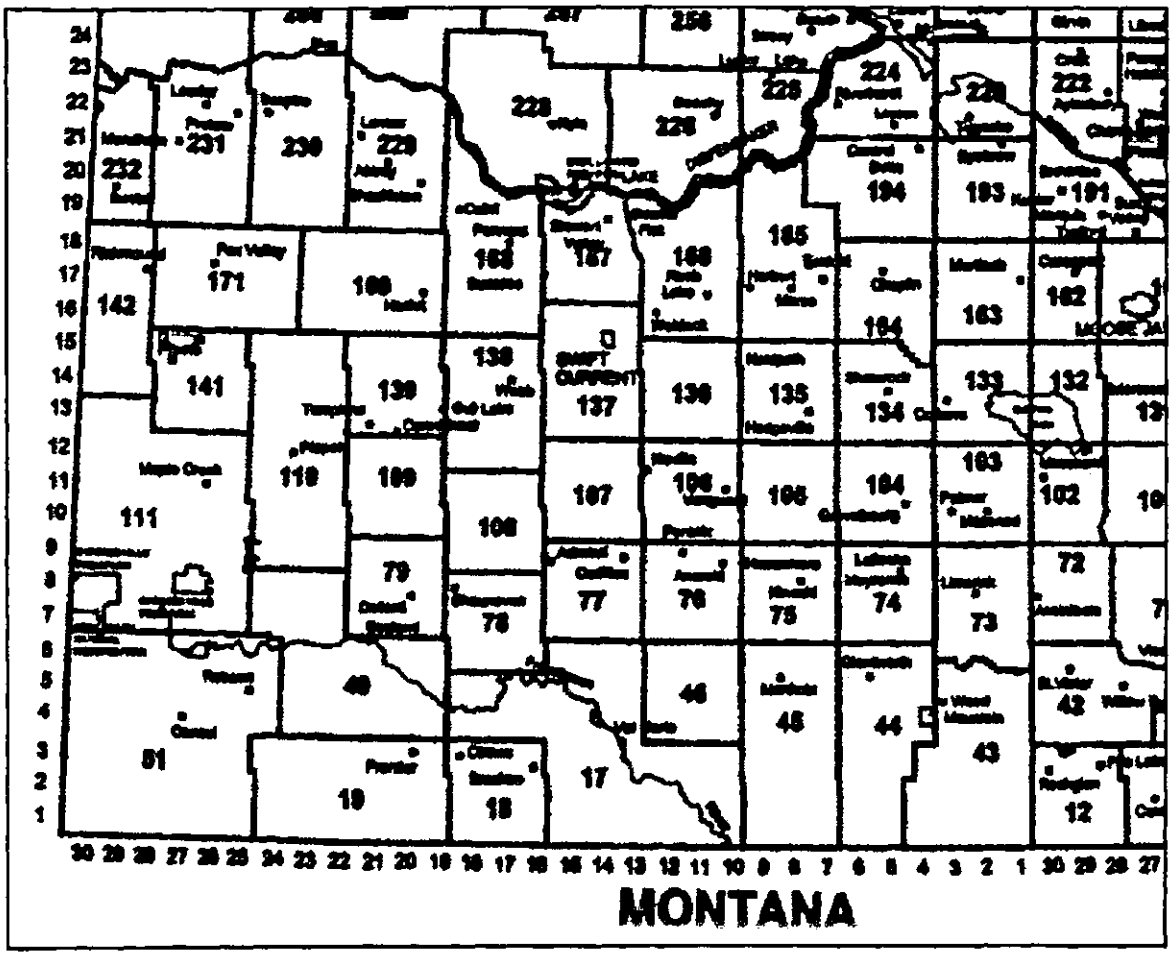


Figure 5.1 Rural Municipalities Used to Define the Southwest Saskatchewan Region

and processing industry, domestic water users, municipal water users, industrial water users, recreation users, beneficiaries from flood control, and wildlife agencies and users. The organizations and individuals can be broken down into users of the water and non-users. The water users can be further divided into: consumptive and non-consumptive. Consumptive water users include forage and cattle producers, domestic, municipal and industrial water users, and recreation facilities. Water based recreation is not a consumptive use of water for activities such as fishing and swimming. The non-users of water include PFRA, cattle slaughter and processing and flood control.

Various activities can also be divided into backward and forward linkages with the systems/direct water users. The direct water users, around which the backward and forward linkages are created, are the consumptive water users. From this the backward linkages are the industry support through inputs purchased by the consumptive water users. The forward linkages created by the direct water users are the cattle production and cattle slaughter and processing. The forward linkages are a direct result of the direct water user activities but do not directly use water from the southwest Saskatchewan water supply systems.

5.5 Development of the Study Input-Output Model

As stated earlier, the study model was a three-region (multi) input-output model. The following discussion explains the features and development of this model.

5.5.1 Salient Features of the Study Model

The study model was developed to meet the objectives of the study. It has the following features:

1) The model is a three-regional input-output model (MRIO). The province was broken down into region a) southwest Saskatchewan region containing the southwest Saskatchewan water supply systems, b) dryland region (adjacent to the system) and c) Rest of Saskatchewan region.

2) The economy is based on the 1996 level of transactions in the Saskatchewan economy.

3) The input-output model was designed to focus on different farm types in the

region. Therefore, the agriculture sector was disaggregated further by different farm types, including small scale irrigation that dominates the southwest Saskatchewan water supply systems.

4) Since estimation of employment was considered important, the model was modified to generate employment from a selected economic activity.

5.5.2 Methodology for Developing the Study Input-Output Model

The methodology for developing the MRIO consisted of five steps. These steps were: 1) development of the regional transactions table, 2) disaggregation of the agriculture sector, 3) development of the regional tables, 4) appending the employment module, and 5) adjustments for leakages and other corrections.

5.5.2.1 Development of Regional Transactions Table

The starting point of an input-output model is a transactions table. For southwest Saskatchewan such a table was not available, and therefore was developed using non-survey methods (Details provided in section 5.5.2.3). To start this process, the Saskatchewan transactions table was obtained from Statistics Canada. This table was based on the 1996 provincial economy. The Saskatchewan transactions table is a rectangular transactions table with 57 commodities and 21 sectors. The relevant portions of the table are typically displayed as 1) output matrix, 2) input matrix, and 3) final demand matrix. The Saskatchewan transactions table contained several confidential cells, where information was not released. These cells were filled using the data on the table so that the actual total of the

row or column matched the given total.

5.5.2.2 Disaggregation of the Agriculture Sector

The agriculture sector in the provincial transactions table was treated as a single sector. Since irrigation production was the main focus of the study, the provincial transaction tables needed further disaggregation. This disaggregation was done using Statistics Canada data in combination with primary farm level data. Statistics Canada data were obtained from Statistics Canada (2000a). The farm types for the agriculture sector, as defined by Statistics Canada, include: wheat farms, grain and oilseed farms (except wheat), field crop (except wheat, grain and oilseed), beef cattle farms, dairy cattle farms, hog farms, poultry and egg farms, fruit farms, vegetable farms, livestock combination farms, miscellaneous specialty farms, other combination farms. Data from this source were collected for farm area, capital, gross receipts, and expenses by farm type. These data were used to construct the transactions table for Saskatchewan. Some of the farm types were combined and others were broken down as required to develop the initial transactions table.

The wheat farms, grain and oilseed farms and field crop farms were initially combined into one farm type called grain farms. This farm type was subsequently broken down into three farm types: 1) dryland grains farms, 2) large scale irrigation farms, and 3) small scale irrigation farms. The breakdown was done by creating crop production budgets for small scale (irrigator survey budget) and large scale (Irrigation Crop Diversification Corporation (ICDC) budget) (Irrigation Crop Diversification Corporation, 2000) irrigation. The irrigation budgets were then multiplied by the area under a specific type of irrigation

(large scale versus small scale) in the region and then broken down by commodity according to the transactions table. This provided the needed vector of purchases by small scale and large scale irrigation farm types. To estimate the dryland grain farm purchases, values for the small scale and large scale irrigation were subtracted from the original grain farms.

The final model contained ten farm types: 1) grain farms, 2) large scale irrigation farms, 3) small scale irrigation farms, 4) dairy farms, 5) beef cattle farms, 6) hog farms, 7) poultry and egg farms, 8) livestock combination farms, 9) miscellaneous farms, and 10) non-commercial farms. These farm types where balanced by rows and columns to equal the original total expenditures of the Saskatchewan agriculture sector. The final transactions tables for input and output for the agriculture sector can be seen in Table C.1 and C.2 respectively in Appendix C.

5.5.2.3 Development of Regional Tables

To develop a regional transactions table, either a non-survey or survey method could be used. Survey methods involve primary data collection and therefore, requirements for time and finances may be large. To reduce the time and money needed non-survey methods may be used. The non-survey method used for this study involved using secondary data to adjust provincial data to determine the regional output coefficients. The coefficients were based on location quotients. Location quotients depict a "measure comparing the relative importance of an industry in a region and its relative importance in the nation" (Richardson, 1972) or in this case the province. It is calculated as:

$$Lq_i = \frac{X_{ir} / X_r}{X_{ip} / X_p} \qquad (5.1)$$

Where X is output, r is the region, i is a sector in the model, and p is the province. There are several ways to estimate the location quotient coefficients. These methods include final demand, purchases only, expenditures, cross-industry, supply-demand, and employment (Richardson, 1972). The employment criterion to estimate the location quotients is the easiest one to implement, on account of available data. This method was used in this study. They were calculated for each sector and for each of the three regions using the employment data in Table C.3 (Appendix C). The location quotients are shown in Table C.4 in Appendix C.

5.5.2.4 Appending the Employment Module

The employment module required employment data for each industry sector of the input-output model. Therefore employment type was determined. This was done using Statistics Canada data (1996). The number of weeks per farm was divided by 48, the working weeks in a year, to find the number of employees by farm type. The number of operators per farm was calculated and added to get a total employment in agriculture of 76,025 persons. The 76,025 was broken down into farm type as shown in Table C.3 (Appendix C).

For the input-output model the employment for all industry sectors was needed. These figures came from Statistics Canada (2001) which is shown in Table C.3. This was

used to calculate the employment coefficients shown in Table C.5 (Appendix C)

5.5.2.5 Adjustment for Leakages and Other Corrections

Following the economic theory for input-output models discussed in section 4.7.2, the regional tables needed to be adjusted for various economic leakages. In this study the leakages included imports (μ), inventory changes (β), and government production (α). These adjustment were carried out using Statistics Canada data to determine the, and matrices.

Using the developed transactions table and adjustment for leakages, the multiplier matrix for Type I multipliers was developed according to equation (5.2)

$$G^{(I)}=(I-DB)^{-1}D\ e \qquad (5.2)$$

Where G is the economic impact, $(I-DB)^{-1}D$ is the multiplier matrix and e is the final demand. The multiplier matric for Type II impacts includes the household impacts which uses an adjusted D and B matrix, D^A and B^A respectively. This is shown in equation (5.3).

$$G^{(II)}=(I-D^AB^A)^{-1}D^A\ e \qquad (5.3)$$

5.6 Method of Economic Impact Assessment

Using the multipliers for Type I and Type II economic impacts developed in section 5.5.2.5 and the commodity vectors, as described below in section 5.7, the economic impact

of the activities associated with the southwest Saskatchewan water supply systems were estimated. The starting point for this estimation is the change in the initial sector which triggers changes in the rest of the economy. Since the model is demand driven, these changes are made equivalent to change in the final demand (Δe). Total change in output of various sectors is then estimated using equations (5.4) and (5.5).

For direct and indirect impacts as:

$$\Delta G^{(I)}=(I-DB)^{-1}D(\Delta e) \tag{5.4}$$

For direct, indirect and induced impacts as:.

$$\Delta G^{(II)}=(I-D^{A}B^{A})D^{A}(\Delta E^{A}) \tag{5.5}$$

Changes in other economic indicators (GDP, imports, household income, or employment are derived from the change in output (in Equation 5.4 or 5.5) as follows:

$$\Delta GDP^{(I)}=(\rho)\Delta G^{(I)} \tag{5.6}$$

Where ρ is a vector containing a proportion of GDP to total output of a sector, and GDP is the gross domestic product. Other indicators are estimated in a similar manner.

For each of the activities the final demand occurred for different reasons. For PFRA activities there was a change in expenditures which created a new final demand. Irrigation

created a change in output which needed additional input and therefore additional demand. Cattle production also caused a change in output and therefore increased demand for inputs along with a change in income. The cattle slaughter and processing creates an increase in output and therefore needs additional input which in turn creates additional demand along with a change in income for additional income impacts. Drought causes an change in income. Domestic, municipal and industrial water use cause both a change in income and change in input which result in a change in final demand. Recreation creates a change in expenditures and therefore a new final demand. Recreation also requires additional inputs and therefore additional demand. Wildlife projects create new expenditures for a new final demand. Flood control creates a change in household income. The values for the commodity vectors associated with each of these activities are described in section 5.7

5.7 Sources of Data for Economic Activities

This section gives a brief explanation of the expenditure data used to determine the impacts for the southwest Saskatchewan region, Saskatchewan and the Prairie region. The expenditures were collected for the year 2000.

5.7.1 Capital and Operations Expenditures

The PFRA expenditure data were provided by PFRA. This data included the expenditures for capital, operations and maintenance for the PFRA portion of the water supply systems. The capital expenditure was for construction of the southwest Saskatchewan water supply systems, such as new structures or rehabilitation of older

structures. The operation and maintenance expenditures were for activities such as providing technical services, operation of the dams and infrastructure up to the irrigators' farmland and maintenance of the dams and canal system.

Total capital expenditures by the PFRA during the year 2000 were $152,000. To break down this data into input-output commodities, factors from the PFRA Assiniboine South-Hespeler area study (PFRA, 1987) were used[3] since appropriate information on the southwest Saskatchewan water supply systems construction of the dams in southwest Saskatchewan was not available. These factors are shown in Table D.1 in Appendix D.

In 1999/2000, PFRA did not report any operation and maintenance expenditures in the engineering set of data. However, in the PFRA financial reporting system (FRS), these expenditures were reported, which were available for the period of 1997 to 1999. The average of these values was used as the value for the year 2000 operation and maintenance expenditures. This was estimated at $1.4 million. For the provincial water users districts, the value of $84,274 was used (Bill Vavra, personal communication, 2002). The total operation and maintenance expenditure of $1.484 million was broken down into a commodity vector using the factors shown in Table D.2 in Appendix D.

5.7.2 Farm Level Irrigation Expenditures

At the farm level, the data needs included expenditures for forage production and the area for each type of irrigation. The data for forage production expenditures in the region

3 This is not an ideal breakdown because the Assiniboine South-Hespeler dam uses different technology and safety standards than the dams in southwest Saskatchewan used during their construction, further reflected in their rehabilitation during the study year.

were not available. To remedy this problem, a survey of irrigators in the region was undertaken.[4] The survey consisted of a forage budget from Saskatchewan Agriculture and Food reports (Saskatchewan Agriculture and Food, 2000). The Saskatchewan Agriculture and Food forage budget was used as a guide to ask for a comparison of expenditures on the irrigator's farm. The survey was undertaken in several stages. The first attempt for the collection of data was done at a local water users meeting in Val Marie on May 14/2000. The survey questionnaire was given to irrigators using the southwest Saskatchewan water supply systems around the town of Val Marie. The response for this survey was zero. The reason for the zero response was most likely caused because the details requested were too much for a take-home survey.

The second attempt at the collection of forage production data was done at the Saskatchewan Irrigation Producers Association/Irrigation Crop Diversification Corporation Irrigation Conference in Swift Current on December 4th and 5th of 2000. The survey was different than the first survey, since it was done in person. The response to this survey was much better, as 13 questionnaires were completed. These surveys represented different size and types of irrigators. The survey information was used to create irrigated forage production budgets for the study region. A forage production budget was created for surface irrigation. Since only one survey for a sprinkler irrigation budget was returned the ICDC budget was used for sprinkler irrigation. The dryland forage production budget was developed from the data collected in the same primary surveys. The capital expenditures for each budget was assumed to be equal to the value of depreciation for the year 2000. The

4 It was based on a questionnaire, details on which are provided in Appendix E.

budgets were developed based on the assumption of a 10 year rotation and a probability of second cut varied by irrigation project and type. The ten year average production can be seen in Table 5.2 in Section 5.7.3. The production budgets can be seen Tables D.3 (surface), D.4 (sprinkler), and D.5 (dryland) in Appendix D.

With the production budgets created, the next step was to develop the commodity vector for use in the impact analysis. The expenditures and income from the budgets were separated into different input-output model commodity types. In Table D.6 in Appendix D the breakdown factors are shown. This was done for each budget of irrigation and dryland forage production. In order to obtain the direct value of irrigation water, dryland production expenditures were subtracted from the irrigation forage expenditures. Thus, the impacts from irrigation shown in this study are marginal impacts. This forage production was estimated for later use in the determination of the number of cattle produced because of the forage available due to irrigation.

The irrigated forage production was used for the production of cattle. Therefore, the forage was not sold and there was not any income from forage production. This assumption was made as most irrigators in the study region produce forage for their own use. Usually extra forage production is stored for drought periods.

To find the total expenditure for the study region, area for each type of irrigation was needed. The irrigated area for PFRA and provincial water user district irrigation projects came from the PFRA. The private irrigated area was estimated by determining the average amount of water irrigated per acre on the federal projects of 51.13 cm per acre and the total water used for these patrons. The water used by private irrigators was reported to be 86,835

dam^3. This resulted in an estimation of 42,021 acres of irrigation under private management. The area for each irrigation type and management group may be seen in Table 5.1. The surface irrigated budget was multiplied by the number of surface acres and the ICDC production budget was multiplied by the sprinkler acres to calculate the total expenditure by irrigators in southwest Saskatchewan. The total expenditure for irrigation was estimated to be $8.688 million.

Table 5.1 Irrigation Area by Irrigation Type in 2000

Irrigation Administration	Surface Acres	Sprinkler Acres	Total Acres
PFRA Irrigation	22,133	0	22,133
Provincial Irrigation	11,877	0	11,877
Private Irrigation	1,452	40,569	42,021
Total Irrigation	34,661	40,569	75,231[5]

Source: Kulshreshtha (2002)

5.7.3 Farm Level Cattle Production

A forward linkage from forage production in southwest Saskatchewan is cattle production. All the forage produced is used for feeding cattle. Without this additional forage, herd size would be smaller. The cattle production budget that was used in this study was obtained from the Western Beef Development Centre (WBDC) (Ian McNinch, Personal Communication, 2001). The budget is made up of an average of six producers in the brown

5 This total excludes all federal community pasture area that may be irrigated.

soil zone. This information was used to best reflect the production methods used by these producers. The feed portion of the WBDC budget was modified to reflect the primary survey results of irrigators with cattle for the study region. The modification was a change in the feed ration of the WBDC which included forage and grains to just forage that would have been produced by the irrigators. The cattle purchases in the budget were adjusted to reflect that producers will use their own calves to replace cows that need to be replaced. The modification consisted of taking 25% of the original cattle purchases and a corresponding adjustment to gross returns (Daryl Tumbach, Personal Communication, 2001). The production budget, Table D.7 in Appendix D, was then separated into the commodities using the factors shown in Table D.8 in Appendix D.

Since in the absence of irrigation the region would have some cattle raising activity, only the additional cattle herd induced by irrigation was estimated. This is the difference between the cattle herd supported on dryland forage and that on irrigated forage production. The dryland cattle herd size was estimated by multiplying the total area in Table 5.1 by dryland forage yield of 0.75 ton per acre and dividing it by the forage requirements per head. In this study, a value of 2.5 tons of forage per head per year was used. The 2.5 tons per head was based on the survey of the irrigators in the region. The total irrigated forage production for PFRA irrigation projects was determined using the ten year average production data from 1984 to 1993. Since the provincial projects data were not available for each specific irrigation project, yields on the nearest PFRA projects were used. The forage production from private land came from the survey of irrigators. The private forage production could not be broken down by area on account of the small sample size. Table 5.2 shows the

average and total irrigated forage production for PFRA, provincial, and private acres.

Total production of forage was estimated to be 241,582 tons. This level of production was divided by 2.5 (tons per head) to estimate herd size under irrigation. The bred cow is fed the 2.5 ton per head of hay during the winter months. During the summer months the cow and calf are on pasture land. The addition was estimated at 74,066 cows on account of irrigated forage availability. This number of cows was multiplied by the cattle production budget to find the total cattle expenditures for the study region. This number of cattle is shown in Table 5.3.

The cattle produced from the irrigated forage production were sold either to a feedlot or to a slaughter plant within or outside the region. This generated income to cattle producers (who were assumed to be forage producers as well). The number of cattle sold to either a feedlot or slaughter plant was determined using information from the PFRA (Ross Anderson, Personal Communication, 2002). The following assumptions were made:

1) In a typical herd, 15% of cows would be heifers. They would require forage, but would not produce a calf until the following year.

2) From the WBDC information, 97% of the cows would have a live calf.

3) Of the calves born in a given year, there would be enough kept as replacements for cows sent to slaughter which would be equivalent to the heifer number becoming cows (15%).

4) The remaining calves would be sent to a feedlot in Alberta in the fall after coming off summer pasture.

Table 5.2 Forage Production on Irrigation Projects and Private Land

Project Name or Management	Project Acres	Second cut acres	First cut production (tons/acre)	Second cut production (tons/acre)	Total production (tons)
PFRA					
Consul/Nashlyn	3,533	0	1.7	0	6,062
Eastend	2,907	1,072	1.9	1.2	6,652
West Val Marie	2,451	737	1.8	0.8	4,884
Val Marie	4,338	356	2	1.2	8,933
Rush Lake	5,623	1,761	2.5	1.2	15,849
Maple Creek	2,481	1,059	1.7	0.8	5,021
Provincial					
Braddock	393	0	1.7	0	668
Herbert	1,779	557	2.5	1.2	5,116
Lodge Creek	968	413	2	1.2	2,432
Middle Creek	1,086	464	2	1.2	2,728
North Waldeck	1,663	521	2.5	1.2	4,782
Pontiex	1,818	670	2	1.2	4,440
Admiral	343	126	2.5	1.2	1,009
Russell Creek	896	171	2	1.2	1,998
Thomson	312	60	2	1.2	696
Vidora	2,619	0	1.9	0	4,976
Private					
Sprinkler	40,569	0	4	0	162,276
Surface	1,452	339	1.9	0.9	3,064
Total	75,231				241,587

Table 5.3 Number of Cattle Supported by Forage Production

Cattle Population	Number of Cattle
Cattle on Irrigated Forage Production	96,635
Cattle on Dryland Forage Production	22,569
Difference in Cattle Population	74,066

The income from calves sold to feedlots was determined to be $837 per head based on a 550 lb animal at $152.18 per cwt (Saskatchewan Agriculture and Food, 2001). The culled cow was sold for $786 per head based on a 1,400 lb animal with 5% shrinkage for 1,330 lb at a D3 grade of $59.13 per cwt (Saskatchewan Agriculture and Food, 2001). The cows were assumed to be the slaughter animal. The total direct impact used in the input-output model was $50.55 million.

5.7.4 Data for Cattle Processing

The cattle that are produced in Section 5.6.4 create an economic impact in the region through processing. Of the slaughter animals 1% (based on Daryl Tumbach, Personal Communication, 2001) are estimated to be slaughtered in the region. The remaining slaughter animals go to packing plants outside the region. The 1% translated into 111 head.[6]

A commodity vector for expenditures was needed for the cattle slaughter and processing for the study region. These expenditures were collected from Yellowhead Meat Processors near Saskatoon, Saskatchewan (Brad Blackmore, Personal Communication, 2002.) Yellowhead Meat Processors custom slaughter and process cattle. The assumption made in this study was that any cattle slaughtered and processed in the southwest Saskatchewan study region would be slaughtered and processed at a small abattoir similar to Yellowhead Meat Processors. Total expenditures for the 111 head of cattle slaughtered and processed in the southwest Saskatchewan region are shown in Table D.9 in Appendix D. The commodity vector for Yellowhead Meat Processors is shown in Table D.10.

6 The number of head was determined using1% of the cattle sent to slaughter which was 15% of the 74,066.

Once the cattle are slaughtered, the next step was wholesale and retail marketing. From the Kulshreshtha, et al. (1981) study the ratio of total value to farm value was used to convert the farm level value of $1,135 in Saskatchewan into a retail level value of $1,962. The result for southwest Saskatchewan was a direct expenditure of $983 thousand.

In Saskatchewan the estimated slaughter was 10,999 head. This number is the annual culled cows that will be replaced in southwest Saskatchewan. For the cattle slaughtered in large plants in the Saskatchewan and Prairie region the value of $1,962 per head minus the value of the animal at the farm level of $786.43 was broken down using the commodity vector for large scale slaughter and processing (Kulshreshtha, Gould and Yap, 1984). The direct expenditure for Saskatchewan slaughter and processing was $5.563 million., which does not include the value for small abattoirs in southwest Saskatchewan.

5.7.5 Farm Level Drought Data

At the farm level the impact of a drought can be significant. In southwest Saskatchewan, shortage of forage reduces the capacity for over-wintering. This may result in higher than normal marketings of cattle. To determine the economic impact of a drought, data for the response of a cattle producer in the case of a drought and the associated costs were needed. Based on Anderson (1983) two strategies were assumed to be undertaken by dryland producers facing a drought: 1) 20% of cattle producers would sell some of the herd, and 2) 80% of cattle producers would purchase extra feed to maintain the herd.

For the 20% of producers that will reduce the herd size during a drought year, the percent of the herd sold was determined to be approximately 67%. The 67% was

determined from the reduction in forage production during a drought year. The number used for a normal year dryland forage production was 0.75 tons per acre. In a drought year the production was assumed to be 0.25 tons per acre. The cattle herd was disposed of in proportion to forage availability. The dryland cattle herd was estimated to be 22,569 head. Twenty percent of this was 4,513 head and with a retention of 15 % there were 3,837 cows but with only a birth rate of 97% there would be 3,721 calves. Therefore the missed sales per drought would be 3,722 head (3,045 calves and 677 cows). The drought was estimated to have an impact on sales for five years. The result was an average impact of $1.4 million per year.

For the 80% of cattle producers that purchase forage they need 2.5 tons of forage per head. If the dryland forage production under a drought period is 0.25 tons per acre they need to purchase 0.5 tons of forage per acre to maintain the herd under dryland conditions. The price used for forage during a drought came from Saskatchewan Agriculture and Food data of $78 per ton in 1984, (a drought year), adjusted for inflation to the year 2000 by the Saskatchewan Farm Index[7] for crops to $111. The cost to cattle producers for the 18,056[8] head would be $751 thousand in one year.

If a single year drought occurred three times in 20 years, (based on number of times wheat yields where affected for Census Agriculture Region 4A during the 1980 to 2000 time period from Saskatchewan Agriculture and Food Statistics), the annual total lost income and

7 The Saskatchewan Farm Index can be found in the Saskatchewan Agriculture and Food Annual Statistics Handbook.

8 The 18,056 was calculated using 22,569 head times 80%.

expenditures of drought would be $2.152 million. For the impact analysis, the hay purchases were broken down into other agriculture products and the cattle sales were assumed to be lost income.

5.7.6 Domestic Water Use Data

The domestic water use data pertains to the household and stockwatering in the rural area of the study region. The data for domestic water use were not used to determine the expenditures for water use but rather what is the saving in expenditures because of the southwest Saskatchewan water supply systems. This savings occurs because the water user does not invest in another water supply source beyond the southwest Saskatchewan water supply systems. In the PFRA report (Brown, 1991), it was assumed that in 1991 there were 167 rural users that relied on the southwest Saskatchewan water supply systems for their water needs. The number of users was adjusted from the 1991 value to reflect the 1996 population. In 1991 there were 18,485 persons living in the rural area of the study region. In 1996 the population declined by 5.6% to 17,440 persons. The same rate of decline in population was used after 1996. The adjusted number of users for the year 2000 was estimated to be 148 households.

According to Saskatchewan Water Corporation (Rob Wiebe, personnel communication, 2001), in the absence of the southwest Saskatchewan water supply systems there would be three alternative water sources in the region. These users will use one of the following 1) groundwater wells (5%), 2) natural inflow of surface water (35%), and 3) pumping of water from a stream into off-stream storage (60%). The capital expenditure for

each alternative was annualized and added to the operations and maintenance expenditure. The operations and maintenance cost is ½% of the capital cost for the alternative and ½% of capital cost for electricity if used (Brown, 1991). The estimated annual capital and operation and maintenance cost of these alternatives and estimated users for each type is shown in table 5.4.

The economic impact of the domestic water use was determined by taking the difference between two situations: one, if the alternative water supply had to be built and two, if it was not built. The result of this estimation is the total savings to domestic water users. The amount of the savings is money that domestic water users could spend elsewhere in the economy. It was assumed in this study that this sum is spent just like any other income.

5.7.7 Municipal Water Use Data

The municipal water use refers to the water used in communities organized as urban (non-farm) centers. There are five communities in the study region that obtain their water needs from PFRA reservoirs. These communities are Eastend, Gravelbourg, Herbert, Lafleche, and Swift Current. The method of alternative cost of water was used to estimate the value of this water.

The alternative water supply for each community along with the estimated cost is shown in Table 5.5. The capital cost was annualized for each alternative. To use groundwater wells as an alternative water supply, the PFRA estimated cost of $185,000 was used and an operating cost of ½% per year (Brown, 1991). For Swift Current the alternative

Table 5.4 Domestic Water Users Alternatives and Expenditures

Alternative	Ground Water Wells (per user)	Natural Inflow of Surface Water (per user)	Pumping Water from Stream (per user)
Number of Households	8	52	89
Original Capital Expenditure	$30,000	$10,000	$5,000
Rate of Amortization	5%	5%	5%
Life of Asset (years)	50	50	30
Annual Capital Expenditure	$1,643	$548	$325
Annual O&M Expenditure	$2,400	$2,600	$4,575
Total Annual Expenditure	$4,043	$3,148	$4,900

water supply is a pipeline from the South Saskatchewan River. The pipeline would be approximately 50 km in length. The electricity cost of operating the pipeline would be $118,000 per year. The dam at Eastend would have been built to the same standards as the one currently in place according to PFRA single use cost data. The total savings to the urban households was estimated at $1.2 million which was treated in the same manner as that of domestic water.

5.7.8 Industrial Water Use Data

The largest industrial user of water in the study region is the Saskatchewan Mineral Sodium Sulphate Mine located at the village of Chaplin on Lake Chaplin. The mine uses water to dissolve sodium sulfate into solution. From the solution, sodium sulfate is extracted for sale. The mine relies on precipitation and surface water for the water it uses. In

Table 5.5 Municipal Water Alternatives and Cost

Town	Alternative	Original Capital Cost	Life of Asset	Amortization Factor	Annual Capital Expenditure	Annual Operations Expenditure	Total Annual Expenditure
Eastend	Dam	$1,600,000	50	5%	$87,643	$8,000	$95,643
Gravelbourg	Water wells	$200,000	50	5%	$109,553	$20,000	$129,553
Herbert	Water wells	$947,340	50	5%	$51,892	$9,473	$61,365
Lafleche	Water wells	$83,000	50	5%	$45,465	$8,300	$53,765
Swift Current	Pipeline	$11,163,200	25	5%	$792,056	$111,632	$903,688
Total					$1,087,036	$157,405	$1,244,014

addition, the mine diverts water from the Wood River down Chaplin Creek to the mine area. The mine diverted a total of 7,632 dam^3 of water in 2000 out of the Wood River system. This water mostly comes from spring runoff from the Wood River basin.

Saskatchewan Minerals Sodium Sulphate mine is owned by Goldcorp Inc, with the corporate office in Toronto, Ontario. Since the corporate office is outside the study region is was assumed that any savings as a result of the southwest Saskatchewan water supply systems would not remain in the region. Therefore, impacts on the study region, or the prairie provinces were assumed to not occur. However without the water diversion there would be reduced output from the mine.

If the production that occurred because of the diverted water did not occur there would be a loss to the region due to fewer employees. The number of employees was determined using Statistics Canada data (Statistics Canada, 2000b). Knowing that a total of 45 persons are employed at the mine the number of laborers was determined to be 18 persons. Of these laborers three are employed because of the water use from the southwest

Saskatchewan water supply systems. Also the lost earnings would be $158 thousand which was run as a loss to the region.

5.7.9 Recreation

The recreation associated with the southwest Saskatchewan water supply systems consisted of water based activities around the reservoirs and the Thomson Lake Regional Park recreation facilities near Thomson Lake at Lafleche. The recreation facilities at Lafleche were included because without the Thomson Lake dam (to form the reservoir for water storage), there would not be enough water from natural stream flow to maintain the recreation facility. The Lafleche recreation facility includes a golf course, swimming pool, camp ground, and cottages. The expenditures for 2000 at the Lafleche recreation facilities were obtained from the manger of the Thomson Lake Regional Park, Wayne Erikson (Personal Communication, 2002).

A survey of various reservoirs was needed as this information had not been collected by any other organization. This survey was done by asking PFRA project managers to determine the level of use for different water related recreational activities that occur at the PFRA reservoirs.

The recreation at the PFRA reservoirs consisted of several activities that include boating, fishing, swimming etc. which are summarized below in Table 5.6. The data in Table 5.6 shows the number of user days per year for each activity.

Table 5.6 Recreation Activity on PFRA Reservoirs, Number of Person-days per year, 2000

Activity	PFRA reservoirs	Thomson Lake Regional Park	Total
Boating	3,950	4,000	7,950
Ice Fishing	10,632	2,000	12,632
Summer Fishing	13,260	6,000	19,260
Swimming	2,500	2,000	4,500
Hiking	7	3,650	3,657
Wildlife Watching	136	3,650	3,786
Beach	2,620	9,000	11,620
Camping	290	50,000	50,290
Ice Skating	430	60	490
Hunting	1,593	300	1,893
Cottages	990	41,150	42,140
Total	36,408	121,810	158,218

There are two types of recreation users in this study. The first type is the local user. The local user lives within the southwest Saskatchewan region. The local user was assumed to make day trips that would not include overnight accommodation. The second type of user is the non-local user. The non-local user lives outside of the region and is more likely to make overnight trips that last longer than one day.

Expenditure data for the recreation activities were collected from secondary sources. There were two sets of expenditure data used in this study: 1) for the local users and 2) for non-local users. These two types of users were chosen based on the recreation survey of PFRA project managers. The local user expenditure data was taken from the study by

O'Grady, Kulshreshtha and Brockman (1986) for Cranberry Flats recreation site. The non-local expenditure data came from Environment Canada (2000). A summary of the local and non-local user expenditures can be seen in Table D.11 in Appendix D.

The Thomson Lake Regional Park used expenditures from the park and outside the park. The park expenditures were supplied by Wayne Erikson. These were broken down into a commodity vector as were the outside park expenditures. The activities outside the park were broken down to be 20% local and 80% non-local. An adjustment was made to the Environment Canada numbers to remove accommodation that was included in the Park expenditures and remove half of the transportation expenditures and all of the other category of expenditures that would have been made outside the region for the non-local users. These expenditures were multiplied by the share of users to find the total expenditure for Thomson Lake Regional Park.

The activity and expenditures at PFRA reservoirs were calculated using the following rationale. The outdoor activities were said to be 95% local and 5% non-local. The outdoor activities were said to be everything except cottages and hunting. The cottages were said to be 75% local and 25% non-local due to the fact that some of the cottages are used as year round homes. The hunting activity was broken down as 25% local and 75% non-local. The expenditures collected were adjusted for local expenditures. The fishing expenditures for local and non-local in southwest Saskatchewan were reduced to only the transportation and food expenditures. At the provincial level for the commodity vector non-local expenditures were left at the full amount, as equipment that was not purchased in southwest Saskatchewan would have been purchased within Saskatchewan. After these adjustments

were made the expenditures were multiplied by the level of activity to get the direct expenditure data. The total expenditures by local and non-local users may be seen in Table D.12 in Appendix D.

5.7.10 Wildlife Project Development

The wildlife information for this study consisted of expenditures made by Ducks Unlimited on wildlife projects operated in the study region. These were collected through personal communication with Brad Uhrich (Personal Communication, 2001) of Ducks Unlimited.. The expenditures were broken down using estimates by the author. The breakdown factors for the $214,911 in the year 2000 can be seen in table D.13 in Appendix D.

5.7.11 Flood Control Data

There are savings in economic impacts from the southwest Saskatchewan water supply systems dams for the urban centers in the study region. Flood control benefits in this study were obtained from the PFRA (Glen McGlaughin, Personal Communication, 2002). According to this source, only the city of Swift Current receives any flood protection from the operations of various water supply infrastructure. The flood control benefits came from the PFRA. The flood control benefits were determined to be $360,000 per year.

Possibility of flood control benefits to the rural areas below the dams was explored. It was hypothesized that a flood would have a negative impact on the cattle producers if they could not use the area flooded for grazing. After discussions with the PFRA personnel (Dan

Runcie, personal communication, 2002) it was stipulated that producers with pasture area subject to flooding would also have pasture area elsewhere that could be grazed until the flooded pastures were available. Therefore the cattle producer would not have to purchase extra inputs such as forage to compensate for the lost use of the pasture. This resulted in no additional flood control benefits to these farms.

5.7.12 Summary of Total Direct Expenditures in Southwest Saskatchewan Region

From the explanation for each economic activity the next step was to run the data though the input-output model at the southwest Saskatchewan level and the province of Saskatchewan level. Table 5.7 is a summary of the total direct expenditures used in the input-output model for each region.

Table 5.7 Total Direct Expenditure by Activity

Activity	Region	
	Southwest Saskatchewan ($ millions)	Saskatchewan ($ millions)
Infrastructure	$1.64	$1.64
Irrigation	$8.69	$8.69
Cattle Production	$50.55	$50.55
Slaughter	$0.85	$6.55
Community Water Use	$0.69	$0.69
Recreation	$4.15	$6.41
Wildlife	$0.21	$0.21
Flood Control	$0.36	$0.36
Total	$67.14	$76.12

5.8 Determining Value of Water in Regional Economic Development

There are several factors that were considered for the methodology to determine the value of water for regional development. The factors included the scope of activities that should be considered to be regional development and the volume of water. In this section this methodology is explained for determining the value of water for regional economic development.

5.8.1 Scope for Value of Water in Regional Economic Development

In this study the total value of regional economic development was determined using the household economic impact results from the input-output model. Only certain activities affect the regional economic development. The activities that directly use the water from the southwest Saskatchewan water supply systems cannot be included in the total regional economic development since they may have occurred even if the southwest Saskatchewan water supply systems had not been built.

The scope for value of regional development in this study was defined as the activities creating regional development. The scope was defined to include indirect and induced activities caused by the direct water user activities of the southwest Saskatchewan water supply systems. The direct water user activities include PFRA, irrigation, recreation, flood control, domestic water use, municipal water use, industrial water use, and wildlife. The activities that are a indirect result of water use in the southwest Saskatchewan water supply systems are cattle processing and slaughter and cattle production in feedlots. Drought mitigation is neither an direct or indirect water user, but does add value to water

for regional economic development.

Once the scope of the activities included in regional development were defined the next step was to define the region where the regional development occurred. There were three regions defined in this thesis for regional development.

5.8.2 Direct Expenditures Leading to Regional Economic Development in Southwest Saskatchewan Region

For the scope of value of regional development that includes the southwest Saskatchewan water supply systems the direct activities that use water were not included. The only direct economic impact result, due to direct expenditures, included was the cattle slaughter and processing by the local abattoir since it is a forward linkage that does not directly use water from the supply systems. All of the indirect and induced economic impacts from the activities were included as they can be used to measure the producer surplus that contributes to the region's economic development.

One activity that contributes value to the regional economic development but does not have an impact is drought mitigation. Drought mitigation does not actually take place in the economy but there is a value for drought mitigation. There is a value because without the southwest Saskatchewan water supply systems the cattle producers would take some type of action to compensate for the drought. With the southwest Saskatchewan water supply systems the cattle producer does not have to take any different action during a drought period and therefore receives value from the southwest Saskatchewan water supply systems.

5.8.3 Direct Expenditures Leading to Regional Economic Development in the Province of Saskatchewan

The Province of Saskatchewan includes all the activities in southwest Saskatchewan along with all purchases made in the Rest of Saskatchewan region of the MRIO. In addition Saskatchewan cattle slaughter and processing activities were added. These were based on the percent of cattle staying in Saskatchewan using the Saskatchewan Agriculture and Food (2000) data.

5.8.4 Direct Expenditures Leading to Regional Economic Development in the Prairie Region

The third scope for regional development was western Canada Prairie region where PFRA has a mandate to provide programs. In the Prairie region the activities that do not occur in the smaller regions, but do create value for the Prairie region, are cattle production in Alberta feedlots and cattle slaughter and processing in Alberta packing plants. For the cattle production it was assumed that all calves from southwest Saskatchewan were moving into Alberta feedlots. Therefore 49,957 calves were moving into Alberta. The budget for Alberta feedlots (Dale Russell, Personal Communication, 2002), which is shown in Table D.14 (Appendix D), was multiplied by the number of calves and broken down into a commodity vector. The direct expenditure was $60.695 million in addition to the $50.55 million for Saskatchewan.

The slaughter and processing cattle were assumed to be the same number as the calves as they will move through the system on an annual basis. The 49,957 head of cattle were multiplied by the same budget as used in Section 5.6.5 for packing plants. The direct

expenditure was $47.7 million. Table 5.8 shows the direct expenditures by activity for the Prairie region.

Table 5.8 Total Direct Expenditure by Activity for the Prairie Region

Activity	Prairie Region ($1,000's)
Infrastructure	$1,636
Irrigation	$8,688
Cattle Production	$111,244
Slaughter	$47,724
Water Use	$694
Recreation	$5,411
Wildlife	$214
Flood	$360
Total	$175,971

5.8.5 Volume of Water for Regional Economic Development

To determine the value of water for the regional development, the amount of water used by the direct activity that gives rise to the indirect and induced activities needs to be estimated. The data for water use came from the PFRA. The value of water for regional economic development may be based on different volumes of water. For this study it was determined that the appropriate volumes would be the volume consumed (174,547 dam^3), volume of consumed and apportionment (336,826 dam^3) and the total volume of storage in the water supply systems (365,402 dam^3). These three volume were chosen because they represent the different volumes of water used in and available from the system.

CHAPTER SIX

ECONOMIC CONTRIBUTION OF THE SOUTHWEST SASKATCHEWAN WATER SUPPLY SYSTEMS

In this chapter, results for the two study objectives follow. The first objective results to determine the total economic impact using the study input-output model are presented. These are based on direct impacts, as reported in Chapter 5. The results are reported for the economic impact of the activities associated with the southwest Saskatchewan water supply systems and the value of water in regional development for the three regions. The second objective which is to determine a value of water for regional economic development is also presented.

6.1 Economic Contributions of the Southwest Saskatchewan Water Supply Systems

The expenditures for the various activities associated with the southwest Saskatchewan water supply systems caused direct impacts within the economy. The activities created direct impacts for each of the three regions which are described below. The direct contributions are equivalent to the initial expenditures for each activity, which were shown in Table 5.7 in Chapter 5

The total economic contribution of the southwest Saskatchewan water supply

systems includes the direct, indirect and induced economic impacts. The total economic impact is a result of the backward and forward linkages created by the activities of the southwest Saskatchewan water supply systems. In the case of the southwest Saskatchewan water supply systems the irrigation of forage and cattle production creates forward linage activities to cattle slaughter and processing in southwest Saskatchewan abattoirs and Alberta slaughter plants and cattle production in Alberta feedlots.

In this chapter the infrastructure results show the impact of PFRA and provincial water user district expenditures. The irrigation impacts are a result of the irrigator expenditures for producing forage. Cattle production impacts occur through the expenditures for raising cattle. The cattle slaughter and processing is a result of small abattoirs in southwest Saskatchewan and large plants in Saskatchewan and Alberta. The water use impacts are a combined result of domestic, municipal and industrial water use. The recreation impacts occur because of expenditure associated with PFRA reservoirs and Lafleche regional park. Wildlife impacts show the impact of Ducks Unlimited expenditures for their related infrastructure and flood control is the result of the benefit of reduced annual costs from reduced flood damage.

6.1.1 Southwest Saskatchewan Total Contributions for the Southwest Saskatchewan Water Supply Systems

In 2000, the southwest Saskatchewan water supply systems was estimated to provide a total of $108.6 million in output for southwest Saskatchewan. A breakdown of the total output, by activity is shown in Table 6.1. The share of the total of each activity is shown

below in Figure 6.1. Figure 6.1 shows that the cattle production had the largest share of the economic impact for the local region at 76%.

Table 6.1 Southwest Saskatchewan Total Economic Output Breakdown by Activity

Activity	Indirect ($ millions)	Induced ($ millions)	Output ($ millions)
Infrastructure	$0.50	$0.58	$2.70
Irrigation	$3.18	$0.46	$12.30
Cattle Production	$29.41	$3.47	$83.40
Cattle Slaughter and Processing	$0.06	$0.11	$1.00
Community Water Use	$0.57	($0.49)	$0.78
Recreation	$2.60	$0.67	$7.40
Wildlife	$0.07	$0.10	$0.38
Flood Control	$0.00	$0.23	$0.59
Total	$36.40	$5.13	$108.60

If the direct expenditures/impacts from Table 5.7 are compared to these results it can be shown that the indirect and induced impacts are significant. For example the total direct impact in Table 5.7 is $67.14 million and the total economic output impact is $108.6 million. This means that the $67.14 million created $41.53 million in indirect and induced impacts.

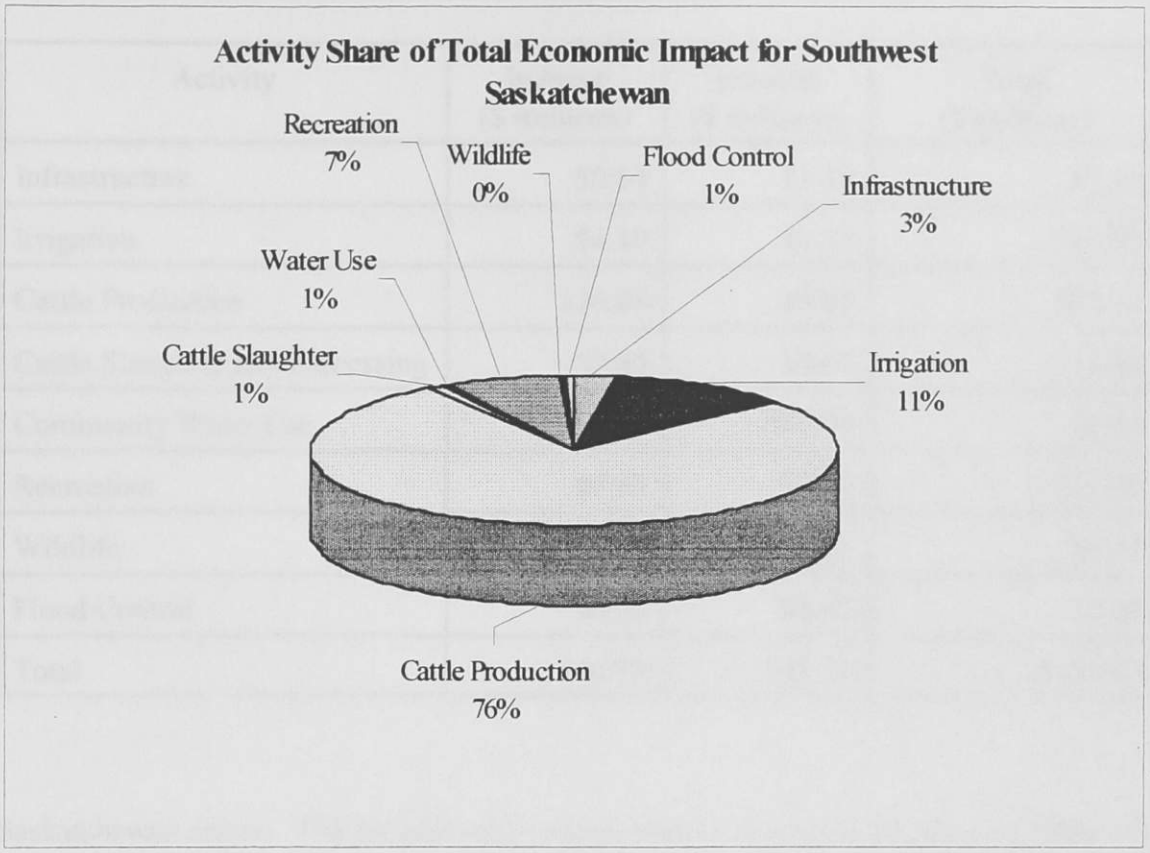


Figure 6.1 Activity Share of Total Economic Impact for Southwest Saskatchewan

6.1.2 Saskatchewan Total Contributions for the Southwest Saskatchewan Water Supply Systems

The Saskatchewan total value of output was estimated to be $136.4 million for 2000. A breakdown of the output by activity is shown in Table 6.2.

The numbers for output include the estimates for southwest Saskatchewan. If the southwest Saskatchewan values given in Section 6.1.1 are subtracted from the Saskatchewan numbers given above the net economic output impact for Saskatchewan can be calculated. The net economic output impact is the contribution to the economy that the southwest Saskatchewan water supply systems makes in the province outside the southwest

Table 6.2 Saskatchewan Total Economic Output Breakdown by Activity

Activity	Indirect ($ millions)	Induced ($ millions)	Total ($ millions)
Infrastructure	$0.64	$1.24	$3.50
Irrigation	$4.10	$1.13	$13.90
Cattle Production	$36.08	$8.67	$95.30
Cattle Slaughter and Processing	$0.84	$2.67	$9.90
Community Water Use	$0.72	($0.99)	$0.42
Recreation	$4.50	$2.06	$11.90
Wildlife	$0.08	$0.21	$0.51
Flood Control	$0.00	$0.51	$0.86
Total	$46.95	$15.51	$136.40

Saskatchewan region. The net economic output impact by activity is shown in Table 6.3. In Table 6.3 it can be seen that outside of southwest Saskatchewan cattle production and cattle slaughter and processing contribute a significant amount to the economy. It should be noted that the net impact of water use in Saskatchewan is negative due to the lost wages that would create induced impacts as a result of consumer expenditures. This suggests that southwest Saskatchewan consumers purchase many goods outside of southwest Saskatchewan.

6.1.3 Prairie Total Contributions for the Southwest Saskatchewan Water Supply Systems

In the Prairie region the total value of output was estimated to be $367.1 million.

The breakdown of the total output is shown in Table 6.4. If Table 6.2 is compared to Table 6.4 it can be seen that the increase in total value of output for the Prairie region comes from cattle producers, an additional $167.7 million, and cattle slaughter and processing, an additional $63 million. The increased cattle production results from the calves from southwest Saskatchewan being raised to market weight in Alberta feedlots. These same calves at market weight go to Alberta slaughter and processing plants on an annual basis to produce the slaughter and processing impact.

Table 6.3 Net Output Impact for Saskatchewan

Activity	Net Economic Output Impact ($ millions)
Infrastructure	$0.80
Irrigation	$1.60
Cattle Production	$11.90
Cattle Slaughter and Processing	$8.90
Community Water Use	($0.35)
Recreation	$4.50
Wildlife	$0.13
Flood Control	$0.27
Total	$27.80

6.2 Regional Economic Development Impacts

In addition to the total economic output impacts the input-output model also reports other impacts. These impacts include GDP at factor cost, income, and employment impacts. These impacts are of interest because they show the GDP in terms of wages and profits. The

income impacts show the income for consumers created by the economic activities. Finally the employment impacts show the change in employment as a result of the economic activities. The tables show the direct, indirect and induced economic impacts.

Table 6.4 Prairie Total Economic Output Breakdown by Activity

Activity	Indirect ($ millions)	Induced ($ millions)	Total ($ millions)
Infrastructure	$0.64	$1.24	$3.50
Irrigation	$1.09	$1.13	$13.90
Cattle Production	$116.88	$34.85	$263.00
Cattle Slaughter and Processing	$8.73	$16.53	$72.90
Community Water Use	$0.71	($0.99)	$0.42
Recreation	$4.50	$2.06	$11.90
Wildlife	$0.08	$0.21	$0.51
Flood Control	$0.00	$0.50	$0.86
Total	$135.64	$55.54	$367.10

6.2.1 Southwest Saskatchewan Regional Economic Development Impacts

The results from the input-output model for GDP at factor cost are shown in Table 6.5, income in Table 6.6 and employment in Table 6.7 by activity.

Table 6.5 shows the GDP at factor cost. The direct contribution values show the direct impact made based on GDP at factor cost. The total direct impact was $45.6 million which created $73.58 million in GDP impacts. This makes up part of the economic output direct impact of $67.14 million and $108.6 million of total economic output.

The income impacts are shown in Table 6.6. The direct income impact was estimated at $1.43 million and the total contribution was $12.44 million for southwest Saskatchewan. This means that the $67.14 million in total direct impact created $12.44 million in additional income for local households.

The employment impacts in Table 6.7 show that there were a total of 855 direct employees and 1,257 employees in total due to the southwest Saskatchewan water supply systems for southwest Saskatchewan.

For the GDP, income and employment tables the irrigation and cattle production values are combined to show that the operations take place on the same farm.

Table 6.5 GDP Impacts for Southwest Saskatchewan

Activity	Direct ($ millions)	Indirect ($ millions)	Induced ($ millions)	Total ($ millions)
Infrastructure	$1.52	$1.08	$0.33	$2.90
Irrigation and Cattle Production	$38.28	$18.02	$2.24	$58.50
Cattle Slaughter and Processing	$0.41	$0.34	$0.06	$0.80
Community Water Use	$0.77	($0.57)	($0.28)	($0.16)
Recreation	$4.14	$1.59	$0.38	$6.11
Wildlife	$0.22	$0.17	$0.05	$0.44
Flood Control	$0.36	$0.36	$0.13	$0.85
Total	$45.60	$22.41	$3.44	$73.58

6.2.2 Saskatchewan Regional Economic Development Impacts

The results from the input-output model for GDP at factor cost are shown in Table

6.8, income in Table 6.9 and employment in Table 6.10 by activity. These values may be interpreted in the same manner as those for southwest Saskatchewan.

In addition to the direct and total contributions of the southwest Saskatchewan water supply system to Saskatchewan the net contribution for Saskatchewan is shown. The net contribution is the impact that occurs within Saskatchewan but outside of the southwest Saskatchewan region and is shown in Table 6.11. The net contribution is the difference between the value for Saskatchewan and southwest Saskatchewan.

Table 6.6 Income Impacts for Southwest Saskatchewan

Activity	Direct ($ millions)	Indirect ($ millions)	Induced ($ millions)	Total ($ millions)
Infrastructure	$0.84	$0.12	$0.19	$1.15
Irrigation and Cattle Production	$5.32	$3.43	$1.26	$10.01
Cattle Slaughter and Processing	$0.16	$0.01	$0.03	$0.21
Community Water Use	($0.92)	$0.19	($0.16)	($0.89)
Recreation	$0.23	$0.90	$0.21	$1.34
Wildlife	$0.13	$0.02	$0.03	$0.18
Flood Control	$0.36	$0.00	$0.07	$0.44
Total	$6.13	$4.66	$1.64	$12.44

6.2.3 Prairie Regional Economic Development Impacts

The results from the input-output model for GDP at factor cost are shown in Table 6.12, income in Table 6.13 and employment in Table 6.14 by activity. The net economic contribution for each activity by impact is shown in Table 6.15.

Table 6.7 Employment Impact for Southwest Saskatchewan

Activity	Direct (persons)	Indirect (persons)	Induced (persons)	Total (persons)
Infrastructure	8	4	6	19
Irrigation and Cattle Production	754	296	43	1,093
Cattle Slaughter and Processing	5	0	1	6
Community Water Use	5	7	-5	7
Recreation	79	38	7	124
Wildlife	4	0	1	5
Flood Control	0	0	3	3
Total	855	346	56	1,257

Table 6.8 GDP Impacts for Saskatchewan

Activity	Direct ($ millions)	Indirect ($ millions)	Induced ($ millions)	Total ($ millions)
Infrastructure	$1.53	$1.13	$0.65	$3.30
Irrigation and Cattle Production	$98.14	$21.04	$18.68	$177.44
Cattle Slaughter and Processing	$44.82	$4.07	$8.58	$72.16
Community Water Use	$0.70	($0.52)	($0.51)	($0.33)
Recreation	$5.40	$2.43	$1.07	$8.90
Wildlife	$0.22	$0.18	$0.11	$0.50
Flood Control	$0.36	$0.36	$0.26	$0.98
Total	$51.23	$28.84	$28.84	$87.97

Table 6.9 Income Impact for Saskatchewan

Activity	Direct ($ millions)	Indirect ($ millions)	Induced ($ millions)	Total ($ millions)
Infrastructure	$0.84	$0.15	$0.38	$1.38
Irrigation and Cattle Production	$5.32	$5.26	$3.01	$13.58
Cattle Slaughter and Processing	$1.92	$0.21	$0.82	$2.95
Community Water Use	($0.92)	$0.22	($0.30)	($1.00)
Recreation	$0.23	$1.38	$0.63	$2.24
Wildlife	$0.13	$0.02	$0.07	$0.22
Flood Control	$0.36	$0.00	$0.16	$0.52
Total	$7.89	$7.24	$4.76	$19.89

Table 6.10 Employment Impact for Saskatchewan

Activity	Direct (persons)	Indirect (persons)	Induced (persons)	Total (persons)
Infrastructure	8	5	11	24
Irrigation and Cattle Production	754	337	86	1,178
Cattle Slaughter and Processing	35	6	24	65
Community Water Use	5	8	-9	4
Recreation	103	57	18	179
Wildlife	4	1	2	6
Flood Control	0	0	4	4
Total	879	424	155	1,510

Table 6.11 Net Economic Contribution for Saskatchewan by Activity

Activity	GDP Net Contribution for Saskatchewan ($ millions)	Income Net Contribution for Saskatchewan ($ millions)	Employment Net Contribution for Saskatchewan (persons)
Infrastructure	$0.37	$0.23	5
Irrigation and Cattle Production	$5.87	$3.57	84
Cattle Slaughter and Processing	$9.40	$2.74	1
Community Water Use	($0.18)	($0.11)	-6
Recreation	$2.79	$0.91	54
Wildlife	$0.06	$0.04	1
Flood Control	$0.13	$0.08	2
Total	$14.38	$7.45	146

Table 6.12 GDP Impacts for Prairie Region

Activity	Direct ($ millions)	Indirect ($ millions)	Induced ($ millions)	Total ($ millions)
Infrastructure	$1.53	$1.13	$0.65	$3.30
Irrigation and Cattle Production	$98.15	$60.63	$18.68	$177.44
Cattle Slaughter and Processing	$44.83	$18.75	$8.58	$72.16
Community Water Use	$0.70	($0.52)	($0.51)	($0.33)
Recreation	$5.40	$2.43	$1.07	$8.90
Wildlife	$0.22	$0.18	$0.11	$0.50
Flood Control	$0.36	$0.36	$0.26	$0.98
Total	$151.19	$82.96	$28.84	$262.95

Table 6.13 Income Impacts for Prairie Region

Activity	Direct ($ millions)	Indirect ($ millions)	Induced ($ millions)	Total ($ millions)
Infrastructure	$0.84	$0.15	$0.38	$1.38
Irrigation and Cattle Production	$12.78	$23.55	$11.06	$47.38
Cattle Slaughter and Processing	$11.48	$1.88	$5.08	$18.44
Community Water Use	($0.92)	$0.22	($0.30)	($1.00)
Recreation	$0.23	$1.38	$0.63	$2.24
Wildlife	$0.13	$0.02	$0.07	$0.22
Flood Control	$0.36	$0.00	$0.16	$0.52
Total	$24.90	$27.21	$17.06	$69.18

Table 6.14 Employment Impacts for Prairie Region

Activity	Direct (persons)	Indirect (persons)	Induced (persons)	Total (persons)
Infrastructure	8	5	11	24
Irrigation and Cattle Production	1,431	1,071	317	2,820
Cattle Slaughter and Processing	264	65	146	474
Community Water Use	5	8	-9	4
Recreation	103	57	18	179
Wildlife	4	1	2	6
Flood Control	0	0	4	4
Total	1,815	1,207	490	3,511

Table 6.15 Net Economic Contribution for Prairie Region by Activity

Activity	GDP Net Contribution for Prairie ($ millions)	Income Net Contribution for Prairie ($ millions)	Employment Net Contribution for Prairie (persons)
Infrastructure	$0.00	$0.00	0
Irrigation and Cattle Production	$113.04	$33.80	1,642
Cattle Slaughter and Processing	$61.95	$15.50	410
Community Water Use	$0.00	$0.00	0
Recreation	$0.00	$0.00	0
Wildlife	$0.00	$0.00	0
Flood Control	$0.00	$0.00	0
Total	$174.99	$49.30	2,052

6.3 Value of Water for Regional Economic Development

6.3.1 Valuation Framework

The second objective of this study was to determine the value of water for regional economic development. This follows directly from the economic impact for the three regions. The value of water for regional economic development comes from the increase in consumer and producer surplus. Without the southwest Saskatchewan water supply systems the increase in consumer and producer surplus would not have occurred. Therefore the income has added value to the region. By taking this household income impact the value of water for regional economic development can be determined.

6.3.2 Estimated Value

The economic value for consumption activities was made up of indirect and induced impacts for irrigation, cattle production and domestic, municipal and industrial water use. In addition the direct impact of cattle slaughter and processing and drought mitigation are included because they are not direct water users. The income impacts created by drought mitigation are shown by region in Table 6.16. These economic impacts are used in addition to the income impacts shown in Tables 6.6, 6.9 and 6.13.

Table 6.16 Income Impacts of Drought Mitigation for Value of Water by Region

Region	Direct ($ millions)	Indirect ($ millions)	Induced ($ millions)	Total ($ millions)
Southwest Saskatchewan	$1.48	($0.03)	$0.29	$1.74
Saskatchewan	$1.48	$0.23	$0.65	$2.37
Prairie	$1.48	$0.23	$0.65	$2.37

The results for estimated value for southwest Saskatchewan are based on water quantities of 174,574 dam^3 for consumption, 336,826 dam^3 for consumption plus apportionment and 365,402dam^3 for storage. These results from these quantities for the corresponding economic value are shown in Table 6.17.

The results for estimated value for Saskatchewan are based on the same volumes of water as southwest Saskatchewan. These results by consumption, consumption plus apportionment and storage capacity are shown in Table 6.18.

The results for estimated value for the Prairie region are based only on the

consumption volume because that is the only volume that creates value for the Prairie region. This result by consumption is shown in Table 6.19.

Table 6.17 Southwest Saskatchewan Value of Water for Regional Economic Development

Water Type	Economic Value ($ millions)	Value ($/dam^3)
Regional Water Consumption	$11.43	$65.50
Total Water Consumption including International Apportionment	$11.43	$33.95
Total Water Storage Capacity	$11.43	$30.29

Table 6.18 Saskatchewan Value of Water for Regional Economic Development

Water Type	Economic Value ($ millions)	Total Value of Water ($/dam^3)
Regional Water Consumption	$30.94	$111.75
Total Water Consumption including International Apportionment	$30.94	$57.92
Total Water Storage Capacity	$30.94	$53.39

Table 6.19 Prairie Value of Water for Regional Economic Development

Water Type	Economic Value ($ millions)	Total Value of Water ($/dam^3)
Regional Water Consumption	$71.59	$394.09

6.4 Summary

The results for the economic impacts and value of water for regional economic development provide several interesting conclusions for this study. The first conclusion that may be drawn from the results, as shown by the $41.46 million of indirect and induced impacts in southwest Saskatchewan, is that the indirect and induced impacts from the southwest Saskatchewan water supply systems are significant in comparison to the direct impacts and should not be ignored. Another conclusion is that the economic impacts of the increased cattle production due to irrigation of forages provides a significant economic contribution to the southwest Saskatchewan region by contributing a total economic output impact of over $95 million. There are also significant economic impacts in the Prairie region because of the feedlot cattle production and cattle slaughter and processing in Alberta at a total net output of $230.7 million.

As a result of the indirect and induced impacts and direct impacts from non-water users there is a value for water from regional economic development. Without the southwest Saskatchewan water supply systems these impacts and value of water may not have been created. The southwest Saskatchewan water supply systems has contributed to the economy through both the backward linkages for inputs in each activity and the forward linkages to the activities such as cattle slaughter and processing and cattle production in Alberta that may not have occurred without the southwest Saskatchewan water supply systems. The southwest Saskatchewan water supply systems also gave the cattle producers a method to mitigate drought which contributed to the value of water. In southwest Saskatchewan the value of water ranges from $30.29 per dam^3 to $65.50 per dam^3 depending on the volume

of water chosen. In the Prairie region the value of water rises to $394 per dam^3. The results show that there is a significant value for water in regional economic development.

CHAPTER SEVEN

SUMMARY

7.1 Summary of Study

The purpose of this study was to determine the economic contribution of the southwest Saskatchewan water supply systems in the year 2000. This was accomplished through two sub-objectives of the study: 1) to determine the economic impacts for southwest Saskatchewan, Saskatchewan and the Prairie region, and 2) to estimate the value of water for regional development for each of the regions.

In the year 2000, the southwest Saskatchewan water supply systems consisted of 22 dams operated by PFRA, six PFRA managed irrigation projects (22,133 acres), ten provincial water projects (11,877 acres) and 42,021 acres of private irrigation. The activities associated with the southwest Saskatchewan water supply systems included infrastructure construction and maintenance, irrigation, cattle production, cattle slaughter and processing, recreation, wildlife, domestic, municipal and industrial water use, and flood control.

All of the southwest Saskatchewan water supply systems were located in a region referred to as southwest Saskatchewan. This region consisted of the rural municipalities with infrastructure associated with the southwest Saskatchewan water supply systems. The region was bounded by the Alberta-Saskatchewan border to the west, the Montana-

Saskatchewan border to the south, the 106° longitude line to the east, and a general line along the South Saskatchewan River to the north.

Most past studies related to the southwest Saskatchewan water supply systems have only determined its direct economic. Estimation of the secondary impacts were not undertaken. Thus, there has not been a basis for determination of the value of water for regional development.

To evaluate the economic impacts for a region, although several economic methods could be considered, the method chosen for this study was an input-output model. This method was chosen because it offered the best level of detail given the data and resources available. To analyze the southwest Saskatchewan water supply systems a rectangular input-output model was developed based on Statistics Canada input-output models (1979). The data which was needed was collected for the activities associated with the southwest Saskatchewan water supply systems. The results as they were determined by the input-output model are described below.

7.2 Summary of Results

The results of this study show that the total economic output impact for southwest Saskatchewan in 2000 was $108.6 million, for Saskatchewan was $136.4 million and the Prairie region was $367.1 million. The household income impact was $12.44 million for southwest Saskatchewan, $19.89 million for Saskatchewan and $39.29 million for the Prairie region.

Following from the economic impacts the value of water for regional economic

development , using consumption as the volume of water, was determined to be $65.50 per dam^3 in southwest Saskatchewan, $111.75 per dam^3 in Saskatchewan and $394.09 per dam^3 for the Prairie region. For water storage the value of water for regional economic development was $30.78 per dam^3 in southwest Saskatchewan and $22.09 per dam^3 in Saskatchewan. These values are based on the producer surplus created by the southwest Saskatchewan water supply systems. The producer surplus was equivalent to the indirect and induced impact of all activities plus the direct impact of forward linkages of the activities associated with the southwest Saskatchewan water supply systems.

The results suggest that if costs to supply the water are less than the value of water for regional economic development there is a value to the region, but if the cost to supply the water is greater than the value of water for regional economic development there is not any economic reason to supply the water.

7.3 Areas for Further Study

In this study several assumptions were made. These assumptions were made to compensate for data limitations and to simplify real world activities.

The irrigation assumptions included the use of an ICDC production budget from Outlook for the sprinkler irrigation in southwest Saskatchewan because only one sprinkler budget for southwest Saskatchewan irrigation survey was returned. Another assumption made was that production costs were uniform across all irrigation acres regardless of location. To rectify these assumptions a more extensive survey of forage producers in the region should be carried out.

The cattle production assumptions were that calves born in the spring were sold in the fall, except for replacement for cows sold in the fall, and therefore feed was only needed for the cows and bulls over winter. It was assumed that only forage was fed to the cattle during winter. This changed the production costs, in terms of feed, by removing grains and other feedstuffs. It was also assumed that all calves were sold to Alberta feedlots. The supply and disposition of cattle information from southwest Saskatchewan needs to be better developed for calf and slaughter cattle movement.

The assumptions for cattle slaughter and processing were made for southwest Saskatchewan and Prairie region. In southwest Saskatchewan the assumption made was that all cattle were slaughtered locally at small abattoirs. The cattle slaughtered outside southwest Saskatchewan were slaughtered at large plants. For the large plants the cost breakdown was done using 1981 margins as newer margins were not available.

For water use the assumptions for municipalities and industrial water use were that the alternative water supply would be groundwater wells for most situations. This was based on very limited knowledge of the groundwater availability in the region. Therefore some locations may not have access to groundwater or would have to spend additional funds on water treatment. This could have a significant influence on economic impacts.

There were several assumptions made for the recreation activity. The assumptions can be broken down by local and non-local users. It was assumed that local users made only day trips which reduced accommodation expenditures. The non-local users were assumed to make several purchases outside the southwest Saskatchewan region but within Saskatchewan which affected the expenditure level used in the model for each region.

As a result of these assumptions several areas of further study could be carried out to improve the results of this study. These areas of study include:

1) updated PFRA expenditures for the year 2000,

2) more extensive survey of forage irrigators regarding productions costs,

3) a survey of cattle producers in the region to establish actual production practices,

4) development of a better supply and disposition charts for cattle movements in and out of southwest Saskatchewan.

5) a study of current slaughter and processing costs in western Canada,

6) determination of water availability in the region for alternative water supplies for domestic, municipal and industrial water users,

7) a primary survey of recreation users by reservoir in southwest Saskatchewan and,

8) flood control study for other dams in the southwest Saskatchewan water supply systems.

One of the objectives of the PFRA Act was to have "greater economic security" (Queen's Printer, 1985). The results of this study suggest that the southwest Saskatchewan water supply systems may have partially achieved this objective. The results show a substantial economic impact from activities and the indirect and induced impacts have created economic value for the region that would not have occurred without the southwest Saskatchewan water supply systems.

REFERENCES

Anderson, Marv and Associates Ltd.,1983. *1980 Drought Adjustment Patterns, Study Element 4.* Regina, Saskatchewan

Anderson, Ross, 2002. Personal Communication, Maple Creek, Saskatchewan

Blackmore, Brad, 2002. Personal Communication. Yellowhead Meat Processors. Saskatoon, Saskatchewan

Blaug, Mark, 1992. *The Methodology of Economics or How Economists Explain.* Cambridge University Press, Cambridge.

Brown, G., 1991. *Economic Assessment of PFRA Irrigation Projects and Reservoirs in Southwest Saskatchewan.* Policy and Analysis Division. Regina: Prairie Farm Rehabilitation Administration

Cicchetti, Charles J., V. Kerry Smith and John Carson, 1975. "An Economic Analysis of Water Resource Investments and Regional Growth". *Water Resources Research.* 11(1): 1-6

Cox, P.T., G.W. Grover and B. Siskin, 1971. "Effect of Water Resource Investment on Economic Growth". *Water Resources Research.* 7(1): 32-38

Crane, David, 1980. *A Dictionary of Canadian Economics.* Hurtig Publishers, Edmonton.

Czamanski, Stanislaw, 1968. *An Econometric Model of Nova Scotia.* Institute of Public Affairs, Dalhousie University. Halifax, Canada

Dinc, Mustafa, Kingsley Hayes and William P. Anderson, 1998. "Regional Productivity Change in Canadian Manufacturing: A Multifactor / Shift-Share Approach." *Canadian Journal of Regional Science.* 21(3): 385-413

Dinc, Mustafa and Kingsley Hayes, 1999. "Sources of Regional Inefficiency: An Integrated Shift-Share, Data Envelopment Analysis and Input-Output Approach." *Annals of Regional Science.* 33(4):469-489

Dominion of Canada Department of Agriculture - Prairie Farm Rehabilitation Administration, 1937a. *The Prairie Farm Rehabilitation Act*. Pamphlet No. 1. Regina.

Dominion of Canada Department of Agriculture - Prairie Farm Rehabilitation Administration, 1937b. *Large Projects*. Pamphlet No. 10. Regina.

Doyle, Chris J., Morag Mitchell and Kairsty Topp, 1997. "Effectiveness of Farm Policies on Social and Economic Development in Rural Areas." *European Review of Agricultural Economics*. 24(3-4): 530-546

Environment Canada, 2000. *The Importance of Nature to Canadians: The Economic Significance of Nature Related Activities*. Ottawa

Erickson, Wayne, 2002. Personal Communication. Thomson Lake Regional Park. Lafleche, Saskatchewan

Findeis, Jill L. and Norman K. Whittleses, 1984. "The Secondary Economic Impacts of Irrigation Development in Washington." *Western Journal of Agricultural Economics Association*. 9(2): 233-243

Gould, B.W. and S.N. Kulshreshtha, 1985. "An Input-Output Analysis of the Impacts of Increased Export Demand for Saskatchewan Products." *Canadian Journal of Agricultural Economics*. 33(2): 127-149

Graham, Daniel J. and Nigel Spence, 1998. "A Productivity Growth Interpretation of the Labour Demand Shift-Share Model." *Regional Studies*. 32(6): 515-525

Graham, Daniel J. and Nigel Spence, 2000. " Manufacturing Employment Change, Output Demand and Labor Productivity in the Regions of Britain." *International Regional Science Review*. 23(2): 172-200

Gramlich, Edward, M., 1990. *A Guide to Benefit-Cost Analysis*. Prentice Hall, Englewood Cliffs, New Jersey.

Hamilton, Joel R. and Richard L. Gardner, 1986. Value Added and Secondary Benefits in Regional Projection Evaluation: Irrigation Development in the Snake River Basin. *Annals of Regional Science*. 20(1): 1-11

Hamilton, Joel R., Norman K. Whittlesey, M. Henry Robison, and John Ellis, 1991. Economic Impacts, Value Added, and Benefits in Regional Project Analysis. *American Journal of Agricultural Economics*. 73(2): 334-244

Hewings, Geoffrey J. D., 1985. *Regional Input-Output Analysis.* Beverly Hills, California: Sage Publications, Inc.

Hewings, Geoffrey J.D., Yasuhide Okuyama and Michael Sonis, 2001. "Economic Interdependence within the Chicago Metropolitan Area: A Miyazama Analysis". *Journal of Regional Science.* 41(2): 195-217

Howe, C.W, 1968. "Water Resources and Regional Economic Growth in the United States 1950-1960". *Southern Economic Journal.* 34(4): 477-489

Irrigation Crop Diversification Corporation, 2000. *Irrigation Economics and Agronomics Saskatchewan 2000.* Outlook, Saskatchewan.

Isard, Walter, 1975. *Introduction to Regional Science.* Englewood Cliffs: Prentice-Hall, Inc.

Kulshreshtha, S.N., 2002. Personal Communication, Department of Agricultural Economics, University of Saskatchewan, .Saskatoon, Saskatchewan

Kulshreshtha, S.N., B.W. Gould and M.T. Yap, 1984. *The Structure of the Saskatchewan Economy: An Input-Output Analysis.* Department of Agricultural Economics, University of Saskatchewan, Saskatoon, Saskatchewan.

Kulshreshtha, S.N., Calvin Kelly, Brent Swallow, and Terri Kristjanson-Wintonyk, 1981. *Estimation of the Canadian Food Marketing Bill 1976 to 1978.* Department of Agricultural Economics, University of Saskatchewan, Saskatoon, Saskatchewan.

Kulshreshtha, Surendra N. and Charles Grant, 2002. *Irrigation: the Economic Impact on Manitoba.* Agriculture and Agri-Food Canada, Prairie Farm Rehabilitation Administration, Winnipeg.

Lee, Yung Joon and Hyoungsoo Zang, 1998. "Urbanisation and Regional Productivity in Korean Manufacturing". *Urban Studies.* 35(11): 2085-2099

Leistritz, F. Larry, 1997. Assessing Local Socioeconomic Impacts of Rural Manufacturing Facilities: The Case of a Proposed Agricultural Processing Plant. *Journal of Community Development Society.* 28(1): 43-64

Leistritz, F. Larry, Norman E. Toman, Steve H. Murdock, and John De Montel, 1981. *Cash Flow Analysis for Energy Impacted Local Governments- A Case Study of Mercer County, North Dakota.* Socio-Economic Planning Sciences. 15: 165-174

Leontief, W.W. and A. Stout, 1963. Multiregional Input-Output Analysis. In *Stuctural Interdependence and Economic Development*, ed. T. Barna, 119-149. Macmillan, London

McConnell, Campbell R. and William Henry Pope, 1984. *Economics Principles, Problems, and Polices. Third Canadian Edition.* McGraw-Hill Ryerson Limited. Toronto

McLaughlin, Glen, 2001. Personal Communication. Prairie Farm Rehabilitation Administration.. Swift Current, Saskatchewan

McNinch, Ian, 2001. Personal Communication, Western Beef Development Centre. Saskatoon, Saskatchewan

Moore, John R, 1967. *The Economic Impact of TVA.* Knoxville: The University of Tennessee Press

Musgrave, Richard A. and Peggy B. Musgrave, 1980. *Publid Finance in Theory and Practice Third Edition.* New York: McGraw-Hill Book Company.

Nijkamp, Peter, 1986. *Handbook of Regional and Urban Economics: Volume 1 Regional Economics.* Amsterdam: Elsevier Science Publishers B.V.

O'Grady, Kevin, S.N. Kulshreshtha and Joanne L. Brockman, 1986. *South Saskatchewan River Basin Recreation Survey: Data Collection and Data Base Development.* Department of Agricultural Economics, University of Saskatchewan, Saskatoon

Prairie Farm Rehabilitation Administration, undated. *PFRA and Irrigation in Southwest Saskatchewan*, Regina.

Prairie Farm Rehabilitation Administration, various years. Annual Reports

Prairie Farm Rehabilitation Administration, 1987. *Assiniboine South-Helspler Area Study.* Regina

Queens' Printer, 1985. Prairie Farm Rehabilitation Act. Ottawa.

Richardson, Harry W., 1972. *Input-Output and Regional Economics.* Trowbridge, Wiltshire: Redwood Press Limited.

Robison, M. Henry and Richard S. Mack, 1996. "The Use of Job and Income Projections as Backdrops for Input-Output Impact Assessments." *Journal of Regional Analysis and Policy.* 28(2): 29-33

Runcie, Dan, 2002. Personal Communication. Prairie Farm Rehabilitation Administration. Swift Current, Saskatchewan.

Russell, K. D., 2002. Personal Communication. Russell Consulting, Diamond City, Alberta

Russell, K. D., K. Craig and S.N. Kulshreshtha, 1993. *Regional Development.* Report submitted to the Alberta Irrigation Projects Association. Lethbridge: UMA Engineering

Saskatchewan Agriculture and Food, 2000. Brown Soil Zone Crop Budgets. Regina, Saskatchewan.

Saskatchewan Agriculture and Food, 2000. Statistics Handbook

Siebert, Horst, 1969. *Regional Economic Growth: Theory and Policy.* Scanton, Pennsylvania: International Textbook Company

Smith, Tony E., 1987. "Poisson Gravity Models of Spatial Flows. *Journal of Regional Science.* 27(3): 315-340

Statistics Canada, 1979. *The Input-Output Structure of the Canadian Economy 1961-74.* Ottawa.

Statistics Canada, 1996. *Agricultural Profile of Saskatchewan.* Catalogue 95-179-XPB. Ottawa.

Statistics Canada, 2000a. 1996 Saskatchewan Transaction Tables

Statistics Canada, 2000b. Employment and Earnings and Hours, December 2000. Catalogue 72-002-XPB. Ottawa.

Statistics Canada, 2001. Special Tablulation

Supply and Services Canada, 1986. Report of the Auditor General of Canada to the House of Commons. Ottawa, Ontario.

Supply and Services Canada, 1997. Report of the Auditor General of Canada to the House of Commons. Ottawa, Ontario.

Tumbach, Daryl, 2001. Personal Communication, Saskatchewan Agriculture and Food, Maple Creek, Saskatchewan.

Urich, Brad, 2000. Personal Communication. Ducks Unlimited. Regina, Saskatchewan

van Kooten, G. Cornelis, 1993. *Land Resource and Sustainable Development: Economic Policies and the Common Good.* UBC Press, Vancouver, British Columbia.

Vavra, Bill, 2002. Personal Communication. Saskatchewan Water Corporation. Outlook, Saskatchewan

Veeman, Terrence S., 1985. *Water and Economic Growth in Western Canada.* Discussion Paper No. 279. Ottawa: Economic Council of Canada.

Wiebe, Rob, 2001. Personal Communication, Saskatchewan Water Corporation. Swift Current, Saskatchewan

APPENDIX A

LIST OF DAMS AND OTHER STRUCTURES IN THE SOUTHWEST SASKATCHEWAN REGION

Table A.1 Dams Constructed by PFRA in the Study Region

Dam	Waterway	Year Built	Purpose
Adams Lake	Battle Creek	1936	Irrigation
Admiral	Notukeu Creek	1949	Irrigation and Stockwatering
Altawan	Lodge Creek	1960	Irrigation
Braddock	Wiwa Creek	1951	Irrigation
Cadillac	Bull Creek	1945	Irrigation
Cypress Lake	Cypress Lake	1939	Irrigation
Downie Lake	Gap Creek	1938	Stockwatering
Eastend	Frenchman River	1937	Irrigation
Gouverneur	Notukeu Creek	1952	Irrigation
Harris	Maple Creek	1956	Irrigation
Herbert	-	1952	Storage
Highfield	Rush Lake Creek	1942	Irrigation
Junction	Maple Creek	1939	Irrigation
Lac Pelletier	Pelletier Creek	1937	Stockwatering
McDougald	Maple Creek	1940	Irrigation
Middle Creek	Battle Creek	1937	Irrigation
Nashlyn	Battle Creek	1961	Irrigation
Reid Lake	Swift Current Creek	1943	Storage & Irrigation
Russell	Russell Creek	1951	Irrigation
Sauder	-	1946	Storage & Irrigation
Semereau	Pinto Creek	1966	Storage
Shaheen	-	1946	Storage & Irrigation
Summercove	Wood River	1963	Irrigation
Thomson Lake	Wood River	1957	Multi-purpose
Val Marie	Frenchman River	1936	Irrigation
West Val Marie	Frenchman River	1939	Irrigation

Source: PFRA Annual Reports

Table A.2 PFRA Irrigation Projects in the Study Region

Project	Year Completed	Year 2000 Acres
Val Marie	1936	4338
West Val Marie	1950	2451
Eastend	1936	2907
Consul/Nashlyn	1946	3533
Maple Creek	1942	2481
Rush Lake	1944	5623

Source: PFRA Annual Reports

Table A.3 Provincial Irrigation Projects in the Study Region

Project	Year Completed	Year 2000 Acres
Admiral	not available	343
Braddock	not available	393
Herbert	1947	1779
Lodge Creek	1958	968
Middle Creek	1937	1086
North Waldeck	1948	1663
Ponteix	1949	1818
Russell Creek	not available	896
Thomson	not available	312
Vidora	1961	2619

Source: SaskWater Corp. data

APPENDIX B

LIST OF RURAL MUNICIPALITIES INCLUDED IN SOUTHWEST SASKATCHEWAN REGION

Table B.1 List of Rural Municipalities Used to Make up the Southwest Saskatchewan Region

Rural Municipality Name	Rural Municipality Number	Rural Municipality Name	Rural Municipality Number
Val Marie	17	Glen Bain	105
Lone Tree	18	Whiska Creek	106
Frontier	19	Lac Pelletier	107
Old Post	43	Bone Creek	108
Waverley	44	Carmichael	109
Mankota	45	Piapot	110
Glen McPherson	46	Maple Creek	111
White Valley	49	Lawtonia	135
Reno	51	Coulee	136
Stonehenge	73	Swift Current	137
Wood River	74	Webb	138
Pinto Creek	75	Gull Lake	139
Auvergne	76	Big Stick	141
Wise Creek	77	Enterprise	142
Grassy Creek	78	Morse	165
Arlington	79	Excelsior	166
Sutton	103	Pittville	169
Gravelbourg	104	Fox Valley	171

APPENDIX C

DATA FOR ECONOMIC IMPACT ANALYZER

Table C.1 Input Proxy Table for Agriculture Sector (in $ millions)

	Farm Type	Grains	Large Scale	Southwest Irrigation	Dairy	Cattle (Beef)	Hog
Commodity Sector							
1	Grains	358.40	0.31	0.00	1.04	12.52	2.88
2	Other agricultural	377.14	6.02	10.66	20.07	330.85	4.72
3	Forestry products	3.65	0.00	0.00	0.04	1.57	0.04
4	Fish, seafood and	0.00	0.00	0.00	0.00	0.00	0.00
5	Metal ores &	0.00	0.00	0.00	0.00	0.00	0.00
6	Mineral fuels	4.14	0.02	0.01	0.10	0.75	0.20
7	Non-metallic	7.65	0.05	0.01	0.18	1.38	0.37
8	Services incidental	0.00	0.00	0.00	0.00	0.00	0.00
9	Meat, fish, and dairy	1.51	0.00	0.00	0.14	1.80	0.20
10	Fruit, veg. and	112.34	0.67	0.19	2.65	20.24	5.49
11	Soft drinks and	0.00	0.00	0.00	0.00	0.00	0.00
12	Tobacco and	0.00	0.00	0.00	0.00	0.00	0.00
13	Leather, rubber, and	12.14	0.07	0.02	0.29	2.19	0.59
14	Textile products	4.78	0.03	0.01	0.11	0.86	0.23
15	Hosiery, clothing	0.00	0.00	0.00	0.00	0.00	0.00
16	Lumber and wood	2.24	0.01	0.00	0.05	0.40	0.11
17	Furniture and	0.00	0.00	0.00	0.00	0.00	0.00
18	Wood pulp, paper	2.66	0.02	0.00	0.06	0.48	0.13
19	Printing and	0.00	0.00	0.00	0.00	0.00	0.00
20	Primary metal	0.00	0.00	0.00	0.00	0.00	0.00
21	Other metal	25.80	0.16	0.04	0.61	4.65	1.26
22	Machinery and	67.33	3.46	0.02	1.21	10.35	1.36
23	Motor veh., oth.	1.19	0.06	0.00	0.02	0.18	0.02
24	Electrical,	0.00	0.00	0.00	0.00	0.00	0.00
25	Non-metallic	0.11	0.00	0.00	0.00	0.02	0.01
26	Petroleum and coal	229.40	1.38	0.40	5.42	41.34	11.21
27	Chemicals,	695.29	3.02	1.48	5.36	59.14	10.85
28	Other manufactured	0.00	0.00	0.00	0.00	0.00	0.00
29	Residential	0.00	0.00	0.00	0.00	0.00	0.00
30	Non-residential	0.00	0.00	0.00	0.00	0.00	0.00
31	Repair construction	49.73	0.30	0.09	1.17	8.96	2.43
32	Transportation and	29.80	0.18	0.05	0.70	5.37	1.46
33	Communications	39.43	0.24	0.07	0.93	7.11	1.93
34	Other utilities	76.07	0.46	0.13	1.80	13.71	3.72
35	Wholesaling	205.63	1.24	0.36	4.86	37.06	10.05
36	Retailing margins	18.39	0.11	0.03	0.43	3.31	0.90
37	Gross imputed rent	0.00	0.00	0.00	0.00	0.00	0.00
38	Other finance,	404.42	2.43	0.70	9.55	72.88	19.77
39	Business and	56.36	0.34	0.10	1.33	10.16	2.75
40	Private education	0.00	0.00	0.00	0.00	0.00	0.00
41	Health and social	0.00	0.00	0.00	0.00	0.00	0.00
42	Accommodation	0.00	0.00	0.00	0.00	0.00	0.00
43	Other services	82.99	0.50	0.14	1.96	14.95	4.06
44	Transportation	46.57	0.28	0.08	1.10	8.39	2.28
45	Operating, office,	276.55	1.66	0.48	6.53	49.84	13.52
46	Travel &	0.28	0.00	0.00	0.01	0.05	0.01
47	Non-profit	0.00	0.00	0.00	0.00	0.00	0.00
48	Government sector	0.00	0.00	0.00	0.00	0.00	0.00
49	Non-competing	0.00	0.00	0.00	0.00	0.00	0.00
50	Unallocated imports	0.00	0.00	0.00	0.00	0.00	0.00
51	Sales of other	5.52	0.03	0.01	0.13	0.99	0.27
52	Indirect taxes	363.81	2.19	0.63	8.59	65.56	17.78
53	Subsidies	-	(1.01)	(1.03)	(1.92)	(21.95)	(2.97)
54	Wages and salaries	212.55	1.28	0.37	5.02	38.30	10.39
55	Supplementary	0.00	0.00	0.00	0.00	0.00	0.00
56	Mixed income	1,139.64	16.33	1.13	29.95	110.10	43.04
57	Other operating	793.85	40.81	0.28	14.31	122.04	16.05
58	TOTAL	5,451.25	82.65	16.47	123.82	1,035.54	187.12

Table C.1 Input Proxy Table for Agriculture Sector (in $ millions) (continued)

		Poultry	Livestock Combination	Misc.	Non-Commercial	Total
1	Grains	0.49	5.26	2.25	0.26	383.40
2	Other agricultural products	2.07	26.33	48.20	3.15	829.20
3	Forestry products	0.01	0.14	0.34	0.01	5.80
4	Fish, seafood and trapping products	0.00	0.00	0.00	0.00	0.00
5	Metal ores & concentrates	0.00	0.00	0.00	0.00	0.00
6	Mineral fuels	0.10	0.15	0.16	0.00	5.62
7	Non-metallic minerals	0.18	0.28	0.29	0.01	10.40
8	Services incidental to mining	0.00	0.00	0.00	0.00	0.00
9	Meat, fish, and dairy products	0.04	0.22	0.30	0.01	4.21
10	Fruit, veg. and other food products, feeds	2.62	4.05	4.31	0.12	152.70
11	Soft drinks and alcoholic beverages	0.00	0.00	0.00	0.00	0.00
12	Tobacco and tobacco products	0.00	0.00	0.00	0.00	0.00
13	Leather, rubber, and plastic products	0.28	0.44	0.47	0.01	16.50
14	Textile products	0.11	0.17	0.18	0.00	6.50
15	Hosiery, clothing and accessories	0.00	0.00	0.00	0.00	0.00
16	Lumber and wood products	0.05	0.08	0.09	0.00	3.05
17	Furniture and fixtures	0.00	0.00	0.00	0.00	0.00
18	Wood pulp, paper and paper products	0.06	0.10	0.10	0.00	3.61
19	Printing and publishing	0.00	0.00	0.00	0.00	0.00
20	Primary metal products	0.00	0.00	0.00	0.00	0.00
21	Other metal products	0.60	0.93	0.99	0.03	35.07
22	Machinery and equipment	0.32	2.11	2.12	0.11	88.40
23	Motor veh., oth. transport equip. and parts	0.01	0.04	0.04	0.00	1.57
24	Electrical, electronic and communic. prod.	0.00	0.00	0.00	0.00	0.00
25	Non-metallic mineral products	0.00	0.00	0.00	0.00	0.15
26	Petroleum and coal products	5.35	8.27	8.80	0.24	311.80
27	Chemicals, pharmaceuticals & chemical	1.61	14.42	11.74	0.09	803.00
28	Other manufactured products	0.00	0.00	0.00	0.00	0.00
29	Residential construction	0.00	0.00	0.00	0.00	0.00
30	Non-residential construction	0.00	0.00	0.00	0.00	0.00
31	Repair construction	1.16	1.79	1.91	0.05	67.60
32	Transportation and storage	0.70	1.07	1.14	0.03	40.50
33	Communications services	0.92	1.42	1.51	0.04	53.60
34	Other utilities	1.78	2.74	2.92	0.08	103.40
35	Wholesaling margins	4.80	7.41	7.89	0.21	279.50
36	Retailing margins	0.43	0.66	0.71	0.02	25.00
37	Gross imputed rent	0.00	0.00	0.00	0.00	0.00
38	Other finance, insurance, and real estate	9.44	14.57	15.52	0.42	549.70
39	Business and computer services	1.32	2.03	2.16	0.06	76.60
40	Private education services	0.00	0.00	0.00	0.00	0.00
41	Health and social services	0.00	0.00	0.00	0.00	0.00
42	Accommodation services and meals	0.00	0.00	0.00	0.00	0.00
43	Other services	1.94	2.99	3.19	0.09	112.80
44	Transportation margins	1.09	1.68	1.79	0.05	63.30
45	Operating, office, cafeteria and lab. supplies	6.46	9.97	10.61	0.29	375.90
46	Travel & entertainment, advertising &	0.01	0.01	0.01	0.00	0.37
47	Non-profit institutions serving households	0.00	0.00	0.00	0.00	0.00
48	Government sector services	0.00	0.00	0.00	0.00	0.00
49	Non-competing imports	0.00	0.00	0.00	0.00	0.00
50	Unallocated imports and exports	0.00	0.00	0.00	0.00	0.00
51	Sales of other government services	0.13	0.20	0.21	0.01	7.50
52	Indirect taxes	8.49	13.11	13.96	0.38	494.50
53	Subsidies	(0.39)	(5.10)	(3.79)	(0.24)	(294.50)
54	Wages and salaries	4.96	7.66	8.16	0.22	288.90
55	Supplementary labour income	0.00	0.00	0.00	0.00	0.00
56	Mixed income	13.38	48.24	28.23	(3.35)	1,426.70
57	Other operating surplus	3.83	24.88	25.01	1.26	1,042.30
58	TOTAL	74.33	198.32	201.54	3.63	7,374.66

Table C.2 Output Proxy Table for Agriculture Sector (in $ millions)

		Grains	Large	Southw	Dairy	Cattle (Beef)	Hog
1	Grains	4,021.56	10.55	0.00	17.16	108.37	109.63
2	Other agricultural	1,391.55	65.23	15.84	101.02	888.24	58.53
3	Forestry products	8.98	0.00	0.00	0.16	3.08	0.39
4	Fish, seafood and trapping	0.00	0.00	0.00	0.00	0.00	0.00
5	Metal ores & concentrates	0.00	0.00	0.00	0.00	0.00	0.00
6	Mineral fuels	0.00	0.00	0.00	0.00	0.00	0.00
7	Non-metallic minerals	0.00	0.00	0.00	0.00	0.00	0.00
8	Services incidental to	0.00	0.00	0.00	0.00	0.00	0.00
9	Meat, fish, and dairy	10.72	0.00	0.00	1.49	10.18	4.88
10	Fruit, veg. and other food	0.00	0.00	0.00	0.00	0.00	0.00
11	Soft drinks and alcoholic	0.00	0.00	0.00	0.00	0.00	0.00
12	Tobacco and tobacco	0.00	0.00	0.00	0.00	0.00	0.00
13	Leather, rubber, and	0.00	0.00	0.00	0.00	0.00	0.00
14	Textile products	0.00	0.00	0.00	0.00	0.00	0.00
15	Hosiery, clothing and	0.00	0.00	0.00	0.00	0.00	0.00
16	Lumber and wood	0.00	0.00	0.00	0.00	0.00	0.00
17	Furniture and fixtures	0.00	0.00	0.00	0.00	0.00	0.00
18	Wood pulp, paper and	0.00	0.00	0.00	0.00	0.00	0.00
19	Printing and publishing	0.00	0.00	0.00	0.00	0.00	0.00
20	Primary metal products	0.00	0.00	0.00	0.00	0.00	0.00
21	Other metal products	0.00	0.00	0.00	0.00	0.00	0.00
22	Machinery and equipment	0.00	0.00	0.00	0.00	0.00	0.00
23	Motor veh., oth.	0.00	0.00	0.00	0.00	0.00	0.00
24	Electrical, electronic and	0.00	0.00	0.00	0.00	0.00	0.00
25	Non-metallic mineral	0.00	0.00	0.00	0.00	0.00	0.00
26	Petroleum and coal	0.00	0.00	0.00	0.00	0.00	0.00
27	Chemicals,	4.68	6.48	0.61	3.49	23.90	11.45
28	Other manufactured	0.00	0.00	0.00	0.00	0.00	0.00
29	Residential construction	0.00	0.00	0.00	0.00	0.00	0.00
30	Non-residential	0.00	0.00	0.00	0.00	0.00	0.00
31	Repair construction	0.00	0.00	0.00	0.00	0.00	0.00
32	Transportation and	0.00	0.00	0.00	0.00	0.00	0.00
33	Communications services	0.00	0.00	0.00	0.00	0.00	0.00
34	Other utilities	0.00	0.00	0.00	0.00	0.00	0.00
35	Wholesaling margins	0.00	0.00	0.00	0.00	0.00	0.00
36	Retailing margins	0.00	0.00	0.00	0.00	0.00	0.00
37	Gross imputed rent	0.00	0.00	0.00	0.00	0.00	0.00
38	Other finance, insurance,	13.76	0.39	0.01	0.51	1.76	2.23
39	Business and computer	0.00	0.00	0.00	0.00	0.00	0.00
40	Private education services	0.00	0.00	0.00	0.00	0.00	0.00
41	Health and social services	0.00	0.00	0.00	0.00	0.00	0.00
42	Accommodation services	0.00	0.00	0.00	0.00	0.00	0.00
43	Other services	0.00	0.00	0.00	0.00	0.00	0.00
44	Transportation margins	0.00	0.00	0.00	0.00	0.00	0.00
45	Operating, office,	0.00	0.00	0.00	0.00	0.00	0.00
46	Travel & entertainment,	0.00	0.00	0.00	0.00	0.00	0.00
47	Non-profit institutions	0.00	0.00	0.00	0.00	0.00	0.00
48	Government sector	0.00	0.00	0.00	0.00	0.00	0.00
49	Non-competing imports	0.00	0.00	0.00	0.00	0.00	0.00
50	Unallocated imports and	0.00	0.00	0.00	0.00	0.00	0.00
51	Sales of other	0.00	0.00	0.00	0.00	0.00	0.00
52	Indirect taxes	0.00	0.00	0.00	0.00	0.00	0.00
53	Subsidies	0.00	0.00	0.00	0.00	0.00	0.00
54	Wages and salaries	0.00	0.00	0.00	0.00	0.00	0.00
55	Supplementary labour	0.00	0.00	0.00	0.00	0.00	0.00
56	Mixed income	0.00	0.00	0.00	0.00	0.00	0.00
57	Other operating surplus	0.00	0.00	0.00	0.00	0.00	0.00
58	TOTAL	5,451.25	82.65	16.47	123.82	1,035.54	187.12

Table C.2 Output Proxy Table for Agriculture Sector (in $ millions) (continued)

		Poultry	Livestock	Misc.	Non-Commercial	Total
1	Grains	29.52	73.65	25.36	0.67	4396.47
2	Other agricultural products	37.96	116.73	167.35	2.92	2845.39
3	Forestry products	0.08	0.44	0.87	0.00	14.00
4	Fish, seafood and trapping products	0.00	0.00	0.00	0.00	0.00
5	Metal ores & concentrates	0.00	0.00	0.00	0.00	0.00
6	Mineral fuels	0.00	0.00	0.00	0.00	0.00
7	Non-metallic minerals	0.00	0.00	0.00	0.00	0.00
8	Services incidental to mining	0.00	0.00	0.00	0.00	0.00
9	Meat, fish, and dairy products	1.55	2.04	2.22	0.01	33.10
10	Fruit, veg. and other food products,	0.00	0.00	0.00	0.00	0.00
11	Soft drinks and alcoholic beverages	0.00	0.00	0.00	0.00	0.00
12	Tobacco and tobacco products	0.00	0.00	0.00	0.00	0.00
13	Leather, rubber, and plastic products	0.00	0.00	0.00	0.00	0.00
14	Textile products	0.00	0.00	0.00	0.00	0.00
15	Hosiery, clothing and accessories	0.00	0.00	0.00	0.00	0.00
16	Lumber and wood products	0.00	0.00	0.00	0.00	0.00
17	Furniture and fixtures	0.00	0.00	0.00	0.00	0.00
18	Wood pulp, paper and paper products	0.00	0.00	0.00	0.00	0.00
19	Printing and publishing	0.00	0.00	0.00	0.00	0.00
20	Primary metal products	0.00	0.00	0.00	0.00	0.00
21	Other metal products	0.00	0.00	0.00	0.00	0.00
22	Machinery and equipment	0.00	0.00	0.00	0.00	0.00
23	Motor veh., oth. transport equip. and	0.00	0.00	0.00	0.00	0.00
24	Electrical, electronic and communic.	0.00	0.00	0.00	0.00	0.00
25	Non-metallic mineral products	0.00	0.00	0.00	0.00	0.00
26	Petroleum and coal products	0.00	0.00	0.00	0.00	0.00
27	Chemicals, pharmaceuticals & chemical	3.64	4.79	5.22	0.03	64.30
28	Other manufactured products	0.00	0.00	0.00	0.00	0.00
29	Residential construction	0.00	0.00	0.00	0.00	0.00
30	Non-residential construction	0.00	0.00	0.00	0.00	0.00
31	Repair construction	0.00	0.00	0.00	0.00	0.00
32	Transportation and storage	0.00	0.00	0.00	0.00	0.00
33	Communications services	0.00	0.00	0.00	0.00	0.00
34	Other utilities	0.00	0.00	0.00	0.00	0.00
35	Wholesaling margins	0.00	0.00	0.00	0.00	0.00
36	Retailing margins	0.00	0.00	0.00	0.00	0.00
37	Gross imputed rent	0.00	0.00	0.00	0.00	0.00
38	Other finance, insurance, and real estate	1.58	0.67	0.50	0.00	21.40
39	Business and computer services	0.00	0.00	0.00	0.00	0.00
40	Private education services	0.00	0.00	0.00	0.00	0.00
41	Health and social services	0.00	0.00	0.00	0.00	0.00
42	Accommodation services and meals	0.00	0.00	0.00	0.00	0.00
43	Other services	0.00	0.00	0.00	0.00	0.00
44	Transportation margins	0.00	0.00	0.00	0.00	0.00
45	Operating, office, cafeteria and lab.	0.00	0.00	0.00	0.00	0.00
46	Travel & entertainment, advertising &	0.00	0.00	0.00	0.00	0.00
47	Non-profit institutions serving	0.00	0.00	0.00	0.00	0.00
48	Government sector services	0.00	0.00	0.00	0.00	0.00
49	Non-competing imports	0.00	0.00	0.00	0.00	0.00
50	Unallocated imports and exports	0.00	0.00	0.00	0.00	0.00
51	Sales of other government services	0.00	0.00	0.00	0.00	0.00
52	Indirect taxes	0.00	0.00	0.00	0.00	0.00
53	Subsidies	0.00	0.00	0.00	0.00	0.00
54	Wages and salaries	0.00	0.00	0.00	0.00	0.00
55	Supplementary labour income	0.00	0.00	0.00	0.00	0.00
56	Mixed income	0.00	0.00	0.00	0.00	0.00
57	Other operating surplus	0.00	0.00	0.00	0.00	0.00
58	TOTAL	74.33	198.32	201.54	3.63	7374.66

Table C.3 Total Employment in 1996

Employment Sector	Saskatchewan (persons)	Rest of Saskatchewan (persons)	Study Region (persons)
Grains Farms	53,673	43,430	7,312
Large Scale Irrigation Farms	1,440	1,440	0
Small Scale Irrigation Farms	363	0	363
Dairy Farms	989	842	107
Cattle (Beef) Farms	11,537	9,319	1,594
Hog Farms	889	775	90
Poultry Farms	409	342	48
Livestock Combination Farms	3,223	2,502	537
Miscellaneous Farms	1,293	1,143	115
Non-Commercial Farms	2,209	2,014	156
Fishing and Trapping	165	165	0
Forestry	1,650	1,640	10
Mining, Quarrying, and Oil Wells	10,950	10,055	655
Manufacturing	29,695	28,845	765
Construction	20,860	19,890	790
Transportation and Storage	20,005	18,900	890
Communications	7,353	6,970	263
Other Utility	7,353	6,970	263
Wholesale Trade	22,350	20,745	1,320
Retail	54,265	51,425	2,365
Finance and Insurance Services	22,070	21,015	880
Other Services	194,545	185,615	7,310
Total	467,285	437,305	24,020

Table C.4 Location Quotient

Employment Sector	Saskatchewan	Rest of Saskatchewan	Study Region
Grains Farms	1	0.995	1.004
Large Scale Irrigation Farms	1	1.230	0.000
Small Scale Irrigation Farms	1	0.000	7.366
Dairy Farms	1	1.047	0.799
Cattle (Beef) Farms	1	0.994	1.018
Hog Farms	1	1.072	0.747
Poultry Farms	1	1.029	0.856
Livestock Combination Farms	1	0.955	1.228
Miscellaneous Farms	1	1.087	0.653
Non-Commercial Farms	1	1.121	0.519
Fishing and Trapping	1	1.069	0.000
Forestry	1	1.062	0.188
Mining, Quarrying, and Oil Wells	1	0.981	1.164
Manufacturing	1	1.038	0.501
Construction	1	1.054	0.263
Transportation and Storage	1	1.056	0.226
Communications	1	1.001	1.232
Other Utility	1	1.001	1.232
Wholesale Trade	1	1.019	0.737
Retail	1	1.010	0.865
Finance and Insurance Services	1	1.022	0.725
Other Services	1	1.022	0.699

Table C.5 Employment Coefficients for Direct Expenditures

Sector Employment Coefficients	(person-years per $1000 output)
1 Grain Farms	0.009846
2 Large Scale Irrigation Farms	0.017428
3 Southwest Irrigation Farms	0.022016
4 Dairy Farms	0.007987
5 Cattle (Beef) Farms	0.011141
6 Hog Farms	0.006118
7 Poultry Farms	0.005497
8 Livestock Combination Farms	0.016254
9 Miscellaneous Farms	0.006417
10 Non-Commercial Farms	0.608358
11 Fishing and Trapping Industries	0.017935
12 Logging and Forestry Industries	0.008643
13 Mining, quarrying and oil well industries	0.001773
14 Manufacturing industries	0.005529
15 Construction industries	0.005057
16 Transportation and storage industries	0.008952
17 Communication and other utility industries	0.006848
18 Wholesale trade industries	0.00943
19 Retail trade industries	0.026153
20 Finance, insurance and real estate industries	0.003753
21 Business service industries	0.019094
22 Educational service industries	0.019094
23 Health and social service industries	0.019094
24 Accommodation and food services industries	0.019094
25 Other service industries	0.019094
26 Operating , office, cafeteria and laboratory service industries	0
27 Travel & entertainment, advertising & promotion industries	0
28 Transportation margins	0
29 Non-profit institutions serving households	0
30 Government sector	0

APPENDIX D

SELECTED INFORMATION RELEVANT FOR DIRECT EXPENDITURES (IMPACTS) OF ECONOMIC ACTIVITIES IN THE SOUTHWEST SASKATCHEWAN REGION

Table D.1 Factors Used for Capital Expenditures

Commodity Sector		Dam	Irrigation Canal
3	Forestry products	0.1	0.1
13	Leather, rubber, and plastic products	0.0	4.0
20	Primary metal products	5.7	5.7
22	Machinery and equipment	8.8	8.8
24	Electrical, electronic and communic. prod.	0.1	0.1
26	Petroleum and coal products	8.7	8.7
28	Other manufactured products	10.3	3.0
39	Business and computer services	3.0	3.0
43	Other services	17.3	17.3
54	Wages and salaries	45.7	50.0
Total		100.0	100.0

Source: PFRA, 1987

Table D.2 Factors Used for Operations and Maintenance

Commodity Sector		Percent
16	Lumber and Wood Products	12.0
22	Machinery and equipment	6.0
23	Motor veh., oth. transport equip. and parts	5.0
26	Petroleum and coal products	8.0
30	Non-residential construction	1.0
31	Repair construction	1.0
32	Transportation and storage	7.0
33	Communications services	3.0
34	Other utilities	4.0
43	Other services	2.0
46	Travel & entertainment, advertising & promotion	4.0
54	Wages and salaries	47.0
Total		100.0

Source: PFRA, 1987

Table D.3 Forage Production Budget for Surface Irrigation in Southwest Saskatchewan

	Establishment	First Cut	Second Cut
Expenditures	$ per acre	$ per acre	$ per acre
Land Preparation	$35.06	$0.00	$0.00
Seed	$21.06	$0.00	$0.00
Fertilizer	$14.60	$8.42	$0.00
Chemical	$2.50	$0.00	$0.00
Equipment Fuel	$7.00	$7.00	$2.25
Equipment Repair	$4.14	$5.57	$3.75
Custom Work	$0.00	$3.50	$0.00
Irrigation Fuel	$0.00	$0.00	$0.00
Irrigation Repair	$0.00	$0.00	$0.00
Irrigation Levy	$11.24	$9.24	$4.00
Crop Insurance	$0.00	$0.00	$0.00
Bale Hauling	$0.00	$13.04	$5.00
Other twine	$0.00	$4.08	$2.40
Farm overhead	$7.00	$7.00	$0.00
Operating interest 8%	$8.21	$4.63	$1.39
Total Cash Costs	$75.75	$62.48	$18.79
Farm equipment and buildings	$35.00	$35.00	$0.00
Specialized Equipment	$0.00	$57.97	$12.19
Land	$30.00	$30.00	$0.00
Total Non Cash Costs	$65.00	$122.97	$12.19
Total Costs	$140.75	$185.44	$30.98

Source: Survey of Southwest Saskatchewan Irrigators

Table D.4 Forage Production Budget for Sprinkler Irrigation in Southwest Saskatchewan

	Establishment	First Cut	Second Cut
Expenditures	$ per acre	$ per acre	$ per acre
Land Preparation	$4.52	$0.00	$0.00
Seed	$24.00	$0.00	$0.00
Fertilizer	$16.00	$28.40	$0.00
Chemical	$8.00	$0.00	$0.00
Equipment Fuel	$10.00	$10.00	$5.00
Equipment Repair	$10.00	$10.00	$5.00
Custom Work	$0.00	$0.00	$0.00
Irrigation Fuel	$5.00	$20.00	$10.00
Irrigation Repair	$5.00	$13.00	$6.50
Irrigation Levy	$12.50	$12.50	$0.00
Crop Insurance	$0.00	$0.00	$0.00
Bale Hauling	$0.00	$20.00	$10.00
Other twine	$0.00	$56.00	$28.00
Farm overhead	$7.00	$7.00	$0.00
Operating interest 8%	$8.16	$14.15	$5.16
Total Cash Costs	$105.66	$191.05	$69.66
Farm equipment and buildings	$35.00	$35.00	$0.00
Specialized Equipment	$0.00	$64.66	$48.36
Land	$30.00	$30.00	$0.00
Total Non Cash Costs	$65.00	$129.66	$48.36
Total Costs	$170.66	$320.72	$118.02

Source: Irrigation Crop Diversification Corporation, 2000

Table D.5 Dryland Forage Production in Southwest Saskatchewan

	Establishment	First Cut
Expenditures	$ per acre	$ per acre
Land Preparation	$5.00	$0.00
Seed	$15.00	$0.00
Fertilizer	$5.00	$5.00
Chemical	$0.00	$0.00
Equipment Fuel	$2.50	$2.50
Equipment Repair	$3.75	$3.75
Custom Work	$0.00	$0.00
Irrigation Fuel	$0.00	$0.00
Irrigation Repair	$0.00	$0.00
Irrigation Levy	$0.00	$0.00
Crop Insurance	$0.00	$0.00
Bale Hauling	$0.00	$2.75
Other Twine	$0.00	$1.13
Farm overhead	$4.45	$2.50
Operating interest 8%	$2.86	$1.41
Total Cash Costs	$33.56	$19.04
Farm equipment and buildings	$35.00	$35.00
Specialized Equipment	$0.00	$38.67
Land	$15.60	$15.60
Total Non Cash Costs	$50.60	$89.27
Total Costs	$84.16	$108.30

Source: Survey of Southwest Saskatchewan Irrigators

Table D.6 Correspondence Between Input-Output Commodity and Expenditures for Forage Production

Expenditure	Commodity Sector		Percent
Land Preparation	23	Motor veh., oth. transport equip. and parts	33
Land Preparation	26	Petroleum and coal products	33
Land Preparation	54	Wages and salaries	33
Seed	2	Other agricultural products	100
Fertilizer	27	Chemicals, pharmaceuticals & chemical prod.	100
Chemical	27	Chemicals, pharmaceuticals & chemical prod.	100
Equipment Fuel	26	Petroleum and coal products	100
Equipment Repair	23	Motor veh., oth. transport equip. and parts	100
Custom Work	23	Motor veh., oth. transport equip. and parts	33
Custom Work	26	Petroleum and coal products	33
Custom Work	54	Wages and salaries	33
Irrigation Fuel	26	Petroleum and coal products	100
Irrigation Repair	23	Motor veh., oth. transport equip. and parts	100
Irrigation Levy	48	Government sector services	100
Crop Insurance	38	Other finance, insurance, and real estate services	100
Bale Hauling	32	Transportation and storage	100
Other	13	Leather, rubber, and plastic products	100
Farm overhead	33	Communications services	40
Farm overhead	34	Other utilities	40
Farm overhead	52	Indirect taxes	20
Operating interest	38	Other finance, insurance, and real estate services	100
Depreciation	57	Other operating surplus	100
Net Income	55	Supplementary labor income	100

Table D.7 Cattle Production Budget

Expenditure or Income	$/Cow
Winter Feed	129.39
Bedding	9.19
Pasture	131.72
Veterinary and Medicine	26.11
Breeding Fees	24.19
Trucking and Marketing	24.87
Fuel	22.38
Machinery Repairs	12.56
Building Repairs	11.95
Utilities Expenses	41.3
Custom Work	9.66
Operating Interest	7.79
Paid Labor	19.48
Taxes, Insurance	13.58
Lease Payments	1.82
Depreciation	27.51
Capital Interest	22.39
Government Subsidy	-4.06
Cattle Purchases	253.31

Source: Western Beef Development Centre

Table D.8 Correspondence Between Input-Output Commodity and Expenditures for Cattle Production

Budget Group	Commodity Sector		Percent
Winter Feed	1	Grains	100
Bedding	2	Other agricultural products	100
Pasture	2	Other agricultural products	100
Veterinary and Medicine	27	Chemicals, pharmaceuticals & chemical prod.	100
Breeding Fees	39	Business and computer services	100
Trucking and Marketing	32	Transportation and storage	75
Trucking and Marketing	39	Business and computer services	25
Fuel	26	Petroleum and coal products	100
Machinery Repairs	22	Machinery and equipment	100
Building Repairs	31	Repair construction	100
Utilities Expenses	34	Other utilities	100
Custom Work	22	Machinery and equipment	33
Custom Work	26	Petroleum and coal products	33
Custom Work	54	Wages and salaries	33
Operating Interest	38	Other finance, insurance, and real estate services	100
Paid Labor	54	Wages and salaries	100
Taxes, Insurance	38	Other finance, insurance, and real estate services	50
Taxes, Insurance	52	Indirect taxes	50
Lease Payments	22	Machinery and equipment	100
Depreciation	57	Other operating surplus	100
Capital Interest	38	Other finance, insurance, and real estate services	100
Government Subsidy	53	Subsidies	100
Cattle Purchases	2	Other agricultural products	100
Net Income	55	Supplementary labor income	100

Table D.9 Expenditures for Southwest Abattoir

Expenditure	500 pound animal	1330 pound animal
Wages	$60.00	$159.60
Electricity and Water	$4.00	$10.66
Cooling	$8.00	$21.28
String and Paper	$17.00	$45.22
Cardboard Boxes	$10.00	$26.60
Income	$50.00	$133.00
Total	$149.00	$396.36

Table D.10 Correspondence Between Input-Output Commodity and Expenditures for Small Abattoir Expenditure Breakdown

Commodity Sector		1330 lb Slaughter Weight
		$ per head
54	Wages and salaries	$159.60
34	Other utilities	$10.64
34	Other utilities	$11.70
57	Other operating surplus	$9.58
13	Leather, rubber, and plastic products	$15.96
18	Wood pulp, paper and paper products	$15.96
57	Other operating surplus	$2.68
33	Communications services	$2.66
46	Travel & entertainment, advertising & promotion	$2.66
38	Other finance, insurance, and real estate services	$2.66
32	Transportation and storage	$2.66
18	Wood pulp, paper and paper products	$26.60
57	Other operating surplus	$133.00
Total		$396.36

Table D.11 Recreation Expenditures for Local and Non-Local Users by Activity

Expenditures per day	Local		Non-Local			
	General	Hunting	Outdoor	Wildlife	Fishing	Hunting
Accommodation	$0.00	$1.44	$7.35	$0.90	$1.85	$1.44
Transportation	$1.66	$12.78	$12.51	$2.17	$5.00	$12.78
Food	$1.30	$6.27	$10.06	$1.39	$2.96	$6.27
Equipment	$0.00	$27.39	$19.19	$9.84	$21.04	$27.39
Other	$0.00	$0.00	$3.02	$3.78	$0.00	$0.00
Total	$2.96	$47.88	$52.14	$18.09	$30.86	$47.88

Table D.12 Expenditures for Recreation for Southwest Saskatchewan

Expenditure	Local	Non-Local	Total
Accommodation	$0.00	$29,259.03	$29,259.03
Transportation	$102,915.46	$574,043.18	$676,958.64
Food	$78,633.07	$829,393.40	$908,026.47
Equipment	$12,961.07	$1,906,814.01	$1,919,775.08
Other	$0.00	$2,255.37	$2,255.37
Total	$194,509.60	$3,341,764.98	$3,536,274.59
Expenditures within Lafleche Regional Park			$612,005.03
Total Expenditures for Recreation in Southwest Saskatchewan			$4,148,279.62

Table D.13 Ducks Unlimited Expenditure Data

Commodity Sector		Expenditure for Commodity Sector	Percent of Total
16	Lumber and wood products	$4,427.00	2
20	Primary metal products	$4,427.00	2
22	Machinery and equipment	$4,427.00	2
23	Motor veh, oth. transport equip. and parts	$4,427.00	2
26	Petroleum and coal products	$8,855.00	4
30	Non-residential construction	$13,282.00	7
33	Communications services	$17,829.00	9
34	Other utilities	$22,257.00	10
54	Wages and salaries	$134,979.00	62
Total		$214,911.00	100

Table D.14 Cattle Feedlot Production Budget

Expenditure	$/head
Feed	$143.12
Bedding	$5.38
Pasture	$0.00
Veterinary and Medicine	$0.00
Breeding Fees	$0.00
Trucking and Marketing	$22.52
Fuel	$1.25
Machinery Repairs	$1.00
Building Repairs	$0.00
Utilities Expenses	$0.28
Custom Work	$2.18
Operating Interest	$0.00
Paid Labor	$18.11
Taxes, Insurance	$0.17
Lease Payments	$0.00
Depreciation	$16.19
Capital Interest	$37.24
Total Expenditures	$247.44

Source: Dale Russell

APPENDIX E

QUESTIONAIRE FOR THE SURVEY OF IRRIGATORS IN SOUTHWEST SASKATCHEWAN

Dear Sir/Madam,

I am a graduate student at the University of Saskatchewan in the Department of Agricultural Economics. The researching and writing of a thesis is part of the requirements for the completion of my studies. In my research I need farm level data about irrigation practices in southwest Saskatchewan. To this extent I am asking for your help in giving me information about your practices. The following pages are a survey that I will use as input for my thesis.

The information you supply me will only be used for research purposes and will remain confidential. You do not have to answer any questions that you do not feel comfortable about.

If you have any questions you can contact me at:

Wayne Thompson
Department of Agricultural Economics
University of Saskatchewan
51 Campus Drive
Saskatoon, Saskatchewan
S7N A58

Phone: 306-966-4043

I thank you for your time and help in the completion of my thesis.

Sincerely,

Wayne Thompson

Producer Name				
Address				
Phone Number				
Fax				
e-mail				
Irrigation Project / Location				
Type of irrigation?	backflood	sprinkler		
How many times a year do you irrigate?				
How much irrigated land do you have?			acres	
How much dryland forage do you have?			acres	
Farm Machinery related to forage production				
Description of Equipment	**Proportion Used to produce forage**	**Size or hp**		

What activities do you carry out during:				
A) An establishment year	B) Year with one cut		C) Year with two cuts	
1)				
2)				
3)				
4)				
5)				
6)				
7)				
8)				
9)				
10)				
11)				
12)				

Forage Production establishment year	**Quantity**	**Irrigated $**	**Quantity**	**Dryland $**
Land preparation				
Seed Purchased				
Chemicals				
Fertilizer				
Crop Insurance/ Hail				
Cash Land Rent				
Repair, Maintenance				
Irrigation Fuel, Electricity				
Water Fees				
Other (specify)				
Other (specify)				
First Cut				
Forage Production non-establishment year	**Quantity**	**Irrigated $**	**Quantity**	**Dryland $**
Chemicals				
Fertilizer				
Crop Insurance/ Hail				
Cash Land Rent				
Twine& Silage Bags				
Bale Hauling				
Repair, Maintenance				
Irrigation Fuel, Electricity				
Water Fees				

Other (specify)				
Other (specify)				
Second cut				
Forage Production non-establishment year	**Quantity**	**Irrigated $**	**Quantity**	**Dryland $**
Chemicals				
Fertilizer				
Crop Insurance/ Hail				
Cash Land Rent				
Twine& Silage Bags				
Bale Hauling				
Repair, Maintenance				
Irrigation Fuel, Electricity				
Water Fees				
Other (specify)				
Other (specify)				
General Questions				
1) What is your average irrigated forage production?			tons/acre	
2) What is your average dryland forage production?			tons/acre	
3) How much forage do you feed to cattle?			tons/year	
4) How much forage do you sell on average?			tons/year	

5) How much forage do you buy on average?			tons/year	
6) What is the cost to import forage?	$			
7) Where does your import forage come from?				
8) How often do you breakup your irrgated land?		years	dryland forage?	years
9) During a drought year what do you do?				
For example: keep whole herd and import forage.				
Domestic Water Use				
1) Do you draw water for your household and livestock water from the PFRA projects ?				
If the answer is no you may stop.				
2) How much water do you use per year?	house		livestock	
3) What structures and equipment do you have to access this water supply? (ex. dugout, pump)				
4) What is your alternative water supply?				
5) What would you have to do to access the alternative water supply? (ex. Drill well, haul water) Please detail. (ex. Depth of well, distance of pipeline or haul)				