IRRIGATION WATER PRODUCTIVITY IN SASKATCHEWAN AND MANITOBA – AN ECONOMIC PERSPECTIVE

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Synopsis

- Three parts:
  - One, introduction to valuation
  - Two, economics of irrigation water in Saskatchewan
  - Three, economics of irrigation water in Manitoba

Part One: Introduction to Economic Valuation

- What is water productivity?
- An Economic Interpretation of water productivity
- Why study economic productivity of irrigation water
- Links between Water and Economic Productivity
- Farm Level Water Use Economics
- Society Level Economics of Water Use

Water Productivity

- Productivity can be measured in various contexts:
  - Technical (Contributions to physical state of a phenomenon)
  - Economic (Contributions to an economic objective of the society or a member of the society)
  - Social (Contributions to the social well-being of members of a society)
  - Ecosystem (Contributions to sustenance and maintenance of ecosystem functions)
- All economic values are based on anthropocentric valuation philosophy

Productivity – An Economic Interpretation

- Productivity of water can be evaluated with at least two accounting stances:
  - Private (Producer)
  - Society
- Private accounting stance looks at farm benefits economics of irrigation water use
- Social accounting stance included not only the producer but all other parties benefiting from that use of water

Links to Economic Productivity of Irrigation Water

- Producers
- Higher net returns
- Drought Proofing the farm
- Risk Management

- Society
- Higher farm level incomes
- Regional Development / Multiplier effect of water use
- Regional diversification and economic security
- Quality of Life

Why study Economic productivity of water -- Farm Level Irrigation Water Use

- Two types of decisions: Adoption of Irrigation
  - If do not have irrigation on the farm: producer faces the question
    - Should the irrigation be adopted on the farm?
  - Question faced by water project development Agency:
    - Would producers be better off with irrigation?
    - Would producer be able to pay for irrigation costs?

Farm Level Irrigation Water Use (2)

- If already having irrigation on the farm:
- Producer need information on
  - How much water to employ for a given crop?
- Water Management agency require information on how much water to allocate
  - Or
- If facing shortages, what is the cost to producers to limit water allocation?

Farm Level Irrigation Water Use (3)

- These two situations – Adoption of irrigation, vs. allocation of water for irrigation, require very different economic measure of productivity of irrigation water
- The first requires “Average Value of Water in Irrigation” whereas the second requires “Marginal Value of Water in irrigation”.
- These values are in the context of improving resource allocation or “Economic Efficiency”

Society Level Irrigation Water Use

- Society may benefit from irrigation water use though forward and backward linkages of irrigation
- New production may lead to new agri-food industries
- New employment may be generated
- More stability in the region
- This provides an economic value to irrigation water for “Regional Economic Development”

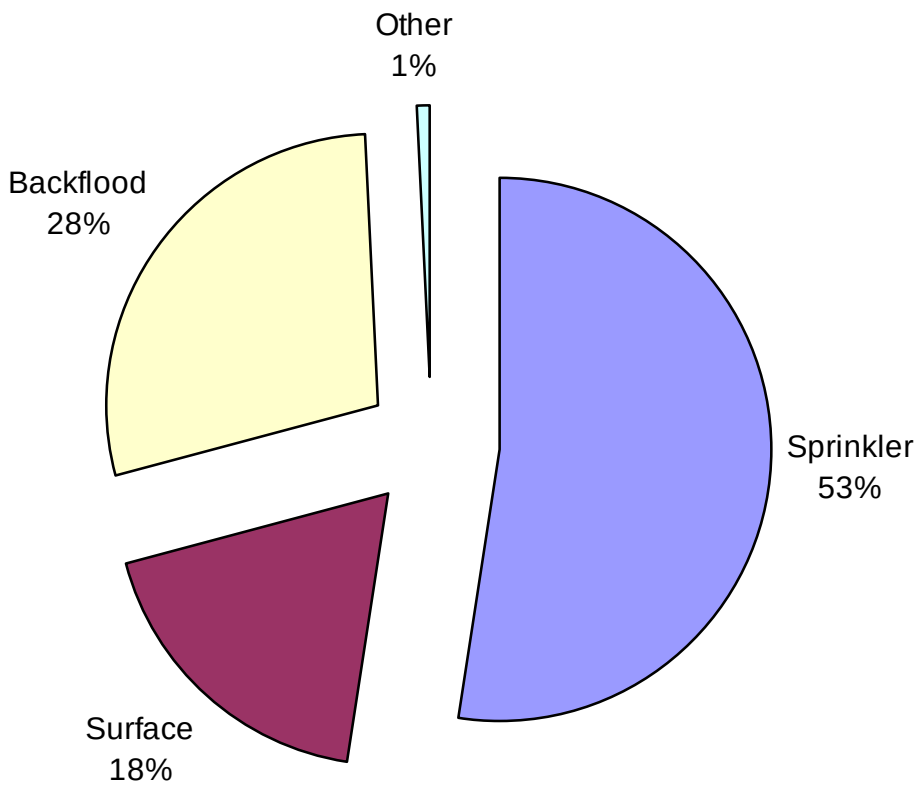
Part Two: Irrigation Water Use in Saskatchewan and its Economic Value

- Background of Irrigation Development in Recent period
- Average Value of Water for Crop Production
- Value of Irrigation for Drought Proofing
- Marginal Value of Irrigation Water
- Societal Value of Water

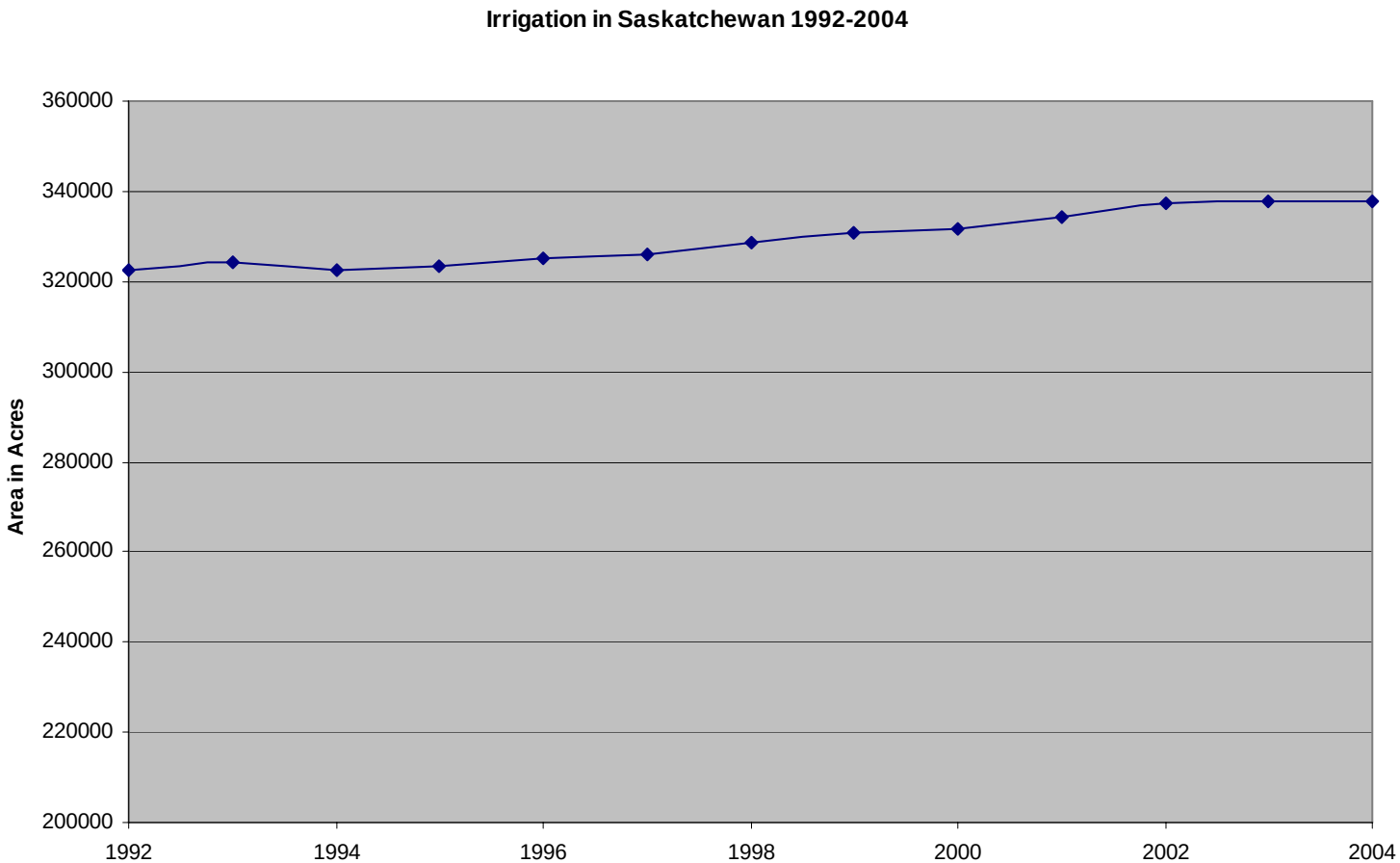
Background: Irrigation in Saskatchewan

- How much area is being irrigated in Saskatchewan?
  - It appears to be a big mystery
- Statistics Canada Agricultural Census provides an estimate of 68,470 ha in 2000
- Saskatchewan Agriculture and Food estimate is around 134,301 ha
- In either case, it is very small portion of the total cultivated area (0.37 to 0.72% of total)

Irrigated Area in Saskatchewan



Growth in Irrigated Area, Saskatchewan



Two distinct types of irrigation

- District Irrigation or Group Irrigation Projects
  - Major area in the South Saskatchewan River Basin is Lake Diefenbaker Development Area (LDDA)
  - Southwest small plot irrigation projects (organized under water user districts
- Land use is different in two areas

Scope of Valuation

- Based on Southern Saskatchewan River Basin – Saskatchewan portion
- All data secondary
- Ten-tear average prices (1994-2003) were used
- Cost of production were for 2003

Crop Mix in the LDDA (Source: John Linsley, 2005)

Crop	Irrigated (Ha)	Percent of Total
Spring wheat	3,995	11.9%
Durum	897	2.7%
Barley/Oats	3,752	11.1%
Canola	5,762	17.1%
Peas	423	1.3%
Lentils	227	0.7%
Beans	1,184	3.5%
Silage crops	2,512	7.5%
Potatoes	3,739	11.1%
Alfalfa mix.	9,883	29.4%
Tame Pasture	1,287	3.8%
TOTAL	33,661	100.0%

Crop Mix in the Southwest

Crops	Percent of the Total Irrigated Area in the SWDA Region
Wheat	3.00%
Durum	4.00%
Oats/barley	6.00%
Canola	2.00%
Lentils	2.00%
Hay (Alfalfa)	82.40%
Total	100.00%

Weighted Net Returns for Various Sub-Regions of SSRB-Saskatchewan

Particulars	Irrigation ($/ha)	Dryland ($/ha)
LDDA		
Short-run Net Returns ($/ha)	$669.81	$67.05
Long-run Returns ($/ha)	$463.54	$17.51
SWDA		
Short-run Net Returns ($/ha)	$192.15	$81.69
Long-run Returns ($/ha)	$132.40	$61.99

Estimated Water Use for Irrigation in Saskatchewan

Sub-Basin	Amount of Water in dam^3 /ha
LDDA	2.21
SWDA	3.05

Total Water Use for Irrigation

- LDDA 74,391 dam^3
- SWDA 13,768 dam^3
- Total 88,159 dam^3

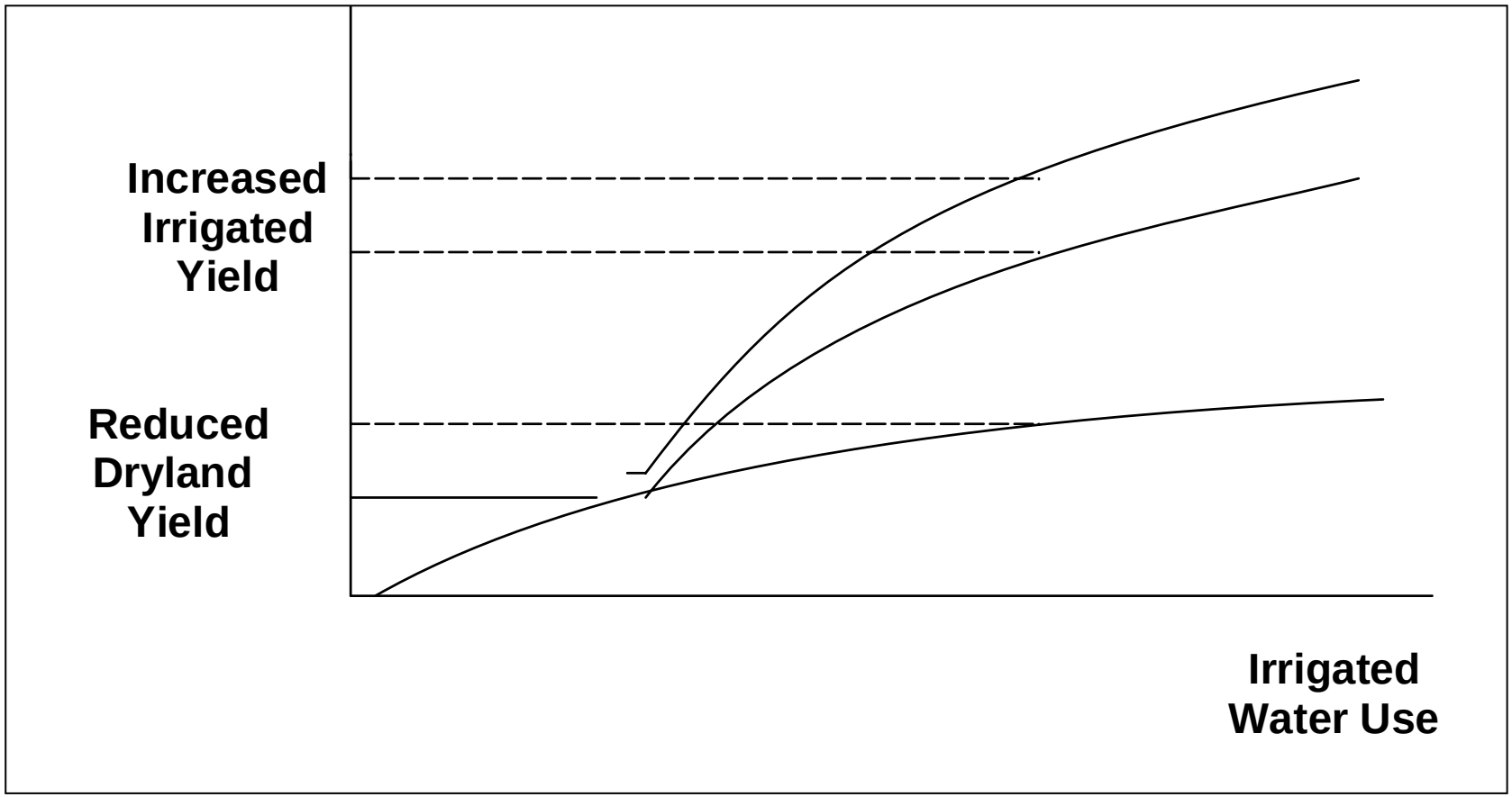
Average Value of Irrigation Water in Saskatchewan by Region

Sub-Basin	Short-run Value per Dam^3	Long-run Value per Dam^3
LDDA	$272.75	$201.82
SWDA	$36.22	$23.09
SSRB (SK)	$235.81	$173.91

Value of Irrigation in Drought Proofing

- Two ways irrigation benefits producers in a drought period:
  - Drought reduces dryland crop yields further
  - Irrigated crop yields are better than under normal climate due, in part, to favourable temperatures

Value of Irrigation Water in a Drought Period



Estimated Value of Irrigation Water in Drought Period ($/ha)

Crop	Value of Reduced Dryland Yield	Increased Irrigation Yield
Wheat	$154	$26
Canola	$217	$51
Dry Beans	$99	$167
Potatoes	$26	$449
Alfalfa	$168	$97

Value of Irrigation Water for Drought Proofing

- Droughts affect other enterprises, such as livestock
- Shortage of forages under dryland may trigger additional cost of transporting hay or sell a part of the herd
- These have significant implications for the net returns and, may further increase the value of irrigation water during a drought period
- This economic value needs further study

Marginal Value of Irrigation Water

- Every incremental dose of water applied to a crop brings additional yield which has a value
- Associated with the increased yield are certain production costs
- Marginal value is change in producer income associated with a given change in the quantity of water

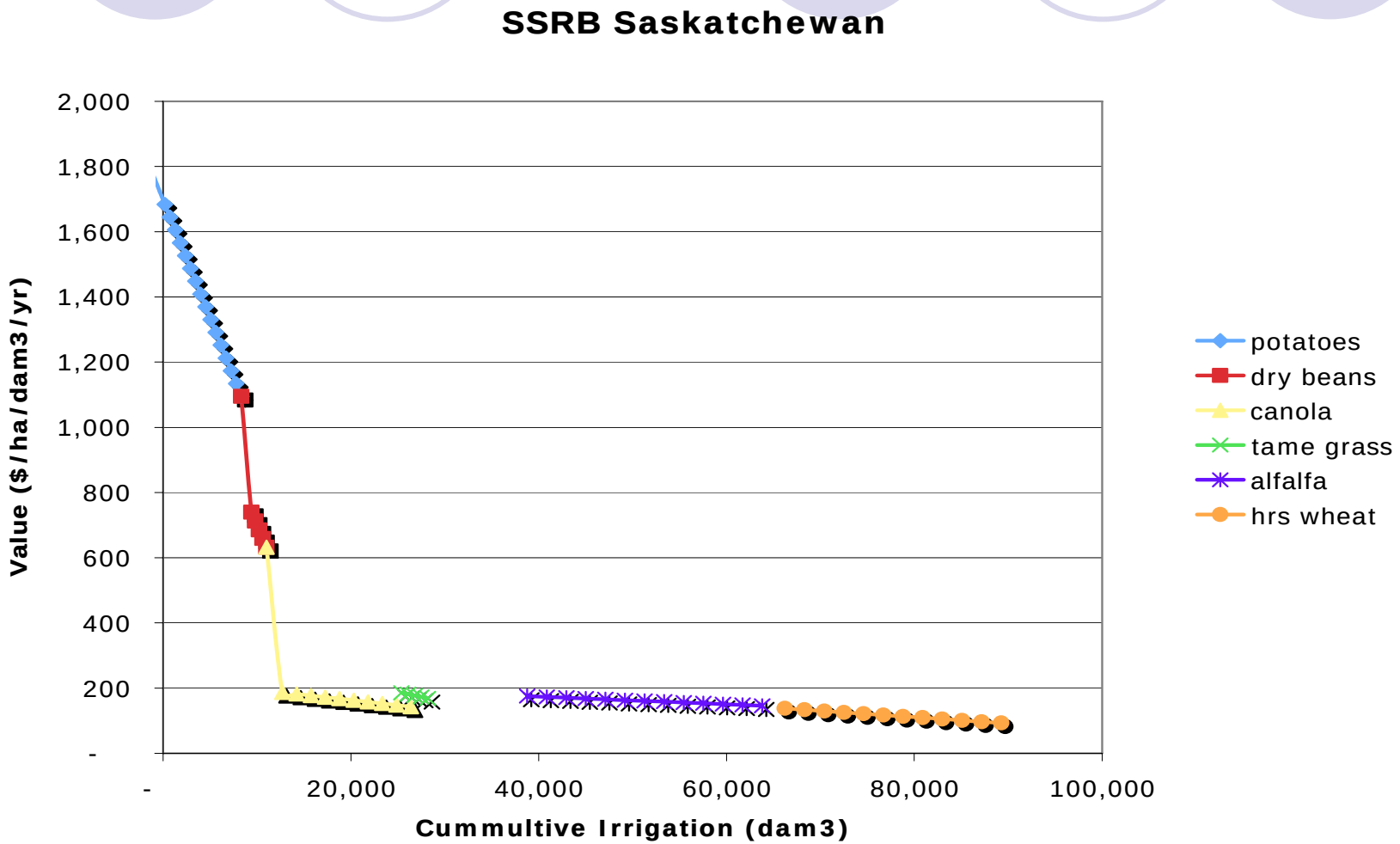
Method of Estimation for Drought Mitigation

- Water Production Functions were obtained from Alberta
- Using Saskatchewan evapotranspiration data for Saskatchewan marginal value of water was estimated for major crops

Marginal value of irrigation water

Crop	Marginal Value of Water in $/dam3
Wheat	$96
Barley	$181
Canola	$140
Dry Beans	$661
Potatoes	$1,094
Alfalfa	$141

Ranking of Crops by Marginal Value



Societal Value of Water – Regional Economic Development

- Study Commissioned by Saskatchewan Water Corporation in 1995 estimated the impact of irrigation under three development scenarios
  - One -- Current crop mix and agri. Processing
  - Two -- SMRID (Alberta) crop mix with current agri-processing
  - Three -- SMRID crop mix with integrated agri. processing

Estimated Share of farmer to total

Scenario	Direct farm income $/ha	Total income in Sask. $/ha	Farmer share of the total
One	$121	$519	38
Two	$319	$633	50
Three	$319	$971	31

Part Three: Economic Value of Water in Manitoba

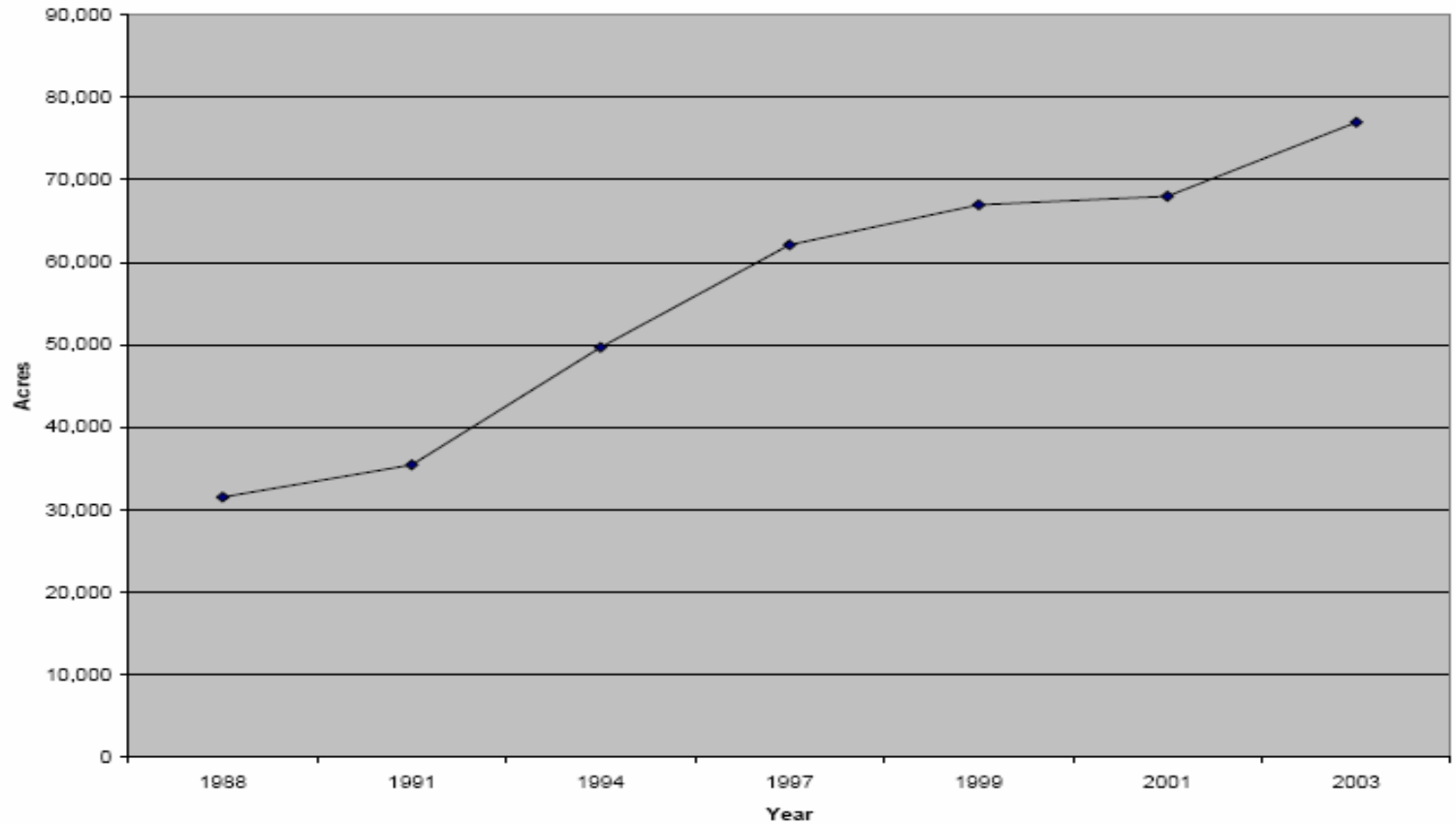
- Background
- Average Value of Water for Crop Production
- Societal Value of Water

Irrigation in Manitoba

- Among the three prairie provinces, Manitoba has the smallest irrigated area
- In 2000, according to Statistics Canada, there were 24,146 ha of irrigated lands, comprising 0.57% of total cultivated area
- By 2003, this grown to 31,142 ha (76,952 acres) [Source: Gaia Consulting 2005]
- Province has seen a tremendous growth from 12,756 ha in 1988 to present area – an increase of 144% over this period

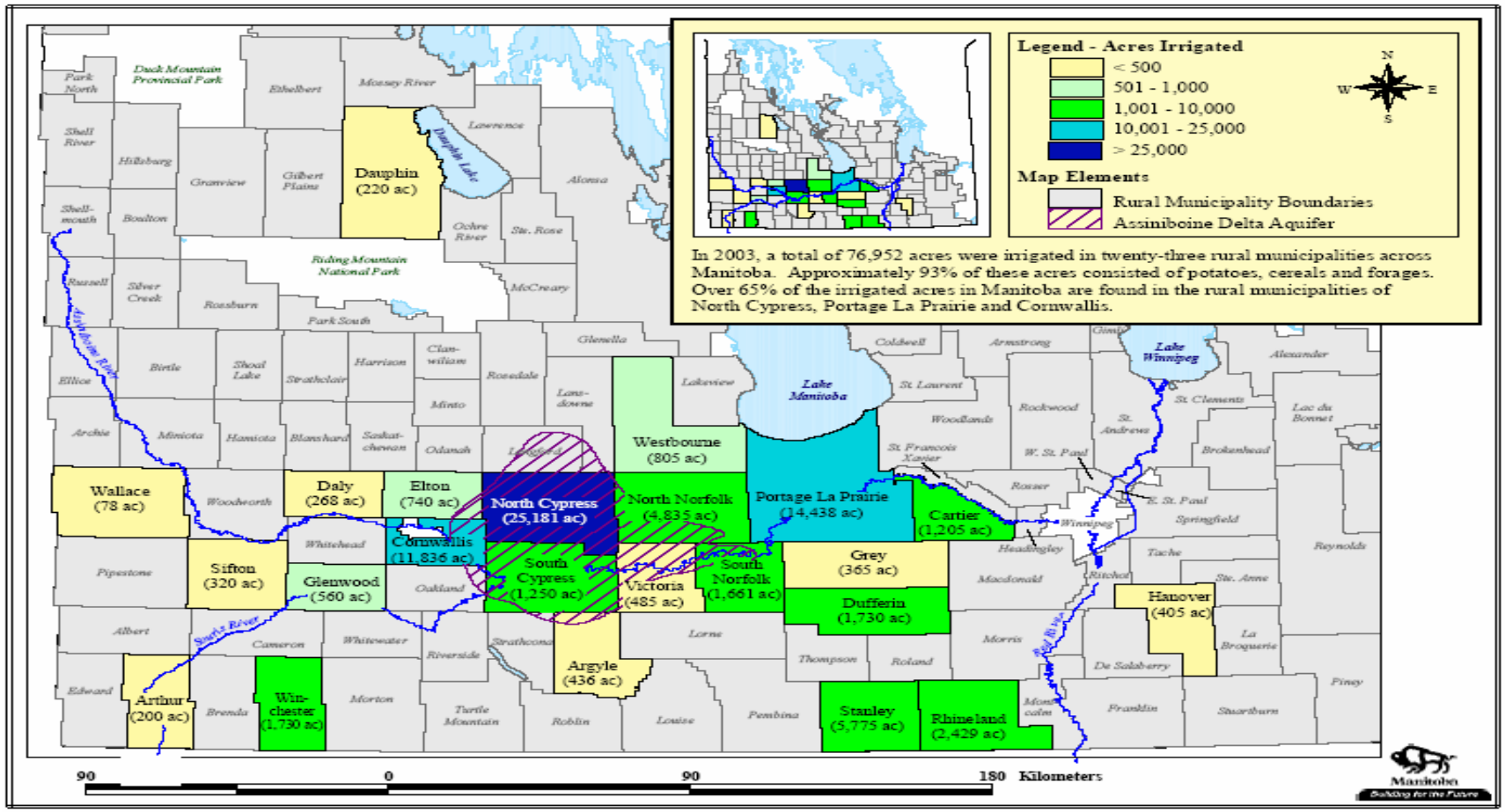
Development of Irrigation

(Source: Gaia Consulting)



Location of Irrigation, Manitoba

(Source: Gaia Consulting)

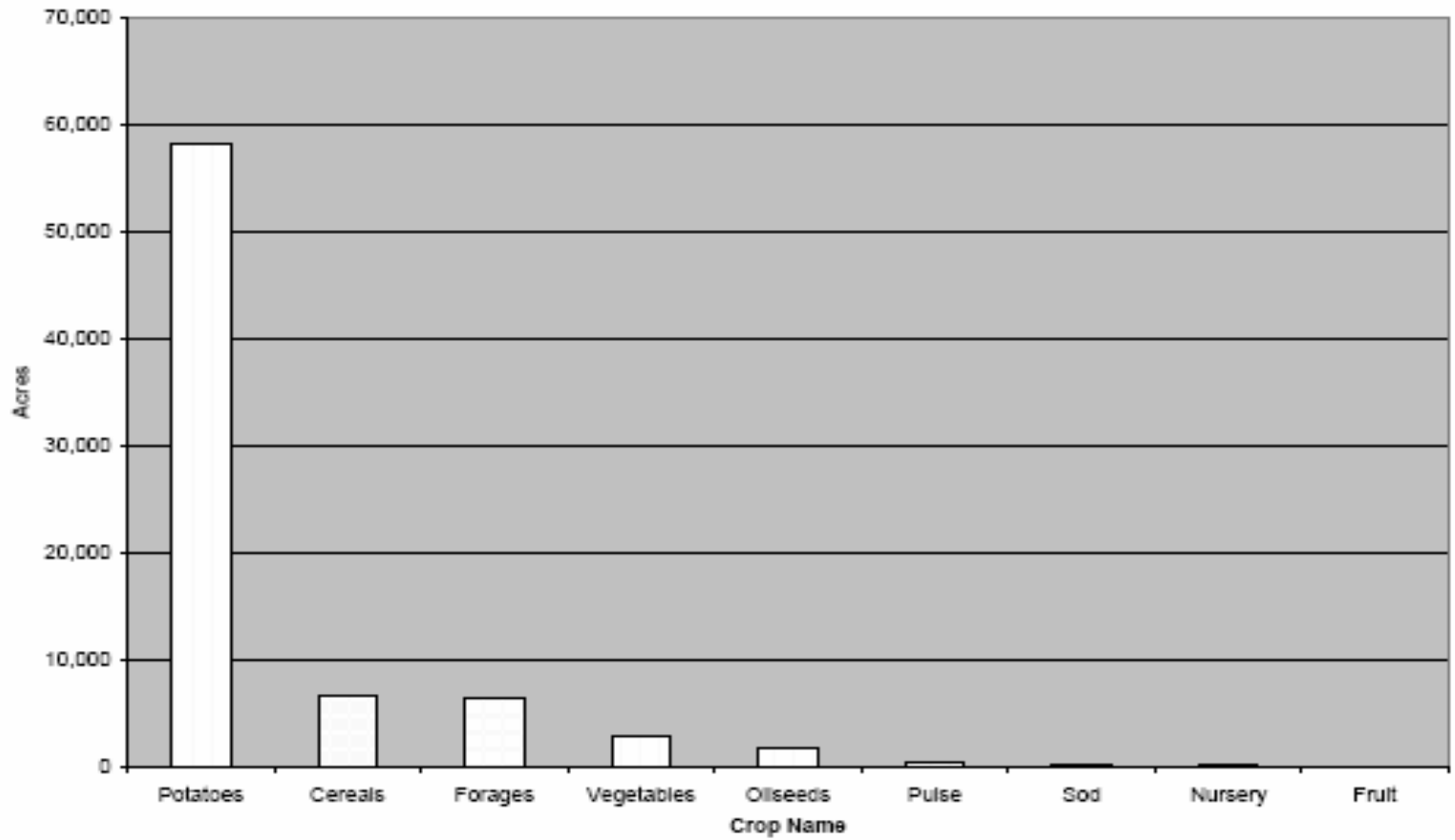


Crop Mix under Irrigation

- Potatoes are driving the demand for irrigation
  - In part, due to specification of quality and tuber size by processors
- Other crops are there for rotational or other requirements

Crop Mix on Irrigated Lands, Manitoba, 2003

(Source: Gaia Consulting)



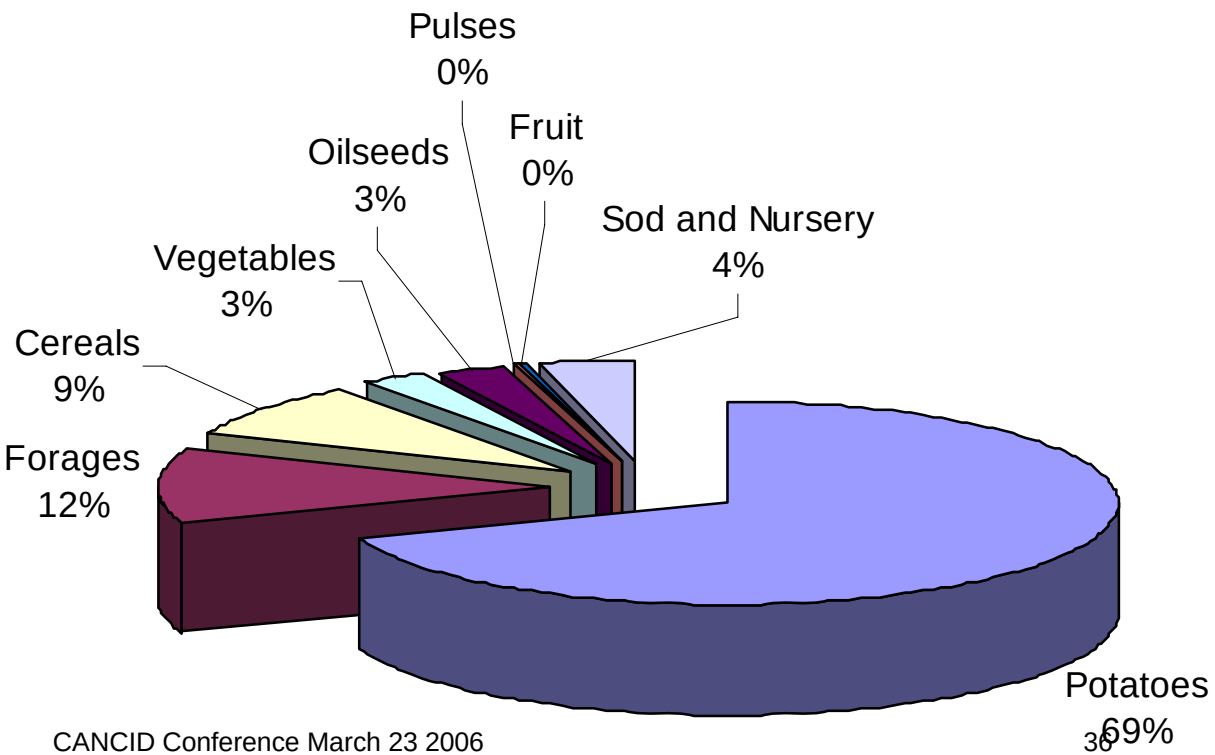
Water Application Rates by Crops

(Source: Gaia consulting)

Crop	Water Use in Inches
Potatoes	5.8
Forages	8.8
Cereals	6.5
Vegetables	4.6
Oilseeds	8.2
Pulse	4.8
Fruits	5.8
Nursery and Sod	31.4 to 52

Total Water Use for irrigation

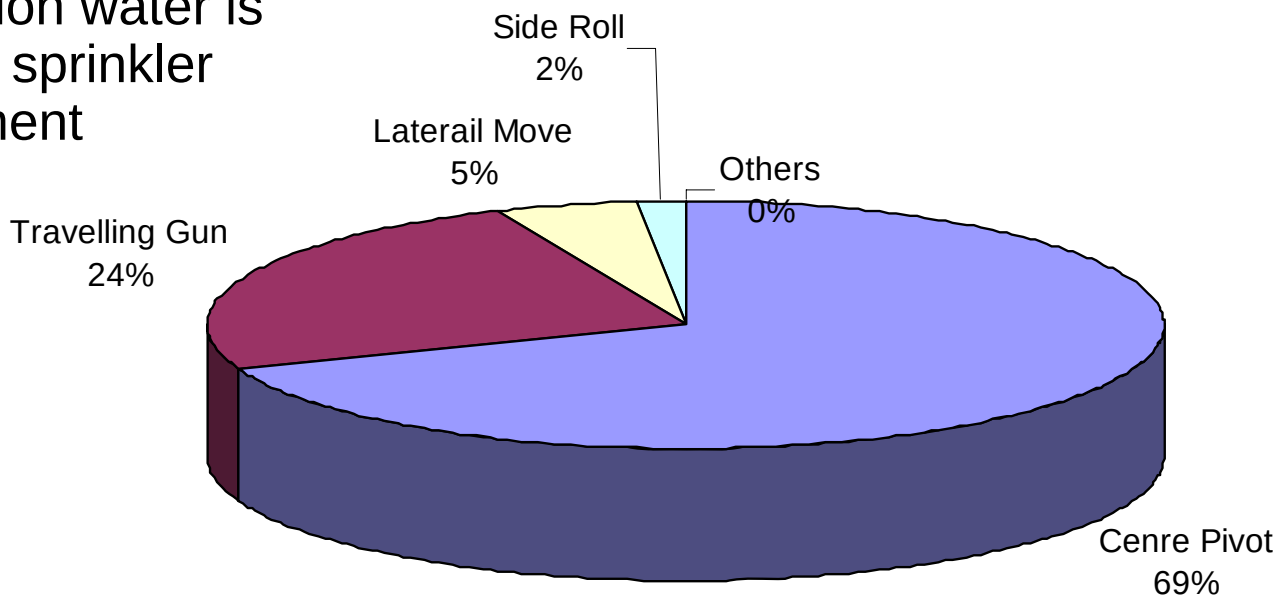
- Estimated 50,373 dam^3 of water is used in 2003
- Based on average use for crops and the 2003 area
- A large proportion is applied to potatoes



Source of Water and Equipment Used

- Combination of groundwater and surface water used
- Groundwater is obtained from the Carberry aquifer
- Surface water comes from the Assiniboine River and other smaller tributaries in the region
- Almost all irrigation water is provided though sprinkler irrigation equipment

Type of Equipment Used for Irrigation



Economic Valuation of Irrigation Water in Manitoba

- No study was found
- In 2001, Association of Irrigators in Manitoba (AIM) and AAFC-PFRA funded a study on “Economic Impact of Irrigation on Manitoba”
- Following results are based on this study

Private Accounting Stance – Value of Irrigation Water

- Relative farm level economics of irrigation water is affected by potatoes
- In 2001 net returns over dryland production was estimated at $549 in the short-run, and $183 per acre in the long-run
- Other than vegetables and fruits, short-run returns were higher than most other crops

Marginal Value of Water

- No studies have been undertaken on this subject
- Similarly on the drought proofing values, no studies have been undertaken for Manitoba

Farm Level Value of Irrigation Water

Crop	LR Return per Acre	SR Return per Acre	Water used in dam3	Value of Water ($/dam3)	
				Short-run	Long-run
Potatoes	$182.64	$549.56	0.596	$922.12	$306.46
Carrots	$953.87	$1,488.27	0.473	$3,148.66	$2,018.06
Strawberries	$83.38	$619.28	0.596	$1,039.11	$139.91
Wheat	$20.00	$177.3	0.668	$265.46	$29.94
Hay	$22.73	$101.03	0.904	$111.73	$25.14

Economic Impacts of Farm Level Production under Irrigation

- Economic Impacts of irrigation decisions are felt on the rest of the economy
- These are through various activities:
  - Investment phase – Purchase of on-farm irrigation equipment, farm machinery, storage (for potatoes)
  - Operations phase – Purchase of inputs from other sectors, Higher income of the producers being spent within the local or provincial economy

Total Economic Impacts of Farm Level Production

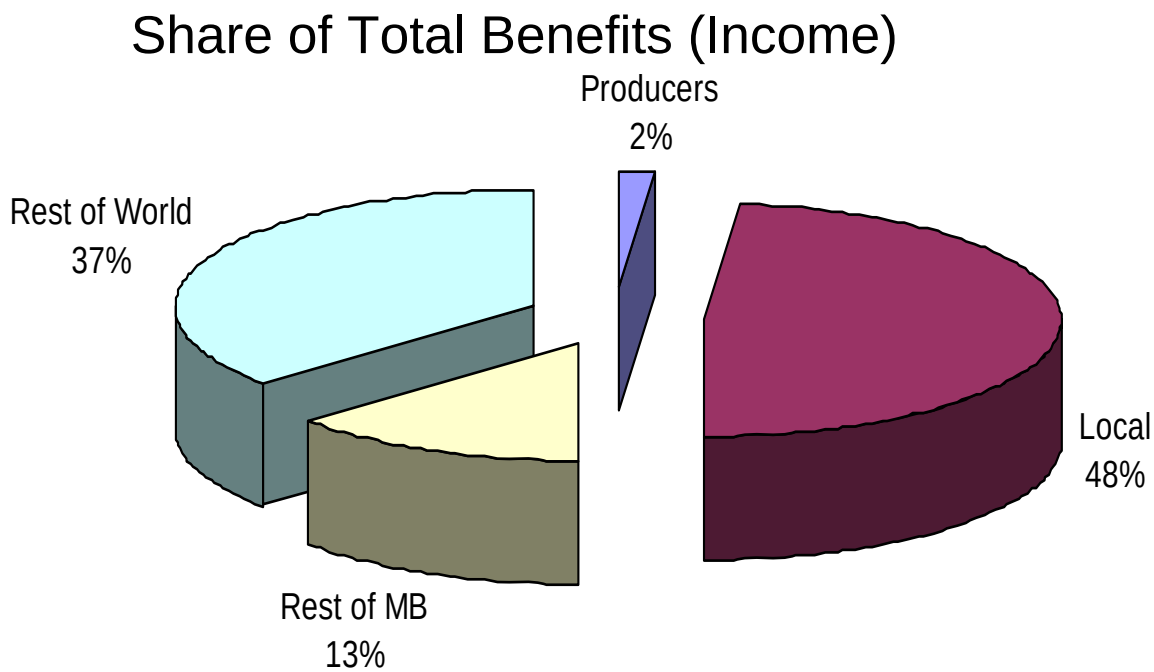
Phase	Total HH Income (Mill. $)	Share of			
		Producers	Local Region	Rest of Manitoba	Rest of the World
Investment	$142	0	36.8%	13.6%	49.6%
Production	$82	15.8%	42.1%	10.6%	31.5%

Contribution of Value-Added Activities Linked to Irrigation

- Processing of potatoes is directly linked to potato production in the Province
- In fact, demand for irrigation is triggered by the processors needs
- Two phases of economic activity
  - Construction and related investment
  - Operations

Economic Impacts from processing potatoes

Phase	Total HH Income (Mill. $)	Share of			
		Producers	Local Region	Rest of Manitoba	Rest of the World
Investment	$539.6	0	34.4%	42.5%	23.1%
Operations	$297.7	0	40.0%	48.3%	11.7%



Societal Value of Irrigation Water

- Society's value of water is much higher than what is received by the producers
- For all irrigated products, value is as follows: ($/dam^3)
  - Producer $ 258
  - To Manitoba Society $ 7,574
  - To global society $12,393
- Caution: Water used for processing is not taken into account

Employment Generation

- Every 100 ha of irrigation creates 6.4 jobs in Manitoba,
- For every full-time farmers engaged in irrigation, there are 3.8 workers employed elsewhere

Issues related to Economic Optimization of Water

- Is irrigation water the best use of Saskatchewan / Manitoba water resources?
  - Requires answers related to value of water in alternative uses in various locations
  - Decisions must be based on ‘opportunity cost of the water’
- Resources for the Future has shown that value of water in irrigation is only lower than that in Navigation, Industrial Processing, and Domestic water use

Issues related to Economic Optimization of Water (2)

- Review of other studies in the RFF study also showed high variability from study to study and location to location for the value of irrigation water (from zero to $1,228 per acre-feet) in 1996 dollars
- Irrigation value of water was found to be higher than that in Waste Disposal, Recreation, Hydroelectric Power Generation, and Thermal Power Generation.

Summary

- Economic productivity of water is high in Manitoba and in Saskatchewan (LDDA region)
- Marginal value of water indicates high loss to existing irrigators if water supply is curtailed
- Irrigation brings additional benefits during drought period; This is important if we take climate change into account
- Society benefits more from irrigation if the industry is integrated with agricultural processing industries

Summary (2)

- There are additional social benefits through community development and economic stability through irrigation
- Availability of good quality data hinders any proper economic valuation of water
  - Starting with area being irrigated, we know little about production practices, water application rates, and crop mix in various irrigated areas of the province
  - Relationships between water application and physical productivity are also lacking
- For water optimization decision, a regional value of water study in alternative uses is required