

Price Policy Impacts on Carbon Emissions in the Canadian Agriculture Sector

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**Varghese Manaloor
Department of Social Sciences**



AUGUSTANA
UNIVERSITY OF ALBERTA

Outline of the Presentation

- **Background**
- **Objectives**
- **Data**
- **Methodology**
- **Results**
- **Conclusions**

Background

- **INTEREST IN ENERGY USE IN THE LATE 70s AND EARLY 80's WAS MAINLY BECAUSE OF PRICE INSTABILITY ([Oil Prices 2.xls](#))**
- **AT PRESENT, ALONG WITH ISSUES RELATED TO SUPPLY – DEMAND, ENVIRONMENTAL CONCERNS ARE CENTRAL TO ENERGY USE DEBATE.**
- **THE INTERNATIONAL COMMUNITY HAS BEEN CONTINUOUSLY ENGAGED IS TRYING TO FIND WAYS TO REDUCE GHG EMISSIONS.**
- **ENERGY USE PATTERNS CHANGE BECAUSE OF CHANGES IN TECHNOLOGY, BEHAVIOURAL CHANGES, CHANGES IN PRICE AND OR GOVERNMENT POLICY**
- **SECTOR WISE REDUCTION TARGET COULD BECOME THE NORM**
- **THERE IS A NEED TO HAVE INFORMATION ON HOW INPUT USE IN A SECTOR WILL BE ALTERED IF INPUT PRICES CHANGE BECAUSE OF MARKET CONDITIONS OR BECAUSE OF PRICE POLICY CHANGES**

Background (contd.)

- **At the international level, several countries have signed an agreement to cut GHG emissions**
- **The Kyoto Protocol was adopted in Kyoto in December 1997 and it came into effect in February 2005. The first commitment period started in 2008 and ended in 2012.**
- **The most recent round of negotiations led to the Doha Amendments to the Kyoto Protocol (Dec. 8, 2012).**
- **During the first commitment period, 37 industrialized countries and the European Community committed to reduce GHG emissions to an average of five percent against 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020; however, the composition of Parties in the second commitment period is different from the first. (Source: http://unfccc.int/kyoto_protocol/items/2830.php)**

Background (contd.)

- **Canada, along with other countries, is committed to reducing GHG emissions. Initial plan was for signatory countries to cut emissions by an average of 5% below 1990 level.**
- **However, under a new announcement made in 2012, Canada has committed to reduce GHGs by 17% below 2005 levels by the year 2020. As part of a national GHG reduction strategy sector wise approach takes center stage with transportation and electricity generation the most important ones. Other sectors like agriculture, forestry and industry could also be part of a national strategy. Sector wise reduction therefore becomes an important policy objective. This presentation focuses on the agriculture sector.**
- **GHG emissions from Prairie agriculture make up approximately sixty percent of total Canadian agricultural GHG emissions.**
- **Reductions can be achieved either by voluntary measures or by the use of economic policy instruments.**

Expenditure on Energy Inputs in Saskatchewan, Manitoba, and Alberta Farms (2003)

	Saskatchewan		Manitoba		Alberta	
	Million \$	Percent of TOE	Million \$	Percent of TOE	Million \$	Percent of TOE
Electricity	97.129	1.93	61.809	2.04	144.99	2.30
Heating Fuel	33.634	0.67	27.844	0.92	73.991	1.17
Machinery Fuel	401.124	7.95	184.494	6.09	368.828	5.85
Sub-total: Direct Energy Inputs	531.887	10.55	274.147	9.05	587.809	9.33
Fertilizer	737.593	14.62	388.539	12.82	570.352	9.05
Pesticides	614.882	12.19	241.656	7.97	321.521	5.10
Sub-total: Indirect Energy Inputs	1352.475	26.82	630.195	20.79	891.873	14.16
Total Operating Expenses (TOE)	5043.642	100.00	3030.631	100.00	6300.494	100.00

Source: CANSIM II (2005) Table Number: 20005

Objectives

- **TO ANALYSE THE IMPACTS OF FUEL PRICES CHANGES ON CO₂ EMISSIONS**
 - **THE REMOVAL OF PROVINCIAL FARM FUEL TAX EXEMPTION**
 - **CHANGE IN DIRECT ENERGY PRICES**

THE ANALYSIS INVOLVED,

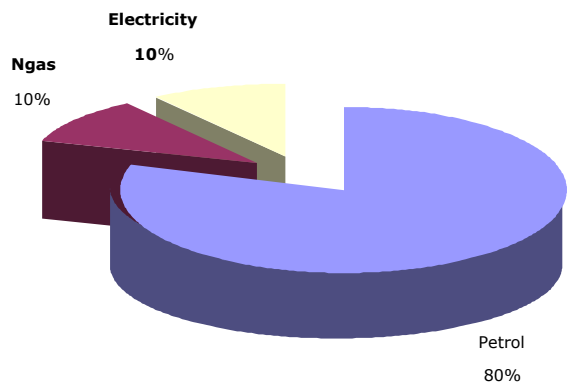
- **CALCULATION OF THE CURRENT LEVELS OF CO₂ EMISSIONS ASSOCIATED WITH AGRICULTURAL PRODUCTION**
- **ESTIMATION OF THE OWN- AND CROSS-PRICE ELASTICITIES OF INPUT DEMAND**
- **CALCULATING THE CHANGE IN CO₂ EMISSIONS IF PROVINCIAL FARM FUEL TAX EXEMPTION IS REMOVED**

Data and Variables

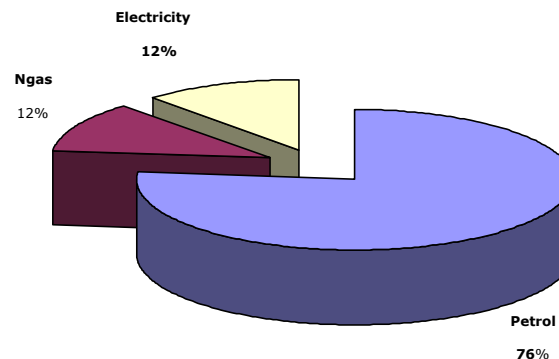
- **DIRECT ENERGY INPUTS**
 - **REFINED PETROLEUM PRODUCTS, NATURAL GAS, ELECTRICITY**
- **INDIRECT ENERGY INPUTS**
 - **FERTILIZER, HERBICIDE, PESTICIDE**
- **LABOUR**
- **LAND AND BUILDINGS**
- **MACHINERY**
- **OTHER INPUTS**

Percentage share of natural gas, refined petroleum, and electricity in Saskatchewan agriculture, 2000-03

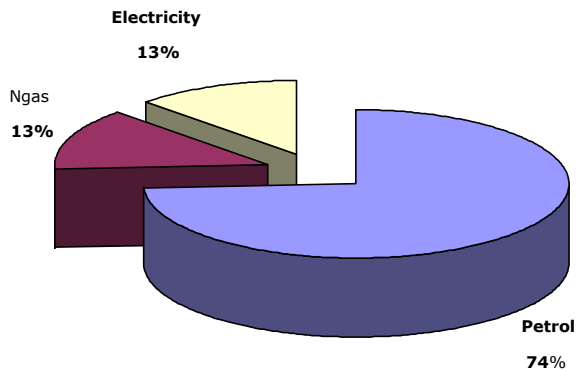
Total Direct Energy (2000) - 48,468 TJ



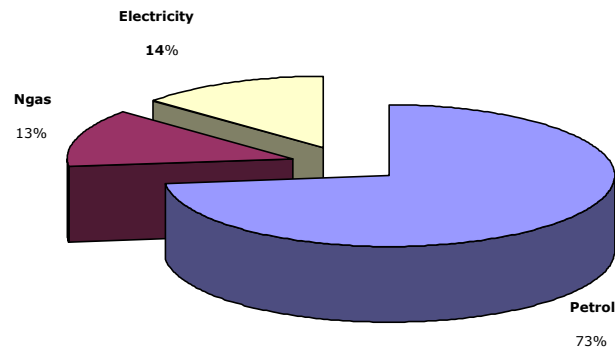
Total Direct Energy (2001) - 42,679 TJ



Total Direct Energy (2002) - 38,961 TJ

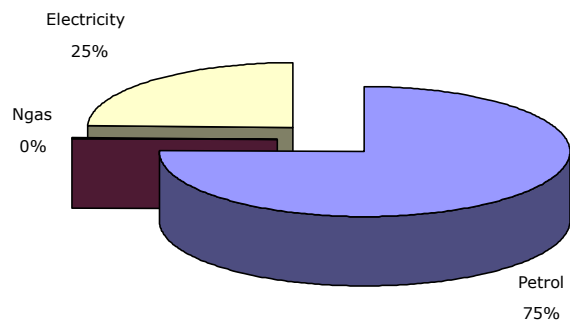


Total Direct Energy (2003) - 38,260 TJ

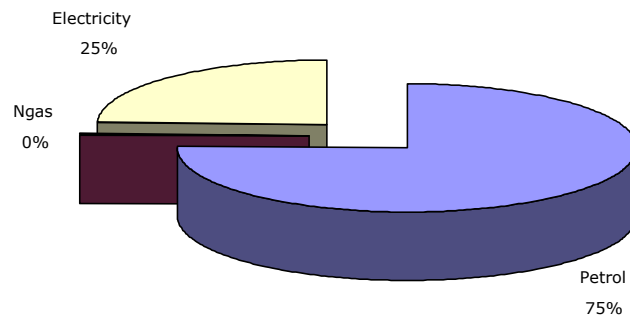


Percentage share of natural gas, refined petroleum, and electricity in Manitoba agriculture, 2000-03

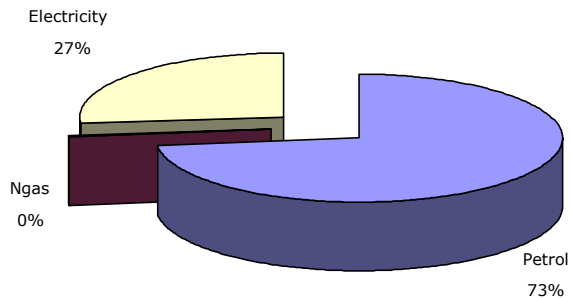
Total Direct Energy (2000) - 20,896 TJ



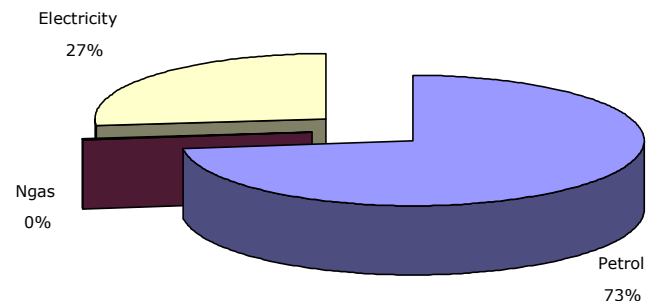
Total Direct Energy (2001) - 21,537 TJ



Total Direct Energy (2002) - 22,115 TJ

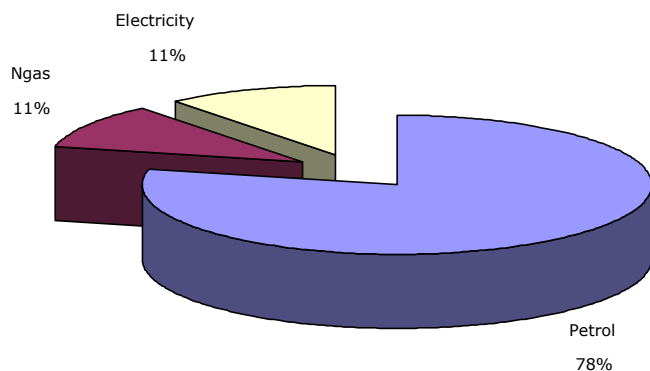


Total Direct Energy (2003) - 21,927 TJ

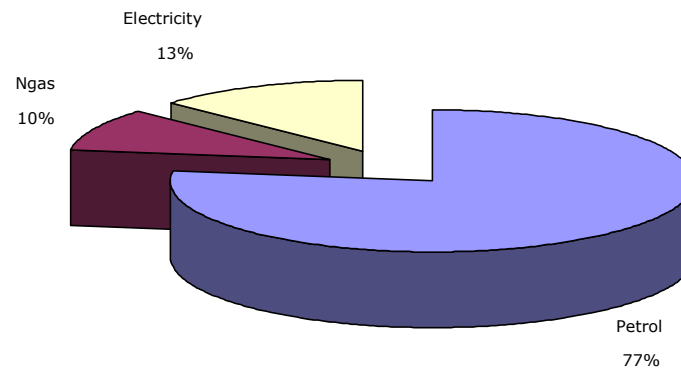


Percentage share of natural gas, refined petroleum, and electricity in Alberta agriculture, 2000-03

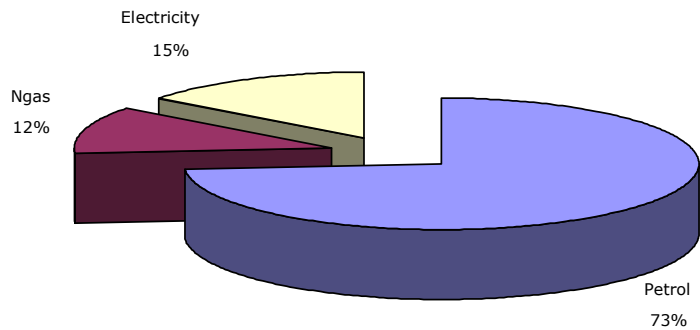
Total Direct Energy (2000) - 60,101



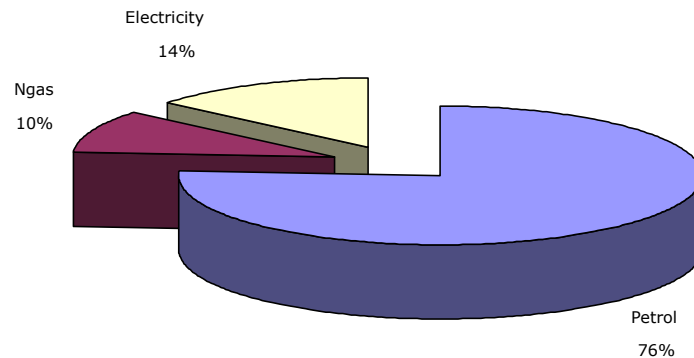
Total Direct Energy (2001) - 51,082 TJ



Total Direct Energy (2002) - 45,089 TJ



Total Direct Energy (2003) - 49,571 TJ



Estimating CO₂ Emission: Direct Energy

- **TWO CONSIDERATIONS**
- **FIRST, BURNING FOSSIL FUELS AND NATURAL GAS RELEASES CO₂ DIRECTLY TO THE ATMOSPHERE**
- **SECOND, AN INPUT LIKE ELECTRICITY DOES NOT RELEASE CO₂ WHEN IT IS USED, BUT THE INPUTS THAT ARE USED TO GENERATE ELECTRICAL ENERGY RELEASE CO₂**
- **IT IS ESTIMATED THAT CARBON EMISSIONS RELEASED INTO THE ATMOSPHERE FROM BURNING FOSSIL FUELS, NATURAL GAS, AND COAL ARE 22.29 KG C PER GJ, 13.78 KG C PER GJ, AND 24.65 KG C PER GJ, RESPECTIVELY (MARLAND 1990)**

Estimating CO₂ Emission: Direct Energy

- **THE THREE PRAIRIE PROVINCES USE DIFFERENT PROPORTIONS OF COAL, NATURAL GAS, AND HYDRO FOR GENERATING ELECTRICITY**
- **ELECTRICITY GENERATION IN**
 - **ALBERTA USES 92 PERCENT COAL, 3 PERCENT NATURAL GAS, AND 5 PERCENT HYDRO**
 - **SASKATCHEWAN USES 70 PERCENT COAL, 5 PERCENT NATURAL GAS, AND 25 PERCENT HYDRO**
 - **MANITOBA USES 1 PERCENT COAL AND 99 PERCENT HYDRO**
- **THE CALCULATION OF EMISSIONS FROM ELECTRICITY USE IN AGRICULTURE IS BASED ON THE RATIO OF COAL AND NATURAL GAS USED IN THE GENERATION PROCESS**
- **THE CARBON EMISSION FROM GENERATING ONE GIGAJoule OF ELECTRICITY IS, THEREFORE, 23.0914 KG C, 17.9440 KG C, AND 0.2465 KG C IN ALBERTA, SASKATCHEWAN, AND MANITOBA**

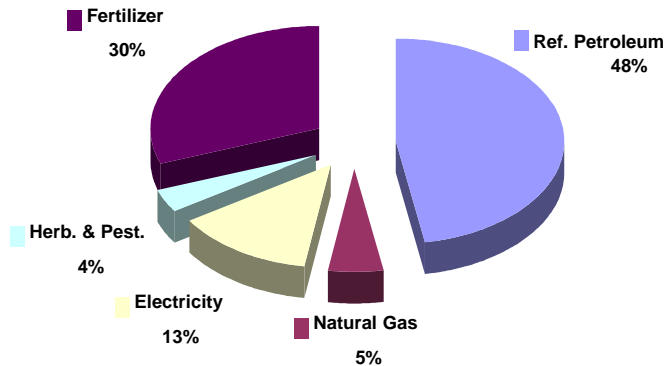
Estimating CO₂ Emission: Indirect Energy

- **Indirect Energy refers to the energy content of farm inputs, such as, fertilizers, herbicides, farm buildings and machinery**
- **In this study, the term “indirect energy” is used narrowly to include only fertilizers and chemicals**
- **90% of total fertilizer energy is derived from nitrogen and 90% of total CO₂ from fertilizer use is associated with use of nitrogenous fertilizers**

Total CO₂ emissions from different energy inputs used in Prairie agriculture (2000 – 03)

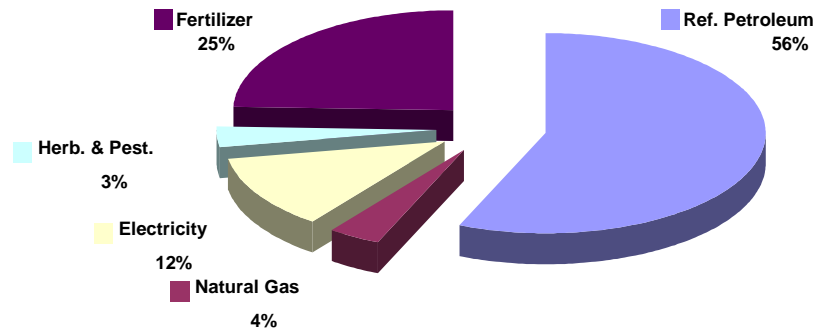
Total CO₂ (2000) - 3,047,248 tonnes

Total CO₂ (2000) 3, 028, 614 tonnes



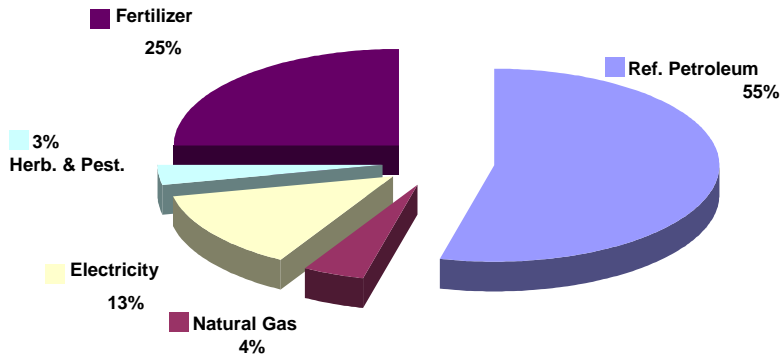
Total CO₂ (2001) - 3,498,618 tonnes

Total CO₂ (2001) 3, 551, 023 tonnes



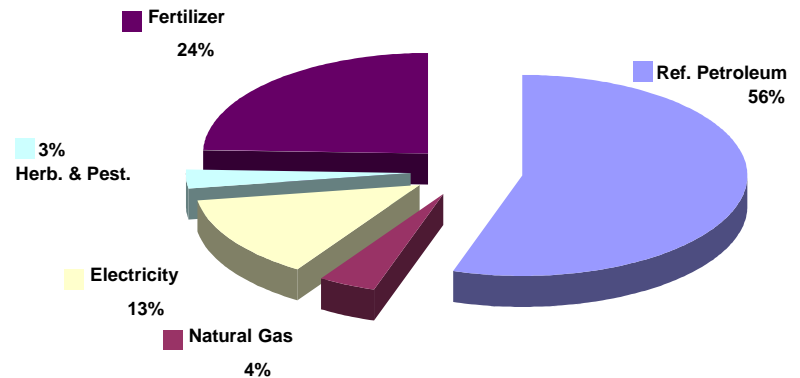
Total CO₂ (2002) - 3,230,651 tonnes

Total CO₂ (2002) 3, 345, 075 tonnes



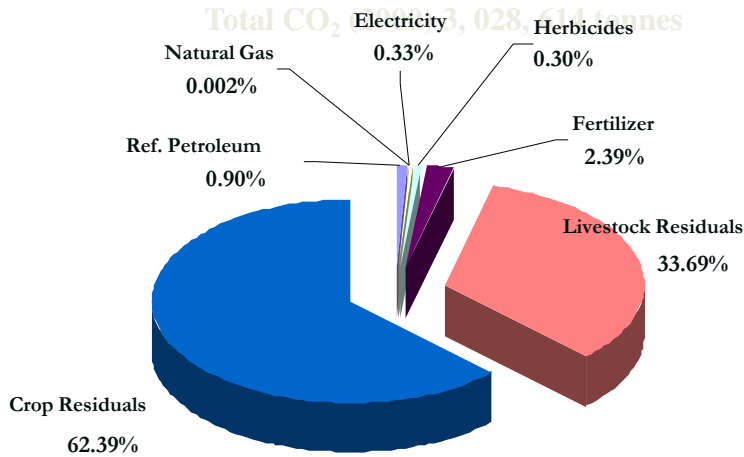
Total CO₂ (2003) - 3,316,050 tonnes

Total CO₂ (2003) 3, 430, 617 tonnes

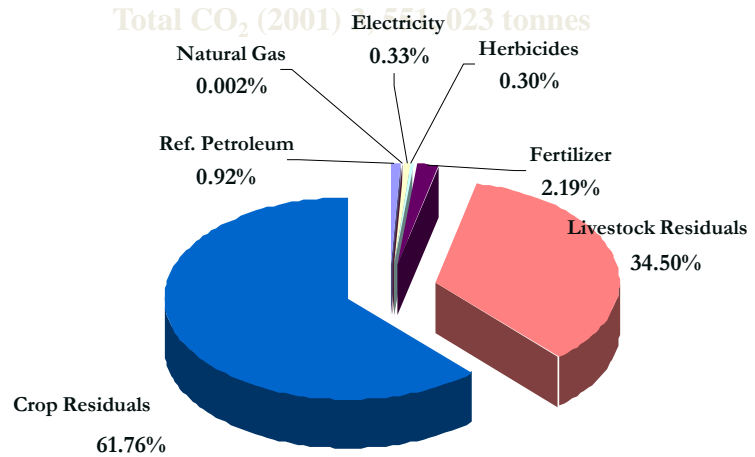


GHG emissions from Prairie agriculture, in CO₂ Equivalents (2000 – 03) [methane-prairies.xls](#)

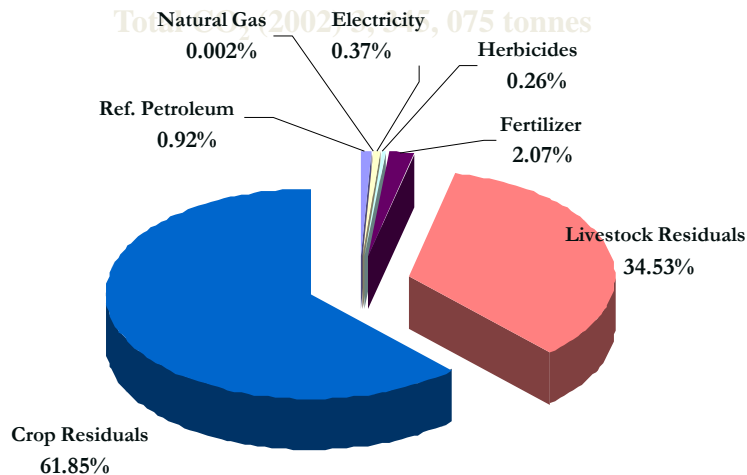
CO₂ Equivalents (2000) - 38,788,342 tonnes



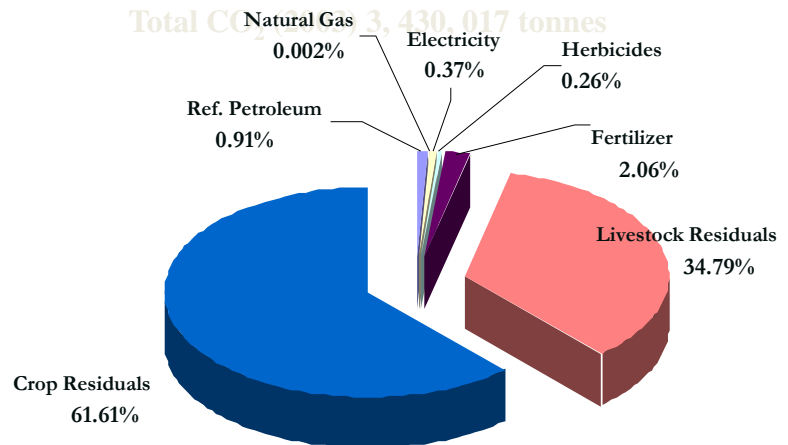
CO₂ Equivalents (2001) - 39,187,063 tonnes



CO₂ Equivalents (2002) - 39,126,638 tonnes



CO₂ Equivalents (2003) - 39,278,764 tonnes



Methodology

The following Translog cost function was used for empirical analysis

$$\ln C(w,q) = a_0 + a_q \ln q + \sum_j a_j \ln w_j + (1/2) \sum_j \sum_k b_{jk} \ln w_j \ln w_k + \sum_j b_{jq} \ln w_j \ln q + \sum_j b_{jt} \ln w_j \ln t$$

Applying Sheppard's Lemma to the above equation yields the following input share equations

$$\frac{\delta \ln C}{\delta \ln w_j} = (\delta C/C) / (\delta w_j/w_j) = (\delta C/\delta w_j) \cdot (w_j/C) = (X_j w_j)/C = S_j,$$

Hence,

$$S_j = a_j + \sum_k b_{kj} \ln w_k + b_{jq} \ln q + b_{jt} \ln t, \\ \text{for } j= 1, 2, \dots, n.$$

Estimated Own- and Cross-Price Elasticities of Input Demands

	Prices of					
Quantity	Labour	Direct Energy	Indirect Energy	Machinery	Land & Bldgs	Misc. Inputs
Labour	-0.2706	-0.1154	0.0475	0.0309	0.0434	0.1602
Direct Energy	-0.0688	-0.3147	0.2366	0.1245	0.0464	-0.0242
Indirect Energy	0.2727	0.2274	-1.2243	0.7081	0.3017	-0.2856
Machinery	0.0779	0.0526	0.3114	-0.8530	0.1652	0.2457
Land & Bldgs	0.2195	0.0339	0.2661	0.3313	-0.6913	-0.1651
Misc. Inputs	0.7101	-0.0179	-0.2208	0.4321	-0.1447	-0.7587

Source: Estimated

Impact of the Removal of Farm Fuel Tax Exemption on
CO₂ Emissions (tonnes of C)

	With Tax Exemption (2002 data)	Without Tax Exemption
Direct Energy		
Refined Petroleum	1,743,680	1,619,483
Electricity	431,695	431,695
Natural Gas	143,657	143,657
Total Tonnes C	2,319,032	2,194,835
% change		-5.36
Indirect Energy		
Fertilizer	810,085	851,779
Herbicides	101,534	106,760
Total Tonnes C	911,619	958,538
% change		5.15
GRAND TOTAL	3,230,651	3,153,373
% change		-2.39

Source: estimated

Economic Effects of the Removal of Provincial Farm Fuel Tax Exemptions (`000 \$)

	2002	After the Removal of Tax Exemption				
	Net Cash Income	Net Cash Income	Change in Net Cash Income	% Change in Net Cash Income	Change in Tax Revenue	Net Gains
Manitoba	1,055,700	1,039,293	-16,407	-1.55	+49,531	+33,123
Saskatchewan	1,501,300	1,473,314	-27,986	-1.86	+108,210	+80,224
Alberta	2,404,100	2,367,675	-36,425	-1.52	+111,369	+74,944
TOTAL	4,961,100	4,880,282	-80,818	-1.63	+269,110	+188,292

Source: Estimated

Summary and Conclusions

- **Sector wise reductions in CO₂ could possibly be a policy objective**
- **In the case of agriculture one aspect could be the removal of farm fuel tax rebate or an increase in direct energy prices**
- **the removal of provincial farm fuel tax rebate program would reduce CO₂ emissions by only 2.39 percent from 2002 levels**

QUESTIONS
AND
COMMENTS/SUGGESTIONS