Agricultural Production Profiles

of Land Systems

within the County of Stettler, Alberta

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Agricultural Production Profiles of Land Systems within the County of Stettler, Alberta

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Executive Summary

This report develops, tests and assesses a method to integrate and summarize agricultural production data with biophysical landscape units. The method produces an effective framework for municipal soil and water conservation planning.

Present methods to integrate production data with landscape units work poorly at the municipal level. These methods use federal Census of Agriculture data, the most consistent and detailed source of farm-level production data. The data are summarized by enumeration area, the smallest unit for which Statistics Canada routinely provides data. Enumeration areas, however, do not coincide with biophysical landscapes. Thus, when the two datasets are combined, valuable data are lost and production summaries are too general for use in municipal planning.

The study method processes Census data by farm headquarters to provide more accurate summaries of agricultural production for landscape units of a municipality. The method is developed using the 1986 Census of Agriculture for the County of Stettler, Alberta. This rural municipality has in place a biophysical landscape classification called *land systems*. Land systems are biophysical units with similar climate, soils and landscape features at a scale appropriate for municipal soil and water conservation planning. The classification shows 23 land systems in the County.

Four steps integrate and summarize agricultural production data for the 23 land systems:

- linking farm headquarters records and associated production data to a land system;
- describing land resource characteristics of the land systems;
- summarizing agricultural production by land system; and
- grouping of the land systems into five broad groups for comparative analyses.

A test of the method shows that farming in the three groups of land systems in the Black soil zone is more productive but not more efficient compared to farming in the two groups in the Dark Brown soil zone. The Black soil zone groups have much larger gross sales per hectare of total farm area. However, they put much more into production, both in absolute and relative terms. They show higher expenses, more crop expenses and greater capital investment. Cultivated land is more extensive, as are barley and oilseeds. Summerfallow is not as widely practised. Fertilizers and herbicides are used more extensively, and fertilizers are applied more intensively. The two Dark Brown soil zone groups have sales to expenses ratios similar to those for the Black soil zone groups, with higher machinery expenses and lower crop expenses, and more spring wheat and summerfallow.

The test also shows that within both soil zones production is less efficient in land systems with extensive biophysical limitations to annual cropping. For the two groups in the Black soil zone with topographical and texture limitations, a lower sales to expenses ratio is associated with

more livestock and less crop expenses. In terms of land use, the two groups show a lower proportion of cultivated land, more feeds and forages and less wheat. In the Dark Brown soil zone, the group with extensive areas of coarse textured parent materials reports less efficient production in conjunction with more livestock expenses.

Comparison of production profiles within a group shows more subtle differences in the allocation of resources to crop and livestock production. At this relatively detailed scale, profiles provide baseline descriptions of agricultural production for a land system.

An assessment of the study method shows that it should be replicable (repeatable) and applicable to municipal conservation planning. Conceptually, it can be replicated for another municipality or Census of Agriculture inventory, subject to the availability of land system and Census farm headquarters files. To test the method's applicability to conservation planning, the issue of wind erosion is considered. Subtle production differences are noted in land systems with a potential wind erosion rating of "severe." These differences guide the selection of conservation projects in a land system. For example, in land systems with economically efficient crop production, the emphasis may be on surface residue management projects. For land systems with less efficient crop production, the focus may be on perennial forage projects. Perennial forage projects may also be emphasized in land systems with efficient livestock production.

Further research is needed to demonstrate the replicability of the study method and to enhance its value for municipal conservation planning. It is suggested that the method be repeated for a different Census year and a different municipality. To improve the applicability of the profiles to conservation planning, several topics require further study including: investigation of potential biases in data integration; development of more sophisticated statistics on the economic structure of agricultural production; classification of farms on the basis of similar cropping systems; evaluation of the 1991 Census of Agriculture Land Management Module; and the addition of a profile on livestock production. The opportunity also exists to expand this analysis into areas such as program planning and policy development. The suggested research will result in multi-year, comparable production databases in support of both municipal and provincial conservation planning in agricultural regions of Alberta.

Acknowledgements

The authors acknowledge the contributions of several individuals during the initial efforts to summarize farm headquarters data within land systems of the County of Leduc, Alberta. These people are: Wayne Pettapiece and Ted Huffman (Agriculture and Agri-Food Canada); Keith Toogood (Alberta Agriculture, Food and Rural Development); and Rick Burroughs and Brenda Clarke (Statistics Canada). As well, input received from many individuals in the County over a five year period has been invaluable to the continued refinement of the method.

The present research has been supported by specialists in several organizations. Timely inputs were received from: Tony Brierley, Gerry Coen, Don Acton, Paula Brand and Les Usher (Agriculture and Agri-Food Canada); Lynda Kemp and Brenda Clarke (Statistics Canada); and Tamara Hursin, Brian West, Jan Kwiatkowski, Brad Lowrie and Gerald Stark (Alberta Agriculture, Food and Rural Development).

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1.0 Introduction

1.1 Objective

The objective of this report is to develop, test and assess a new method to summarize agricultural production data by biophysical landscape units. The study area is the County of Stettler, a rural municipality in central Alberta. The agricultural production data are from the 1986 Census of Agriculture. The integration of agricultural production data with biophysical landscape data can provide an effective framework for municipal conservation planning.

1.2 Municipal Conservation Planning

Rural municipalities have a major stake in sustainable land management. They rely on assessment revenues from agricultural lands to finance their activities. Revenue amounts depend in part on how these agricultural lands are managed and on the quality of the soil and water resources. The level of agricultural production and the type of management influence the sustainability of both the natural resources and the rural community.

Planning is important in achieving sustainable land management. It allows municipalities to integrate and evaluate a range of information on economics, agronomics, resource capability, and farm manager needs and values. The municipal conservation planning process follows four steps to assess existing and proposed land management practices. It inventories existing resources, analyzes their capabilities, sets priorities and targets actions (MCPPP Steering and Technical Committees 1993). This process produces a strategic direction to meet present and future demands on natural resources.

1.3 Landscape Approach to Municipal Conservation Planning

The landscape approach to municipal conservation planning involves evaluating land management options in relation to the biophysical characteristics of a municipality. Although this approach requires a significant effort to collect and analyze information and set objectives for individual landscapes, the result can be a vital component in achieving environmental sustainability in agricultural areas (Hiley and Wehrhahn 1991). The approach allows accurate assessment of physically appropriate land uses. In addition, diverse land use objectives can be accommodated during the planning process as the landscape's physical capabilities are considered in relation to social, economic and other environmental issues.

The landscape approach is the foundation on which the Municipal Conservation Planning Pilot Project (MCPPP) was developed (MCPPP Steering and Technical Committees 1993). This interdisciplinary project was conducted by representatives from the federal, provincial and municipal governments, the regional planning commission, and the private sector. The project's

purpose was to develop an integrated conservation plan for local government use, emphasizing the conservation of soil, water and wildlife on agricultural lands. The County of Stettler in central Alberta was selected as the pilot municipality.

The pilot project used biophysical landscape units called *land systems*. Brierley et al. (1992) applied a series of attributes to classify the County into 23 land systems (Appendix 7). These attributes include agroclimatic zone*, dominant parent materials, soil zone, dominant soil series, dominant slope, surface form, slope length, percent salinity, percent eroded soils and percent gleyed soils, Gleysolics and water.

The pilot project's planning team developed an inventory of soil, water and wildlife resources in each land system. The team then identified conservation issues and land management activities for each land system based on its biophysical and agricultural production characteristics. Feedback from County officials has been very positive. They believe the plan will provide the County with the tools to manage its resource base in a more holistic, integrated manner than in the past.

1.4 Agricultural Production Data by Land System

Recommendations for land management strategies need to be based on social and economic characteristics as well as biophysical characteristics. Land use data, especially agricultural production data, are essential because they indicate how the landscape units are being managed and help in evaluating the sustainability of agricultural practices. However, agricultural production data are not readily available for individual land systems.

The most consistent and detailed source of farm-level production data is the federal Census of Agriculture. Previous studies have integrated Census data within larger biophysical landscape units using Statistics Canada Enumeration Area (EA) files (Huffman 1988; Patterson and Langman 1992). Two common techniques to link EA files to biophysical landscape units include weighting EA data by degree of overlap with a landscape unit or selecting EAs that are predominantly within a unit (Kraft 1980; Fox and Coote 1986). Regardless of the linking technique used, valuable data can be and often are lost, and production summaries are too general for use in local planning (Brierley et al. 1992; Huffman et al. 1993). Therefore, EA files are not an effective way to summarize Census data for use in landscape-based municipal conservation planning. Statistics Canada's procedure to produce EA files was evaluated to determine if other linking variables could be used.

Statistics Canada uses a three-step procedure to generate agricultural production data by EA. Farmers report production characteristics on a Census form, to which a Census enumerator

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* Refer to Appendix 1 for definitions of agroclimate, parent materials and other terms used in this report.

attaches an EA code. Data on each form, along with the EA code, are computerized and all data are subjected to a rigorous verification procedure. The records are then sorted by EA and production data are summarized at this level. Conversion files assign EAs and associated data to the Census Subdivision (i.e., municipality) or broader levels. Examination of the Census form shows at least one alternative to summarizing data by EA.

Farmers report the legal location of the farm headquarters, data which can be used in a process to sort Census data into land systems. An inventory of the legal locations within a land system can be rapidly completed with geographic information system (GIS) technology. A land system code can be assigned to a farm headquarters record on the basis of matching legal locations. This code permits the processing of Statistics Canada data by biophysical landscape unit. Given the poor fit between EAs and land systems, and the importance of integrated land resource and production information to the conservation planning process, an assessment of the farm headquarters technique is the objective of this study.

2.0 Method

Four procedures sort and summarize agricultural production data from farm headquarters records by land system. They are: linking farm headquarters records and associated production data to a land system; describing the land resource characteristics of a land system; summarizing agricultural production by land system; and grouping of land systems for comparative analyses. The major steps within each procedure are presented in this Section.

2.1 Linking Census Records to Land Systems

Legal location files are used to assign farm headquarters records to land system units as follows. A GIS is used to overlay the legal survey grid and land system polygons. It produces a file containing a land system code for each legal location in the County. A second file containing the legal location of each farm headquarters is maintained in strict confidentiality by Statistics Canada. The two files are merged and a land system code is assigned to each farm headquarters record by matching the legal location. This new file permits the reprocessing of farm headquarters records and associated agricultural production data by land system.

2.2 Land Resource Descriptions

A naming convention references each land system to the tables and figures in this report. Each land system's name is followed by its number (LS #) (e.g., Buffalo Lake Upland (LS 1) and Boss Hill Upland (LS 2)).

Five variables indicate land resources available for agricultural production in a land system. They are: agroclimatic zone; texture of the parent material; topography; dominant soil development; and other landscape features. Broad classes for each variable describe the land resources for the purposes of this report. More detailed information on terms and definitions is available from other sources (see Agriculture Canada 1976, 1987; Brierley et al. 1992).

2.3 Agricultural Production Profiles (APPs)

Production summaries, called agricultural production profiles (APPs), are generated for each land system from the Census data. APPs describe agricultural production in terms of the measures of output and inputs available from the Census. They include cash flow, capital investment, land use and land management characteristics by land system.

2.3.1 Data Integration

Integration variables indicate the 'goodness of fit' between the land system and Census farm headquarters data. A good fit between the datasets indicates that the APP is probably

representative of production within a land system. Integration variables include total land system area, number of farms and total farm area as well as the ratio of total Census farm area to land system area. The closer this ratio is to one, the better the fit.

2.3.2 Cash Flow

Measures of sales and expenses indicate cash flow. These variables, with the exception of output measured by gross farm sales, are relative measures. Relative output is measured by gross farm sales per hectare of total farm area. Economic efficiency is measured by the ratio of total gross sales to summary expenses. The percentages of expenses in interest, machinery, crops, livestock and other expenses indicate the distribution of short-term monetary input. 'Other expenses' includes expenditures on rent/leasing, wages, telephone, electricity, fuel for heating and crop drying and any other expenses (Statistics Canada 1986).

2.3.3 Capital Investment

Capital input refers to the value of land, buildings, machinery, equipment and livestock. It is measured in relative terms and in total value. Variables include: percentage of farm area in private ownership; total capital value per hectare of total farm area; and the percent distribution of capital in land and buildings, machinery and livestock. All capital values, except livestock, are the farmers' estimates in 1985 dollars. Livestock values are calculated by Statistics Canada using a standard value for each livestock type.

2.3.4 Land Use

These variables indicate the type and extent of agricultural land uses, another category of production inputs. They include average farm size, the total of cultivated area (i.e., the sum of cropland and summerfallow), cultivated area as a percent of total farm area, and the percent distribution of crops on cultivated land in seven categories. These categories, representing the major field crops in the County, are: feeds and forages (i.e., mixed grains, alfalfa and alfalfa mixtures cut for hay or silage and all other tame hay); oats; barley; oilseeds (principally canola); total wheat (spring wheat, winter wheat, durum wheat); summerfallow; and other field crops.

2.3.5 Land Management

Land management variables indicate the extent and intensity of agricultural chemicals used in production. Fertilizer use variables include: area applied as a percent of cropland; and, rate in kilograms per hectare. The base variable, cropland, is defined as cultivated area less summerfallow acreage, as summerfallow does not receive fertilizer applications. Herbicide use is calculated as the area sprayed as a percent of cultivated land.

2.4 Comparative Analyses

For comparative analyses, land systems are grouped by biophysical characteristics affecting annual cultivation. These groups are useful for preliminary assessments of conservation problems and solutions as well as the targeting of human and financial resources. A hierarchical approach is used to group land systems initially by agroclimate and soil zone characteristics, then on the basis of texture of the parent material, surface form, soil development and spatial contiguity (i.e., proximity to other land systems in a group). In the tables and discussions, the land systems within a group are ordered from largest to smallest total reported farm area.

Aggregate Group Agricultural Production Profiles (AGAPPs) differ slightly from land system APPs in terms of comparative statistics, the technique to calculate summary statistics and the naming convention. In particular, sum totals for economic and crop production statistics are not used for AGAPPs. Sum totals for these statistics are biased by variation in the absolute size of the groups and thus have little value for comparative analyses. Instead, medians are calculated for group comparisons. The median (the middle value) is used rather than the average because, for small datasets, an average is affected by unusually high or unusually low data points. When missing data are encountered in the calculation of a median, the observation is omitted and the statistic is based on the remaining data.

For ease of presentation, a group naming convention references each group to one or more major physiographic district(s) and the compass direction from the centre of the municipality. For example, Castor Plain/Central (Group 1) refers to a subdivision of the medium textured till plain of Black Solonetzic soils in the centre of the County (Pettapiece 1986). It is distinguished from Bashaw and Delburne Uplands/West (Group 2), an area with hummocky uplands of Black Chernozemic soils on the western side of the County.

3.0 Results

Results are presented in two subsections. The first subsection describes the land resources and AGAPPs for each group followed by a summary of the results for the County. The second subsection describes the land resources and APPs for each land system in each group. Within a group, land systems are ordered from the largest to smallest total farm area, as reported from the Census farm headquarters database. There are no results for River Valleys (LS 23) due to unrepresentative data.

3.1 Land System Groups

Five land system groups were defined for the County (Figure 1). Each group generally contains spatially contiguous land systems with similar resource characteristics (Table 1). Groups 1 to 3 are in the Black soil zone (including the Thin Black soils) and the 2H agroclimatic zone (slight heat limitation to dryland annual crop production) (Alberta Soils Advisory Committee 1987). Groups 4 and 5 are in the Dark Brown soil zone and the 2AH agroclimatic zone (slight heat and moisture limitations to dryland annual crop production).

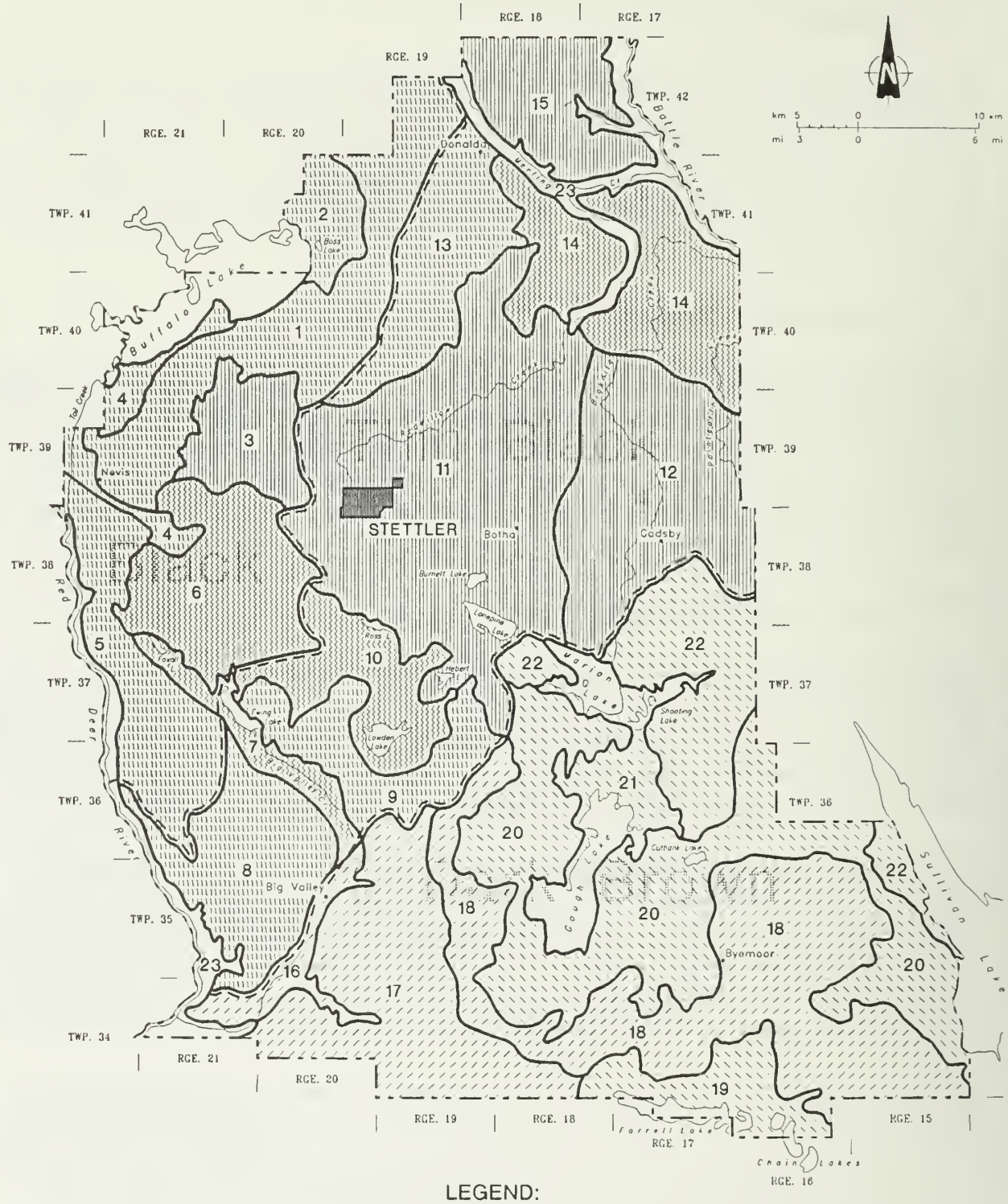
3.1.1 Group Land Resource Description

Castor Plain/Central (Group 1) is a medium textured, level plain with dominantly Black Solonetzic soils. It contains four land systems (Figure 1). Liberal Plain (LS 3), Stettler Plain (LS 11) and Bigknife Plain (LS 12) are spatially contiguous; Meeting Creek Plain (LS 15) is a small unit located between the junction of Meeting Creek and the Battle River. Liberal Plain (LS 3) differs most from the group profile with dominantly Black Chernozemic soils (Table 1).

Bashaw and Delburne Uplands/West (Group 2) is a medium to coarse textured, hummocky upland with Black Chernozemic and Solonetzic soils. It contains seven land systems with similar resource characteristics. It extends along the western boundary of the County, from the north to the southeast, where it meets the Dark Brown soil zone at Big Valley Creek (Figure 1). The exception to these medium textured, hummocky till uplands is Nevis Lowland (LS 4), a small hummocky landscape with soils developed on coarse textured parent materials (Table 1).

Castor Plain/West and Central (Group 3) is a coarse textured, level to undulating plain with dominantly Black Chernozemic soils. It has four land systems with similar land resources. Three of the land systems (LS 3, 6 and 10) are located southwest of the Town of Stettler; the other land system, Red Willow Plain (LS 14), is in the County's northeast corner (Figure 1). The dominantly Black Chernozemic soils in these land systems have developed on a level to undulating plain of coarse textured parent materials (Table 1).

Rumsey Upland/South (Group 4) is a medium textured hummocky upland of Dark Brown Chernozemic and Solonetzic soils. It contains three land systems and is located in the southern



LEGEND:

Black Soil Zone Groups

- Group 1 (Land Systems 11, 12, 3, 15)
- Group 2 (Land Systems 1, 8, 5, 9, 13, 2, 4)
- Group 3 (Land Systems 6, 14, 10, 7)

Dark Brown Soil Zone Groups

- Group 4 (Land Systems 18, 17, 16)
- Group 5 (Land Systems 20, 21, 22, 19)

Land System 23 is not included in the analysis due to insufficient data

Soil zone boundary

FIGURE 1. *Land system groups within the County of Stettler*

Table 1. Land Resource Characteristics of Land System Groups

Group Number	Group Name	Land System Number	Land System Name	Land Resource Characteristics			
				Agroclimate*	Texture of Parent Material	Topography	Dominant Soil Development
1	Castor Plain / Central	11	Stettler Plain	2H	Medium	Level	Black Solonetzic
		12	Bigknife Plain	"	"	"	"
		3	Liberal Plain	"	"	Undulating/Level	Black Chernozemic
		15	Meeting Creek Plain	"	"	Level	Black Solonetzic
2	Bashaw and Delburne Uplands / West	1	Buffalo Lake Upland	2H	Medium	Hummocky	Black Chernozemic
		8	Scollard Upland	"	"	"	Black Chernozemic & Solonetzic
		5	Foxall Lake Upland	"	"	"	Black Chernozemic
		9	Fenn Upland	"	"	"	Black Chernozemic & Solonetzic
		13	Donalda Upland	"	"	"	"
		2	Boss Hill Upland	"	Medium/Coarse	"	Black Chernozemic
		4	Nevis Lowland	"	Coarse	Hummocky	"
3	Castor Plain / West and Central	6	Oberlin Plain	2H	Coarse	Undulating	Black Chernozemic
		14	Red Willow Plain	"	Medium/Coarse	Level	Black Chernozemic & Solonetzic
		10	Lowden Lake Plain	"	Coarse	Level/Undulating	Black Chernozemic
		7	Ewing Lake Lowland	"	Medium/Coarse	Undulating	"
4	Rumsey Upland / South	18	Byemoor Upland	2AH	Medium	Hummocky	Dark Brown Chernozemic & Solonetzic
		17	Gopher Head Upland	"	"	"	"
		16	Big Valley Lowland	"	Coarse	Level/Undulating	Dark Brown Chernozemic
5	Castor Plain / Southeast	20	Cutbank Lake Plain	2AH	Medium	Level/Undulating	Dark Brown Solonetzic & Chernozemic
		21	Gough Lake Lowland	"	Fine/Medium	Level	Saline & Gleysolic Soils
		22	Shooting Lake Plain	"	Medium	Level/Undulating	Dark Brown Solonetzic & Chernozemic
		19	Farrell Lake Plain	"	Coarse	Undulating	Dark Brown Chernozemic & Solonetzic

* 2H = slight heat limitation to dryland annual crop production; 2AH = slight heat and moisture limitations to dryland annual crop production (Pettapiece 1987)

Notes:

Land systems within each group are listed from largest to smallest reported farm area.

Land system 23 is not included in the analysis due to insufficient data.

half of the County (Figure 1). Big Valley Lowland (LS 16), which differs most from the groupcharacteristics, has dominantly Dark Brown Chernozemic soils developed on coarse textured parent materials and level to undulating topography (Table 1).

Castor Plain/Southeast (Group 5) contains land systems with the greatest diversity in land resources. Its four land systems are part of a medium textured level to undulating till plain of Dark Brown Solonetzic and Chernozemic soils (Figure 1). Gough Lake Lowland (LS 21) has saline and Gleysolic soils on medium to fine textured parent materials (Table 1). Farrell Lake Plain (LS 19) has coarse textured parent materials and dominantly Chernozemic soils.

3.1.2 Aggregate Group Agricultural Production Profiles (AGAPPs)

Data integration between the groups and Census farm headquarters data is generally excellent. Nearly 850 headquarters report a total farm area of approximately 360,000 hectares (Table 2.A) which is about 90 percent of the total land system area. The ratio of total farm area to land system area is greater than 80 percent for every group. Castor Plain/Central (Group 1) contains the greatest farm area and most farms, each at about 30 percent of the respective total for the County. The two Dark Brown soil groups report fewer farms than the Black soil zone groups.

Data integration may be an issue in Rumsey Upland/South (Group 4) even though the ratio of total farm area to total land system area is 91 percent. Gopher Head Upland (LS 17), one of the land systems in the group, has a very low ratio of farm area to land system area (41 percent, see Appendix 5). This land system includes Rumsey South, a large, environmentally significant area of public land leased for grazing. As well, several landowners with large holdings and grazing associations operate within the land system (L. Usher, pers. comm.). Thus, it appears that the low ratio may be due to the fact that many of the farm headquarters for these extensive grazing operations are outside the land system's boundaries. The other two land systems in this group have much higher ratios of total farm area to land system area, resulting in a high ratio for the group.

Groups in the Black soil zone have more productive, but not more efficient, farming compared to groups in the Dark Brown soil zone. That is, the Black soil zone groups show much larger gross sales per hectare of total farm area (a measure of productivity) but similar sales to expenses ratios (a measure of efficiency) (Table 2.B.1). Castor Plain/Central (Group 1) has the highest efficiency in the Black soil zone (Figure 2.A). Relative to this group, the Bashaw and Delburne Uplands/West (Group 2) and Castor Plain/West and Central (Group 3) have lower efficiencies, lower crop expenses and higher livestock expenses (Figure 2.B). In comparison to the Black soil zone groups, the two Dark Brown soil zone groups have lower gross sales per hectare and higher machinery expenses. As well, Castor Plain/Southeast (Group 5) has higher livestock expenses.

Table 2. Aggregate Group Agricultural Production Profiles (AGAPPs)

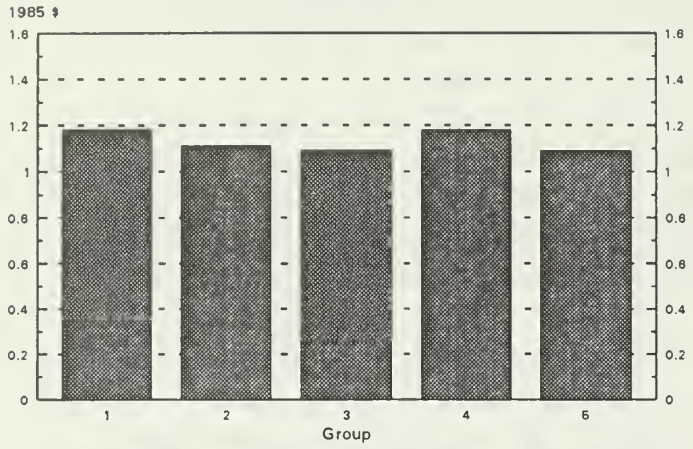
	Group 1 Castor Plain / Central	2 Bashaw and Delburne Uplands/ West	3 Castor Plain/ West and Central	4 Rumsey Upland / South	5 Castor Plain / Southeast
(A) Integration -- Summary					
Land System Area (ha)*	104804	92197	57158	73371	74122
Number of Farms*	297	192	137	101	118
Total Farm Area (ha)*	100331	74512	54671	54342	75324
Tot. Farm Area as % of Land System	93	81	94	91	90
(B.1) Cash Flow					
Gross Sales per Ha(1985 $)	230	236	230	131	110
Sales to Expenses Ratio	1.18	1.11	1.09	1.18	1.09
Distribution of Expenses					
% Interest	10	12	12	11	10
% Machinery	16	16	16	21	21
% Crops	23	19	15	15	13
% Livestock	22	23	30	24	33
% Other	28	27	24	27	28
(B.2) Capital Investment					
Area Owned as % Total Farm Area	66	57	70	70	66
Cap. Value($)/Ha of Tot. Farm Area	1497	1230	1365	965	1068
Distribution of Capital					
% Land and Buildings	70	65	68	67	72
% Machinery	20	18	18	20	16
% Livestock	9	12	13	12	12
(C.1) Land Use					
Average Farm Size (ha)	383	401	384	523	646
Cult. Area as % Total Farm Area	66	50	58	45	49
Dist. of Crops as % of Cult. Land					
% Feeds and Forages	13	24	24	13	12
% Oats	6	4	4	8	7
% Barley	22	23	22	17	13
% Oilseeds	16	14	17	4	6
% Wheat	32	23	25	35	34
% Summerfallow	10	6	6	29	27
% Other Crops	2	3	4	1	3
(C.2) Land Management					
Area Fert. as % of Cropland	90	83	77	75	68
Kg Fertilizer per Ha of Cropland	92	118	89	60	59
Herb. Sprayed Area as % Cult. Land	72	67	70	58	53

* Totals of land systems within the group. All other values are medians.

Figure 2. Selected Variables for Aggregate Group Agricultural Production Profiles

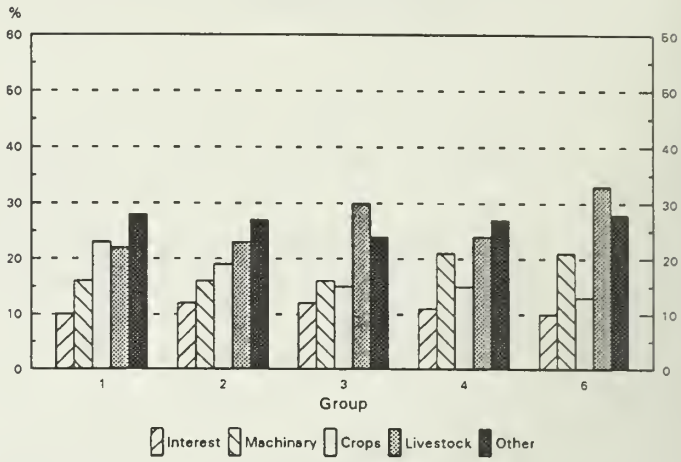
A. SALES TO EXPENSES RATIO

Group Medians



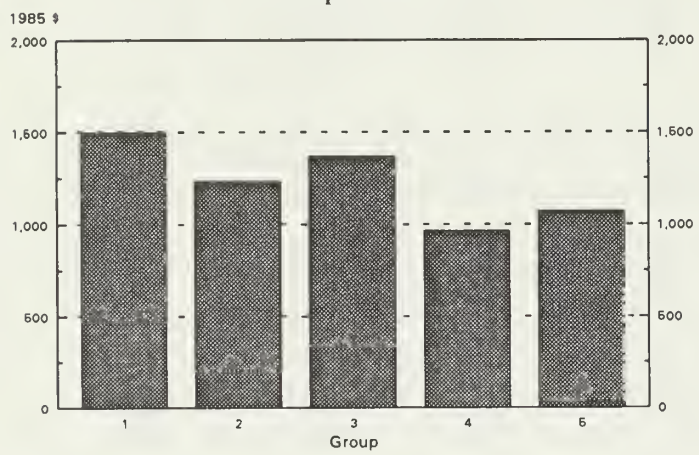
B. % DISTRIBUTION OF EXPENSES

Group Medians



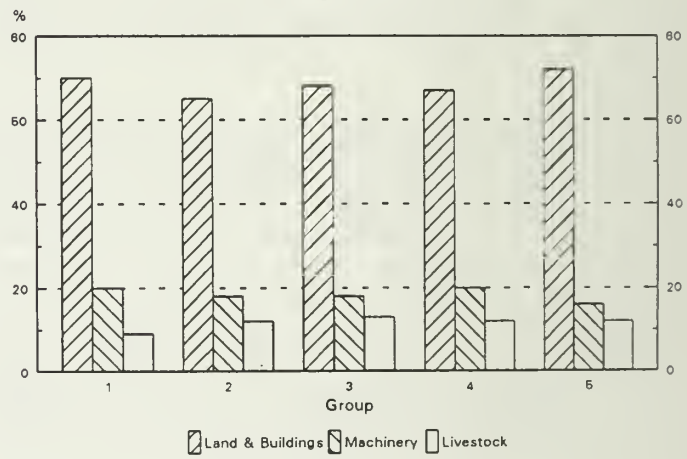
C. CAPITAL VALUE PER HECTARE

Group Medians



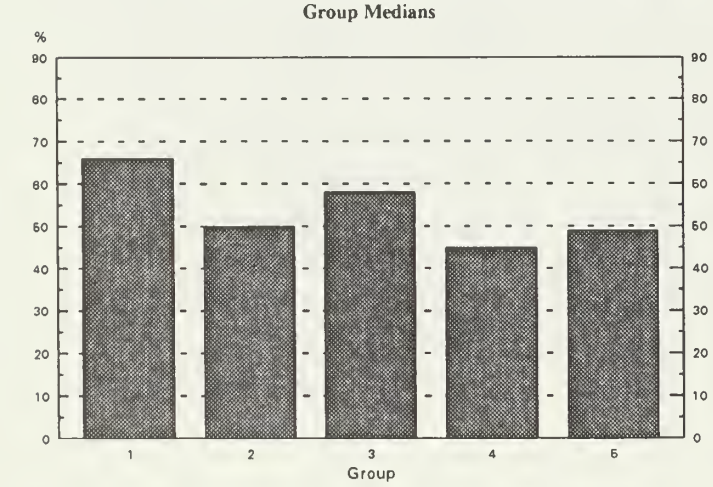
D. % DISTRIBUTION OF CAPITAL

Group Medians



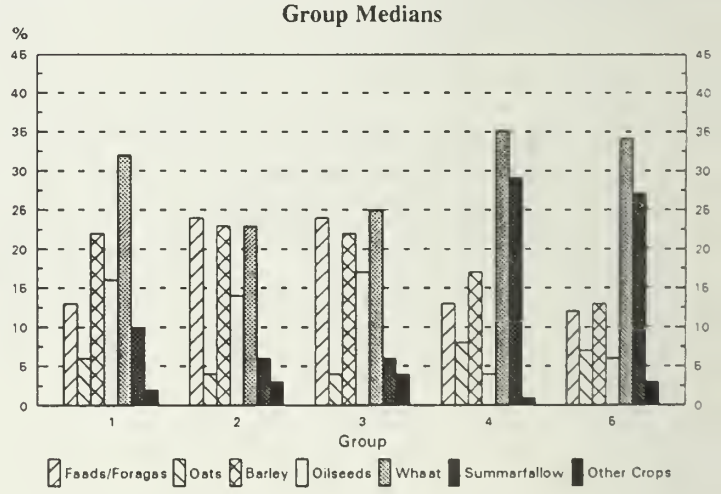
E. CULTIVATED AREA AS % OF TOTAL FARM AREA

Group Medians



F. % DISTRIBUTION ON CULTIVATED LAND

Group Medians



The Black soil zone groups report more capital investment but similar distributions of investment in comparison to the Dark Brown soil zone groups. Castor Plain/Central (Group 1) shows nearly $1500 investment per hectare with about 65 percent of the area privately owned (Table 2.B.2, Figure 2.C). In comparison to Group 1, Bashaw and Delburne Uplands/West (Group 2) has less private land ownership and less total investment. Central Plain/West and Central (Group 3) also has less total investment. Both Dark Brown soil zone groups report much less total capital investment than the Black soil zone groups. All groups have about 70 percent of total capital investment in land and buildings, about 20 percent in machinery and about 10 percent in livestock (Figure 2.D).

The Black soil zone groups show more extensive cultivated land and a more diverse crop mix than the Dark Brown soil zone groups. Castor Plain/Central (Group 1) reports an average farm size of almost 400 hectares of which about 70 percent is cultivated (Table 2.C.1, Figure 2.E). Wheat accounts for about 30 percent of the cultivated land with barley about 20 percent and oilseeds and feeds and forages each at about 15 percent (Figure 2.F). Relative to the profile of this group, both Bashaw and Delburne Uplands/West (Group 2) and Castor Plain/West and Central (Group 3) have less extensive cultivated land, more feeds and forages, and less wheat. The two Dark Brown soil zone groups report much larger average farm sizes, less oilseeds and more summerfallow.

Fertilizers and herbicides are used more extensively in the Black soil zone groups than in the Dark Brown soil zone groups. In Castor Plain/Central (Group 1), fertilizer is applied to 90 percent of the cropland at just over 90 kilograms per hectare (Table 2.C.2). About 70 percent of the cultivated land receives herbicides. Compared to this group, Bashaw and Delburne Uplands/West (Group 2) has less extensive but more intensive fertilizer use. Fertilizers are also used less extensively in Castor Plain/West and Central (Group 3). Both groups in the Dark Brown soil zone show less extensive fertilizer and herbicide use. Fertilizers are also used less intensively in these groups.

3.1.3 Summary

The three groups in the Black soil zone report more productive but not more efficient farming compared to the two groups in the Dark Brown soil zone. The Black soil zone groups show much larger total gross sales per hectare; however, more inputs are used to achieve this output. They report more: expenses; capital investment per hectare; cultivated land; oilseeds; fertilizer and herbicide use; and intensive use of fertilizer. Wheat and summerfallow are more extensive in the groups in the Dark Brown soil zone.

Within the Black soil zone, Groups 2 and 3, which have textural and topographic limitations to annual cropping, are less efficient than Group 1, which does not have these limitations. Livestock are relatively more important than crops in these two groups. They report higher livestock and lower crop expenses, more capital investment in livestock, less extensive cultivated land, more feeds and forages, and less extensive use of fertilizers.

In the Dark Brown soil zone, Group 5, which has greater topographic and textural limitations to annual cropping than does Group 4, is less productive and less efficient than Group 4. Castor Plain/Southeast (Group 5) shows lower gross sales per hectare and a lower sales to expenses ratio. It also reports a higher percentage of livestock expenses and a larger farm size, which are indications of extensive cattle grazing.

3.2 Land Systems by Group

This subsection presents the land resource and agricultural production profiles (APPs) of the 22 land systems within the appropriate land system groups. The descriptions of land resources and APPs are followed by a summary of results for the group and each land system in it.

3.2.1 Castor Plain/Central (Group 1)

Four land systems are found on this medium textured till plain of dominantly Black Solonetzic soils, with some differences in topographic features and soil development (Brierley et al. 1992). Stettler Plain (LS 11) and Meeting Creek Plain (LS 15) are typical of the group. Bigknife Plain (LS 12) has a more incised drainage network and higher proportions of saline soils and Solonetzic soils developed on bedrock. Liberal Plain (LS 3) has a large number of depressional areas and dominantly Black Chernozemic soils.

3.2.1.1 Agricultural Production Profile

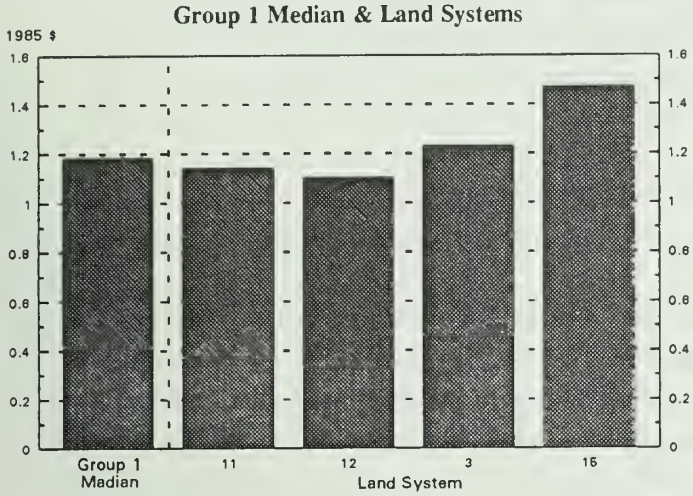
Data integration between the land systems and Census data is excellent for the group. Approximately 300 farm headquarters are located within a total land system area covering more than 11 townships (Appendix 2.A). Median total farm area is over 90 percent of the total land system area. The largest unit, the Stettler Plain (LS 11), has more than half of the farm headquarters and total farm area. The smallest unit, Liberal Plain (LS 3), reports nearly 25 percent more farm area compared to its total land system area. This result indicates that operators in the land system are farming areas outside of it. For Meeting Creek Plain (LS 15), total farm area is nearly 85 percent of the land system area. This result indicates that about 15 percent of the land system area is not farmed and/or is managed by operators with headquarters outside of the land system.

Cash flow for this group is very large with respect to total sales and sales to expenses. The group profile shows nearly $24 million (1985 dollars) in gross sales, or $230 per hectare of total farm area (Appendix 2.B.1). Sales are generated in a very efficient manner, with a sales to expenses ratio of nearly 1.20 (Figure 3.A). The distribution of expenses shows approximately 25 percent in each of crops, livestock and other expenses, with about 15 percent in machinery and 10 percent in interest (Figure 3.B). Relative to the group profile, Bigknife Plain (LS 12) reports lower efficiency, and more livestock expenses and less crop

Figure 3. Selected Variables for Group 1: Castor Plain/Central

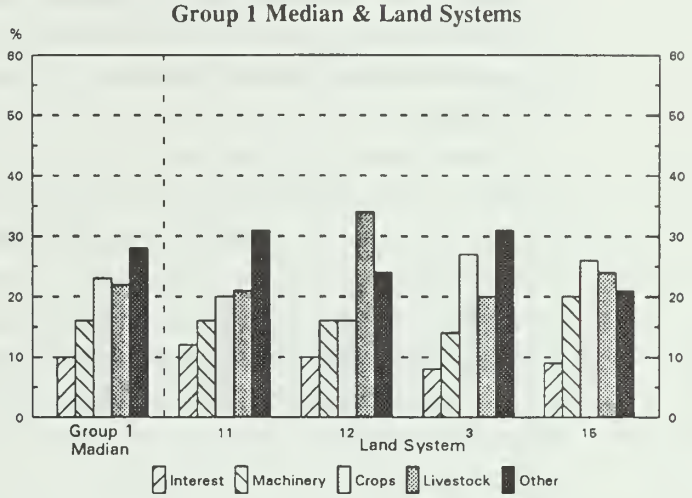
A. SALES TO EXPENSES RATIO

Group 1 Median & Land Systems



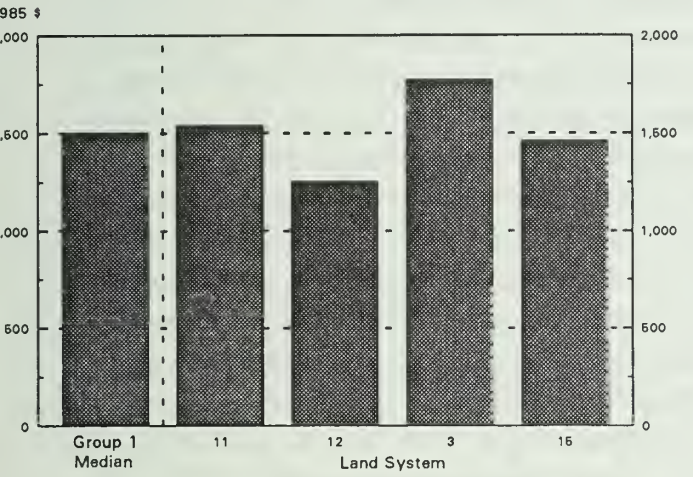
B. % DISTRIBUTION OF EXPENSES

Group 1 Median & Land Systems



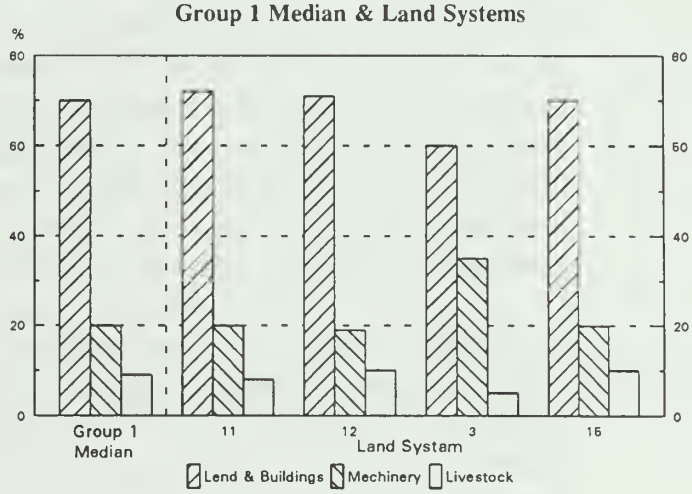
C. CAPITAL VALUE PER HECTARE

Group 1 Median & Land Systems



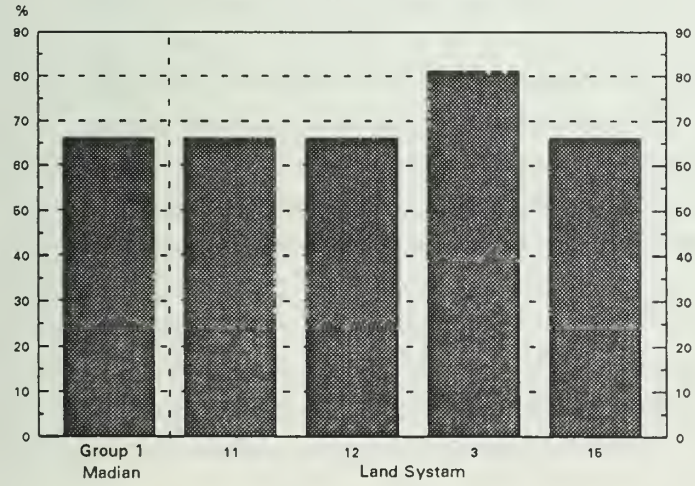
D. % DISTRIBUTION OF CAPITAL

Group 1 Median & Land Systems



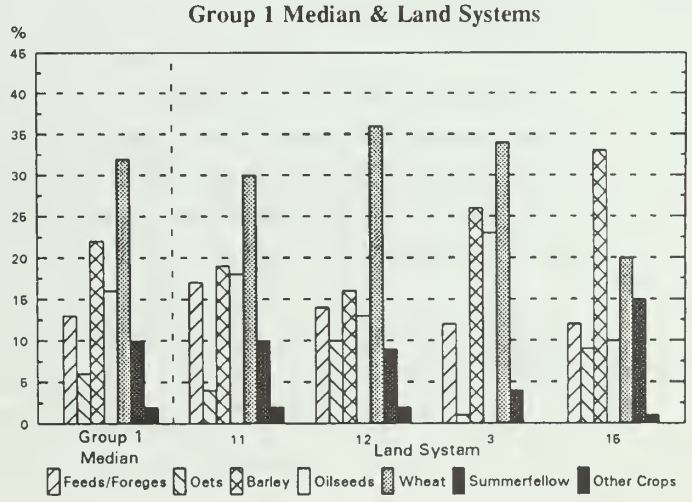
E. CULTIVATED AREA AS % OF TOTAL FARM AREA

Group 1 Median & Land Systems



F. % DISTRIBUTION OF CULTIVATED LAND

Group 1 Median & Land Systems



expenses. Liberal Plain (LS 3) shows more productive farming (i.e. higher gross sales per hectare). Meeting Creek Plain (LS 15) reports higher efficiency and approximately equal proportions of expenses in machinery, crops, livestock and other expenses, totalling about 90 percent.

Capital investment for the group is very large in total and on a per hectare basis. The group reports total capital investment at nearly $150 million (1985 dollars), representing just under $1500 per hectare of total farm area (Appendix 2.B.2, Figure 3.C). About 65 percent of the total farm area is privately owned. The distribution of capital shows 70 percent in land and buildings, 20 percent in machinery and about 10 percent in livestock (Figure 3.D). Compared to the group profile, Bigknife Plain (LS 12) shows less total capital investment per hectare. Liberal Plain (LS 3) has less farm area privately owned, more capital investment per hectare, less capital invested in land and buildings, and more in machinery. Meeting Creek Plain (LS 15) reports more privately owned land.

A broad range of crops are cultivated over very extensive areas in this group. About 65 percent of the average farm area is cultivated (Appendix 2.C.1, Figure 3.E). About 30 percent of the cultivated land is sown to wheat, about 20 percent to barley and 10 percent or more to each of feeds and forages, oilseeds and summerfallow (Figure 3.F). Relative to the group profile, Stettler Plain (LS 11) has a smaller average farm size. Bigknife Plain (LS 12) reports less barley. Liberal Plain (LS 3) shows more extensive cultivated land, more oilseeds, less oats and less summerfallow. Meeting Creek Plain (LS 15) reports more barley and summerfallow, and less oilseeds and wheat.

In this group, fertilizers and herbicides are applied over extensive areas. Ninety percent of the cropped area is fertilized at just over 90 kilograms per hectare (Appendix 2.C.2). About 70 percent of the cultivated land receives herbicide applications. In relation to the group profile, Bigknife Plain (LS 12) reports less extensive use of fertilizers. Liberal Plain (LS 3) shows more extensive and more intensive fertilizer use. Herbicides are also used more extensively in this group. Meeting Creek Plain (LS 15) reports more extensive and less intensive fertilizer use.

3.2.1.2 Summary

Efficient mixed farming is reported on the medium textured till plain of Black Solonetzic soils. The results of excellent data integration show very large cash flows and capital investment. Crop selection is diverse, including wheat, barley, oilseeds, and feeds and forages. Fertilizer and herbicide use is extensive. Stettler Plain (LS 11) corresponds closely to the group profile; other land systems vary from it in both land resources and production characteristics.

Bigknife Plain (LS 12), with more Solonetzic soils developed on bedrock, more saline soils and a more incised drainage network, has a greater emphasis on livestock. It reports lower capital inputs, a smaller sales to expenses ratio, more livestock expenses and more extensive fertilizer use.

Liberal Plain (LS 3) differs most from the group profile in both land resource and production characteristics. It contains Black Chernozemic soils with extensive areas of sloughs and other depressional features. It has a profile of a productive and efficient cash cropping area. It has more total gross sales per hectare, higher machinery expenses and a higher capital value per hectare. It shows less private land ownership and more extensive cultivated land. More barley and oilseeds are reported, and fertilizers and herbicides are used more extensively. Approximately 25 percent more farm area than land system area is reported.

Mixed farming occurs in Meeting Creek Plain (LS 15). Most of the farm area is privately owned and the distribution of summary expenses shows a balance among machinery, crops, livestock and other expenses. Barley and summerfallow are more extensive, wheat is less extensive, and fertilizer use is less intensive.

3.2.2 Bashaw and Delburne Uplands/West (Group 2)

The seven land systems within these medium textured, hummocky till uplands of Black Chernozemic soils are distinguished by landscape features and texture of the parent material. Buffalo Lake Upland (LS 1) has strong relief with slope lengths of 25 to 75 metres and gradients of 11 to 15 percent (Brierley et al. 1992). Scollard Upland (LS 8) has more pronounced hummocks, with longer slopes and steeper gradients, and extensive Solonetzic soils. Foxall Lake Upland (LS 5), Fenn Upland (LS 9), Donalda Upland (LS 13) and Boss Hill Upland (LS 2) all have knob and kettle landforms similar to those of Buffalo Lake Upland (LS 1). Higher proportions of Solonetzic soils are found in Fenn Upland (LS 9) and Donalda Upland (LS 13). Most soils in the Boss Hill Upland (LS 2) have developed on parent materials ranging from coarse to medium texture. Large areas of moderately to very coarse textured parent materials are found in Nevis Lowland (LS 4). Soil erosion is visible in the mid to upper slope positions of cultivated hummocks in these land systems.

3.2.2.1 Agricultural Production Profile

Data integration between the land systems and Census data is very good for the group. Almost 200 farm headquarters are recorded within a total land system area of 10 townships (Appendix 3.A). Median total farm area as a percent of total land system area is about 80 percent. Buffalo Lake Upland (LS 1), the largest unit, has approximately 25 percent of the total land system area, number of farms and farm area. Scollard Upland (LS 8) and Foxall Lake Upland (LS 5) report about 20 percent less farm area than total land system area. Donalda Upland (LS 13) and Nevis Lowland (LS 4) have the lowest ratios (around 60 percent) of total farm area to total land system area. These low ratios indicate that large areas may not be in agricultural production, may be farmed by operators with farm headquarters elsewhere, or some combination of these two factors.

Measures of income and expenses for the group show very large cash flows. Over $18 million in gross sales are reported (1985 dollars), for a median value of nearly $240 per hectare of

total farm area (Appendix 3.B.1). The sales to expenses ratio of just over 1.10 shows moderately efficient production (Figure 4.A). Fifty percent of the expenses are in livestock and other expenses, about 20 percent in crops, about 15 percent in machinery, and about 10 percent in interest (Figure 4.B). Relative to the group profile, Scollard Upland (LS 8) reports lower productivity, higher efficiency and more crop expenses. Much higher productivity and livestock expenses are reported by the Foxall Lake Upland (LS 5). Fenn Upland (LS 9) reports less crop and other expenses and more livestock expenses. Donalda Upland (LS 13) shows more interest and crop expenses and less livestock expenditures. Much lower productivity is recorded by Boss Hill Upland (LS 2), along with higher other expenses and lower livestock expenses. Nevis Lowland (LS 4) reports much higher productivity and efficiency.

Total capital investment for the group is large. Nearly $92 million (1985 dollars) is reported, representing $1230 per hectare of total farm area (Appendix 3.B.2, Figure 4.C). Nearly 60 percent of the total farm area is privately owned. Sixty-five percent of capital is invested in land and buildings, with about 20 percent in machinery and just over 10 percent in livestock (Figure 4.D). In comparison to the group profile, Buffalo Lake Upland (LS 1), with approximately 25 percent of total capital investment, reports greater investment in machinery. Scollard Upland (LS 8) shows more investment in land and buildings. Fenn Upland (LS 9) has more private land ownership and more capital in land and buildings. Donalda Upland (LS 13) shows much more in machinery and less in livestock. Boss Hill Upland (LS 2) has much more privately owned farm land, much lower investment per hectare and more capital in land and buildings. Nevis Lowland (LS 4) shows much more private land ownership, much more capital investment per hectare and more investment in livestock.

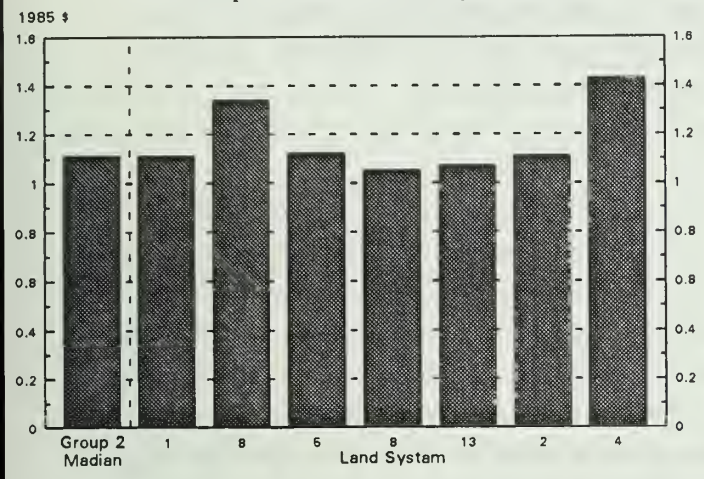
Cultivation of a broad range of crops is extensive. Average farm size is about 400 hectares, with half the area cultivated (Appendix 3.C.1, Figure 4.E). About 25 percent of the cultivated land is in each of feeds and forages, barley and wheat, and nearly 15 percent is in oilseeds (Figure 4.F). In relation to this group profile, Buffalo Lake Upland (LS 1) has more cultivated land, more oilseeds, and less feeds and forages. Scollard Upland (LS 8) has a larger average farm size and less cultivated land. It has much higher percentages of wheat and summerfallow and lower proportions of feeds and forages and barley. Foxall Lake Upland (LS 5) has more barley and less wheat. Fenn Upland (LS 9) reports a smaller average farm size, more feeds and forages, more summerfallow, and less barley. Donalda Upland (LS 13) has a much smaller average farm size and more cultivated land. It also reports much less feeds and forages and much more oilseeds. Boss Hill Upland (LS 2) records much more oats and barley and much less oilseeds and wheat. Nevis Lowland (LS 4) shows a smaller average farm size, much more feeds and forages, more oats and much less barley.

Fertilizer use and herbicide use are extensive in this group. More than 80 percent of the cropped land receives fertilizers at a rate of almost 120 kilograms per hectare (Appendix 3.C.2). About 65 percent of the cultivated land receives herbicide applications. In relation to this group profile, Buffalo Lake Upland (LS 1) has more extensive herbicide use. Scollard Upland (LS 8) shows more extensive and intensive use of fertilizers. Fertilizers are also used

Figure 4. Selected Variables for Group 2: Bashaw and Delburne Uplands/West

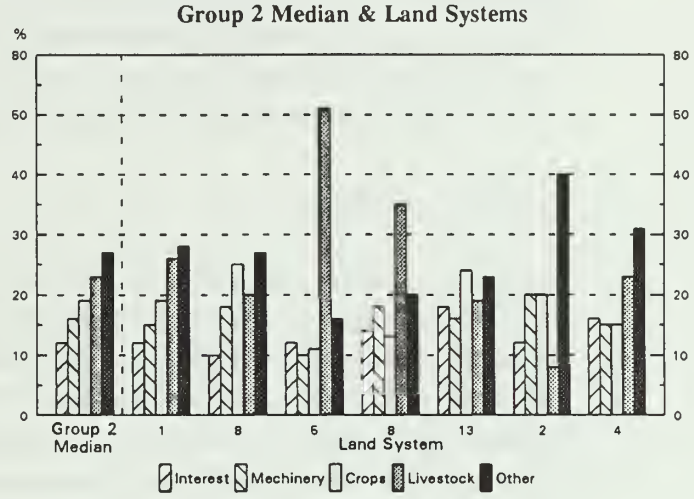
A. SALES TO EXPENSES RATIO

Group 2 Median & Land Systems



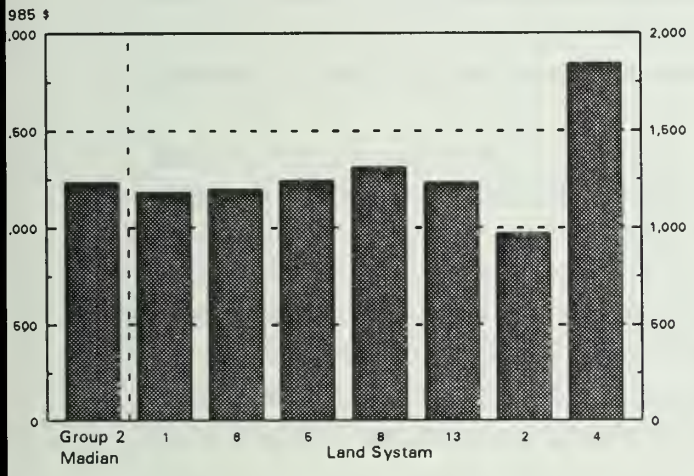
B. % DISTRIBUTION OF EXPENSES

Group 2 Median & Land Systems



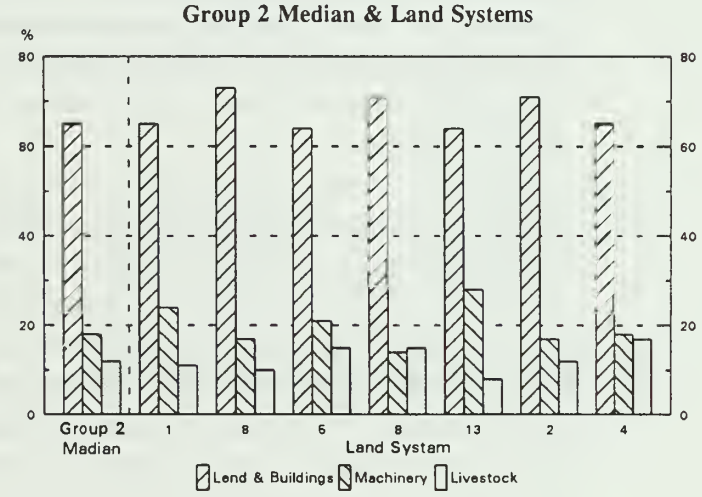
C. CAPITAL VALUE PER HECTARE

Group 2 Median & Land Systems



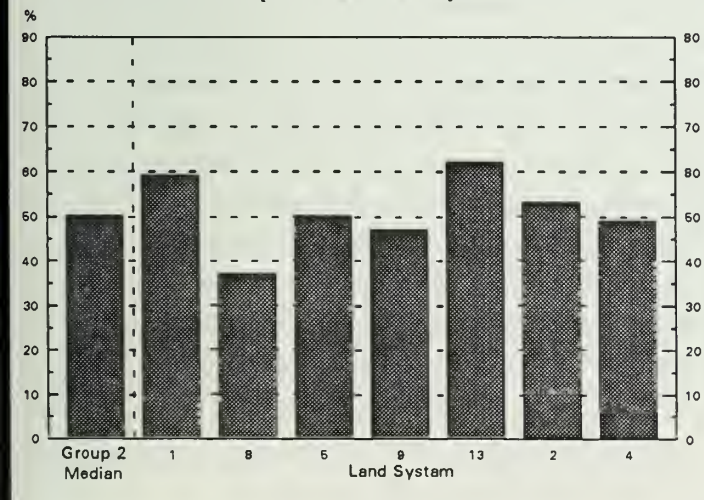
D. % DISTRIBUTION OF CAPITAL

Group 2 Median & Land Systems



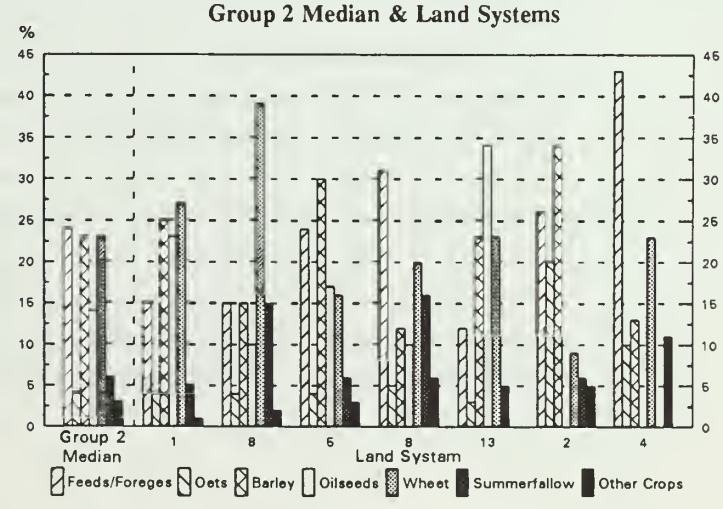
E. CULTIVATED AREA AS % OF TOTAL FARM AREA

Group 2 Median & Land Systems



F.% DISTRIBUTION OF CULTIVATED LAND

Group 2 Median & Land Systems



more extensively in Foxall Upland (LS 5). Fenn Upland (LS 9) has less extensive fertilizer and herbicide use, with the former applied less intensively. Donalda Upland (LS 13) reports much more extensive and intensive applications of fertilizer, and more extensive herbicide use. Boss Hill Upland (LS 2) reports much less extensive and intensive fertilizer use.

3.2.2.2 Summary

Productive and efficient mixed farming occurs on hummocky landscapes of Black Chernozemic soils. Data integration is very good overall and shows very large cash flows and high capital investment. Extensive cultivation of wheat, barley, feeds and forages, and oilseeds is reported. Fertilizers and herbicides are widely used. The largest land system, Buffalo Lake Upland (LS 1), differs from the group profile in two main respects. It reports more machinery expenses and more intensive use of fertilizers. The remaining land systems vary from this group profile not only in land resources but also the mix of crop and livestock production.

Less productive but more efficient mixed farming occurs in Scollard Upland (LS 8) which has pronounced relief and extensive areas of Solonetzic soils. It has much higher efficiency, more crop expenses and larger average farm size. It reports less extensive cultivated land, more wheat and summerfallow, and less barley and oilseeds. Fertilizer use is much more intensive in this land system.

Foxall Lake Upland (LS 5) shows much higher productivity and livestock expenses. It reports more barley, less wheat and more extensive fertilizer use.

Livestock production dominates in Fenn Upland (LS 9) which has extensive areas of Solonetzic soils. It reports lower efficiency and more livestock expenses. More capital is invested in land and buildings, and livestock. Feeds and forages and summerfallow are more extensive, and barley and oilseeds are less extensive. Fertilizers and herbicides are used less extensively and fertilizers are applied less intensively.

Donalda Upland (LS 13), a unit with extensive areas of Solonetzic soils, reports more expenditures and investment in crop production. It has more crop expenses and more capital in machinery. It shows more oilseeds, much more extensive use of fertilizers and herbicides, and more intensive fertilizer use. About 40 percent of the total land system area is not accounted for by the farm headquarters data.

Mixed farming in Boss Hill Upland (LS 2) occurs along with extensive areas of medium to coarse textured soils. This land system shows much lower productivity, more machinery and other expenses, and less livestock expenses. It has much more privately owned farmland, more capital in land and buildings and much less capital investment per hectare. Oats and barley are more extensive, and oilseeds and wheat less extensive. Fertilizer use is much less extensive and intensive.

Nevis Lowland (LS 4), with significant areas of coarse textured soils, has very productive and efficient mixed farming. It reports much higher productivity and efficiency than the group. More privately owned land is reported, while the average farm size is smaller. It shows more extensive cultivated land and much more feeds and forages. The Census data do not account for 35 percent of the total land system area.

3.2.3 Castor Plain/West and Central (Group 3)

The four land systems in this group contain Black Chernozemic soils developed on coarse textured materials on level to undulating plains (Brierley et al. 1992). These plains are characterized by high proportions of eroded soils and wet depressional areas. Oberlin Plain (LS 6) is typical of the group, with slope lengths of 50 to 100 metres and low slope gradients. Red Willow Plain (LS 14), located in the northeast part of the County, has slope lengths of 100 to 200 metres and areas of Solonetzic soils developed on medium textured morainal deposits. Lowden Lake Plain (LS 10) is similar to Oberlin Plain (LS 6). Ewing Lake Lowland (LS 7) is a floodplain contained by the walls of Big Valley. Coarse and medium textured parent materials are intermixed; poorly drained, saline soils are common on the floodplain.

3.2.3.1 Agricultural Production Profile

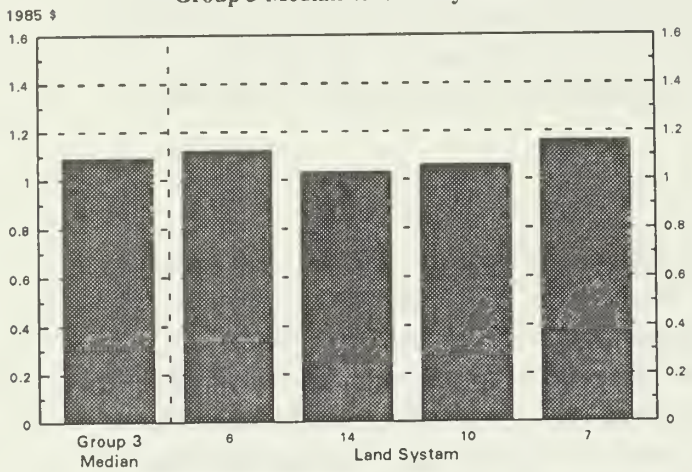
Data integration is excellent for the group. Nearly 140 farm headquarters are located within the group, with a total land system area of more than six townships (Appendix 4.A). Median total farm area, as a proportion of total land system area, is almost 95 percent. The largest total farm area is found in Oberlin Plain (LS 6), which also contains nearly 40 percent of the farm headquarters. Red Willow Plain (LS 14) reports a similar value for total farm area; however, at just over 70 percent, it has the lowest value for total farm area as a percentage of total land system area. It appears that a large area in this land system may be farmed by operators with farm headquarters elsewhere and/or may not be in agricultural production. The highest value for this ratio occurs in Ewing Lake Lowland (LS 7), with nearly twice as much total farm area as land system area. It appears that operators with farm headquarters in this land system are working large areas outside the land system.

Indicators of income and expenditures show very large cash flows. The group profile shows nearly $14 million in total gross sales (1985 dollars), for a median value of $230 per hectare of total farm area (Appendix 4.B.1). Production is moderately efficient, with a median sales to expenses ratio of almost 1.10 (Figure 5.A). The relative distribution of expenses shows 30 percent in livestock, about 25 percent in other expenses and more than 10 percent in each of interest, machinery and crops (Figure 5.B). In relation to this group profile, Oberlin Plain (LS 6) reports much higher productivity. Red Willow Plain (LS 14) reports much lower productivity and lower efficiency. It also shows more interest and crop expenses, and less livestock expenditures. Ewing Lake Lowland (LS 7) has more efficient production, and less interest and more livestock expenses.

Figure 5. Selected Variables for Group 3: Castor Plain/West and Central

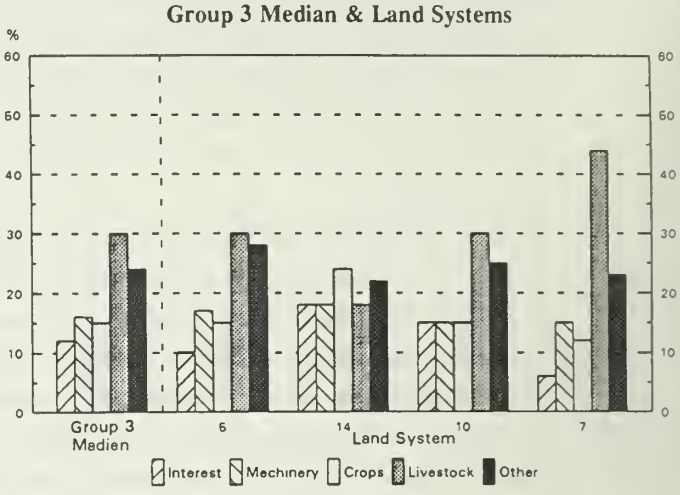
A. SALES TO EXPENSES RATIO

Group 3 Median & Land Systems



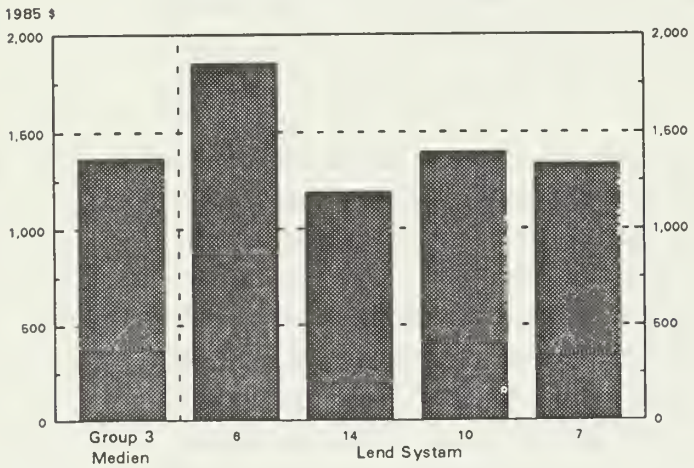
B. % DISTRIBUTION OF EXPENSES

Group 3 Median & Land Systems



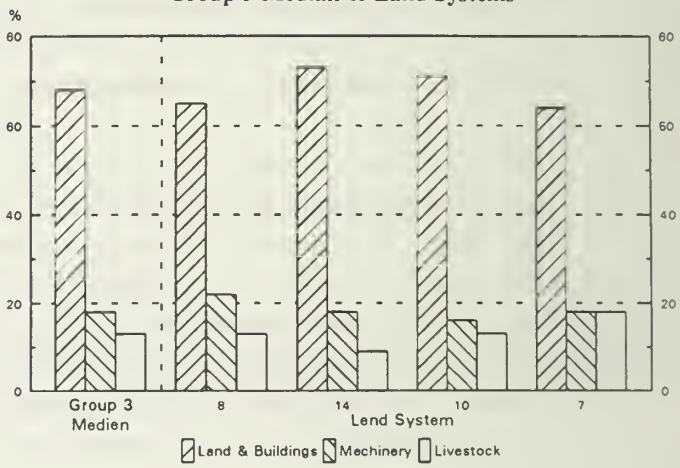
C. CAPITAL VALUE PER HECTARE

Group 3 Median & Land Systems



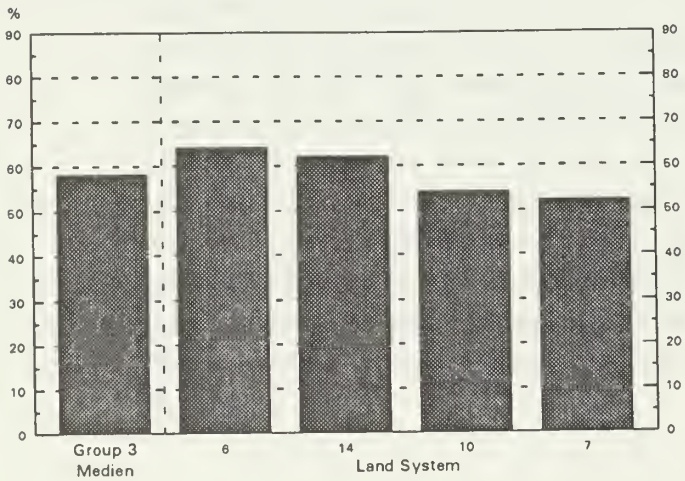
D. % DISTRIBUTION OF CAPITAL

Group 3 Median & Land Systems



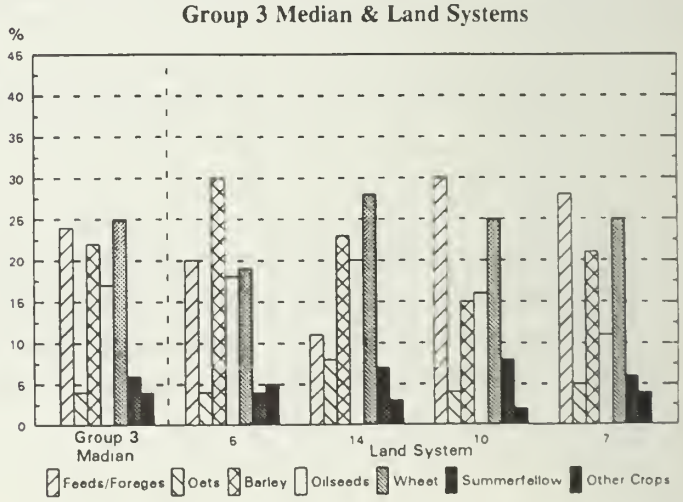
E. CULTIVATED AREA AS % OF TOTAL FARM AREA

Group 3 Median & Land Systems



F. % DISTRIBUTION OF CULTIVATED LAND

Group 3 Median & Land Systems



Capital investment for the group is large, with moderate variability among the land systems in the total value per acre and its distribution. The group profile shows about $80 million (1985 dollars) invested, or $1365 per hectare of total farm area (Appendix 4.B.2, Figure 5.C). Seventy percent of the total farm area is privately owned. About 70 percent of capital is invested in land and buildings, with nearly 20 percent in machinery and nearly 15 percent in livestock (Figure 5.D). In relation to the group profile, the Oberlin Plain (LS 6) shows much more capital investment per hectare of total farm area and more capital in machinery. Red Willow Plain (LS 14) has lower capital investment per hectare with more investment in land and buildings, and less in livestock.

A broad mix of crops are extensively cultivated. The group profile shows an average farm size of almost 385 hectares, with nearly 60 percent cultivated land (Appendix 4.C.1, Figure 5.E). About 25 percent of the cultivated area is each of feeds and forages, barley and wheat, and about 15 percent is in oilseeds (Figure 5.F). In comparison to this group profile, all land systems report one or more variations in production characteristics. Oberlin Plain (LS 6) reports a smaller average farm size with more cultivated land, more barley and less wheat. Red Willow Plain (LS 14) shows a larger average farm size and less feeds and forages. A smaller average farm size, more feeds and forages and less barley are reported by Lowden Lake Plain (LS 10). Ewing Lake Lowland (LS 7) has a much larger average farm size and less oilseeds.

Fertilizers and herbicides are used over extensive areas. About 75 percent of the cropped land receives fertilizers at a rate of almost 90 kilograms per hectare (Appendix 4.C.2). Herbicide applications occur on 70 percent of the cultivated area. In comparison to the group profile, Oberlin Plain (LS 6) reports more extensive and intensive use of fertilizers. Less extensive fertilizer use is reported by the Red Willow Plain (LS 14) and Lowden Lake Plain (LS 10). The latter also reports less intensive fertilizer applications. Ewing Lake Lowland (LS 7) has more extensive fertilizer use, and less extensive herbicide use.

3.2.3.2 Summary

Productive mixed farming is associated with Black Chernozemic soils developed on coarse textured parent materials with high proportions of eroded soils and wet soils. Excellent data integration shows a productive agricultural area, with large cash flows and high capital investment. Cereal, oilseed and forage crops are extensively cultivated. Fertilizer use and herbicide use are extensive. Relative to this group description, each land system reports variations in resource and production characteristics.

Oberlin Plain (LS 6) is characterized by very productive farming with an emphasis on crop production. It reports much larger gross sales, more capital investment per hectare and more capital in machinery. It shows the smallest average farm size, more extensive cultivated land, more barley, and more extensive and intensive use of fertilizers.

Crop production predominates in Red Willow Plain (LS 14) which has extensive areas of Solonetzic soils. It reports much lower productivity and efficiency. More interest and crop expenses are reported. It has lower expenses and less capital in livestock. Less feeds and forages are reported and fertilizer use is less extensive. The Census data do not account for about 30 percent of the total land system area.

Lowden Lake Plain (LS 10) has mixed farming. It reports more feeds and forages, less barley, and less intensive fertilizer use.

Livestock production predominates in Ewing Lake Lowland (LS 7) which has medium to coarse textured parent materials and extensive areas of saline soils. It reports higher efficiency, more livestock expenses, and more capital in livestock. Average farm size is much larger and oilseeds are less extensive. Fertilizer use is more extensive and herbicides are less widely used. The total farm area is almost twice the total land system area, an indication that land outside of this land system is being reported.

3.2.4 Rumsey Upland/South (Group 4)

The topography and soils vary among the three land systems in this group. Byemoor Upland (LS 18) consists of a hummocky landscape with Dark Brown Chernozemic soils developed on medium textured till on mid to upper slope positions and Solonetzic soils on lower slope positions (Brierley et al. 1992). Eroded soils are prevalent in the mid to upper slope positions of cultivated hummocks. Like Byemoor Upland (LS 18), Gopher Head Upland (LS 17) has Chernozemic soils on mid and upper slopes and Solonetzic soils on lower slopes, but Gopher Head Upland has stronger relief. Depressional areas, containing gleyed variants and Gleysolic soils, are found in 20 to 40 percent of this land system. The topography of Big Valley Lowland (LS 16) varies from a level to undulating floodplain to steep valley walls. Dark Brown Chernozemic soils in this land system have developed on gravelly, coarse textured parent material.

3.2.4.1 Agricultural Production Profile

Data integration for the group is excellent. Over 100 farm headquarters are located in the group, with a total land system area of about eight townships (Appendix 5.A). Median total farm area, as a percent of total land system area, is just over 90 percent. Byemoor Upland (LS 18) reports more than half of the total farm area and contains approximately three-quarters of the farm headquarters. Gopher Head Upland (LS 17) shows a very low ratio of total farm area to total land system area. As noted in Section 3.1.2, the low ratio is an indication that farmers with headquarters in this land system do not lease extensive areas of the public grazing reserve.

The group profile of cash flow shows large incomes and expenditures. More than $7 million in total gross sales are recorded (1985 dollars), representing a median value of just over $130 per

hectare of total farm area (Appendix 5.B.1). Production is very efficient with a sales to expenses ratio of almost 1.20 (Figure 6.A). The distribution of expenses shows about 25 percent in each of livestock and other expenses, about 20 percent in machinery, about 15 percent in crops, and about 10 percent in interest (Figure 6.B). In comparison to the group profile, Gopher Head Upland (LS 17) reports lower interest and higher other expenses. Much higher efficiency is reported by Big Valley Lowland (LS 16), along with more machinery and crop expenses, and lower livestock expenses.

A moderate level of capital investment is reported. Capital investment, at $965 per hectare, is nearly $55 million (1985 dollars) in total (Appendix 5.B.2, Figure 6.C). Seventy percent of the total farm area is privately owned. Nearly 70 percent of capital is invested in land and buildings, with 20 percent in machinery and about 10 percent in livestock (Figure 6.D). In comparison to this profile, Big Valley Lowland (LS 16) reports much less privately owned land.

Extensive areas of wheat and summerfallow occur on the large farms in this group. The group profile shows a large average farm size of almost 525 hectares, less than half of which is cultivated (Appendix 5.C.1, Figure 6.E). Approximately 65 percent of the cultivated land is in wheat and summerfallow combined, and about 15 percent is in each of barley, and feeds and forages (Figure 6.F). Relative to the group profile, Byemoor Upland (LS 18) reports more cultivated land and less barley. Big Valley Lowland (LS 16) has a much larger average farm size and less cultivated land. It also reports more feeds and forages and much less summerfallow.

Fertilizer use is moderate in extent and intensity. Fertilizers are applied to 75 percent of the cropland at a rate of 60 kilograms per hectare (Appendix 5.C.2). Herbicide use is moderate with herbicides applied to nearly 60 percent of the cultivated land. Compared to the group profile, Byemoor Upland (LS 18) shows less extensive and much less intensive fertilizer use. Big Valley Lowland (LW 16) has more extensive and much more intensive fertilizer use.

3.2.4.2 Summary

The group profile shows efficient mixed farming on hummocky landscapes of Dark Brown Chernozemic and Solonetzic soils with a high proportion of wet soils. Data integration is excellent. Capital investment is moderate. Less than half of the total farm area is cultivated with about 65 percent of cultivated land in wheat and summerfallow combined. Fertilizer use is moderately extensive and intensive.

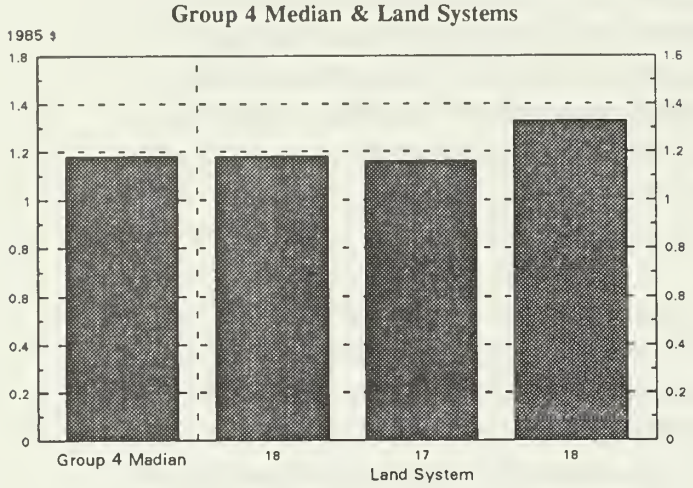
The Byemoor Upland (LS 18), with more Solonetzic and eroded soils but a lower proportion of wet soils, reports less extensive and intensive use of fertilizers in comparison to the profile.

Mixed farming predominates in Gopher Head Upland (LS 17) which has stronger relief. Approximately 60 percent of the land system area is not accounted for by farms with headquarters in the land system.

Figure 6. Selected Variables for Group 4: Rumsey Upland/South

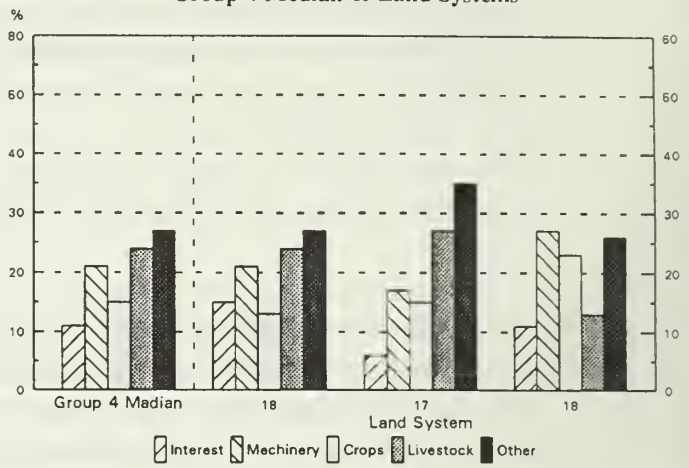
A. SALES TO EXPENSES RATIO

Group 4 Median & Land Systems



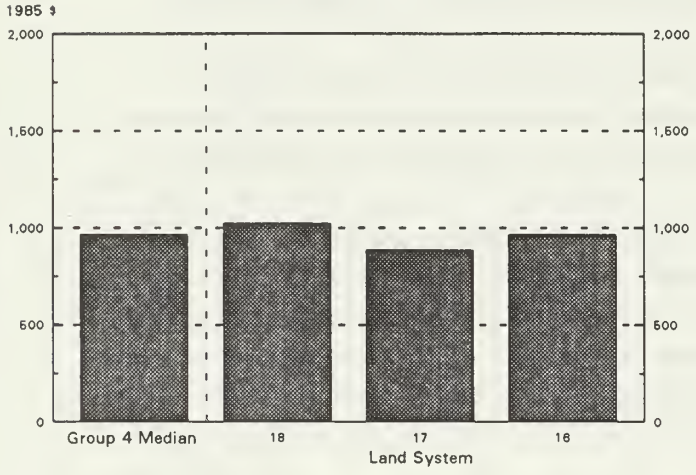
B. % DISTRIBUTION OF EXPENSES

Group 4 Median & Land Systems



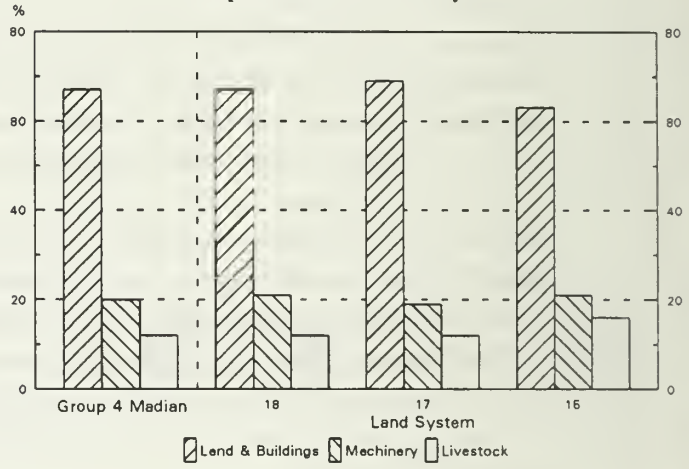
C. CAPITAL VALUE PER HECTARE

Group 4 Median & Land Systems



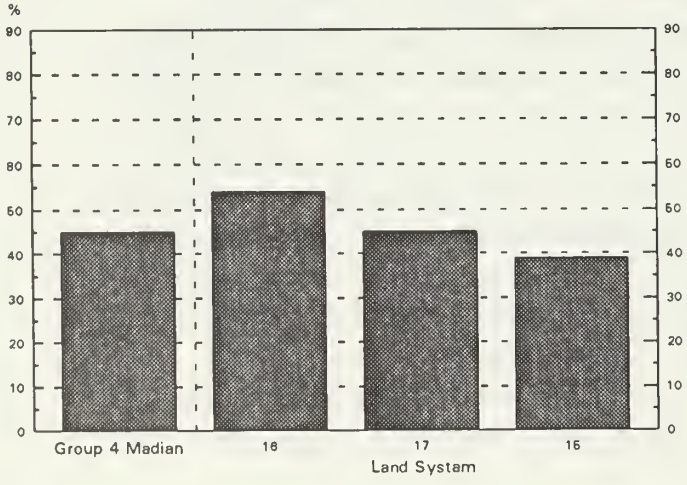
D. % DISTRIBUTION OF CAPITAL

Group 4 Median & Land Systems



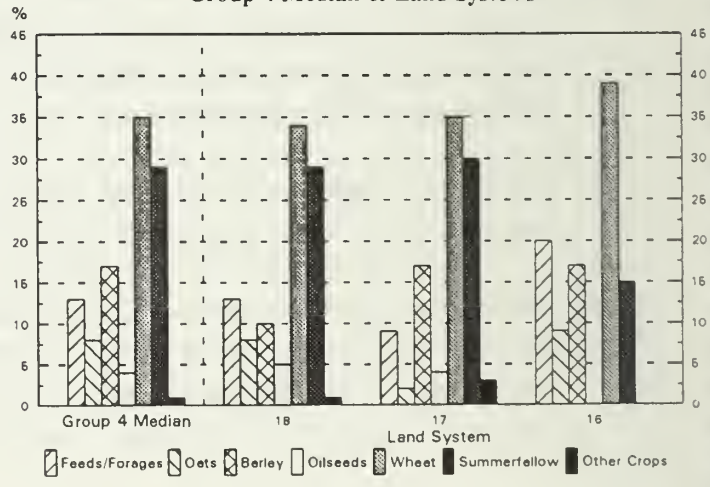
E. CULTIVATED AREA AS % OF TOTAL FARM AREA

Group 4 Median & Land Systems



F. % DISTRIBUTION OF CULTIVATED LAND

Group 4 Median & Land Systems



Big Valley Lowland (LS 16), which has variable surface relief and soils developed on coarse textured materials, reports very efficient farming. It shows higher machinery and crop expenses, lower livestock expenses and more capital in livestock. It has more feeds and forages and less summerfallow. Fertilizers are applied more extensively and intensively.

3.2.5 Castor Plain/Southeast (Group 5)

Differences in landscape features and soil development are found in the four land systems comprising this group. They are subdivisions of a broad medium textured plain of dominantly Dark Brown Solonetzic and Chernozemic soils (Brierley et al. 1992). Cutbank Lake Plain (LS 20) contains eroded and saline soils, the latter in association with depressional areas. Gleysolic and saline soils are dominant in Gough Lake Lowland (LS 21), an area containing several shallow lake basins. Solonetzic soils dominate Shooting Lake Plain (LS 22), in addition to significant amounts of saline soils in poorly drained areas. Farrell Lake Plain (LS 19) has soils developed on moderately coarse textured parent materials, and sloughs and wet areas account for 20 to 40 percent of the land system.

3.2.5.1 Agricultural Production Profile

Data integration between the land systems and Census information is excellent for the group. Approximately 120 farm headquarters are recorded, covering a total farm area of more than nine townships (Appendix 6.A). Median total farm area, as a percent of total land system area, is 90 percent. Relative to the group profile, Cutbank Lake Plain (LS 20), the largest unit, reports more than half of the farm headquarters and 65 percent of the total farm area. Results for Gough Lake Lowland (LS 21) are not included due to confidentiality restrictions.

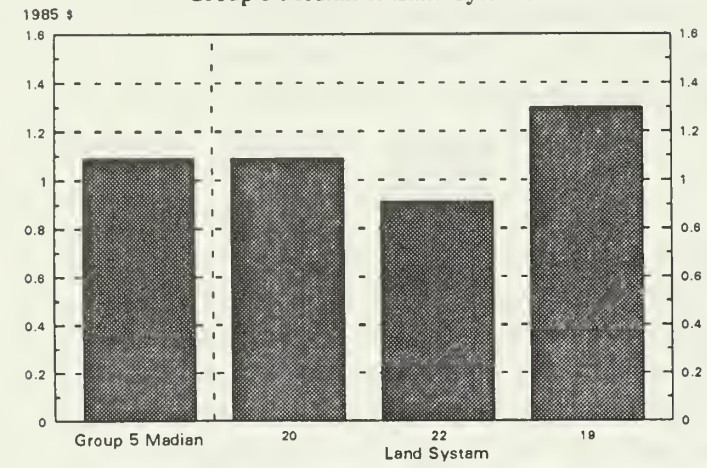
The cash flow profile for the group shows moderate income and expenses. It has about $9.5 million in total gross sales (1985 dollars), for a median value of $110 per hectare of total farm area (Appendix 6.B.1). Production is moderately efficient with a sales to expenses ratio of almost 1.10 (Figure 7.A). The distribution of expenses is about 30 percent in each of livestock and other expenses, about 20 percent in machinery and about 10 percent in each of interest and crops (Figure 7.B). Relative to these group values, Cutbank Lake Plain (LS 20) reports much higher productivity. Shooting Lake Plain (LS 22) shows inefficient production, with total gross sales less than expenses. Farrell Lake Plain (LS 19) has much higher productivity, and higher expenses in interest, much higher in machinery and much lower in livestock.

The group reports a moderate level of capital investment. About $81 million (1985 dollars) is invested, representing nearly $1070 per hectare of total farm area (Appendix 6.B.2, Figure 7.C). About 65 percent of the total farm area is privately owned. About 70 percent of capital is invested in land and buildings, about 15 percent in machinery and about 10 percent in livestock (Figure 7.D). Compared to the group profile, Shooting Lake Plain (LS 22) reports much more privately owned land. More investment in machinery is reported by Farrell Lake Plain (LS 19).

Figure 7. Selected Variables for Group 5: Castor Plain/Southeast

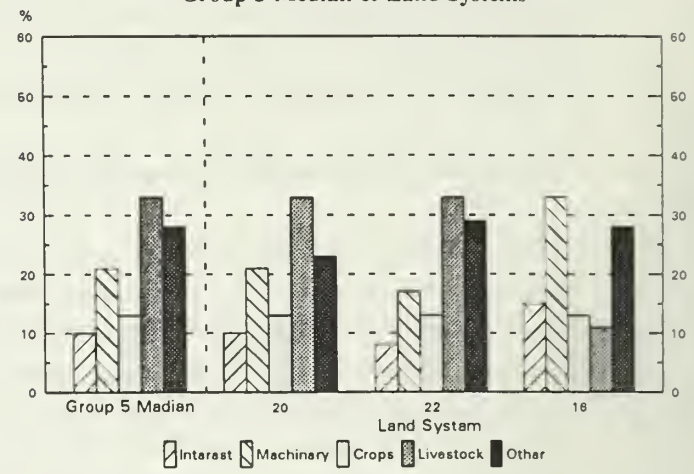
A. SALES TO EXPENSES RATIO

Group 5 Median & Land Systems



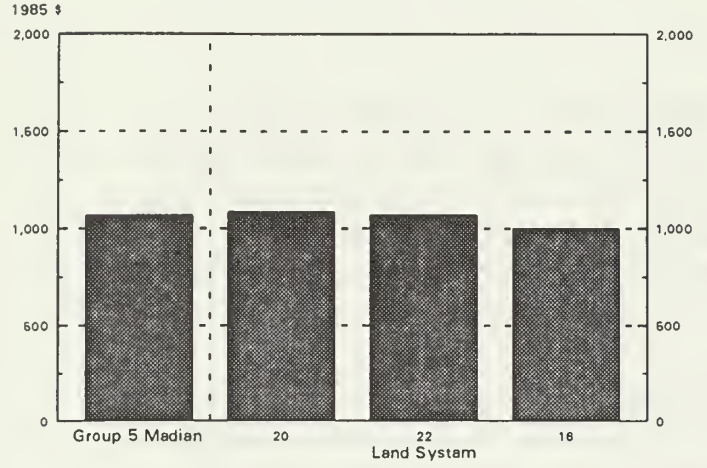
B. % DISTRIBUTION OF EXPENSES

Group 5 Median & Land Systems



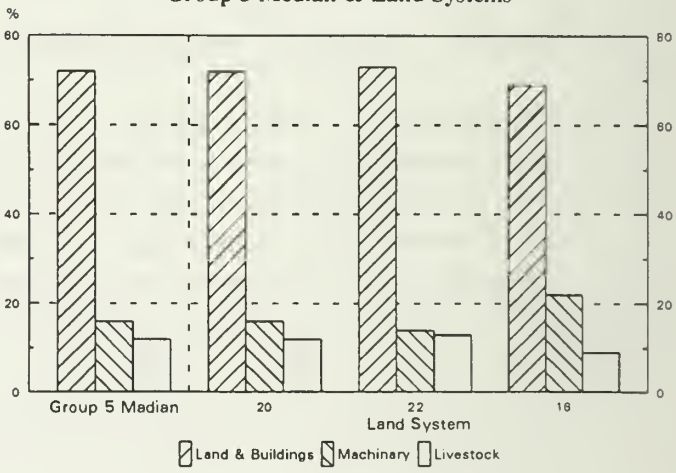
C. CAPITAL VALUE PER HECTARE

Group 5 Median & Land Systems



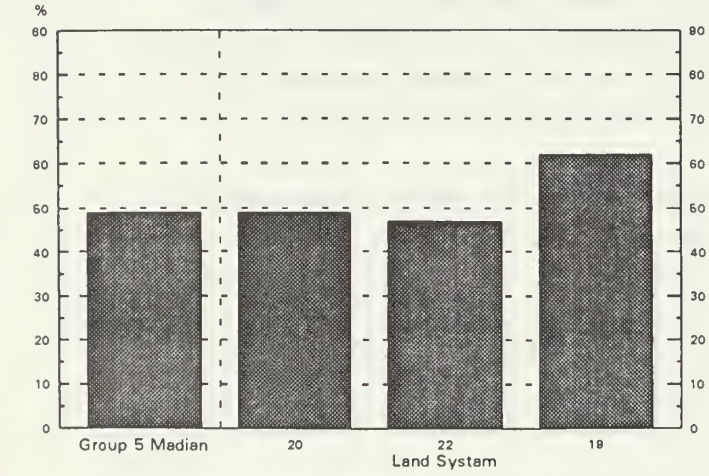
D. % DISTRIBUTION OF CAPITAL

Group 5 Median & Land Systems



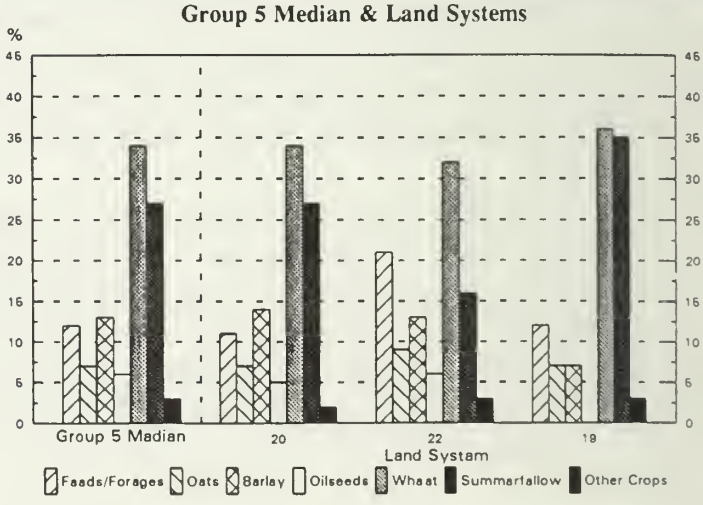
E. CULTIVATED AREA AS % OF TOTAL FARM AREA

Group 5 Median & Land Systems



F. % DISTRIBUTION OF CULTIVATED LAND

Group 5 Median & Land Systems



The group profile shows large farms with extensive areas of wheat and summerfallow. Average farm size is about 645 hectares, of which half is cultivated (Appendix 6.C.1, Figure 7.E). Wheat and summerfallow combined occupy approximately 60 percent of the cultivated area (Table 7.F). In relation to this group profile, Shooting Lake Plain (LS 22) has much more feeds and forages and much less summerfallow. Farrell Lake Plain (LS 19) reports a smaller average farm size and more extensive cultivated land.

Fertilizer use and herbicide use are moderately extensive, with the former applied at a moderate intensity. About 70 percent of the cropped land is fertilized, at a rate of about 60 kilograms per hectare (Appendix 6.C.2). Herbicides are applied to about half of the cultivated land. Relative to the group profile, more intensive fertilizer use is recorded for Shooting Lake Plain (LS 22). Farrell Lake Plain (LS 19) has less extensive use of fertilizers and herbicides, and less intensive applications of fertilizer.

3.2.5.2 Summary

Mixed farming occurs on this plain of dominantly Dark Brown Solonetzic and Chernozemic soils with extensive areas of saline and wet soils. Data integration is excellent. Cash flow and capital investment are moderate. The highest percentage of expenses is in livestock. Almost 50 percent of the total farm area is cultivated, about 60 percent of which is in wheat and summerfallow combined. Fertilizer use and herbicide use are extensive, with moderately intensive fertilizer management. Cutbank Lake Plain (LS 20), with more eroded soils, reports higher productivity. The other two land systems have land resource and production characteristics which differ more from the group profile.

Shooting Lake Plain (LS 22), with a higher proportion of Solonetzic soils, reports inefficient mixed farming. It shows total gross sales less than summary expenses. It reports more privately owned farmland, more feeds and forages, and less summerfallow. This land system has the most intensive use of fertilizer in the group.

Crop production in Farrell Lake Plain (LS 19) occurs on soils developed on coarse textured parent materials. Gross sales per hectare are smaller but the sales to expenses ratio is much larger. This land system has a higher percentage of expenses in machinery and a lower percentage in livestock. It shows a smaller average farm size and more cultivated land. Wheat and summerfallow are more extensive. Fertilizer use and herbicide use are less extensive.

4.0 Discussion

The results show that associations exist between agricultural production and land resources of a land system. Associations between agricultural production and land system groups are also documented. Of additional interest to planners are two other aspects of the method: its replicability; and the applicability of its results for municipal conservation planning. This section discusses these two aspects and outlines future research to improve them.

4.1 Replicability of Method

Planners require periodic updates of agricultural information within a land system framework for monitoring and evaluating municipal conservation plans. Ideally, this information should be provided for the same areas at regular intervals using a standard method to ensure that changes in production data are indicative of real changes, and not a function of different methods of data collection. Because comparative production data from the 1991 Census were not available at the time of writing, this subsection presents a conceptual assessment of the replicability of the method.

Four criteria assess the replicability of the method to reprocess and summarize Census data by land systems. These criteria are:

- regular intervals of data collection;
- consistent definition and collection of production variables;
- consistent definition and delineation of land systems; and
- reapplication of the method to other locations.

With regard to the first criterion, Statistics Canada compiles Census data on a five-year interval. This period reflects a balance between the expenses of national inventories of farm level production and the time frame within which fundamental production changes occur. As municipal conservation plans are considered operational over a 10-year period (MCPPP Steering and Technical Committees 1993), data from at least three Census inventories should be available. For instance, a plan developed in 2002 could use the inventory from 2001 for plan development and inventories from 2006 and 2011 for evaluation.

Consistency in the definition of variables is a recurring problem with Census information. Definitions change in response to current farming practices and information requirements. However, changing definitions may lead to less comparative data through time. The variables used in the AGAPPs and APPs are based on Census definitions; therefore, conservation planners should confirm the appropriateness of these definitions for their work. In the longer term, planners may influence definition of variables through communication with Census of Agriculture personnel.

Consistent definition of land systems is a function of the inventory and application of land resource information. It is possible that updated land resource inventories may result in changes in land system boundaries or that new information needs for municipal conservation planning may require revised definitions to create more appropriate biophysical landscape units. However, unless there are major changes to the inventory and application of natural resource information to planning, land systems should be more stable through time than EA boundaries.

Reapplication of the study method to other locations within the province is subject to the availability of land systems and Census information, and link files. A forthcoming report (Kwiatkowski and Marciak in press) demonstrates the reapplication of the land systems method described in Brierley et al. (1992) to another Alberta municipality (the County of Vulcan). The reapplication of custom processing of farm headquarters data from the 1991 Census has been demonstrated in the three prairie provinces (Hiley and Huffman 1993). Thus, subject to the availability of the necessary data, it appears that the method can be reapplied throughout agricultural regions of Alberta.

This discussion shows, at a conceptual level, that the method to reprocess Census data by farm headquarters is replicable. The methods to identify landscape units and reprocess Census data within these units are reapplicable. It is feasible for planners to compare consistently defined production characteristics at regular intervals within a stable biophysical landscape unit.

4.2 Applicability of APPs to Municipal Conservation Planning

Municipal planners require information on agricultural production in a land system to complete several tasks. One critical task is the development of projects appropriate to the solution of local conservation issues. This subsection discusses the applicability of the agricultural production profiles to this planning task, in the context of the soil conservation issue of wind erosion risk in the County of Stettler.

The risk of wind erosion is associated with the textural class of the parent material and usual crop management. The parent material's textural class influences surface roughness, soil aggregate size and soil particle size which all affect a soil's susceptibility to wind erosion (Coote and Pettapiece 1989). For example, soils developed from coarse textured parent materials are at greater risk of wind erosion than soils developed from medium textured parent materials, other factors being equal. The term "usual crop management" refers to cropping and land management practices typical of an area. This factor is used to estimate the wind erosion protection provided by plants and plant residues in the crop management system. For example, practices which leave little crop or crop residue cover to protect the soil (e.g., burying crop residues after harvest, cultivated summerfallow) increase wind erosion risk. Practices which leave more cover (e.g., direct seeding, standing stubble, reduced tillage, perennial crops and fall-seeded crops) reduce wind erosion risk. Information on textural class of the parent material

is available from the land system data and information on usual crop management is available from the APP data.

The risk of wind erosion on bare soil in the County of Stettler varies from low to severe, and is associated with parent material textural classes. Two areas near the Town of Stettler are rated as severe for wind erosion risk (Coote and Pettapiece 1989). These areas correspond to Castor Plain/West and Central (Group 3) which contains dominantly coarse textured parent materials. Information from this group's AGAPP and land system APPs indicates soil conservation projects to support both annual crop production and livestock production are required.

Productive mixed farming in Castor Plain/West and Central (Group 3) suggests different types of projects to reduce wind erosion risk. This group has high productivity and a high percentage of expenses in livestock (Table 2). Capital investment per hectare is large as is the percentage of investment in livestock (Table 2). Approximately 40 percent of the total farm area is not cultivated and nearly 70 percent of the cultivated land is in cereals and oilseeds. Fertilizers and herbicides are used extensively and fertilizers are applied intensively. Based on this profile, projects to improve surface residue management would be directed to the cultivated land in cereals and oilseeds. For the rest of the farm area, projects to improve and increase permanent cover would benefit livestock production while protecting the soil.

The balance of projects in support of crop and livestock production would also vary from land system to land system within Group 3. For example, more emphasis on surface residue management projects would be appropriate for Oberlin Plain (LS 6) (Appendix 4). This land system reports very high productivity and capital investment per hectare. About 65 percent of the total farm area is cultivated and grains and oilseeds are extensive. Fertilizers and herbicides are applied extensively and fertilizers are applied very intensively. With significant areas of eroded soils associated with this production profile, there is a need for residue management projects.

Permanent cover projects may be more appropriate in Red Willow Plain (LS 14), although crop production at present receives more inputs than livestock. This land system, with significant areas of Solonetzic soils, reports the lowest productivity and efficiency of the group (Appendix 4). It has more interest and crop expenses and less total capital in livestock. Feeds and forages are less extensive, as is fertilizer use. Given the natural resource constraints to annual crop production (i.e., coarse textured and Solonetzic soils) and the lower economic returns, opportunities for increased permanent cover and livestock production should be considered.

Projects to reduce wind erosion risk in Lowden Lake Plain (LS 10) would support both crop and livestock production. Values for cash flow and capital investment per hectare of total farm area are similar to the group values (Appendix 4). Cultivated land is less extensive with more feeds and forages and less barley reported. Fertilizer use and herbicide use are less extensive and fertilizers are applied more intensively. Given this profile and significant areas of eroded soils,

projects to improve both surface residue management and permanent cover appear to be appropriate.

Data integration is an issue in using the production profile of Ewing Lake Lowland (LS 7). Permanent cover projects would, at first, appear to be consistent with the descriptions of resources and production in this land system. It has variable textured parent materials and significant areas of saline soils. It shows high productivity and more expenses and capital invested in livestock (Appendix 4). It also has a much larger average farm size. However, the total farm area is nearly twice the total land system area; thus, the representativeness of the information within the boundaries of Ewing Lake Lowland (LS 7) must be verified. Field inspection of its production characteristics along with information from local specialists should guide the development of appropriate projects in the land system.

AGAPP and APP information is applicable to the development of soil conservation projects to reduce wind erosion risk in the County of Stettler. The production profiles integrate usual crop management with economic and other crop production characteristics. They provide more complete production inventories for the development of appropriate conservation projects. The AGAPPs and APPs can be used to estimate the balance of surface residue management and permanent cover projects required in a land system or group. Based on the economic returns and associated natural resource and production characteristics in a land system, projects directed to alternative land uses may be developed. The production profiles, while providing a more complete reconnaissance level inventory, could be improved as outlined in the next section.

4.3 Topics for Future Research

The assessment shows that the method has several strengths and some areas that could be improved for municipal conservation planning. The method appears to be replicable, subject to data availability, throughout agricultural regions of Alberta. It also provides a more complete description of agricultural production, information which has a demonstrated applicability to the development of municipal soil and water conservation projects. Further research could improve the replicability of the method and the applicability of APPs. This subsection discusses the principal research questions related to these two aspects.

4.3.1 Demonstrated Replicability of Method

Of the four criteria which define replicability, reapplication of the method is the most critical criterion to municipal conservation planners in the short term. Reapplication to other municipalities and Census time periods will provide planners with applicable, multi-date databases for plan development, monitoring and evaluation. The procedures required to demonstrate reapplication of the method in Alberta are outlined below.

Minor modifications are required to reapply the method to another municipality. Land systems must be defined and associated legal location link files must be compiled. A file of farm headquarters' legal locations must be developed by Statistics Canada personnel. The program to generate land system APPs should be modified to produce more applicable profile information (see Section 4.3.2). Subject to these adjustments, information comparable to the County of Stettler land system database could be created for evaluation in another municipality.

Demonstration of the method on another Census time period, if conducted in the County of Stettler, requires no procedural modifications. With the requisite link file from Statistics Canada and incorporation of improvements in the description of agricultural production, the method can be executed on the 1991 Census information. The results, compared with the APPs in this study, will help to determine whether:

1. changes in economic and crop production characteristics have occurred in each land system and group;
2. these changes are indicative of fundamental shifts in agricultural production;
3. these shifts have important consequences for municipal conservation planning; and
4. the method is feasible for multi-date monitoring of agricultural production within a land systems framework.

4.3.2 More Applicable APP Information

Improvements to the various components of the APP could better describe agricultural production in a land system thereby increasing the applicability of APPs to conservation planning. The following discussion outlines suggested research topics for: data integration; economic performance (cash flow); crop production (land use and land management); and livestock production.

There may be a systematic bias in data capture. Results of the present study show that the ratio of total farm area to total land system area was generally lower for land systems along the County boundary. The ratio of total farm area to total land system area was below 80 percent in six of the 13 land systems along the County boundary (i.e., Land Systems 4, 5, 8, 13, 14 and 17). Gopher Head Upland (LS 17) appears to be an area of extensive grazing on public lands in the Dark Brown soil zone. Lands used for extensive cattle grazing, if reported to farm headquarters outside of the land system, would account for the low ratio for this land system. The remaining five land systems, all in the Black soil zone, show diverse production characteristics and profiles. A specific type of production profile would not account for the low ratios in these cases. Further studies could be directed to an evaluation of the 1991 Census using the same method or to an application of the method to other municipalities. Each study would provide additional information for evaluating a potential systematic bias in data capture.

A measure of the degree of concentration of agricultural production in a land system, a useful cash flow characteristic, would assist conservation planning. At present, APPs provide sum

totals for all farms in a land system. Cross tabulation of farm size and total gross sales would indicate, for instance, whether production is concentrated among a small number of operators with the majority of total farm area and gross sales. In the case of concentrated production, conservation plans would need to focus on the activities of these large operators.

Descriptions based on groups of farms with similar cropping patterns would promote the development of conservation projects appropriate to local land uses. A study in Manitoba, based on 1981 and 1986 Census data, demonstrated a classification algorithm appropriate to the description and characterization of farm-level cropping systems in the prairie provinces (Huffman et al. 1993). It shows Wheat and Wheat & Oilseeds Systems, both with low proportions of uncultivated land, are dominant in areas with higher quality natural resources. Conversely, higher percentages of uncultivated land and Mixed, Feeds & Forages, and Pasture Systems are dominant in areas with lower quality land resources. The balance of surface residue management and permanent cover projects could be adjusted in accordance with the distribution of farms among major cropping systems.

An evaluation is required of the new Land Management Practices Module in the 1991 Census. Previous to the 1991 Census, there was no national inventory of tillage practices for seedbed preparation, erosion control practices and summerfallow methods. The information from this module is potentially useful to both erosion assessments and development of municipal conservation projects and should be evaluated.

A new component on livestock production would benefit conservation planning, as in the following example. Assume two land systems have high wind erosion risk, high proportions of land in annual crop production and high percentages of expenses and capital investment in livestock. Additional information on livestock type and numbers could show hogs in one land system, cattle in the other. Surface residue management projects would be more appropriate in the first case because hog production is generally not linked to perennial forage crop production. Perennial forage projects would be more appropriate in the latter land system because the forages would provide feed for cattle as well as erosion protection for the soil.

A method with demonstrated replicability and more applicable descriptions of agricultural production, relative to the conservation planning process, is the goal of the suggested future research. The above discussion shows that the research process will be dynamic, with periodic assessments of the procedures to determine land systems and reprocess Census data at the farm headquarters level. Subsequent to the application of APPs to municipal conservation planning, planners are expected to provide strategic input to the direction of future research.

5.0 Conclusions

A new method to integrate and summarize agricultural production data within land systems has been successfully tested. This shows that Census of Agriculture data can be reprocessed by farm headquarters within landscapes appropriate to municipal soil and water conservation planning. Eight conclusions are reached, four relating to the method and its applicability to soil and water conservation planning, and four relating to associations between agricultural production and land systems.

5.1 Method

The method of farm headquarters processing provides a more accurate inventory of agricultural production in a landscape than do EA summaries. The key limitation to the use of Census data for municipal conservation planning has been the poor fit between the EA reporting unit and a land system. This limitation has been overcome. The farm headquarters method effectively links Census data to a landscape unit appropriate to municipal conservation planning. Continued research on the factors affecting data integration will improve the goodness of fit between the Census and land systems.

The method identifies associations between agricultural production and land systems for municipal conservation planning. As demonstrated for the issue of wind erosion, these associations can be a guide to the selection of appropriate conservation projects in a land system. Appropriate projects would not only conserve soil and water resources but also enhance the economic performance of production systems. The appropriateness of projects will vary with the particular conservation issue under consideration.

The method is an effective tool in support of soil and water conservation planning within the County of Stettler. The method allows monitoring of agricultural production in a more stable base unit at various time intervals. Land system boundaries will not change as frequently as EA boundaries. Time series information within a stable base unit will more accurately describe real changes in agricultural production. It remains to demonstrate the method's replicability for another Census year.

The method can be an effective conservation planning tool for other Alberta municipalities. At a conceptual level, the method tested for the County of Stettler is not limited to this municipality. The method should be tested for other Alberta municipalities to show that the development of land systems and Census link files will provide the type of production profiles demonstrated in this study. Thus, descriptions of agricultural production on a land system basis could be provided for municipal conservation planning throughout Alberta.

5.2 Associations Between Agricultural Production and Land Systems

Differences in output and inputs are associated with differences in agroclimatic and soil development characteristics. Production in the Black soil zone has higher output and inputs than the Dark Brown soil zone. Farmers in the Black soil zone report higher productivity. They spend and invest more resources over a smaller average farm size. Cultivated land is more extensive, fertilizer use and herbicide use are more extensive, and fertilizer use is more intensive.

Differences in land use characteristics are associated with differences in agroclimatic and soil development characteristics. Farmers in the Black soil zone report more cultivated land and more small grains and oilseeds whereas farmers in the Dark Brown soil zone report more wheat and summerfallow. Differences in moisture requirements are linked to these differences in crop choice: small grains and oilseeds require greater moisture than wheat and summerfallow. Moisture availability is more of a limitation in the Dark Brown soil zone and farmers in this zone tend to use drought tolerant cropping systems.

Differences in agricultural production are associated with local variations in topography, parent material texture and soil development. Farmers in the Black soil zone groups with topographic, texture and soil development limitations to annual cultivation report more expenses and investment in livestock, and more feeds and forages. Farmers in the Dark Brown soil zone group with these limitations also report more livestock than crop expenses. These variations suggest that farmers are attempting to maintain viable economic returns with due consideration of the natural resources available to production.

Differences in agricultural production systems are influenced by a farmer's understanding of the effects of land resources on crops and livestock. The three previous conclusions show that associations exist between the type and intensity of production systems and landscape characteristics. These associations indicate that many farmers in a land system have reached similar conclusions concerning the effect of land resources on agricultural production. What is unclear to both farmers and municipal planners is whether these associations, and the understanding on which they are based, work towards the conservation of local soil and water resources.

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Appendices

Appendix 1. Glossary

Aggregate group agricultural production profile (AGAPP) - A description of agricultural production for a group of biophysical landscape units called **land systems**.

Agricultural production profile - A description of agricultural production in a **land system**.

Agroclimate - A classification for general agricultural assessment following a recognized system in Alberta (Alberta Soils Advisory Committee 1987). The classification is based on heat and moisture factors affecting patterns of dryland crop production.

Biophysical landscape unit - A land unit defined on the basis of characteristics that affect biological production. In this study, the biophysical landscape units are **land systems** and are based on climate, landscape and soil development characteristics.

Capital - A stock of accumulated goods, rather than income received at a specified time. In this study, capital is comprised of land and buildings, machinery and livestock.

Capital investment - The present market value of land and buildings, machinery and equipment, and livestock. It is estimated by the farmer based on 1985 information.

Cash crop - A crop that is grown for sale, not for use on the farm.

Census enumerator - A person who administers the Census questionnaire to a respondent.

Census subdivision - A unit for the presentation of Census data. In Alberta, it generally corresponds to a municipality.

Characteristic - A concept that describes one aspect of an object under study. For example, economic performance is a characteristic of agricultural production. A characteristic is distinguished from an *indicator* and a *variable*. An indicator is a concept that measures one aspect of a characteristic. For example, economic efficiency is an indicator of economic performance. A variable is a measure of one aspect of an indicator. For instance, the sales to expenses ratio is a variable that measures economic efficiency.

Chernozemic - A grassland and parkland soil developed under semi-arid conditions. See Agriculture Canada (1976) for a formal definition.

Coarse texture - The texture exhibited by sands, loamy sands and sandy loams except very fine sandy loam. See Brierley et al. (1992) for a formal definition.

Contiguous - Touching along a boundary.

Cropland - A variable derived from the Census. It refers to the total area of: crops seeded or to be seeded in 1986; tree fruits, cultivated berries, grapes, vegetables, sod and nursery products for sale; and summerfallow.

Cultivated land - A variable derived from the Census. It is equal to cropland less summerfallow.

Data integration - A characteristic describing the goodness of fit between the Census and land systems databases.

Data integration variables - Variables that measure the goodness of fit between the Census and land systems databases. These variables include sum totals for land system area, number of farms and total farm area, as well as the percentage of total farm land to land system area.

Economic - Relating to the production and consumption of goods and services.

Economic efficiency - Relating to the rate of outputs produced for a given level of inputs. In this study, it is measured by the ratio of total gross sales to summary expenses.

Enumeration area (EA) - The area covered by an enumerator. In rural areas it generally contains about 50 farms. See Statistics Canada (1986) for a formal definition.

Environmentally significant area - An area defined on the basis of natural resource and biological characteristics of value to society.

Equipment - see **Machinery**.

Extensive - Having a wide extent. In this study, it is an adjective to describe the following variables: cultivated area as a percent of total farm area; percentage distribution of crops; area receiving fertilizers; and area receiving herbicides.

Farm headquarters - A Census variable that records the location of the main farm buildings.

Fine texture - Consisting of or containing large quantities of silt and clay particles. See Brierley et al. (1992) for a formal definition.

Geographic information system (GIS) - A set of computer hardware, software and geographic data designed to efficiently capture, store, update, manipulate, analyze and display geographically referenced information. (Dangermond 1992)

Gleyed soil - A soil that has been affected by standing water for some period of time. See Agriculture Canada (1976) for a formal definition.

Gleysolic - An order of soils that have been affected by standing water. See Agriculture Canada (1976) for a formal definition.

Gross sales - A Census variable that contains total sales from all agricultural products for the 1985 calendar year. It also includes shares from tenants, cash advances for stored crops, Marketing Board or other Agency payments, direct sales and income from custom work. Sales of capital items (e.g., farm land or machinery) or forest products are not included.

Hummocky landscape - A complex pattern of bowl-shaped depressions (or "kettles") and irregular to conical hills (or "knobs"). See Agriculture Canada (1976) for a formal definition.

Input - Something added as a component of production. In this study, inputs refer to summary expenses, capital, land use and land management.

Intensive - Relating to a land management method designed to increase productivity by an increase in inputs rather than an increase in area farmed. For example, two farmers may farm the same total area. If Farmer A uses more inputs than Farmer B to achieve more gross sales for the same total area, then Farmer A is using more intensive methods than Farmer B. In this study, intensive is an adjective to describe land management, particularly the amount of fertilizer per hectare of cultivated land.

Knob and kettle landforms - See **hummocky landscape**.

Land system - A category within the Ecological Land Classification, used to recognize an area of land throughout which there is a recurring pattern of landforms, soils and vegetation chronosequences and drainage patterns. (Sub-committee on Biophysical Land Classification 1969)

Legal location - The position of an object or place described in Dominion Land Survey coordinates.

Machinery - Refers to the Census variables for machinery and equipment. See Statistics Canada (1986) for a formal definition of these variables.

Medium texture - Intermediate between fine and coarse textured (usually referring to soils). It includes the following textural classes: very fine sandy loam, loam silt loam and silt. See Brierley et al. (1992) for a formal definition.

Municipal conservation planning - A process by which a municipality prepares the framework to manage and conserve soil and water resources within its borders. Agricultural as well as wildlife factors are considered in this planning process.

Output - Something produced. In this study, output refers to total gross sales in 1985 dollars.

Parent material - The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of a soil has developed by pedogenic processes. (Agriculture Canada 1976)

Permanent cover - Land cover classes that generally do not change in a five to eight year period. For example, pasture and trees are permanent cover.

Physiographic district - A physiographic subdivision, based upon the recognition of areas of similar landforms. Physiography is the study involving the description, classification, correlation and origin of landforms. (Holland 1976)

Production - Total output. In this study, it refers to total output of 1985 dollars.

Productivity - Rate of production. In this study, productivity is described in terms of gross sales (1985 dollars) per hectare of total farm area.

Relative measure - A variable that measures one variable in terms of another. For example, total capital value is an absolute measure whereas total capital value per hectare of total farm area is a relative one. Relative measures are used when the size of a unit may bias the results. For instance, total capital value may be two times larger for one land unit compared to another, but that unit is also two times larger in area. The relative measure would indicate no difference between the two land units on the basis of how much capital is invested per unit area.

Slope - The degree of deviation of a surface from horizontal, usually expressed in percent or degree. (Brierley et al. 1992)

Soil series - A group of soils having similar developmental characteristics. See Agriculture Canada (1976) for a formal definition.

Soil zone - A large geographic area with similar soil characteristics due to the influences of climate, vegetation and topography. For example, soils in the Black soil zone have more organic matter than soils in the Dark Brown soil zone due to higher moisture in the Black soil zone. See Agriculture Canada (1976) for a formal definition.

Solonetzic - A poor quality grassland and parkland soil. It is affected by accumulations of sodium salts in the root zone. See Agriculture Canada (1987) for a formal definition.

Summary expenses - A Census variable that contains a partial inventory of expenses for the 1985 calendar year. It contains rent and leasing expenses, cash wages, interest, machinery expenses, crop expenses, livestock expenses, small containers, twine and wire, custom work, electricity, fuel and all other farm business operating expenses. It does not include mortgage payments against principle and depreciation or capital cost allowance. See Statistics Canada (1986) for a formal definition.

Sustainable agriculture - Agri-food systems that provide safe, nutritious food in an economically viable and environmentally responsible manner. See Federal-Provincial Agriculture Committee on Environmental Sustainability (1990) for a formal definition.

Total farm area - A Census variable that includes the sum of: summerfallow; improved pasture or grazing; other improved land; unimproved land for pasture, grazing or hay; woodland; and other unimproved land.

Total land system area - The total area of land located within the boundary of a land system.

Appendix 2. Agricultural Production Profile for Group 1: Castor Plain / Central

	Group	*Land System*			
	1 Castor Plain / Central	*11 Stettler Plain*	*12 Bigknife Plain*	*3 Liberal Plain*	*15 Meeting Creek Plain*
(A) Integration – Summary					
Land System Area (ha)	104804 *	56057	27694	8675	12377
Number of Farms	297 *	179	64	28	26
Total Farm Area (ha)	100331 *	54905	24383	10786	10256
Tot. Farm Area as % of Land System	93	98	88	124	83
(B.1) Cash Flow					
Total Gross Sales (1985 $)	23943286 *	12328342	5493593	3707946	2413405
Gross Sales per Ha	230	225	225	344	235
Sales to Expenses Ratio	1.18	1.14	1.10	1.23	1.47
Distribution of Expenses					
% Interest	10	12	10	8	9
% Machinery	16	16	16	14	20
% Crops	23	20	16	27	26
% Livestock	22	21	34	20	24
% Other	28	31	24	31	21
(B.2) Capital Investment					
Total Capital Value (1985 $)	148849212 *	84332328	30481336	19084196	14951352
Area Owned as % Total Farm Area	66	69	63	56	82
Cap. Value($)/Ha of Tot. Farm Area	1497	1536	1250	1769	1458
Distribution of Capital					
% Land and Buildings	70	72	71	60	70
% Machinery	20	20	19	35	20
% Livestock	9	8	10	5	10
(C.1) Land Use					
Average Farm Size (ha)	383	307	381	385	395
Total Cultivated Area (ha)	68011 *	36336	16090	8791	6793
Cult. Area as % Total Farm Area	66	66	66	81	66
Dist. of Crops as % of Cult. Land					
% Feeds and Forages	13	17	14	12	12
% Oats	6	4	10	1	9
% Barley	22	19	16	26	33
% Oilseeds	16	18	13	23	10
% Wheat	32	30	36	34	20
% Summerfallow	10	10	9	4	15
% Other Crops	2	2	2	0	1
(C.2) Land Management					
Total Area Fertilized (ha)	51180 *	26095	11020	8346	5719
Area Fert. as % of Cropland	90	80	75	99	99
Kg Fertilizer per Ha of Cropland	92	98	85	155	58
Total Herbicide Sprayed Area (ha)	50056 *	25861	11845	7500	4850
Herb. Sprayed Area as % Cult. Land	72	71	74	85	71

*Total of land systems within the group. All other group values are medians.

Appendix 3. Agricultural Production Profile for Group 2: Bashaw and Delburne Uplands / West

	Group	*Land System*						
	2 Bashaw and Delburne Uplands/W	*1 Buffalo Lake Upland*	*8 Scollard Upland*	*5 Foxall Lake Upland*	*9 Fenn Upland*	*13 Donalda Upland*	*2 Boss Hill Upland*	*4 Nevis Lowland*
(A) Integration – Summary								
Land System Area (ha)	92197 *	24353	16579	15865	11386	14487	4797	4729
Number of Farms	192 *	50	23	30	34	34	11	10
Total Farm Area (ha)	74512 *	21220	13356	12016	11636	8472	4756	3056
Tot. Farm Area as % of Land System	81	87	81	76	102	58	99	65
(B.1) Cash Flow								
Total Gross Sales (1985 $)	18021890 *	5510546	2315155	4350946	2216983	2002378	501592	1124290
Gross Sales per Ha	236	260	173	362	191	236	105	368
Sales to Expenses Ratio	1.11	1.11	1.34	1.12	1.05	1.07	1.11	1.43
Distribution of Expenses								
% Interest	12	12	10	12	14	18	12	16
% Machinery	16	15	18	10	18	16	20	15
% Crops	19	19	25	11	13	24	20	15
% Livestock	23	26	20	51	35	19	8	23
% Other	27	28	27	16	20	23	40	31
(B.2) Capital Investment								
Total Capital Value (1985 $)	91800075 *	25023803	15975805	14911326	15229893	10422271	4605596	5631381
Area Owned as % Total Farm Area	57	57	55	50	66	57	82	87
Cap. Value($)/Ha of Tot. Farm Area	1230	1179	1196	1241	1309	1230	968	1843
Distribution of Capital								
% Land and Buildings	65	65	73	64	71	64	71	65
% Machinery	18	24	17	21	14	28	17	18
% Livestock	12	11	10	15	15	8	12	17
(C.1) Land Use								
Average Farm Size (ha)	401	425	581	401	342	249	432	306
Total Cultivated Area (ha)	38217 *	12510	5001	5986	5424	5261	2531	1505
Cult. Area as % Total Farm Area	50	59	37	50	47	62	53	49
Dist. of Crops as % of Cult. Land								
% Feeds and Forages	24	15	15	24	31	12	26	43
% Oats	4	4	4	4	5	3	20	10
% Barley	23	25	15	30	12	23	34	13
% Oilseeds	14	23	10	17	10	34	0	**
% Wheat	23	27	39	16	20	23	9	23
% Summerfallow	6	5	15	6	16	5	6	**
% Other Crops	3	1	2	3	6	0	5	11
(C.2) Land Management								
Total Area Fertilized (ha)	29023 *	9825	3843	5402	2716	4937	1133	1168
Area Fert. as % of Cropland	83	83	91	96	60	99	48	78
Kg Fertilizer per Ha of Cropland	118	127	154	108	57	181	56	112
Total Herbicide Sprayed Area (ha)	27032 *	10246	3355	4119	2657	4028	1633	993
Herb. Sprayed Area as % Cult. Land	67	82	67	69	49	77	65	66

* Total of land systems within the group. All other group values are medians.

** Values not included due to confidentiality.

Appendix 4. Agricultural Production Profile for Group 3: Castor Plain / West and Central

	Group	*Land System*			
	3 Castor Plain / West and Central	*6 Oberlin Plain*	*14 Red Willow Plain*	*10 Lowden Lake Plain*	*7 Ewing Lake Lowland*
(A) Integration – Summary					
Land System Area (ha)	57158 *	17711	21915	12223	5310
Number of Farms	137 *	52	38	32	15
Total Farm Area (ha)	54671 *	17120	15794	11305	10451
Tot. Farm Area as % of Land System	94	97	72	92	197
(B.1) Cash Flow					
Total Gross Sales (1985 $)	13961383 *	6207441	2768009	2414042	2571891
Gross Sales per Ha	230	363	175	214	246
Sales to Expenses Ratio	1.09	1.12	1.03	1.06	1.16
Distribution of Expenses					
% Interest	12	10	18	15	6
% Machinery	16	17	18	15	15
% Crops	15	15	24	15	12
% Livestock	30	30	18	30	44
% Other	24	28	22	25	23
(B.2) Capital Investment					
Total Capital Value (1985 $)	80188640 *	31740018	18740269	15778754	13929599
Area Owned as % Total Farm Area	70	70	69	61	75
Cap. Value($)/Ha of Tot. Farm Area	1365	1854	1187	1396	1333
Distribution of Capital					
% Land and Buildings	68	65	73	71	64
% Machinery	18	22	18	16	18
% Livestock	13	13	9	13	18
(C.1) Land Use					
Average Farm Size (ha)	384	329	416	353	697
Total Cultivated Area (ha)	32310 *	11028	9730	6102	5450
Cult. Area as % Total Farm Area	58	64	62	54	52
Dist. of Crops as % of Cult. Land					
% Feeds and Forages	24	20	11	30	28
% Oats	4	4	8	4	5
% Barley	22	30	23	15	21
% Oilseeds	17	18	20	16	11
% Wheat	25	19	28	25	25
% Summerfallow	6	4	7	8	6
% Other Crops	4	5	3	2	4
(C.2) Land Management					
Total Area Fertilized (ha)	24210 *	10028	6015	3752	4416
Area Fert. as % of Cropland	77	94	67	66	86
Kg Fertilizer per Ha of Cropland	89	132	90	61	87
Total Herbicide Sprayed Area (ha)	22882 *	7972	7299	4169	3442
Herb. Sprayed Area as % Cult. Land	70	72	75	68	63

*Total of land systems within the group. All other group values are medians.

Appendix 5. Agricultural Production Profile for Group 4: Rumsey Upland / South

	Group	*Land System*		
	4 Rumsey Upland / South	*18* *Byemoor* *Upland*	*17* *Gopher Head* *Upland*	*16* *Big Valley* *Lowland*
(A) Integration – Summary				
Land System Area (ha)	73371 *	41863	26507	5002
Number of Farms	101 *	73	21	7
Total Farm Area (ha)	54342 *	38171	10771	5400
Tot. Farm Area as % of Land System	91	91	41	108
(B.1) Cash Flow				
Total Gross Sales (1985 $)	7143966 *	5019050	1458621	666295
Gross Sales per Ha	131	131	135	123
Sales to Expenses Ratio	1.18	1.18	1.16	1.33
Distribution of Expenses				
% Interest	11	15	6	11
% Machinery	21	21	17	27
% Crops	15	13	15	23
% Livestock	24	24	27	13
% Other	27	27	35	26
(B.2) Capital Investment				
Total Capital Value (1985 $)	53811851 *	39063245	9539924	5208682
Area Owned as % Total Farm Area	70	70	73	50
Cap. Value($)/Ha of Tot. Farm Area	965	1023	886	965
Distribution of Capital				
% Land and Buildings	67	67	69	63
% Machinery	20	21	19	21
% Livestock	12	12	12	16
(C.1) Land Use				
Average Farm Size (ha)	523	523	513	771
Total Cultivated Area (ha)	27381 *	20464	4828	2089
Cult. Area as % Total Farm Area	45	54	45	39
Dist. of Crops as % of Cult. Land				
% Feeds and Forages	13	13	9	20
% Oats	8	8	2	9
% Barley	17	10	17	17
% Oilseeds	4	5	4	0
% Wheat	35	34	35	39
% Summerfallow	29	29	30	15
% Other Crops	1	1	3	0
(C.2) Land Management				
Total Area Fertilized (ha)	13112 *	8962	2566	1584
Area Fert. as % of Cropland	75	61	75	89
Kg Fertilizer per Ha of Cropland	60	44	60	83
Total Herbicide Sprayed Area (ha)	15347 *	11217	2786	1344
Herb. Sprayed Area as % Cult. Land	58	55	58	64

* Total of land systems within the group. All other group values are medians.

Appendix 6. Agricultural Production Profile for Group 5: Castor Plain / Southeast ***

	Group	*Land System*		
	5 Castor Plain / Southeast	*20 Cutbank Lake Plain*	*22 Shooting Lake Plain*	*19 Farrell Lake Plain*
(A) Integration – Summary				
Land System Area (ha)	74122 *	44481	20815	8826
Number of Farms	118 *	75	29	14
Total Farm Area (ha)	75324 *	48998	18747	7579
Tot. Farm Area as % of Land System	90	110	90	86
(B.1) Cash Flow				
Total Gross Sales (1985 $)	9529761 *	6707221	2058264	764276
Gross Sales per Ha	110	137	110	101
Sales to Expenses Ratio	1.09	1.09	0.91	1.30
Distribution of Expenses				
% Interest	10	10	8	15
% Machinery	21	21	17	33
% Crops	13	13	13	13
% Livestock	33	33	33	11
% Other	28	23	29	28
(B.2) Capital Investment				
Total Capital Value (1985 $)	80807829 *	53199546	20027858	7580425
Area Owned as % Total Farm Area	66	66	83	64
Cap. Value($)/Ha of Tot. Farm Area	1068	1086	1068	1000
Distribution of Capital				
% Land and Buildings	72	72	73	69
% Machinery	16	16	14	22
% Livestock	12	12	13	9
(C.1) Land Use				
Average Farm Size (ha)	646	653	646	541
Total Cultivated Area (ha)	37486 *	23992	8815	4679
Cult. Area as % Total Farm Area	49	49	47	62
Dist. of Crops as % of Cult. Land				
% Feeds and Forages	12	11	21	12
% Oats	7	7	9	7
% Barley	13	14	13	7
% Oilseeds	6	5	6	**
% Wheat	34	34	32	36
% Summerfallow	27	27	16	35
% Other Crops	3	2	3	3
(C.2) Land Management				
Total Area Fertilized (ha)	18707 *	11966	5341	1400
Area Fert. as % of Cropland	68	68	72	46
Kg Fertilizer per Ha of Cropland	59	59	83	34
Total Herbicide Sprayed Area (ha)	20362 *	13720	4714	1929
Herb. Sprayed Area as % Cult. Land	53	57	53	41

* Total of land systems within the group. All other group values are medians.

** Values not included due to confidentiality.

*** Results for Gough Lake Lowland (LS 21), are not included due to confidentiality.

LEGEND:

Land system boundary — Soil zone boundary — County boundary

APPENDIX 7. *Location of land systems within the County of Stettler*

Source: Land Systems within the County of Stettler, Alberta, J.A. Brierley, J. Kwiatkowski, and L.C. Marciak. 1992