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Assessment of cropping systems in Manitoba using agroecological resource regions



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Assessment of cropping systems in Manitoba using agroecological resource regions

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This work was published with the support of the National Soil
Conservation Program, Soil Quality Evaluation Program

Technical Bulletin 1993-4E

Research Branch
Agriculture Canada
1993

Copies of this publication are available from
Director
Centre for Land and Biological Resources Research
Research Branch, Agriculture Canada
Ottawa, Ontario
K1A 0C6

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Cat. No. A54-8/1993-4E
ISBN 0-662-20366-6

ABSTRACT

This study characterizes and compares farm-level cropping systems in Manitoba, employing a biophysical framework for database organization and presentation. The province was subdivided into Agroecological Resource Areas (ARAs), which are areas of similar landscape, soil classification and parent material. These ARAs were then grouped into ten Agroecological Resource Regions (ARRs), which are areas of similar agriculture production potential based on ARA parameters and agroclimatic conditions.

A farm-level cropping systems legend, based on the type and proportion of crops within a farm unit, was developed using Census of Agriculture data in consultation with local agronomic and soils specialists. Four specialized Systems (Irrigation, Horticulture, Specialty Crops and Pasture) and eight Dryland Systems (Wheat & Fallow, Wheat, Wheat & Oilseeds, Wheat & Barley, Barley, Barley & Feeds/Forages, Feeds & Forages and Mixed) were identified. The eight Dryland Systems were each further subdivided into Low Pasture and Moderate Pasture variants. Irrigation and Horticulture Systems were not assessed in this study.

Farm-level information from the Census of Agriculture for 1981 and 1986 was extracted for each ARA and simple descriptive statistics were used to summarize crop and economic information for each system at the ARR level.

Over 17,500 farms were classified in each study period, representing about 60 percent of all farms in the Province. Approximately 80 percent of these farms occur in four ARR (Manitoba Escarpment, Winnipeg Plain, West Lake and Sandilands). For analysis purposes, only cropping systems which represented at least 10% of the farms within an ARA in 1986 were considered characteristic of that ARA. Analysis of only these 'Major Systems' resulted in 43 combinations of ARRs and cropping systems and reduced the number of farms analyzed per time period to approximately 11,500.

Several basic trends were noted as a result of the analysis of Major Systems by ARR for 1981 and 1986. Generally, farm size increased, the proportion of total farm area under cultivation increased, and the proportion of oilseeds increased in those ARRs with suitable climatic and land characteristics. In terms of changes in cropping patterns, an overall decline in the number of farms within the Specialty and Mixed Systems was accompanied by an increase in the number in the Wheat System. With respect to financial comparisons, there was a general increase in the value of fuel and fertilizer inputs for most Major Systems, but a similar comparison of gross margins and economic efficiency is subject to question due to a drought throughout Manitoba in 1980 (the year of sales and expenses for the 1981 Census). However, farms in regions with better agroecological resources were subject to generally smaller declines in economic returns than those in regions with less favourable resources.

RÉSUMÉ

Les auteurs ont caractérisé et comparé les systèmes cultureux du Manitoba en se servant d'un cadre biophysique pour l'organisation et la présentation des données. Ils ont subdivisé la province en zones agroécologiques, qui correspondent à des portions de territoire caractérisées par un relief, une classe de sol et un matériel parental semblables. Ces zones ont ensuite été regroupées en dix régions agroécologiques, qui sont des portions de territoire ayant, selon leurs caractéristiques pédologiques et géomorphologiques et leurs conditions agroclimatiques, un potentiel agricole comparable.

Après consultation des pédologues et phytotechniciens locaux, les auteurs ont établi, en partant des données de recensement de l'agriculture, une légende des systèmes cultureux fondée sur le type et la proportion des cultures à l'intérieur des exploitations agricoles. Ils ont défini quatre systèmes cultureux spécialisés (cultures irriguées, horticulture, cultures spéciales et pâturages) et huit systèmes en culture non-irriguée (blé et jachère, blé, blé et oléagineux, blé et orge, orge, orge et grains de provende/fourrages, et fourrages et cultures mixtes). Ces derniers ont ensuite été subdivisés en deux catégories selon la proportion de pâturage (faible et modérée). Les cultures irriguées et l'horticulture n'ont pas été évaluées dans la présente étude.

Les auteurs ont extrait des recensements de l'agriculture de 1981 et 1986 les données sur les fermes pour chaque zone agroécologique et ont utilisé la statistique descriptive pour résumer l'information sur les cultures et les données économiques pour chaque système à l'échelon des régions agroécologiques.

Pour chacune des périodes visées par l'étude, ils ont classé plus de 17 500 exploitations agricoles de la province, soit 60% du total. Environ 80% d'entre elles sont situées dans quatre régions agroécologiques (escarpement du Manitoba, plaine de Winnipeg, West Lake et Sandilands). Aux fins de l'analyse, seuls les systèmes cultureux représentant au moins 10% des exploitations à l'intérieur d'une zone agroécologique en 1986 ont été considérés comme caractéristiques de cette dernière. En ne retenant que ces principaux systèmes, les auteurs en sont arrivés à 43 combinaisons de régions agroécologiques et de systèmes cultureux, et ont ramené le nombre d'exploitations à analyser par période à environ 11 500.

L'analyse des principaux systèmes par région agroécologique pour 1981 et 1986 a fait ressortir plusieurs grandes tendances. En règle générale, la taille des exploitations a augmenté, la proportion de leur superficie totale en culture s'est accrue, et la proportion des superficies en oléagineux a progressé dans les régions agroécologiques présentant les caractéristiques climatiques et pédologiques adéquates. Pour ce qui concerne la répartition des exploitations selon les systèmes cultureux, on a noté une baisse globale du nombre d'exploitations dans les catégories systèmes cultureux spécialisés et cultures mixtes, conjuguée à une augmentation du nombre d'exploitations dans la catégorie culture du blé. Sur le plan financier, on constate un accroissement aux postes des carburants et des engrais dans la plupart des principaux systèmes, mais les résultats des comparaisons portant sur les marges brutes et l'efficacité sont sujets à caution en raison de la sécheresse qui a sévi partout au Manitoba en 1980 (année des ventes et des dépenses aux fins du recensement de 1981). Toutefois, dans les régions favorisées par de meilleures ressources agroécologiques, les recettes ont accusé de moins fortes baisses que dans celles moins bien pourvues.

ACKNOWLEDGMENTS

The implementation of integrated research on the geographic distribution of farm-level cropping systems within a regional biophysical framework has required timely input from a large number of individuals. People from across the Prairie Region and from the following agencies were consulted: Agriculture Canada, Statistics Canada, Manitoba Agriculture, University of Manitoba, Saskatchewan Institute of Pedology, Alberta Agriculture, Alberta Economic Development and Trade, and the University of Alberta. Specific acknowledgements are directed to Dr. W.W. Pettapiece and Dr. J. Dumanski for their continued commitment to integrated studies of agricultural land use in Canada.

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1.0 INTRODUCTION

In Manitoba there are strong associations between land resources and agricultural land use; climatic and soil resources impose different types and levels of constraints on land use options. This relationship reveals the impact of physical setting on agricultural activities and economic options, and determines the strategies landowners can use to generate a living within a specific area. Documentation of the links between resources and production activities can lead to an improved understanding of needs and opportunities, and thus enhance the management of resources. Programs and policies tailored to specific areas could assist in optimizing production and minimizing environmental impacts, while management strategies which recognize different levels of limitation could reduce financial risk.

1.1 Objective

The objective of this report is to assess farm-level cropping systems in Manitoba, employing a biophysical framework for database organization and analysis. Within that spatial framework, the assessment is based on individual farms which are grouped according to similarities in crop type and proportions. The Manitoba study is intended to be one in a series covering all three prairie provinces, so the development of a standardized approach employing Census data, Agroecological Resource Regions and a prairie-wide cropping systems classification scheme is part of the goal.

There are five sections in the report, including this introduction. The second section outlines the methodology, while the third describes each Agricultural Resource Region on the basis of the distribution of cropping systems and the characteristics of those systems in both 1981 and 1986. The fourth section is a discussion of trends in economic performance and agricultural land use in Manitoba. The final section presents conclusions based on this integrated assessment of agricultural land use within a biophysical framework.

1.2 Background

Integrated assessments of agricultural land use based on biophysical principles has been a topic of interest for some time (FAO, 1978). The critical point of this approach is that the climate and land resources impose a set of constraints on agricultural activity at broad scales. These limitations are addressed at the farm-level through variations in the mix of crops and livestock as well as the management practices associated with these factors. The resultant combinations of capital investment, cropping systems and enterprise type are relatively stable through time.

Regional patterns of agricultural production can be expressed by a farm-level classification based on cropping systems (Huffman and Dumanski, 1985). Differences in the economic structure and performance of cropping systems were documented and expressed by quantitative measures of land use intensity, and the spatial association between agricultural land use intensity and a generalized classification of land capability was outlined. For example, in eastern Ontario, cropping systems based on corn and soybeans used more land of higher agricultural capability and had greater capital investment and higher income, expenses and gross margins than systems based on a combination of cereal grains and hay.

A more thorough examination of the association between soil capability and land use was conducted to determine if specific land characteristics were associated with different cropping systems (Dumanski et al., 1987). The results, based on the use of Information Theory, indicated that there were definite links between agricultural land use and land characteristics such as soil, parent material and surface texture.

A spatially stratified approach at a much smaller scale was used more recently to summarize farming strategies in the major soil zones of the Canadian prairies (Huffman, 1988). A link between the Soils of Canada map polygons (scale 1:5 M) and Statistics Canada Enumeration Areas was used for broad scale research on agricultural land use. The analysis identified several important trends:

- 1) Agricultural land use in the Black Chernozemic Soil Zone was more diverse than in Zones with less available moisture;
- 2) The quantity and value of farm inputs were greatest in the Black Soil Zone;
- 3) Gross margins (income minus operating expenses) were generally only slightly higher in the Black Soil Zone; and
- 4) Relative economic efficiency (ratio of sales to expenses) was generally highest in the low input wheat/fallow system of the Brown Soil Zone.

These results indicate that different management strategies are used in different Soil Zones, with differing economic results. Recognition of the economic performance of cropping systems in the context of landscape characteristics underscores the importance of integrated physical/socioeconomic assessments to agricultural land use studies.

Results from past research indicate that increasing the scale of study and refining the classification of farming activity would provide improved understanding of agricultural land use. Such recommendations are incorporated into this assessment of agricultural land use in Manitoba.

2.0 METHOD

Describing defined regions on the basis of cropping systems and socioeconomic characteristics was accomplished by linking Enumeration Areas (EAs), which typically represent between 15 and 40 farms, with biophysically delineated Agricultural Resource Areas (ARAs). Each farm within each ARA was then assigned to a cropping system based on its crop distribution as reported in the Census. Then a statistical summary of socioeconomic data for each cropping system for each ARA was extracted. Data

for cropping systems with fewer than 10 farms in an ARA were suppressed by Statistics Canada in accordance with confidentiality policy. Because of the large number of ARAs in the province, further analysis was restricted to Agricultural Resource Regions (ARRs), which are associations of ARAs grouped according to similarities in broad agroclimatic potentials.

2.1 Agroecological Resource Classification

Delineation of land units for land evaluation purposes was suggested by FAO (1976) as ideally being based on biophysical principles and a hierarchical structure. The main characteristics of a relevant biophysical land classification for agriculture include agroclimate, landform and soil information (FAO, 1978, 1984). Land classification based on these characteristics has been developed for Alberta (Pettapiece, 1989), wherein Agroecological Resource Regions (ARRs) represent broad groupings based on climate (heat and moisture limitations) while Agroecological Resource Areas (ARAs) represent subdivisions of these units on the basis of regional landform. A preliminary map following a similar method of classification was available for use in the current study (Eilers, 1989, pers. comm.). The map and associated information are presented in Figure 1 and Table 1 respectively, and a brief description of each ARR is presented below.

The Winnipeg Plain ARR is one of four lowland areas in south-central Manitoba. It is noted for minimal relief, fine-textured soils and an agroclimate suitable for the commercial production of specialty crops such as sugar beets, corn and sunflowers. The West Lake ARR is a northern extension of this Plain, with cooler climate and medium-textured soils. The region is well suited to cereal grains and oilseed production.

Southeastern Manitoba is dominated by the Sandilands ARR, a region of coarse textured mineral soils with organic soils in poorly drained depressions. The climate for agriculture is slightly limited by a lack of heat, while variable surface expression and poor drainage impose significant limitations on the extent of cultivation. The production of cereals for feed and forages is common.

The Interlake ARR is a level to undulating plain characterized by subdued ridge and swale topography, medium-textured soils and a slight heat limitation. It has good land resources in the southern and central portions, but land capability is limited by limestone bedrock close to the surface in the north. Feed and forage production and native grazing are common throughout the ARR.

The Manitoba Escarpment ARR is a hummocky upland plain of medium-textured till soils, and suffers from a slight heat limitation. It lies between regions of high elevation (Turtle, Riding and Duck Mountain ARRs) and those of low elevation (Souris River Basin and Spruce Woods ARRs), and is noted for production of spring grains and oilseeds. Cultivation within Duck and Riding Mountain ARRs, and at higher elevations in Turtle Mountain ARR, is limited due to steep topography, moderate heat limitations and bedrock, but some wheat, oilseeds and forages are grown in areas of better soils on the perimeters.

The Souris River Basin and Spruce Woods ARRs, with more level landforms, coarse-textured soils and only slight heat limitations, have greater crop diversity, with specialty crops like corn being grown in the Souris River ARR, and potatoes and sunflowers in Spruce Woods ARR.

2.2 Cropping System Classification

The objective of the classification scheme was to identify groups of farms with similar mixes and proportions of crops. These 'systems' were then characterized and compared in terms of key land use

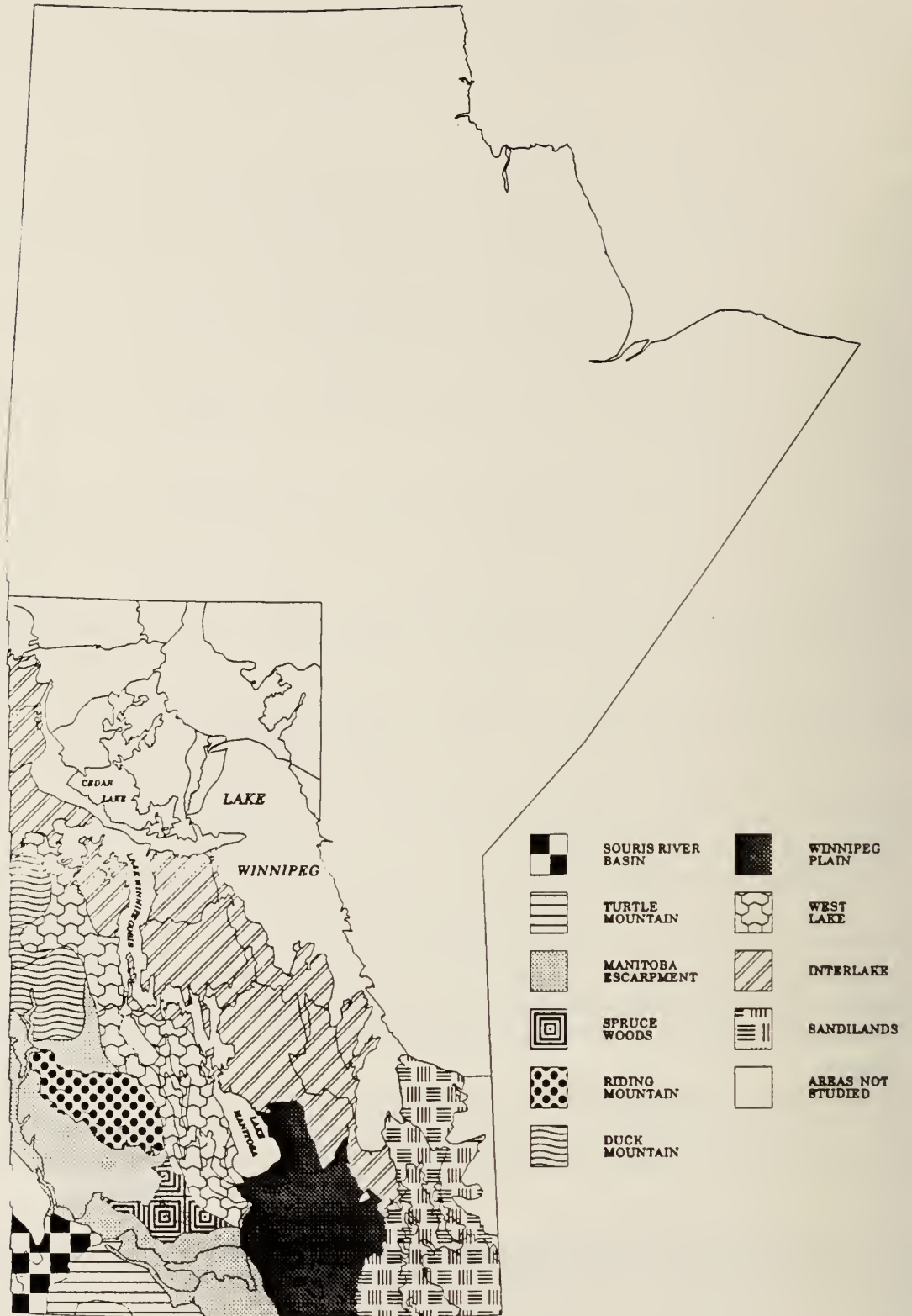


Figure 1. Manitoba Agroecological Resource Regions

Table 1. Summary of climate and soil characteristics of Agroecological Resource Regions of Manitoba.

Region	Agro-climate Zone*	Land-form	Texture	Soil Classification
Winnipeg Plain	2A	Plain	Clayey	Black Chernozemic, Gleysolic
West Lake	2H	Plain	Fine Loamy	Black Chernozemic, Gleysolic
Sandilands	2H	Plain	Sandy	Dark Gray Chernozemic, Gray Luvisolic
Interlake	2H	Plain	Fine Loamy	Dark Gray Chernozemic, Gleysolic
Manitoba Escarpment	2H	Hummocky	Fine Loamy	Black Chernozemic
Souris River Basin	2H	Plain	Coarse Loamy	Black Chernozemic
Spruce Woods	2H	Hummocky	Sandy	Black Chernozemic, Regosolic
Turtle Mountain	2H	Steep	Fine Loamy	Dark Gray Chernozemic
Riding Mountain	3H	Steep	Fine Loamy	Gray Luvisolic
Duck Mountain	3H	Steep	Fine Loamy	Gray Luvisolic

- * 2A - slight moisture limitation for the production of cereal crops
 2H - slight heat limitation for the production of cereal crops
 3H - moderate heat limitation for the production of cereal crops

and economic indicators. The procedure of identifying systems, defining them with respect to crop proportions, linking census farms to biophysical units, sorting farms according to system and characterizing systems and ARRs was carried out as follows:

- 1) General crop rotations and cropping systems applicable to the Prairie Region were identified through consultation with regional specialists;
- 2) Cropping systems diagnostic criteria (crop mixes and proportions) were established through an iterative process with specialists, regional data sources and analysis of Census data;
- 3) Crop and land use variables of the Census were correlated with cropping systems diagnostic variables, and a classification scheme based on the mix, biophysical specificity and proportion of different crops in each Census farm was prepared. Some grouping of Census variables into 'diagnostic' variables (Table 2) was required in order to make the

- data manageable, to account for similarities in management and biophysical requirements of different crops and to resolve a problem of changes in the definition of some Census variables between 1981 and 1986;
- 4) Census of Agriculture data was linked to ARAs through manually overlaying Enumeration Area (EA) maps on the ARA base map and selecting EAs with at least 70 percent overlap with an ARA;
 - 5) A preliminary classification of Census farms was carried out for a representative range of landscapes in Manitoba. The results were presented to regional specialists and criteria were adjusted where necessary;
 - 6) The final classification program was run for all areas, and a computer tape summarizing the characterization variables for each cropping system by ARA was produced; and
 - 7) Data from ARAs was aggregated to ARRs and a statistical summary of characterization variables for each 'Major System' was generated.

Table 2. Correlation of Census Variables with Cropping Systems diagnostic variables.

1981 Census Variables	1986 Census Variables	Diagnostic Variable
- irrigated area	- no change	- Irrigation
- mushrooms, tree and small fruits, greenhouse crops, nursery crops and vegetables	- no change	- Horticulture
- corn for grain, corn for ensilage, field peas, potatoes, tobacco, field beans, sugar beets, sunflowers, buckwheat, soya beans and 'other field crops'*	- no change	- Specialty Crops
- fallow	- no change	- Summerfallow
- all wheat (winter, spring, durum)	- no change	- Wheat
- barley for grain	- no change	- Barley
- canola, mustard, flax	- no change	- Oilseeds
- mixed grains, oats for feed, other forage crops, alfalfa and tame hay	- add feed barley and all hay	- Feeds & Forages
- improved pasture, other improved land, unimproved pasture, woodland	- add other unimproved land	- Pasture

* 'other field crops' includes other dry beans, lentils, millet, triticale, canary seed, root crops for feed, safflower, caraway seed and sod grown for sale.

2.3 Cropping System Characterization

The objective of the statistical summary was to provide a concise description of key farm characteristics, selected to highlight the physical and economic structure of farms within a system and to provide a consistent comparison of systems within and between ARR. The characterization variables included farm size, proportion of land cultivated, crop distribution, capital investment levels and annual income and expenses (Table 3). Crop variables used for characterization were not identical to those used as 'diagnostic variables'.

The database acquired from Statistics Canada consisted of a single value for each characterization variable for each cropping system in each ARA.

Table 3. Cropping Systems characterization variables.

Type	Label	Definition
General	1 Number of farms	- Number of farms in the system in the ARR
	2 Percent of farms in region	- Farms in the system as percentage of total farms in the ARR
Physical	3 Farm size	- Total farm area, including owned and rented land, in hectares (ha)
	4 Cultivated area	- Cultivated area as a percentage of farm size
Crop Distribution	5 Specialty crop	Area of each crop or crop group as a percent of cultivated area
	6 Summerfallow	
	7 Wheat	
	8 Oilseeds	
	9 Barley	
	10 Cereals for feed	
	11 Oats for grain	
	12 Forages	
Economic	13 Total Capital Investment	- Total capital investment (owned land, buildings, machinery, equipment and livestock) in \$/ha ¹
	14 Land	- Land as a % of total capital
	15 Machinery	- Machinery as a % of total capital
	16 Livestock	- Livestock as a % of total capital
	17 Annual sales	- Total agricultural sales of previous year in \$/ha ²
	18 Operating Expenses	- Operating expenses of previous year in \$/ha ³
	19 Gross Margin	- Total sales minus operating expenses in \$/ha ⁴
	20 Fuel	- Fuel (machinery + drying) expenses in \$/ha
	21 Fertilizer	- Fertilizer expenses in \$/ha
	22 Sales to Investment	- Ratio of total sales to total capital investment
	23 Sales to Expenses	- Ratio of total sales to operating expenses

1. The Census respondent estimates the present market value of their owned land, buildings, machinery and equipment. Livestock value (cattle, pigs, sheep, bees, poultry and other) is a derived variable, calculated by Statistics Canada from information on the number of livestock provided by the respondent. Variable is calculated as total value ÷ farm size.
2. Total sales includes sales of all agricultural products, shares from tenants, cash advances for stored crops, Marketing Board or Agency payments, income from custom work and rebates, all for the year previous to the Census year (1980 and 1985). Sales of capital items (e.g. machinery) or forest products are not included. Variable is calculated as total sales ÷ farm size.
3. Operating expenses include cash rent, share rent, cash wages, feed, fertilizer, chemicals, custom work, fuel, repairs, electricity and other miscellaneous expenses, all for the year previous to the Census year. It does not include livestock purchases, veterinary bills, telephone and postage, professional services, insurance, Marketing Board fees, taxes, interest payments, mortgage payments nor depreciation. The operating expenses variable was created to standardize some measure of inputs across two time periods, and caution is advised when interpreting it, particularly for systems which have a major livestock component (e.g., Feeds and Forages System). Variable is calculated as operating expenses ÷ farm size.
4. Variable is calculated as (total sales - operating expenses) ÷ farm size.

The arithmetic mean of all farms in a system in an ARA was used to summarize physical and crop variables, since wide deviations in these populations would be non-existent due to the use of class limits for definition of cropping systems. However, in the case of economic variables, the median was used in order to minimize the impact of extreme values within the data. For example, a small farm with a large livestock component might produce extreme financial values per hectare. The mean and median values for all ARAs within an ARR were averaged to produce the characterization values for that ARR.

The procedure of identifying predominant crop rotations and cropping patterns in different parts of the prairies, and testing and refining specifications for classifying Census farms, resulted in a legend of 12 primary cropping systems as outlined in Table 4. Since the diagnostic criteria for dryland systems were based on percentage of cultivated area, and since many of these farms had substantial areas of pasture, each system was further subdivided into 'low pasture' (pasture <20% of farm area) and 'moderate pasture' (20-70%) variants. Farms with greater than 70% pasture were typed as specialized 'Pasture' farms. The legend differentiates systems on the basis of crops which reflect major soil, climate and management requirements, and is applicable to the prairie region.

To classify individual Census farms, each farm was tested against the diagnostic criteria outlined in Table 4, and was assigned to the first category into which it fit. The testing order was important, since the classes were not mutually exclusive. For example, a 100 ha farm with 51 ha of wheat, 21 ha of barley, 21 ha of oilseeds, 5 ha in fallow and 2 ha of irrigated horticultural crops could fit into any of five

Table 4. Cropping Systems legend (in specific order for classification) and diagnostic criteria

Cropping System	Diagnostic Criteria (area of crop as a percent of cultivated area ¹ , unless specified)
Specialized Systems:	
1. Irrigation	- irrigated area greater than 10%
2. Horticulture	- horticulture crops greater than 0.1 ha
3. Specialty	- special crops (corn, sunflowers, potatoes, etc.) greater than 10%
4. Pasture	- pasture greater than 70% of total farm area
Dryland Systems:²	
5. Wheat & Fallow	- wheat greater than 50% and fallow greater than 20% of farmland
6. Wheat	- wheat greater than 50% and fallow less than 20% of farmland
7. Wheat & Oilseeds	- wheat greater than 30% and oilseeds greater than 20% of farmland
8. Wheat & Barley	- wheat greater than 30% and barley greater than 20% of farmland
9. Barley	- barley greater than 50% of farmland
10. Barley & Feeds/ Forages	- barley greater than 25% and feed grains plus forages 25% to 50% of farmland
11. Feeds & Forages	- feed grains plus forages greater than 50% of farmland
12. Mixed	- farms not otherwise classified.

¹ Cultivated area includes all annual crops, fallow, alfalfa, other forage crops and tame hay, but not improved pasture, other improved land or unimproved land.

² Each dryland system was further subdivided on the basis of the proportion of the total farm area that is pasture. 'Low Pasture' variants have less than 20% pasture, 'Moderate Pasture' variants have 20%-70% pasture. (Greater than 70% pasture is a Specialized 'Pasture' system).

different classes. The order of the classification scheme reflects the economic intensity and locational significance of the diagnostic variables and eliminates the need for repeated exclusions in preparing definitions of systems.

3.0 RESULTS

Approximately 17,500 farms, or about 60 percent of all farms in Manitoba, were captured in each Census period. Those not captured were in EAs which did not meet the 70% correspondence criteria with an ARA, and thus were not included in the study. There were approximately the same number of farms captured in both time periods, although the number of farms within an ARR was not necessarily the same in 1981 as in 1986. This was due in some cases to real changes in farm numbers, and in others to changes in EA boundaries.

'Major Systems' were defined as cropping systems that accounted for at least 10 percent of the farms in an ARR in 1986. Approximately 12,000 farms, or about 69 percent of the farms in the study, were included in Major Systems. Generally, Major Systems encompassed 70 percent or more of the farms in a Region (Table 5).

Four regions (Winnipeg Plain, Manitoba Escarpment, West Lake and Interlake), which have no major limitations to annual cultivation of crops suited to Manitoba's climate, contained approximately 77 percent of the farms in the study. About 12 percent of all farms were associated with ARRs with a moisture limitation due to coarse-textured parent material (Sandilands, Souris River Basin and Spruce Woods) and 11 percent occurred on or in close proximity to steep topography and moderate heat limitations for cereal production (Turtle, Riding and Duck Mountain ARRs).

Table 5. Distribution of farms by ARR and Major Cropping System, 1981 and 1986.

Agroecological Region	No. of Farms (1981)	No. of Farms (1986)	No. of Major Systems in ARR	No. of Farms in Major Systems (1986)	Farms in Major Systems as a % of all Farms in ARR (1986)
Winnipeg Plain	4,488	4,484	4	3,049	68
West Lake	2,265	2,343	5	1,781	76
Sandilands	1,075	1,194	4	884	74
Interlake	2,126	1,835	4	1,486	81
Manitoba Escarpment	4,661	4,903	4	2,884	59
Spruce Woods	286	361	5	292	81
Souris River Basin	677	632	6	543	86
Turtle Mountain	1,027	811	4	592	73
Riding Mountain	452	595	3	405	68
Duck Mountain	386	319	4	230	72
Total	17,443	17,477		12,146	

The following sections provide extensive descriptions of each ARR in terms of location, physical setting, cropping systems and socioeconomic characteristics in 1981 and 1986. Several cautionary notes about the data should be taken into consideration. First, sales and expenses figures for the 1981 Census refer to the 1980 crop year, a year of significant drought throughout Manitoba. With decreased yields, sales figures were bolstered somewhat with inventory (grain and livestock) decreases and subsidies, creating a distorted relationship between yields, expenses and income. Even though costs were reduced through decreased inputs and field activities, it is difficult to assess the relative impact on gross margins and economic efficiencies. A general, province-wide decline in these variables between the 1981 and 1986 Censuses indicates that 1981 values may be inflated over a 'normal' situation. In any case, financial comparisons between 1981 and 1986 should be made with caution. However, comparisons between ARRs and cropping systems within each year should remain valid.

Another concern is the spatial distribution of farms within ARRs. The ARRs are not sufficiently homogeneous to assume that farming activities are evenly distributed within each one, particularly in the large or 'fringe' regions. In most cases, some spatial segregation of systems within an ARR must be assumed, especially in the case of regions such as Riding, Duck and Turtle Mountains and West Lake and Interlake.

Finally, the data presented here is intended primarily for description rather than explanation. The intent of this report is to provide a base for cause-and-effect research by highlighting the spatial relationships between the landscape and economic activity.

3.1 Winnipeg Plain ARR

This region is composed of six ARAs and includes the cities of Winnipeg and Portage La Prairie. Most of the unit consists of a plain of fine-textured Black Chernozemic soils with a climate unrestricted for production of crops such as cereals, oilseeds and grain corn. The western portion of the ARR consists of a plain of medium-textured soils that merges with the Manitoba Escarpment ARR, while soils of somewhat more coarse texture are found toward the eastern border of the ARR. The Canada-United States border delineates the southern limit while the Interlake and West Lake ARRs form the northern boundary.

Farms of all four Major Systems (Wheat, Specialty, Wheat-Oilseeds and Mixed) were in the Low Pasture category, indicating extensive annual cultivation (Table 6). In 1981, the Specialty System and the Wheat System accounted for approximately half of the total number of farms. The Specialty System had in general the largest farms, and a diverse crop mix of special crops, wheat, oilseeds and barley. Wheat, oilseeds and barley were also important in the Wheat & Oilseeds System, whereas summerfallow, oats for grain and forages represented greater proportions in the Mixed System.

Total capital value per hectare was highest for the Wheat System, but the distribution of capital among land, buildings, machinery and livestock was virtually identical across all Major Systems. Specialty farms had the highest income and expenses per hectare, but gross margins were greater for the Wheat & Oilseed System, due in part to lower operating expenses. All Systems in this ARR had roughly similar fuel use per hectare, but fertilizer expenses were considerably lower for the Mixed System than for the others. Capital investment use efficiency was similar among the Major Systems, while operating expenses use efficiency was highest in the Wheat & Oilseeds System and lowest in the Specialty System.

Data from the 1986 Census indicated that there was a decline in the proportion of farms in the Specialty System and an increase in the proportion in the Wheat and Wheat & Oilseeds Systems (Table 7). All systems except the Specialty System had a larger land base in 1986 than in 1981, while crop distribution summaries indicated a trend towards more oilseeds and less barley in all Systems.

The absolute value of total capital investment per hectare declined for all Major Systems between 1981 and 1986, with a lower percentage apportioned to land. This reflected a dramatic decline in land values between the two dates. Both sales and expenses per hectare nearly doubled; however, it was beyond the scope of this study to ascertain the extent to which drought, inflation and/or real increases in costs of production accounted for this. Gross margins for the Specialty and Wheat & Oilseeds Systems were similar in 1986. Both of these systems exhibited a much larger increase relative to 1981 values than either Wheat or Mixed Systems. Sales to investment ratios in 1986 were higher than in 1981 for all Major Systems, whereas the sales to operating expenses ratios were lower, especially for the Wheat & Oilseeds System.

Table 6. Characterization of Major Cropping Systems, Winnipeg Plain, 1981. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Wheat-Low Pasture	763	17	128	95	1	2	29	13	16	0	3	2
2. Specialty-Low Pasture	1526	34	128	95	30	4	29	13	15	2	3	5
3. Wheat & Oilseeds-Low Pasture	180	4	128	97	1	3	35	35	16	0	3	2
4. Mixed-Low Pasture	449	34	126	95	1	15	29	20	16	2	3	8

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Specialty-Low Pasture	2415	84	16	0	260	163	102	18	38	0.11	1.67
3. Wheat & Oilseeds-Low Pasture	2270	86	15	0	244	130	116	18	42	0.11	2.00
4. Mixed-Low Pasture	2348	85	14	0	193	111	77	18	16	0.09	1.86

* (a) Major Cropping Systems are those which accounted for 10% or more of the farms in the ARR in 1986.

(b) Farm size, cultivated area and crop distribution variables are the average of ARA mean values, while capital investment, annual sales, expenses, gross margins and capital use efficiency ratios are the average of ARA median values.

(c) Sales and Expenses figures relate to the year prior to the Census.

Table 7. Characterization of Major Cropping Systems, Winnipeg Plain, 1986. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Wheat-Low Pasture	986	22	181	98	1	1	70	10	0	1	0	3
2. Specialty-Low Pasture	942	21	229	97	27	2	70	10	10	1	2	3
3. Wheat & Oilseeds-Low Pasture	583	13	219	98	1	2	10	70	10	1	0	3
4. Mixed-Low Pasture	538	12	177	96	1	13	19	35	10	2	0	8

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
1. Wheat-Low Pasture	2192	80	20	0	395	267	114	30	57	0.18	1.44
2. Specialty-Low Pasture	2234	80	21	0	422	278	152	30	55	0.21	1.54
3. Wheat & Oilseeds-Low Pasture	2067	80	21	0	406	258	145	70	59	0.18	1.53
4. Mixed-Low Pasture	1947	80	20	0	301	210	90	29	36	0.17	1.44

* See notes for Table 6, page 20.

3.2 West Lake ARR

This Region contains eight ARAs and includes the Town of Dauphin. The largest portion of this unit is a plain of medium-textured Black Chernozemic soils, although coarse-textured soils occur in the south and Dark Gray Chernozemic soils are found in the north. There is a slight heat limitation for annual cereal production. The eastern limit of the ARR is defined by Lake Manitoba, Lake Winnipegosis and the Interlake ARR. The western limit includes the Spruce Woods, Riding Mountain, Duck Mountain and Manitoba Escarpment ARRs.

The 1981 Census data indicated that five Major Systems (Mixed-Moderate Pasture, Pasture, Mixed-Low Pasture, Feed and Forages and Wheat-Low Pasture) accounted for 70 percent of the farms (Table 8). The type of systems, as well as crop proportions, highlighted the relatively low level of agricultural intensity in this ARR. Forages, barley, oats and cereals for feed dominated except in the Wheat System, where wheat constituted 68% of the cultivated area. The Mixed-Moderate Pasture System had the largest farm size, but the Mixed-Low Pasture System had a greater worked area given the higher proportion of land under cultivation.

The Low Pasture Systems had the highest total capital investment per hectare values, while the proportion of total capital value represented by livestock in the Moderate Pasture and Pasture Systems indicated that livestock production was a significant component. The highest sales, expenses and gross margins per hectare were in the Wheat-Low Pasture and Mixed-Low Pasture Systems. The gross margins indicated that these intensive systems (as evidenced by high fuel and fertilizer costs) were also the most profitable of the Major Systems in this ARR, despite the drought. There was little differentiation among the Major Systems on the basis of the sales to investment ratio, but the sales to expenses ratio indicated that the Pasture System was relatively less efficient.

The 1986 Census data indicated a decline in the proportion of farms in the Mixed Systems and an increase in the Wheat-Low Pasture System (Table 9). The Pasture System and Wheat-Low Pasture System underwent a considerable increase in total farm size. Crop proportions remained fairly stable between 1981 and 1986, with a slight shift from barley to oilseeds in the Mixed-Low Pasture System and an increased proportion of forages in both the Pasture System and Feed & Forages System.

Total capital investment values declined in all Major Systems except the Feed & Forages-Moderate Pasture, while the proportion of capital attributable to machinery and equipment increased. Sales and expenses values were higher in the 1986 data than in 1981 data in all cases, but gross margins were lower. The sales to investment ratio was slightly higher in 1986 for all systems, but the sales to expenses ratio was lower. The difference in these ratio values between Systems that was evident in the 1981 data was not seen in the 1986 results.

Table 8. Characterization of Major Cropping Systems, West Lake ARR 1981. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Mixed-Moderate Pasture	544	16	259	62	1	13	22	7	14	3	12	16
2. Pasture	362	16	253	20	0	11	7	7	14	11	14	46
3. Mixed-Low Pasture	408	18	207	92	1	13	22	12	14	2	7	3
4. Feed & Forages-Moderate Pasture	227	10	168	48	0	7	3	1	4	18	4	60
5. Wheat-Low Pasture	11	2	207	94	0	5	68	5	12	2	7	3

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Pasture	625	69	16	28	54	35	20	7	0	0.11	1.52
3. Mixed-Low Pasture	1158	76	21	4	146	81	63	11	18	0.13	1.98
4. Feed & Forages-Moderate Pasture	848	63	15	21	84	51	38	12	0	0.12	1.81
5. Wheat-Low Pasture	1220	69	19	0	189	106	84	13	26	0.14	1.71

* See notes for Table 6, page 20.

Table 9. Characterization of Major Cropping Systems, West Lake ARR, 1986. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Mixed-Moderate Pasture	469	20	202	59	0	23	20	10	9	1	10	19
2. Pasture	469	20	469	21	0	13	8	2	9	11	8	53
3. Mixed-Low Pasture	328	10	202	93	0	23	25	18	11	1	6	11
4. Feed & Forages-Moderate Pasture	281	12	144	50	0	3	4	1	3	11	7	72
5. Wheat-Low Pasture	234	10	218	94	0	4	26	10	1	0	1	3

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Pasture	452	55	18	27	67	46	17	8	0	0.14	1.38
3. Mixed-Low Pasture	1137	74	24	0	198	150	53	26	21	0.18	1.39
4. Feed & Forages-Moderate Pasture	1109	62	19	18	198	89	25	27	0	0.12	1.33
5. Wheat-Low Pasture	1207	73	27	0	267	191	53	27	44	0.20	1.36

* See notes for Table 6, page 20.

3.3 Sandilands ARR

There are five ARAs in this region, which includes the Town of Steinbach near its western boundary. A plain of coarse-textured Dark Gray Chernozemic and Gray Luvisolic soils dominates much of the unit, and organic soils are found in depressional areas. There is a slight heat limitation for annual crop production. This ARR is bounded on the north and east by the Canadian Shield, by the Winnipeg Plain ARR on the west, and by the Canada-United States border on the south.

In 1981, four Major Systems (Feed & Forages-Moderate Pasture, Pasture, Mixed-Moderate Pasture and Mixed-Low Pasture) accounted for 68 percent of the farms (Table 10). These Systems had a high proportion of pasture, with only the Mixed-Low Pasture System having a relatively high proportion of annual cultivation. Hay and cereal grains grown for feed dominated the cultivated area of the Feed & Forages and Pasture systems, while cash grains, oilseeds and summerfallow were the principal choices in the more intensive Mixed Systems.

Total capital value per hectare was highest for the two Mixed Systems and decreased with increasing pasture proportions. The high proportion of capital in the livestock component of the Feed & Forages and Pasture Systems highlighted the emphasis on livestock production in these systems. The Mixed-Low Pasture System had the highest sales, expenses and gross margins but the Feed & Forages System also showed a respectable gross margin based on much lower sales and expenses. Sales to investment ratios for the 1981 data were consistently low for all Major Systems, while sales to expenses ratios indicated higher relative economic efficiencies for the livestock-based Feed & Forages System and the intensively cropped Mixed-Low Pasture System.

The 1986 Census data indicated stability in the proportion of farms in each Major System except Mixed-Low Pasture, which showed an increase from six percent in 1981 to eleven percent in 1986. The 1986 data also showed a decline in the average farm size for the Feed & Forages System and an increase in size for the Mixed-Moderate Pasture System (Table 11). Both Mixed Systems underwent an adjustment in crop distributions between 1981 and 1986, with an increase in the proportion of oilseeds and a decrease in oats for grain.

Total capital value per hectare for the Mixed-Moderate Pasture System declined, but a modest increase was noted for the Pasture system. There was a shift to a greater proportion of capital value in livestock in both the Feed & Forages and Pasture Systems. A greater proportion of capital value in machinery in the Mixed Systems was demonstrated in the 1986 results.

Annual sales and expenses increased for all Systems, while gross margins fell for the Feed & Forages and Pasture Systems and remained stable for the Mixed Systems. In fact, the Pasture System in 1986 had a negative gross margin and a sales to expenses ration below 1.0, both indications of a shortfall in net margin. Sales to investment ratios generally showed a small decline between 1981 and 1986, while the sales to expenses ratios declined significantly, especially for the Feed & Forages and Mixed-Low Pasture systems.

Table 10. Characterization of Major Cropping Systems, Sandilands ARR, 1981. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Feed & Forages-Moderate Pasture	312	29	162	52	0	5	4	1	1	9	6	70
2. Pasture	215	20	184	21	0	11	15	7	6	12	6	52
3. Mixed-Moderate Pasture	140	13	184	61	0	11	15	7	7	1	16	23
4. Mixed-Low Pasture	64	6	184	95	0	32	15	6	16	1	7	12

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
1. Feed & Forages-Moderate Pasture	1100	70	16	35	68	38	28	12	0	0.08	1.81
2. Pasture	635	72	14	80	32	28	1	6	0	0.05	1.08
3. Mixed-Moderate Pasture	1129	80	14	5	59	45	16	12	2	0.07	1.29
4. Mixed-Low Pasture	1372	78	21	0	112	80	41	15	10	0.09	1.81

* See notes for Table 6, page 20.

Table 11. Characterization of Major Cropping Systems, Sandilands ARR, 1986. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Feed & Forages-Moderate Pasture	19	28	121	52	0	4	2	1	3	8	3	78
2. Pasture	227	19	195	20	0	6	8	8	8	11	8	59
3. Mixed-Moderate Pasture	179	19	209	60	0	32	15	13	8	3	8	21
4. Mixed-Low Pasture	131	19	152	93	0	31	20	20	8	1	8	12

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Pasture	800	68	14	18	42	89	-11	20	0	0.06	0.77
3. Mixed-Moderate Pasture	965	74	21	6	93	80	16	20	5	0.10	0.77
4. Mixed-Low Pasture	1397	76	24	0	162	139	39	30	17	0.14	1.28

* See notes for Table 6, page 20.

3.4 Interlake ARR

Nine ARAs make up this ARR, which stretches north and west from Beausejour and Selkirk to the Saskatchewan border at the Pas. Most of the unit is a plain of medium-textured Dark Gray Chernozemic soils with a slight heat limitation for annual cereal production, but heavy-textured Black Chernozemic soils occur in the southeast. This ARR represents the northern fringe of agriculture in Manitoba and most farms are located in the southern portion of it between Lakes Winnipeg and Manitoba.

Results from the 1981 Census indicated that four Major Systems (Pasture, Feeds & Forages-Moderate Pasture, Mixed-Low Pasture, Mixed-Moderate Pasture) accounted for 68 percent of the farms (Table 2). There was a negative association between farm size and cultivated area, i.e. Systems with smaller farm sizes had a higher proportion of cultivated land.

Total capital value per hectare was highest in the Mixed Systems, while the distribution of capital shows the importance of livestock in the Feeds & Forages and Pasture systems. The Mixed-Low Pasture System had the highest sales and expenses values per hectare, but the Feeds and Forages System had a comparable gross margin due to relatively low expenses. There was very little variation in capital investment use efficiency amongst Major Systems, but higher values in the sales to operating expenses ratios were seen in the Feeds & Forages and Pasture Systems. This trend was due in part to the higher expenses of the Mixed Systems; expenses which did not result in relatively higher sales in the 1980 drought year.

There was little change in the proportion of farms in Feeds & Forages and Mixed-Moderate Pasture Systems between 1981 and 1986, but the Mixed-Low Pasture System and the Pasture System increased their representation significantly (Table 13). Farm size relative to 1981 increased for all Major Systems except Mixed-Low Pasture, but the proportion under cultivation remained fairly constant. An increase in the summerfallow proportion was evident in Mixed Systems.

By 1986, total capital value per hectare increased in the least intensive Pasture System and most intensive Mixed-Low Pasture System, but declined in all others. The Pasture System showed an increase in the proportion in machinery and less in the land component. Sales and expenses increased and gross margins decreased, most notably in the Mixed Systems, for which fertilizer and fuel expenses nearly doubled. The ratio of gross sales to operating expenses dropped dramatically for all Major Systems, a demonstration that the high operating costs in 1985 were not matched by comparably high gross incomes. Sales to expenses ratio values for 1986 for the Mixed Systems (1.12-1.15) indicated very low economic efficiencies.

Table 12. Characterization of Major Cropping Systems, Interlake ARR, 1981. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Pasture	510	24	251	19	0	16	8	8	10	6	5	49
2. Feeds & Forages-Moderate Pasture	404	19	221	46	0	6	4	1	4	8	4	73
3. Mixed-Moderate Pasture	319	15	167	60	0	28	21	8	10	2	5	18
4. Mixed-Low Pasture	213	10	146	90	0	23	23	12	12	2	5	18

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
1. Pasture	523	56	16	23	55	28	18	8	0	0.10	1.70
2. Feeds & Forages-Moderate Pasture	986	62	17	21	84	41	41	11	0	0.10	1.96
3. Mixed-Moderate Pasture	893	78	20	9	76	53	22	10	3	0.09	1.47
4. Mixed-Low Pasture	1094	78	20	0	109	85	40	20	12	0.11	1.53

* See notes for Table 6, page 20.

Table 13. Characterization of Major Cropping Systems, Interlake ARR, 1986. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)								
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages	
1. Pasture	532	29	300	18	0	16	4	2	2	2	6	5	58
2. Feeds & Forages-Moderate Pasture	367	20	252	46	0	8	3	1	1	1	5	4	76
3. Mixed-Moderate Pasture	312	17	186	55	0	39	13	11	7	2	2	5	16
4. Mixed-Low Pasture	275	15	137	94	0	39	22	11	7	6	5	5	7

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Feeds & Forages-Moderate Pasture	762	63	19	19	92	65	24	16	3	0.11	1.38
3. Mixed-Moderate Pasture	836	69	24	0	97	16	12	10	9	0.13	1.15
4. Mixed-Low Pasture	1212	71	29	0	157	147	15	11	27	0.12	1.12

* See notes for Table 6, page 20.

3.5 Manitoba Escarpment ARR

This region is comprised of nine ARAs and includes the city of Brandon. The majority of this unit is a plain of medium-textured Black Chernozemic soils with a slight heat limitation for annual cereal production. The northern extreme is defined by the Duck Mountain ARR while the western limit is the Manitoba-Saskatchewan border. The Canadian border delineates the southern extent and the Winnipeg Plain, West Lake, Spruce Woods and Riding Mountain ARRs delimit the eastern boundary.

The 1981 Census indicated that two Mixed Systems accounted for nearly 45 percent of the farms, while two other Major Systems (Wheat-Low Pasture and Wheat-Moderate Pasture) accounted for only nine percent (Table 14). The Mixed-Moderate Pasture System had the largest average farm size.

Capital investment totals were highest in Low Pasture Systems, and the distribution of capital was relatively consistent for all Major systems, with the exception of higher values in the livestock component for the Mixed-Moderate Pasture System. Operating expenses per hectare were highest for the Low Pasture Systems, a reflection of the greater proportion of the land base under cultivation. Fuel and fertilizer expenses were also highest for these systems, an indication of the intensive use of such inputs. Sales and gross margins followed the same pattern of higher levels in the Low Pasture Systems. The capital use efficiency ratios were fairly uniform, with a slightly higher sales to expenses ratio for the Mixed Systems relative to the Wheat Systems.

A shift in the distribution of farms in each Major System was evident in the 1986 results, with Wheat Systems making large gains in farm numbers, and Mixed Systems showing losses of a similar magnitude (Table 15). Farm size increased substantially for all systems except Mixed-Low Pasture, which showed little change. Increased proportions of cropland in oilseeds and decreased percentages in barley also occurred for most Major Systems.

A decrease in total capital value in all Major Systems was coincident with a lower proportion of value in land and buildings and a higher proportion in machinery and equipment. Operating expenses per hectare increased considerably, especially for inputs such as fuel and fertilizer. Gross margins for all systems fell relative to the 1981 data, an indication that total sales did not keep pace with increases in operating expenses. This observation was supported by the decline in the sales/expenses ratios.

Table 14. Characterization of Major Cropping Systems, Manitoba Escarpment, 1981. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Mixed-Moderate Pasture	1305	28	252	68	1	23	26	2	18	3	10	10
2. Wheat-Low Pasture	231	5	190	90	1	4	67	2	18	3	2	2
3. Mixed-Low Pasture	746	16	231	68	1	25	26	67	18	3	2	4
4. Wheat-Moderate Pasture	186	4	221	68	1	5	68	4	12	1	4	4

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
1. Mixed-Moderate Pasture	1036	72	17	10	121	56	66	18	6	0.12	2.04
2. Wheat-Low Pasture	1398	70	20	0	202	101	93	17	16	0.13	1.94
3. Mixed-Low Pasture	1273	78	17	3	155	81	75	18	16	0.13	2.08
4. Wheat-Moderate Pasture	1100	82	18	0	129	67	75	18	12	0.13	1.95

* See notes for Table 6, page 20.

Table 15. Characterization of Major Cropping Systems, Manitoba Escarpment, 1986. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Mixed-Moderate Pasture	1079	22	284	63	0	24	14	14	12	2	4	13
2. Wheat-Low Pasture	735	15	250	91	0	3	14	14	9	0	4	2
3. Mixed-Low Pasture	539	11	284	90	0	24	20	14	15	1	4	8
4. Wheat-Moderate Pasture	490	19	297	69	0	4	14	14	9	1	2	5

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
1. Mixed-Moderate Pasture	897	68	21	11	154	100	45	20	12	0.16	1.47
2. Wheat-Low Pasture	1305	75	25	0	287	192	84	20	45	0.21	1.51
3. Mixed-Low Pasture	1252	75	23	6	154	137	56	20	19	0.18	1.47
4. Wheat-Moderate Pasture	1006	73	25	2	214	133	70	20	29	0.21	1.48

* See notes for Table 6, page 20.

3.6 Spruce Woods ARR

This region is comprised of two ARAs and contains the Town of Carberry. The majority of this unit consists of hummocky terrain and coarse-textured parent material on which Black Chernozemic and Regosolic soils have developed. Smaller areas of level terrain with medium-textured parent material and Black Chernozemic soils occur. The eastern portion of the ARR consists of deeply dissected areas of Dark Gray Chernozemic soils. There is a slight heat limitation for annual cereal production throughout the ARR. The region is bounded on the east and north by the West Lake ARR and on the west and south by the Manitoba Escarpment ARR.

Data from the 1981 Census indicated that four Major Systems (Specialty-Moderate and Low Pasture, Pasture and Mixed-Moderate Pasture) accounted for nearly 85 percent of the farms (Table 16). In this ARR, larger farm sizes were associated with higher percentages of the land base in cultivation, except for the Specialty-Low Pasture System, which had the smallest farm size and the greatest percentage under cultivation. The crop mix in the Pasture System differed from the Specialty and Mixed Systems in that a greater percentage of the cultivated land base was in feed grains and forage crops.

The distribution of capital investment in 1981 indicated that the Specialty Systems were highly capitalized, particularly in land and buildings and machinery and equipment. Distinctive differences were evident in sales and expenses per hectare, with Pasture and Mixed-Moderate Pasture Systems showing the lowest economic inputs and outputs. Conversely, higher fuel and fertilizer expenses were characteristic of the more intensive Specialty Systems. The sales to investment ratio demonstrated that the highest returns with respect to capital investment were in the Specialty System, while the sales to expenses ratio indicated that the high annual input costs of the Specialty System were not used as efficiently as in the Mixed-Moderate Pasture System.

A shift in the proportion of farms in each Major System between 1981 and 1986 was evident, with the Wheat-Low Pasture System showing a large gain and the Specialty-Moderate Pasture System showing a decline (Table 17). Farm size increased substantially for all Major Systems except the Mixed-Moderate Pasture, in which it declined. The proportion of total farm area under cultivation remained constant in comparison to the 1981 figures. Crop distributions showed a lower percentage of special crops and a higher proportion of wheat and oilseeds in the Specialty and Wheat Systems in 1986.

Total capital value per hectare was lower in 1986 than in 1981 for all Major Systems. The decline was accompanied by a shift to lower percentages of capital in land and buildings and higher percentages in machinery and equipment, particularly in the Specialty-Low Pasture System. Operating expenses per hectare for inputs such as fuel and fertilizer increased considerably in all Major Systems while gross margins fell. The 1986 Census data sales to investment ratios were higher than those for 1981 as a result of higher total sales and significantly lower total capital values. The sales to expenses ratios followed the Province-wide trends and of a narrowing of the gap between systems.

Table 16. Characterization of Major Cropping Systems, Spruce Woods ARR, 1981. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Pasture	21	20	191	94	1	6	9	9	9	17	12	50
2. Mixed-Moderate Pasture	21	19	315	63	3	12	21	21	21	3	12	16
3. Specialty-Moderate Pasture	21	34	374	63	31	4	21	9	21	-	6	10
4. Specialty-Low Pasture	21	34	374	94	26	1	21	9	21	1	6	3
5. Wheat-Low Pasture	9	0	-	-	-	-	9	9	9	-	6	-

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Mixed-Moderate Pasture	1073	81	20	12	114	56	99	21	8	0.16	2.20
3. Specialty-Moderate Pasture	1303	76	19	6	168	80	88	21	20	0.16	2.09
4. Specialty-Low Pasture	1671	81	18	1	233	135	99	21	37	0.16	1.73
5. Wheat-Low Pasture	-	-	-	-	-	-	-	-	-	-	-

* See notes for Table 6, page 20.

Table 17. Characterization of Major Cropping Systems, Spruce Woods ARR, 1986. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Pasture	47	11	211	17	0	2	47	6	6	15	8	51
2. Mixed-Moderate Pasture	68	11	211	52	0	16	23	6	16	3	12	18
3. Specialty-Moderate Pasture	68	11	68	63	20	4	33	6	16	3	8	11
4. Specialty-Low Pasture	47	11	287	94	23	2	47	16	6	0	9	3
5. Wheat-Low Pasture	40	11	211	95	1	2	68	16	9	0	9	2

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Mixed-Moderate Pasture	829	68	24	12	122	80	51	16	9	0.16	1.49
3. Specialty-Moderate Pasture	1002	71	24	4	210	178	11	16	26	0.21	1.56
4. Specialty-Low Pasture	1464	71	29	0	300	204	96	16	53	0.24	1.49
5. Wheat-Low Pasture	1464	75	25	4	279	178	89	25	46	0.20	1.49

* See notes for Table 6, page 20.

3.7 Souris River Basin ARR

There are two ARAs within this ARR in the southeastern corner of Manitoba which includes the Town of Melita. The Region consists of coarse-textured Black Chernozemic soils with a minor heat limitation and a slight moisture deficit for annual crop production. The northern boundary is defined by the Manitoba Escarpment ARR, the western by the Saskatchewan border, the southern by the United States border and the eastern by Turtle Mountain ARR.

Six Major Systems (Mixed and Wheat with Low and Moderate Pasture, Feeds & Forages-Moderate Pasture and Pasture) accounted for 74 percent of the farms in 1981, with Mixed Systems accounting for more than half of this total (Table 18). All systems were characterized by relatively large farms, with Low Pasture Systems showing high proportions under cultivation, and Feeds and Forages and Pasture Systems with relatively low percentages of cultivated land.

The Feeds & Forages and Pasture Systems had the lowest total capital value per hectare and the highest percent of capital in the livestock component. The Feeds & Forages and Mixed Systems had the highest gross margins while Wheat and Pasture Systems had the lowest. Wheat Systems had the highest total sales per hectare for 1980, but had high fuel and fertilizer costs and low gross margins. The sales to investment ratios indicated minimal differentiation amongst systems, while the sales to expenses ratios showed a downward continuum from Pasture to Feeds & Forages through Mixed-Moderate Pasture, Wheat Moderate Pasture, Mixed-Low Pasture to Wheat-Low Pasture.

The 1986 Census indicated a shift in the proportion of farms per Major Systems, with Wheat Systems showing large increases and Mixed, Feeds & Forages and Pasture Systems showing declines or no change (Table 19). Farm size rose substantially in Wheat-Low Pasture and Pasture Systems but dropped in Mixed-Low Pasture and Feeds & Forages Systems. Changes in crop mixes for 1986 included more wheat in the Wheat Systems, more oilseeds in the Mixed-Low Pasture System and more forages and less cereals for feed in the Feeds & Forages System.

A decrease in total capital value per hectare between 1981 and 1986 for all Major Systems was associated with a higher proportion in machinery and equipment. Operating expenses per hectare were considerably higher, especially for fuel and fertilizer. Gross margins were similar in both years in four of the six systems, while the Pasture Systems had a 50 percent decline and the Wheat-Low Pasture System had a 50 percent increase. The Wheat System improvement corresponded to a similar increase in sales. Sales to investment ratios increased over the time interval, as sales rose and total capital value fell. The sales to expenses ratios mirrored the declines in other ARRs, with a narrowing of the gap between Major Systems as well.

Table 18. Characterization of Major Cropping Systems, Souris River Basin ARR, 1981. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Mixed-Moderate Pasture	190	28	374	64	1	22	23	6	6	3	13	14
2. Wheat-Low Pasture	34	5	291	90	1	5	34	6	6	1	2	3
3. Wheat-Moderate Pasture	34	5	411	69	0	10	61	6	10	2	6	5
4. Mixed-Low Pasture	190	16	291	88	1	25	23	6	6	1	6	8
5. Feeds & Forages-Moderate Pasture	68	10	324	47	0	5	1	1	1	19	10	60
6. Pasture	61	10	364	88	0	8	0	2	6	14	13	48

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Wheat-Low Pasture	1148	86	14	0	134	72	44	10	16	0.11	1.59
3. Wheat-Moderate Pasture	978	86	14	8	92	56	41	13	5	0.09	2.01
4. Mixed-Low Pasture	1022	86	14	1	134	13	50	10	9	0.11	1.73
5. Feeds & Forages-Moderate Pasture	862	60	14	26	116	42	55	7	0	0.12	2.15
6. Pasture	690	64	13	23	87	40	42	6	0	0.12	2.26

* See notes for Table 6, page 20.

Table 19. Characterization of Major Cropping Systems, Souris River Basin ARR, 1986. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Mixed-Moderate Pasture	158	25	386	88	0	21	11	7	12	3	70	15
2. Wheat-Low Pasture	158	18	371	80	0	8	77	7	5	0	1	3
3. Wheat-Moderate Pasture	70	18	386	67	0	8	77	5	5	1	2	5
4. Mixed-Low Pasture	70	18	206	88	0	25	77	70	5	0	1	5
5. Feeds & Forages-Moderate Pasture	63	10	259	53	0	3	0	0	3	6	0	74
6. Pasture	63	10	453	88	0	8	2	7	7	11	11	49

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Wheat-Low Pasture	876	73	27	0	182	122	63	21	20	0.20	1.61
3. Wheat-Moderate Pasture	813	70	23	7	153	95	42	17	20	0.18	1.51
4. Mixed-Low Pasture	910	70	19	2	143	94	51	17	11	0.18	1.40
5. Feeds & Forages-Moderate Pasture	786	63	17	20	115	78	41	16	0	0.15	1.46
6. Pasture	644	60	17	24	93	16	19	11	0	0.14	1.38

* See notes for Table 6, page 20.

3.8 Turtle Mountain ARR

One of the two ARAs that make up this region is dominated by an area of loamy Dark Gray Chernozemic soils with steep topography that roughly corresponds to Turtle Mountain Provincial Park. The other is a hummocky to undulating plain with medium-textured Black Chernozemic soils used for agriculture. This ARR has a slight heat limitation for annual cereal production. It is bounded by the Souris River Basin ARR to the northwest, the Manitoba Escarpment ARR to the northeast and the United States border to the south.

In 1981, four Major Systems (Wheat and Wheat & Oilseeds with Low Pasture, Wheat and Mixed with Moderate Pasture) accounted for 45 percent of the farms (Table 20). Large farm sizes were common in all systems, and the importance of wheat was noted by its predominance in crop distributions. Hay or cereals for feed did not form a significant proportion of any Major System.

Total capital value per hectare was highest in the Low Pasture Systems, while a greater proportion of capital in livestock was associated with Moderate Pasture Systems. Gross margins were highest in the Wheat & Oilseeds Systems, which had the highest total sales per hectare. In terms of inputs, the Low Pasture Systems had higher expenditures for fuel and fertilizer. The sales to investment ratio in 1981 was similar in all Major Systems, while the sales to expenses ratios indicated a clear advantage in economic efficiency for the Moderate Pasture Systems.

In 1986, the same four Major Systems accounted for over 70 percent of the farms, and the proportion of farms classified in Wheat Systems had more than doubled (Table 21). Farm size rose substantially for the Wheat Systems while the proportion of the land base in cultivation remained stable. There was no significant change in crop mix for any Major System.

A decrease in total capital value per hectare over the five year period 1981-1986 for all Major Systems was associated with an increase in the portion of value in machinery and equipment. Operating expenses per hectare increased, as noted in higher fuel and fertilizer expenditures relative to 1981 figures. Gross margins reported for 1986 in the Low Pasture Systems were roughly similar to those in 1981, while Moderate Pasture systems had lower margins in 1986. Sales to investment ratios had increased by 1986 due to higher total sales and a significant decline in total capital value. Sales to expenses ratios followed the province-wide trend of a decline and a narrowing of the gap between systems within an ARR.

Table 20. Characterization of Major Cropping Systems, Turtle Mountain ARR, 1981. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Wheat-Low Pasture	340	10	259	94	1	7	65	14	16	0	2	1
2. Wheat & Oilseeds-Low Pasture	134	13	340	93	1	6	65	33	16	0	2	1
3. Wheat-Moderate Pasture	41	4	259	73	1	7	32	2	13	1	2	3
4. Mixed-Moderate Pasture	154	10	259	68	1	19	27	65	15	2	9	9

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
1. Wheat-Low Pasture	1483	79	20	0	178	97	74	33	24	0.12	1.92
2. Wheat & Oilseeds-Low Pasture	1559	81	19	0	188	97	83	12	29	0.12	1.92
3. Wheat-Moderate Pasture	1228	79	19	5	143	66	74	12	10	0.12	2.05
4. Mixed-Moderate Pasture	1251	79	19	62	132	62	74	27	10	0.11	2.13

* See notes for Table 6, page 20.

Table 21. Characterization of Major Cropping Systems, Turtle Mountain ARR, 1986. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Wheat-Low Pasture	284	35	360	95	0	2	69	37	9	0	2	1
2. Wheat & Oilseeds-Low Pasture	130	16	251	71	0	4	18	37	18	0	2	2
3. Wheat-Moderate Pasture	10	14	284	71	0	6	18	37	18	0	2	4
4. Mixed-Moderate Pasture	10	11	240	67	0	13	27	18	18	3	8	14

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
1. Wheat-Low Pasture	1303	71	29	0	267	170	94	24	42	0.21	1.59
2. Wheat & Oilseeds-Low Pasture	1392	71	27	4	283	126	110	22	42	0.22	1.59
3. Wheat-Moderate Pasture	1184	70	25	4	226	138	71	24	26	0.21	1.53
4. Mixed-Moderate Pasture	1184	64	21	14	196	126	62	22	14	0.17	1.65

* See notes for Table 6, page 20.

3.9 Riding Mountain ARR

This region contains two ARAs, the larger and more northerly of which generally corresponds to Riding Mountain National Park. The majority of the southern ARA is a hummocky upland of medium-textured Dark Gray Chernozemic soils with a slight heat limitation for annual cereal production. The West Lake ARR forms the eastern boundary while the Manitoba Escarpment ARR surrounds the remainder of this ARR.

Three Major Systems (Mixed-Moderate Pasture, Feeds & Forages-Moderate Pasture, and Pasture) accounted for over 70 percent of the farms in 1981 (Table 22). Farm size varied considerably amongst the Major Systems, with Mixed-Moderate Pasture having the largest land base and the largest proportion cultivated. Crop distributions indicated a high proportion of wheat and summerfallow on the cultivated land in both Mixed and Pasture systems.

Total capital value per hectare was highest for Feeds & Forages, and a high percentage of capital was invested in livestock in all Major systems. Gross margins were highest for the Mixed System, which also had the highest total sales per hectare. Sales to investment ratios were similar for all systems, while the sales to expenses ratio was highest for the Feeds & Forages System. This result would not be expected from the annual income and expense figures, and was perhaps a result of the relatively small sample size and considerable variability in the economic situation of farms in this system.

Analysis of 1986 Census data indicated that the same three systems still accounted for approximately 70 percent of the farms (Table 23). Farm size increased for all Major Systems, especially the Pasture System. In this system there was a decreased proportion of wheat and summerfallow and an increased percentage of hay on the cultivated land area.

A general decrease in total capital value per hectare was associated with shifts in the distribution of capital from land to machinery in the Mixed System and from machinery to livestock in the Pasture System. Total sales and operating expenses increased in all Major Systems between the two Census years, but gross margins declined. Sales to investment ratios increased due to a rise in total sales and a large decline in total capital value per hectare. The sales to expenses ratios calculated from 1986 Census data declined relative to 1981 and the gap between Systems narrowed. The Feeds and Forages System showed the most dramatic decline in efficiency of use of operating expenses, as it dropped from the position of highest in 1981 to lowest in 1986.

Table 22. Characterization of Major Cropping Systems, Riding Mountain ARR, 1981. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Mixed-Moderate Pasture	231	51	217	58	0	36	26	3	13	2	7	11
2. Feeds & Forages-Moderate Pasture	54	12	126	49	0	8	7	6	9	8	6	68
3. Pasture	45	10	171	19	0	21	18	3	8	5	7	38

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Feeds & Forages-Moderate Pasture	803	72	18	9	60	37	22	9	0	0.08	2.08
3. Pasture	624	64	21	65	49	36	18	10	0	0.08	1.68

* See notes for Table 6, page 20.

Table 23. Characterization of Major Cropping Systems, Riding Mountain ARR, 1986. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Mixed-Moderate Pasture	250	42	259	59	0	36	25	7	12	1	7	13
2. Feeds & Forages-Moderate Pasture	89	15	160	49	0	5	6	1	4	4	4	77
3. Pasture	65	42	251	23	0	14	10	7	7	5	6	55

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
1. Mixed-Moderate Pasture	713	64	26	10	91	74	21	19	5	0.14	1.28
2. Feeds & Forages-Moderate Pasture	852	75	17	7	84	74	13	18	0	0.10	1.18
3. Pasture	514	64	16	20	56	38	13	11	0	0.10	1.30

* See notes for Table 6, page 20.

3.10 Duck Mountain ARR

Two of the three ARAs in this region correspond to Provincial land reserves: Porcupine Provincial Forest and Duck Mountain Provincial Forest and Park. The small central land unit linking these two is a plain of medium-textured Black Chernozemic soils which suffers from a slight heat limitation for annual cereal production. The eastern and northern boundaries of this ARR are defined by the West Lake ARR, while the Saskatchewan border delimits the western edge and the Manitoba Escarpment ARR the southern limit.

Four Major Systems (Wheat, Wheat & Oilseeds and Mixed, all with Low Pasture, and Mixed-Moderate Pasture) accounted for over 65 percent of the farms in 1981 (Table 24). Farm size varied, with the Wheat & Oilseeds System having the largest land base and the highest percentage of area cultivated. Wheat was the dominant crop in all Major Systems, while secondary choices ranged from oilseeds and barley in the Wheat & Oilseeds System to summerfallow and barley in the Mixed Systems.

The Wheat System had the highest total capital value per hectare of all systems compared, and only the Mixed-Moderate Pasture System had a significant investment in livestock. Gross margins were highest for the Wheat & Oilseeds and Wheat System, even though expenses per hectare were also highest. The sales to investment and sales to expenses ratios were similar across systems, although the sales to expenses ratios were relatively high compared to other ARRs. However, caution is advised when considering these results, since the sample size is small.

The four Major Systems still accounted for approximately 70 percent of the farms in 1986 (Table 25). The distribution of farms changed, with the number of farms decreasing in Mixed Systems and increasing in Wheat Systems. Farm size decreased in the Wheat & Oilseeds System and increased in the others, although the proportion of the land base under cultivation in each Major System remained constant. Crop mixes indicated an increased proportion of oilseeds.

The Major Systems in this ARR increased in total capital value per hectare although there was a decrease in the proportion in land and buildings. Total sales and operating expenses per hectare increased, but the result was a decline in gross margins, as expenses increased more than sales. The sales to investment ratios increased by 1986, but the sales to expenses ratios decreased with respect to the earlier time period.

Table 24. Characterization of Major Cropping Systems, Duck Mountain ARR, 1981. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Mixed-Moderate Pasture	104	27	194	63	0	12	71	8	16	2	8	12
2. Wheat-Low Pasture	35	4	132	92	0	3	71	8	16	0	8	1
3. Wheat & Oilseeds-Low Pasture	35	4	308	92	0	12	71	18	16	0	0	5
4. Mixed-Low Pasture	16	24	187	90	0	28	29	11	16	0	3	5

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
1. Mixed-Moderate Pasture	943	75	17	8	111	54	43	71	4	0.11	2.02
2. Wheat-Low Pasture	1494	77	23	0	173	95	70	18	33	0.12	1.88
3. Wheat & Oilseeds-Low Pasture	1240	80	20	0	173	98	93	18	26	0.11	1.91
4. Mixed-Low Pasture	1236	80	20	0	138	71	74	15	14	0.12	2.14

* See notes for Table 6, page 20.

Table 25. Characterization of Major Cropping Systems, Duck Mountain ARR, 1986. *

Cropping System	No. of Farms	% of Farms in Region	Farm Size (ha)	Cultivated Area (% of Farm Size)	Crop Distribution (% of Cultivated Area)							
					Specialty	Summer-Fallow	Wheat	Oil-Seeds	Barley	Cereals for Feed	Oats for Grain	Forages
1. Mixed-Moderate Pasture	13	25	258	55	0	30	20	8	13	1	13	17
2. Wheat-Low Pasture	13	24	194	91	0	4	66	20	0	0	0	2
3. Wheat & Oilseeds-Low Pasture	13	12	258	91	0	6	37	37	13	0	0	2
4. Mixed-Low Pasture	35	25	194	90	1	23	20	13	13	1	0	4

Cropping System	Total Capital (\$/ha)	Land (% of Total)	Machinery (% of Total)	Livestock (% of Total)	Annual Sales (\$/ha)	Operating Expenses (\$/ha)	Gross Margin (\$/ha)	Fuel (\$/ha)	Fertilizer (\$/ha)	Sales to Investment (Ratio)	Sales to Expenses (Ratio)
2. Wheat-Low Pasture	1521	73	27	0	271	206	33	13	54	0.17	1.38
3. Wheat & Oilseeds-Low Pasture	1401	76	24	0	302	191	88	20	46	0.20	1.53
4. Mixed-Low Pasture	1330	76	22	0	230	156	74	20	28	0.18	1.49

* See notes for Table 6, page 20.

4.0 DISCUSSION

The analysis of Census data at the farm level, grouped by Agroecological Resource Regions and analysed at the level of intensity of cropping systems, provides an overview of production characteristics within the agricultural region of Manitoba. When analyzed over two (or more) time periods, it also reveals trends in management techniques and cropping practices as influenced by changing external conditions such as markets and weather.

The cropping systems classification scheme established for this study was based on specific combinations and proportions of crops, carefully selected to reflect land use intensity. Legend classes ranged from the high intensity Specialty System to the less intensive Wheat, Wheat & Oilseeds and Mixed Systems, to the low intensity Feeds & Forages and Pasture Systems. The subdivision into Low and Moderate Pasture versions further defined this trend in land use intensity, as well as recognizing local variations in land capability for agriculture.

The predominant cropping systems within an ARR, and the physical and economic characterization of these cropping systems, identify the general land use profile of an ARR. In this sense there are five distinct profiles of biophysical units in Manitoba.

The highest intensity of land use is in the Winnipeg Plain, which is unique in being dominated by high intensity Specialty Systems and Low Pasture versions of Wheat and Wheat & Oilseeds Systems, with a virtual absence of low intensity systems such as Feeds & Forages and Pasture. Trends in this area between 1981 and 1986 include a decline in the number of Specialty farms, increases in the number of Wheat, Wheat & Oilseeds and Mixed farms, increases in farm size and oilseed acreage and decreases in summerfallow and barley acreage. This ARR has the highest levels of economic inputs and performance, and it is the only ARR with an increase in gross margins for all Major Systems in the 1981-1986 period.

The second profile, represented by Spruce Woods ARR, is similar to the Winnipeg Plain in that specialty crops are common, but here the dominant system is the Moderate Pasture version of Specialty. In this ARR, more than 10% of the farms are in each of the Mixed-Moderate Pasture or Pasture Systems. This is indicative of a landscape with a mix of high quality and poorer quality soils. Between 1981 and 1986 the number of farms in Specialty-Moderate Pasture decreased and the number in Specialty-Low Pasture and Wheat-Low Pasture increased. This is coincident with lower specialty crop proportions, higher wheat and oilseeds percentages and larger farm sizes. The economic conditions in the Spruce Woods ARR were only moderate, with the best gross margin (for Specialty-Low Pasture in 1981) equivalent to the second poorest (Wheat-Low Pasture) on the Winnipeg Plain. However, Spruce Woods stands out from other ARRs in that gross margins did not fall dramatically between 1981 and 1986.

The third profile is one of Wheat Systems in association with Mixed Systems, without Specialty, Feeds & Forages or Pasture Systems. This is characteristic of the agricultural areas of Turtle Mountain, Manitoba Escarpment and Duck Mountain ARRs. These areas are also typified by general and sometimes dramatic shifts from Mixed Systems to Wheat Systems between 1981 and 1986. These shifts are accompanied by an increase in oilseed acreage and a decrease in barley within systems. Economic performance is moderate, with sales, expenses and gross margin values somewhat below those of farms in the Winnipeg Plain and Spruce Woods ARRs. Gross margins are generally lower in 1986 than in 1981, with only the top performers (Wheat-Low Pasture and Wheat & Oilseeds-Low Pasture) in Turtle Mountain showing modest increases.

West Lake and Souris River Basin ARRs are similar to the previous profile, being characterized by Wheat and Mixed Systems, but they also had significant numbers of Feed & Forage and Pasture Systems. Like Spruce Woods, these cropping routines signify a variable landscape. Between 1981 and 1986 there was a general shift from Mixed Systems into Wheat Systems, while those systems based on forages and pasture remained relatively stable in number. Crop proportions within systems shifted toward

more oilseeds and forages and less barley and feed cereals. The economic margin of these Systems in these ARR was poor in 1981 and generally worse in 1986. The gross margin, which was about 50% of those in the Winnipeg Plain, improved somewhat for Wheat-Low Pasture System in the Souris Basin, while all systems in West Lake showed lower gross margins in 1986 than in 1981.

The final group of ARRs consists of Sandilands, Interlake and Riding Mountain; areas dominated by Mixed, Feeds & Forages and Pasture Systems. There was a shift from Feeds & Forages to Mixed Systems between 1981 and 1986, and a trend to more oilseeds in Mixed Systems. Economic conditions were very poor. The gross margins were about 20% of those in the Winnipeg Plain, and declined or, in the best cases, remained stable over the 1981-1986 period. In the Sandilands ARR, Pasture Systems showed an average gross margin of -\$11/ha in 1986.

There were some fairly consistent trends for all cropping schemes in all areas of Manitoba over the time period studied. Between 1981 and 1986 in Manitoba there was an almost universal increase in the proportion of cultivated land devoted to oilseeds (primarily canola) and wheat. This increase came at the expense of specialty crops (corn, sunflowers, beans, etc.), barley and to a certain extent summerfallow, and was expressed as changes in cropping systems as well as changes in crop proportions within systems. There was also a general shift from cereals used for feed to forages. These crop changes were accompanied by a general increase in farm size and an increase in the proportion of land cultivated. This was probably the result of farmers acquiring additional cultivated land as well as bringing formerly uncultivated land into annual crop production.

In terms of farm finances, Census data indicated a general decline in value of assets and profitability between 1981 and 1986. For most systems in most ARRs, total capital investment declined, while total sales of agricultural products and annual (operating) expenses increased. The decline in capital values was probably due in part to a reduction of livestock inventories and depreciation of machinery in an attempt to improve cash flow, but it was also due to devaluation of land as a function of declining land prices. A widespread decline in gross margins as calculated from Census data was revealed, which may be due to selling off of inventory in 1980, thus raising sales figures above that associated with crop production.

The sales to expenses ratio also showed lower values based on the 1986 Census than on the 1981 figures for all Major Systems except one (Wheat-Low Pasture, Souris River Basin ARR). This indicates that sales relative to expenses in 1985 were lower than sales relative to expenses in 1980. In other words, it appears that not only did the economic margin per unit of land area decrease, but that it cost more to generate that lower margin.

Several responses to these changing economic conditions were evident. One strategy was to increase farm size in order to expand total production and realize economies of scale. This trend was found in essentially all Major Systems and Regions in Manitoba. The substitution of high-value oilseed crops for forages and barley was another attempt to maintain or increase gross margins. This resulted in shifts to cropping systems with high proportions of higher valued crops.

An increase in the number of farms in Wheat Systems, associated with a decline in Specialty and Mixed Systems, indicates an attempt to reduce risk and increase income. The shift away from an expensive and risky specialty crop such as corn toward a conventional and reliable crop such as wheat decreases the chance of crop failure and thus reduces income variability. Conversely, movement away from a diversified, low-risk Mixed system toward a more risky monoculture Wheat System represents an attempt to overcome rising costs by concentrating on the production of a higher-valued crop.

Despite the general decline in economic profitability and efficiency, it is evident that farms in areas with better quality land generally operate more effectively than those in areas with more constraints. The average sales to expenses ratios and gross margins per hectare of all Major Systems within each ARR

(Table 26), show the higher-ranking regions (Winnipeg Plain, Manitoba Escarpment, Turtle Mountain and Duck Mountain) to be those where land resource limitations are the fewest, while middle-ranked ARR's (Spruce Woods, Souris River Basin and West Lake) have some moderate limitations. Conversely, those ARR's that ranked lowest in both 1981 and 1986 (Sandilands, Riding Mountain and Interlake) have the highest number of major physical limitations, notably with respect to soil parent materials.

Table 26. Average Gross Margins and Average Sales to Expenses Ratios by ARR, 1981 and 1986.

Agroecological Resource Region	Average Gross Margins (\$/ha)		Average Sales to Expenses Ratio	
	1981	1986	1981	1986
Winnipeg Plain	98	103	1.84	1.49
West Lake	49	40	1.77	1.36
Sandilands	22	16	1.50	1.14
Interlake	20	17	1.66	1.23
Manitoba Escarpment	76	64	2.00	1.48
Spruce Woods	68	68	1.86	1.48
Souris River Basin	48	45	1.93	1.51
Turtle Mountain	76	84	1.99	1.60
Riding Mountain	24	16	1.84	1.25
Duck Mountain	75	65	1.99	1.44

Table 27. Gross Margins and Sales to Expenses Ratios for Mixed Cropping Systems by ARR, 1981 and 1986.

Agroecological Resource Region	Gross Margins (\$/ha)		Sales to Expenses Ratio	
	1981	1986	1981	1986
Winnipeg Plain	77	90	1.86	1.44
West Lake	63	53	1.98	1.39
Sandilands	41	39	1.81	0.28
Interlake	40	15	1.53	1.12
Manitoba Escarpment	75	56	2.08	1.47
Spruce Woods	61	51	2.20	1.49
Souris River Basin	53	51	1.73	1.40
Turtle Mountain	71	62	2.13	1.65
Riding Mountain	33	21	1.77	0.14
Duck Mountain	74	74	2.14	1.49

This association of better financial performance with more agronomically favourable areas is apparent even when differences in cropping systems are eliminated. Table 27 presents gross margins and sales to expenses ratios for Mixed cropping systems in each ARR for both the 1981 and 1986 Census data. Comparison of similar cropping systems (Mixed-Low Pasture and Mixed-Moderate Pasture) show similar groupings of ARRs, with the Winnipeg Plain, Manitoba Escarpment and Turtle and Duck Mountains being the favoured regions.

5.0 CONCLUSIONS

The data presented and discussed in this report were produced by a method which links broad agriculturally important landscape units with farm-level socioeconomic data through a cropping systems classification. The use of biophysically defined land units in an hierarchical structure provided an efficient and effective technique for database organization and analysis. The development of a farm classification based on crop distributions provided the opportunity to review the physical and economic characteristics of more than 17,000 farms in both 1981 and 1986. The result is a socioeconomic characterization of distinct landscape units in the agricultural area of Manitoba, stratified by defined crop combinations.

The characterization of landscape units included the identification of all 'Major Systems' within each Agroecological Resource Region, as well as the socioeconomic description of those systems in relation to other regions and systems, and the changes which occurred between 1981 and 1986. This method provided an opportunity to identify characteristics and trends within specific ARRs as well as more wide ranging conditions common to all regions.

The description of spatial and economic variation in agricultural production indicates several important farm management trends. With respect to the years 1981 and 1986, (1980 and 1985 for sales), the following general differences are evident:

1. generally better economic performance in both 1981 and 1986 in those regions with less severe land resource constraints;
2. fewer farms in Specialty and Mixed Systems and more farms in Wheat Systems in 1986;
3. larger farm sizes and greater proportions of land cultivated in 1986;
4. greater proportion of cultivated land in oilseed crops in 1986;
5. higher levels of land use intensity (ie: cropping system changes) in 1986; and
6. lower sales to expenses ratios in 1986.

Descriptive studies such as this - although necessary to identify and focus attention on successes or problems - often raise numerous questions pertaining to cause and effect. Such is the case here, particularly with respect to economics. For example, the differences noted in gross margins and sales ratios between 1981 and 1986 seem contradictory with respect to crop production (i.e. drought, 1980). What caused the Census results? What is the long-term trend in sales to expenses ratios? A more 'explanatory' study using other and/or more years of data is warranted.

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