1

CANADIAN THESES ON MICROFICHE

I.S.B.N.

THESES CANADIENNES SUR MICROFICHE

National Library of Canada
Collections Development Branch

Canadian Theses on
Microfiche Service

Ottawa, Canada
K1A 0N4

Bibliothèque nationale du Canada
Direction du développement des collections

Service des thèses canadiennes
sur microfiche

NOTICE

The quality of this microfiche is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us a poor photocopy.

Previously copyrighted materials (journal articles, published tests, etc.) are not filmed.

Reproduction in full or in part of this film is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30. Please read the authorization forms which accompany this thesis.

THIS DISSERTATION
HAS BEEN MICROFILMED
EXACTLY AS RECEIVED

AVIS

La qualité de cette microfiche dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de mauvaise qualité.

Les documents qui font déjà l'objet d'un droit d'auteur (articles de revue, examens publiés, etc.) ne sont pas microfilmés.

La reproduction, même partielle, de ce microfilm est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30. Veuillez prendre connaissance des formules d'autorisation qui accompagnent cette thèse.

LA THÈSE A ÉTÉ
MICROFILMÉE TELLE QUE
NOUS L'AVONS REÇUE

National Library
of Canada

Bibliothèque nationale
du Canada

79

CANADIAN THESES
ON MICROFICHE

THÈSES CANADIENNES
SUR MICROFICHE

0-315-12051-7

59964

NAME OF AUTHOR/NOM DE L'AUTEUR EDWARD CHARLES HUFFMAN
TITLE OF THESIS/TITRE DE LA THÈSE AGRICULTURAL LAND USE SYSTEMS
A NEW APPROACH TO CLASSIFICATION
AND INVENTORY
UNIVERSITY/UNIVERSITÉ CARLETON UNIVERSITY
DEGREE FOR WHICH THESIS WAS PRESENTED/
GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE Master of Arts
YEAR THIS DEGREE CONFERRED/ANNÉE D'OBTENTION DE CE GRADE 1983
NAME OF SUPERVISOR/NOM DU DIRECTEUR DE THÈSE Dr. J. K. Torrance

Permission is hereby granted to the NATIONAL LIBRARY OF
CANADA to microfilm this thesis and to lend or sell copies
of the film.

L'autorisation est, par la présente, accordée à la BIBLIOTHÈ-
QUE NATIONALE DU CANADA de microfilmer cette thèse et
de prêter ou de vendre des exemplaires du film.

The author reserves other publication rights, and neither the
thesis nor extensive extracts from it may be printed or other-
wise reproduced without the author's written permission.

L'auteur se réserve les autres droits de publication; ni la
thèse ni de longs extraits de celle-ci ne doivent être imprimés
ou autrement reproduits sans l'autorisation écrite de l'auteur.

DATED/DATE April 28 /83 SIGNED/SIGNÉ Edward Huffman

PERMANENT ADDRESS/RÉSIDENCE FIXE

892 Rob Roy Ave
Ottawa, Ont.
K2B 5U9

LIST OF FIGURES

Figure	1.1	World, Canadian and Canada Land Inventory Land Use Legends.....	7
	2.1	Abbreviated Legend - Land Use Systems of Ottawa-Carleton.....	21
	2.2	Land Survey Map.....	23
	2.3	Lot and Concession Lines.....	23
	2.4	Forest and Uncultivated Land.....	24
	2.5	Fields Crossing Lot Lines.....	24
	2.6	'Long Hundreds'.....	26
	2.7	'Square Hundreds'.....	26
	2.8	Farm Location.....	31
	2.9	Characterization Variables.....	36
	3.1	Duration and Scheduling of Inventory Procedures.....	40
	3.2	West Carleton-March-Goulbourn (Map).....	Back cover
	3.3	Farm Size.....	41
	3.4	Total Farm Value.....	41
	3.5	Total Farm Value per Unit Area.....	42
	3.6	Total Annual Labour Input.....	42
	3.7	Total Annual Labour Input per Unit Area.....	43
	3.8	Net Margin per Unit Area.....	43
	3.9	Net Return per Labour Unit.....	44
	3.10	Operator Off-farm Work.....	44

The undersigned recommend to the Faculty of Graduate
Studies and Research acceptance of the thesis

"AGRICULTURAL LAND USE SYSTEMS: A NEW APPROACH TO
CLASSIFICATION AND INVENTORY"

submitted by Edward Huffman, B.Sc.

in partial fulfilment of the requirements for
the degree of Master of Arts.

THESIS SUPERVISOR

CHAIRMAN, DEPARTMENT OF GEOGRAPHY

Carleton University

April 29, 1983

ABSTRACT

A methodology of conducting land use inventories for agricultural regions was formulated and implemented at a scale of 1:50,000. The focus of the methodological research was on alleviating the perceived inadequacies of traditional land use surveys.

The primary limitations of conventional maps and reports were identified as 1) time and location specificity; 2) lack of socio-economic information and 3) unrealistic map unit boundaries. The methodology presented proposes a map of land use intensity, supported by socio-economic characterization of mapped categories. The mapping routine involves legend development, and data collection through field survey and systems characterization through landowner interviews. A map representing 84 percent accuracy was prepared for an area of 276,000 hectares, and the mapped categories are shown to be significantly different in physical and socio-economic characteristics. Recommendations for improving map accuracy and statistical reliability are provided and further research needs are suggested.

PREFACE

A methodological research project such as this, with emphasis on field survey, could not easily be accomplished by an individual. This study was conducted as one facet of an ongoing research program within the Land Use and Evaluation Section, Land Resource Research Institute, Agriculture Canada. The LRRI, a national institution responsible for research in soil classification and inventory, land evaluation and land use, provided salaries, travel expenses, facilities and material for the project. I am deeply indebted to the Land Resource Research Institute for the opportunity of reporting on my activities while in their employ.

I am most appreciative of the guidance, support and faith expressed by Dr. J. Dumanski and Dr. J. Van Schaik, both of LRRI. Many thanks also to E. Yaxley for his enthusiasm and support, and to the other members of the field survey crew (M. Tutt, L. Lizotte, B. Dunning, M. Rooney and W. Martin) for their good-natured tolerance of repetition and change. To Dr. J.K. Torrance of Carleton University, I express my appreciation for stimulation and support.

This thesis is dedicated to all of the farmers who contributed time, data and wisdom.

Ottawa, Canada

April, 1983

TABLE OF CONTENTS

ABSTRACT.....	11
PREFACE.....	111
TABLE OF CONTENTS.....	iv
LIST OF FIGURES.....	vi
LIST OF TABLES.....	vii
CHAPTER	
1. INTRODUCTION.....	1
1.1 Overview.....	1
1.2 The Problem.....	2
1.3 Background to the Problem.....	3
1.4 Purpose and Objectives.....	9
2. THE STUDY.....	11
2.1 Introduction.....	11
2.2 Classification and Procedures.....	12
2.3 The Study Area.....	14
2.4 The Methodology.....	14
2.4.1 Classification Development.....	14
2.4.2 Field Mapping.....	20
2.4.3 Farm Interviews.....	28
2.4.4 Questionnaire Analysis.....	34
3. RESULTS AND DISCUSSION.....	38
3.1 The Map.....	38
3.2 Questionnaires.....	39

3.3	Characterization Variables.....	45
3.3.1	Physical Characteristics.....	45
3.3.2	Livestock Types and Productivity.....	47
3.3.3	Capital Investment.....	47
3.3.4	Income and Expenses.....	50
3.3.5	Labour.....	50
3.3.6	Operator Characteristics.....	53
3.4	Systems Characterization.....	53
3.4.1	Monoculture.....	55
3.4.2	Corn.....	55
3.4.3	Mixed.....	56
3.4.4	Hay.....	57
3.4.5	Pasture.....	57
3.4.6	Grazing.....	58
3.5	SUMMARY.....	59
4.	CONCLUSIONS AND RECOMMENDATIONS.....	61
4.1	Conclusions.....	61
4.2	Recommendations.....	63
4.2.1	Recommendation 1: Sampling.....	64
4.2.2	Recommendation 2: Class Size.....	64
4.2.3	Recommendation 3: Map Error.....	64
4.2.4	Recommendation 4: Contact with Landowners.....	65
4.3	Further Research.....	65
	LIST OF REFERENCES.....	66
	APPENDIX A - Mapping Legend - Land Use Systems of Ottawa-Carleton.....	74
	APPENDIX B - Interview Questionnaire.....	82
	APPENDIX C - Summary Statistics - Land Use Systems of Ottawa-Carleton.....	91

LIST OF FIGURES

Figure	1.1	World, Canadian and Canada Land Inventory Land Use Legends.....	7
	2.1	Abbreviated Legend - Land Use Systems of Ottawa-Carleton.....	21
	2.2	Land Survey Map.....	23
	2.3	Lot and Concession Lines.....	23
	2.4	Forest and Uncultivated Land.....	24
	2.5	Fields Crossing Lot Lines.....	24
	2.6	'Long Hundreds'.....	26
	2.7	'Square Hundreds'.....	26
	2.8	Farm Location.....	31
	2.9	Characterization Variables.....	36
	3.1	Duration and Scheduling of Inventory Procedures.....	40
	3.2	West Carleton-March-Goulbourn (Map).....	Back cover
	3.3	Farm Size.....	41
	3.4	Total Farm Value.....	41
	3.5	Total Farm Value per Unit Area.....	42
	3.6	Total Annual Labour Input.....	42
	3.7	Total Annual Labour Input per Unit Area.....	43
	3.8	Net Margin per Unit Area.....	43
	3.9	Net Return per Labour Unit.....	44
	3.10	Operator Off-farm Work.....	44

LIST OF TABLES

Table 3.1	Results of Test of Significance of Class Means; Physical Characteristics.....	46
Table 3.2	Results of Test of Significance of Class Means; Livestock Types and Productivity.....	48
Table 3.3	Results of Test of Significance of Class Means; Capital Investment.....	49
Table 3.4	Results of Test of Significance of Class Means; Income and Expenses.....	51
Table 3.5	Results of Test of Significance of Class Means; Labour.....	52
Table 3.6	Results of Test of Significance of Class Means; Operator Characteristics.....	54

CHAPTER 1.

INTRODUCTION

1.1 Overview

It is no co-incidence that human settlements the world over are concentrated on fertile land. In fact, a principal reason for the survival of the human race is that Earth's natural processes have created productive land near another of man's necessities - water. With the advent of commerce and the movement of goods as critical requirements of man's world dominance, it is both natural and economical that urban concentrations have been established on productive land near navigable water bodies. With a relatively small population and a large reserve of unused land, this process initially met with few serious concerns. Indeed, the absence of problems has fostered an attitude of exploitation as the accepted method of utilizing natural resources.

But Earth has a finite surface area, and over the past century, and particularly the past decade, man has begun to realize the implications of an expanding population on a fixed resource base. The population is in 'bloom', the 'untapped reserves' are quickly being tapped, and the 'frontiers' are fast becoming main streets. We are beginning to think "manage" rather than "exploit". And critically so, for exploitation becomes increasingly hazardous and expensive as we move outward from the best and most tolerant areas to the poorest and most fragile.

In Canada, twelve per cent of the total land area of 922 million hectares is suitable for some type of agricultural production, seven percent is suitable for cultivation of field crops, and two percent is considered as prime agricultural land (Simpson-Lewis, 1979). Seventy-one percent of the field crop area has significant economic or physical limitations to that use, and more than one-third of the prime agricultural land is within 80 km of a major metropolitan center. In addition, almost every soil type is subject to some form of degradation (Coote, 1982).

Since the majority of land rated as Class 1, 2 or 3 by the Canada Land Inventory is currently in production (Dumanski and Stewart, 1981), the task of supplying a growing demand for food and fibre must be concerned with land management. Not only will agriculture lose more land to urban development, but land related problems such as erosion and pollution are bound to increase. It is therefore urgent that the information base pertaining to the agricultural industry's relationships with natural resources be strengthened considerably. But agricultural production is a complex system, and an understanding of the inter-relationships of the various components of that system can only be fostered by a comprehensive and integrated data base.

1.2 The Problem

Land use inventories can provide a strong base for a comprehensive investigation of the agricultural production industry. James F. Maclaren Ltd, Environmental Consultants, indicate the importance of land use in the statement that "The existing fabric of active farms is the second most important and tangible evidence of an agricultural resource area." (after land capability), (James F. Maclaren, Ltd., 1976, p.29). But agricultural land use information can serve as much more than 'evidence', for it is a reflection of the combined effect of all physical, economic, and social

elements of the industry. In addition, it is a visible component which provides a precise and convenient method of dealing with location.

Agricultural land use, however, has often been ignored as an information source in Canadian land use planning efforts, not because the information is unavailable, but because land use planning has traditionally been the responsibility of urban planners, who considered farmland as a reserve for urban land needs. With this attitude, a designation such as 'cropland' or 'cleared' was sufficient representation for agricultural land, and the effort and expertise required to acquire and interpret the land use information that was available was considered to be unnecessary. Without a strong demand for a detailed assessment of the agricultural economy, the social structure, and the activities of a rural area - indeed, of the total present utilization of the land resource - agricultural locational studies have been primarily oriented toward technical production concerns or academic exercises. At the present time, even with our general awareness of soil and land deterioration, rural-urban conflicts, and the importance of sustained, high intensity agricultural production, soil capability maps remain the primary and almost exclusive documents used for designating agricultural land use priorities.

It is to the problem of an under-utilized but potentially valuable information base that this research was directed. It is based on the premise that if socio-economic problems and mistakes in land use change are to be minimized, then knowledge and understanding of the present relationships between soil, farm location, economic conditions and social characteristics must be enhanced. The agricultural community has consistently lobbied for more consideration of the agricultural milieu in planning, but it has never developed a consistent method of collecting, interpreting and presenting the necessary information. This thesis outlines an attempt to develop such a method.

1.3 Background to the Problem

Over the relatively short history of agricultural land use studies, two basically different approaches have been used: the statistical analysis and mapping of crop data from Census files, and the mapping of ground cover

through field survey and/or airphoto interpretation. The first has been used principally in the identification and description of agricultural 'regions' and in the determination of farming 'types', while the second has generally related to the delimitation and description of 'land types' and to the preparation of large-scale 'resource assessment' maps and reports.

The technique of portraying Census data in the form of dot and isogram maps is generally attributed to American geographers of the 1920's and 30's, who used the maps to identify and describe agricultural regions (Baker, 1926; Hartshorne and Dicken, 1935). Several years later similar but more sophisticated methods were employed to depict statistically defined types of farming (McArthur and Coke, 1939; Hudson et al., 1949), but it was not until 1954 that the procedure was applied specifically to crop acreage data to portray crop combination regions (Weaver, 1954). More recently, increasingly complex procedures have been used very effectively at a large scale (Laut, 1974), for routine reporting (Statistics Canada, 1978a) and in a study of the spatial distribution of internationally defined agricultural types (Troughton, 1975). This type of analysis and mapping routine has contributed significantly to our understanding of land use classification, land use distribution, and land use and physical resource relationships, but the practical application of it is essentially restricted to provincial or smaller scale analyses due to the relatively large minimum map unit size. At the county, parish or rural municipality level, where most land use zoning is undertaken, this mapping technique is unsuitable.

Land cover mapping through field survey, with roots in prehistorical paintings and Roman "Censuses" (Stamp, 1948) has a considerably longer and more active past than Census mapping. The Domesday Survey of England in 1086 has been cited as the first land utilization survey (Darby, 1970), but the first evidence of the application of cartographic techniques to land use information is generally considered to be Thomas Milne's maps of London and area, published in 1800 (Bull, 1956). This series of six map sheets, which introduced the technique of symbols and shading notation, proved to be the prototype of modern land use maps.

The period from 1900 to 1950 was a time of rapid development in the field of geography, and the spatial distribution of land use activities became a topic of widespread study. Early North American efforts dealt with land use classification and mapping methodology (Sauer, 1919, 1924; Jones and Finch, 1925; Whittlesey, 1925), but it was the practical concerns related to regional geography that were of most benefit to land use mapping. Techniques such as aerial photo interpretation, field survey, sample field survey, traverses, farmer interviews, grid mapping, coding formats, unit area calculations, and combined census-land cover maps were introduced or refined by researchers attempting to identify and describe economic regions (Lewis, 1934; Stewart and Porter, 1942; Irving, 1957), land types (Veatch, 1941; Lee, 1944; Reeds, 1946), or land use patterns (Whitaker, 1938; Nicholson, 1955; Cornwall, 1956; Wood, 1956; Krueger, 1960; Raymond, 1960).

While procedures for collecting and interpreting land use information were of principal concern to North American land use specialists, the more abstract concern of standardized classification and survey methodologies was of particular interest to European investigators. Of particular importance in this regard is "The Land Utilization Survey of Britain", an entirely objective land use inventory of all of England, Wales and Scotland conducted under the leadership of Sir Dudley Stamp in the years 1930-1948 (Stamp and Willatts, 1934; Stamp, 1948). The results of this survey consisted of nearly 200 map sheets at 1:63,360 scale, 15 sheets of generalized information at 1:253,440, 2 sheets at 1:625,000, 92 county reports and a major report on use and misuse of land in Britain. Of most significance, though, was world wide recognition of the benefits and feasibility of objective land use surveys, and the promotion of a standardized 'land use-land cover' classification scheme. However, even by the middle of the 20th century, land use surveys were essentially considered as a means to an end, and variation in classification concepts and methodological procedures was extreme (Duckham and Masefield, 1970; Beek, 1978).

With the establishment of the Commission on World Land Use Survey within the International Geographical Union in 1949, a new era of systematic land use inventories began. The Commission, in consultation with member

countries, established the basic principals of survey, introduced a master legend (FIGURE 1.1), and urged all countries to participate in a World Land Use Survey (Van Valkenburg, 1950). As a result, in the early 1950's many countries began land use surveys on a systematic or pilot project basis, with modifications of the master legend to accommodate local conditions and various scales (Jankowski, 1975).

In Canada, the task was taken on by the Geographical Branch of the Department of Mines and Technical Surveys, and a number of pilot projects were conducted in several areas of the country (Nicholson et al, 1961). These efforts generally followed the World Land Use Survey Legend, with data collection being either through sampling and air photo interpretation or complete field survey. By 1960, the Geographical Branch had developed a Canadian Land Use Legend similar to the World's (FIGURE 1.1) and a procedure of mapping which relied on analysis of statistical data, air photo interpretation and field checks (Forward and Raymond, 1959). Systematic mapping at various scales from 1:50,000 to 1:500,000 was carried out in parts of Newfoundland, Nova Scotia, New Brunswick, Prince Edward Island, Ontario, Saskatchewan and British Columbia, and a complete map of Southern Ontario was published (at 1:1,000,000 scale) in accordance with World Land Use Survey directives (Geographical Branch, 1960; Nicholson et al., 1961).

With the initiation of the Canada Land Inventory (CLI) under the Agricultural Rehabilitation and Development Act (ARDA) in October, 1963, (ARDA, 1965) the focus of systematic land use surveys in Canada was concentrated on aerial photo interpretation. Faced with preparing 1:50,000 scale land use maps for an area of approximately 290 million hectares in four years, the CLI adopted a procedure of "Air photograph interpretation, supplemented by limited field checking..." (McClellan, 1965, p. 75). The Geographical Branch again conducted pilot studies and developed a legend similar in format to the World's land use-land cover system, but with fewer 'cropland' and 'woodland' categories and more 'urban' and 'unproductive' distinctions (FIGURE 1.1).

WORLD	CANADIAN	CANADA LAND INVENTORY
Settlements and associated non-agricultural lands	Urban <ul style="list-style-type: none"> a) Industrial b) Commercial c) Residential d) Recreation e) Associated non-agricultural land 	Urban <ul style="list-style-type: none"> a) Built-up b) Mines, quarries, sand and gravel pits c) Outdoor Recreation
Horticulture	Tree Fruits and Horticulture <ul style="list-style-type: none"> a) Horticulture b) Vineyards c) Orchards d) Other-blueberries, etc 	Horticulture, Poultry and Fur Operations Orchards and Vineyards
Tree and other Perennial Crops		
Cropland <ul style="list-style-type: none"> a) Continual and rotation cropping b) Land rotation 	Cropland <ul style="list-style-type: none"> a) Hay b) Grain c) Other-oilseeds, potatoes d) Other-tobacco, etc 	Cropland
Improved Permanent Pasture-managed or enclosed	Pasture <ul style="list-style-type: none"> a) Improved pasture b) Open grass land-unimproved grazing land, used c) Scrub grass land-unimproved grazing land, unused 	Improved Pasture and Forage Crops
Unimproved Grazing Land <ul style="list-style-type: none"> a) Used b) Not used 		Rough Grazing and Rangeland
Woodlands <ul style="list-style-type: none"> a) Dense b) Open c) Scrub d) Swamp forests e) Cut-over or burnt-over forest areas f) Forest with subsidiary cultivation 	Woodlands <ul style="list-style-type: none"> a) Dense b) Open c) Scrub d) Cut-over and burnt-over 	Woodland <ul style="list-style-type: none"> a) Productive woodland b) Non-productive woodland
Swamps and Marshes-fresh and salt water, non-forested	Water <ul style="list-style-type: none"> a) Water b) Swamps and marshes 	Swamp, Marsh or Bog Water
Unproductive Land	Unproductive	Unproductive Land <ul style="list-style-type: none"> a) Sand b) Rock and other unvegetated surface

FIGURE 1.1 World, Canadian and Canada Land Inventory land use legends¹

¹ Scace, 1981.

During the period 1964 - 1968, most of the "settled" portion of Canada was mapped, partially through the use of existing maps, and partially through air photo interpretation. Approximately 3200 map sheets at 1:50,000 scale were prepared in manuscript (ozalid) form. The primary use of this information was in the preparation of soil or land capability maps, one for each of: 1) agriculture, 2) forestry, 3) recreation, 4) wildlife ungulates and 5) wildlife waterfowl. The Present Land Use series, though not formally published, has remained available for study. At the present time, the Canada Land Use Monitoring Program has as an objective the mapping of land use through aerial photo interpretation every five years. Two components; the Urban Centered Region Component, and the Special Resource Lands Component, are in progress.

The CLI had a dramatic effect on land use mapping in Canada, both as a standardizing influence on classification, and as a promotion for the use of such information. Many subsequent surveys in Canada have utilized legends based on the CLI (Scace, 1981), and the maps have been used in research, environmental studies and planning. (See for example; Ryerson and Gierman, 1975; James F. MacLaren Ltd., 1976; Gierman, 1976; Scace, 1981). However, as was established prior to the survey, it was a reconnaissance type inventory and, "It will not provide the detailed information needed for the management of small parcels of land." (McClellan, 1965, p. 74).

In 1975 the Soil Research Institute (SRI) of Agriculture Canada conducted a land use inventory of Nepean and Gloucester townships in the Regional Municipality of Ottawa-Carleton, Ontario, as one component of a "total resource inventory" suitable for local planning. Three maps; Soils, Soil Capability and Land Use, were prepared at the detailed scale of 1:25,000 (Marshall et al., 1979). A conventional land use-land cover legend, consisting of an expanded version of the CLI Present Land Use Legend was adopted. The minimum mapping unit size of 0.4 ha enabled very detailed data collection, and eight "Urban", ten "Agricultural", and five "Non-Agricultural" land uses or covers were identified. The agricultural categories consisted of: corn, soybeans, cereal grain, hay, pasture, rough grazing, fallow, specialty agriculture, orchards and sod farms. Mapping

involved a complete ground survey, and the final product appeared to qualify as a comprehensive and accurate land use map.

However, when attempts were made to use this map to promote agricultural land use as a necessary consideration in local planning, it fell short. Questions relating to enterprise types, economic levels, management practices and long term land use intensity could only be interpreted in a general way. The major shortcomings of the Nepean-Gloucester approach related to: 1) the extensive time required for data collection; 2) the lack of validity over time; 3) the expense and logistical problems of drafting, printing and handling such a large-scale, detailed map; and 4) the lack of socio-economic information.

The original 1:25,000 scale map was generalized to approximately 1:250,000 on the basis of the mix and proportion of crops within general 'regions'. The broad categories such as 'commercial, large-scale farming', 'mixed, small-scale farming' and 'abandoned land and permanent pasture' (Huffman and Dumanski, 1978) gave a somewhat better representation of the organization of agricultural characteristics in the area, but the generalization seriously reduced the accuracy and detail that had been such a major focus of the project. The frustration of trying to interpret the original map, and the realization that the generalized map was not a significant improvement provided the impetus for a research project on agricultural land use inventories.

1.4 Purpose and Objectives

The recognition of a need for more information on how land is currently being used for agricultural production, supported by an understanding of the basic differences in land utilization, provides the framework for this research. It is the premise of this thesis that a methodology of mapping, analyzing, and presenting agricultural land use information can be developed such that the resultant maps/reports give an integrated and comprehensive explanation of the spatial distribution of important production characteristics. The purpose of this project was to construct such a methodology.

In light of the problems and inadequacies identified in traditional land use surveys, and particularly with reference to the descriptive nature of these inventories, it was essential that this methodology:

- 1) incorporate a certain aspect of interpretation by agriculture specialists,
 - 2) reflect levels of land use intensity,
 - 3) reflect actual land management units,
 - 4) reflect social and economic parameters of agricultural production,
 - 5) produce maps which have validity over a number of years, and
 - 6) be relatively inexpensive and able to produce results quickly.
-

CHAPTER 2.

THE STUDY

2.1 Introduction

It became apparent, when attempting to describe the general agricultural regions of Nepean-Gloucester, that 'intensity' or the degree of alteration of the natural growing conditions undertaken to increase productivity, was the most meaningful concept.* But the regions had been delimited on the basis of the mix and proportion of crops. If the

* There exists a certain amount of variation in the interpretation of the meaning of 'land use intensity', with some authors (Barlowe, 1958; Stamp, 1966) adhering to the essentially economic interpretation of 'concentration of capital and labour', and others (Baker, 1926; Clawson and Stewart, 1965; Vink, 1975) taking a more abstract 'degree of activity' perspective. This writer supports the latter view, in that improvements to a property (capitalization) are not necessarily a function of agricultural activities. Intensity is more accurately reflected by the amount, kind and frequency of inputs to crop production.

relationship between crop mix and intensity was recognized prior to data collection, then a much better map of land use intensity could be produced. In order to test this hypothesis, a pilot mapping project near the previous study area was proposed. Since soil mapping of the entire Regional Municipality of Ottawa-Carleton was in progress, the Land Resource Research Institute (formerly SRI) conducted, for complementarity in resource data, a land use inventory of the Regional Municipality. The research effort was focussed on the field crop portion of the agricultural milieu, and in anticipation of changes in approach, the scale of 1:50,000 was adopted.

2.2 Classification and Procedures

As a general approach to survey, principles modelled on those used in soil surveys in Canada (Marshall et al., 1979), were established. A categorical approach to classifying land use intensity, a concept in which classes are identified by similarities and differences in a number of key characteristics, was adhered to. Through field survey procedures, the present study established a level of detail appropriate to mapping at 1:50,000 scale.

Soil surveys in Canada are conducted by: 1) establishing a regionally specific classification scheme; 2) mapping the landscape using nationally standardized techniques; and 3) characterizing categories through detailed and standardized 'site descriptions'. Adoption of this procedure for land use inventories was facilitated by developing a classification based on intensity, establishing diagnostic criteria for each category and conducting farm interviews.

Development of a classification related to the mix and proportion of various crops required the establishment of a basic areal unit (mapping unit) on which categorical decisions would be made. Ideally that unit would consist of the area managed under common practices by a farm operator, and as the most close approximation of that, the 'lot' was selected. These parcels of approximately 60-80 ha* form the basic building blocks of the

* The original land survey used the Imperial system of measurement (rods, miles, acres etc.) and centered on a lot size of 200 acres. In this report lots are considered to be 80 ha in size.

legal survey in Eastern Ontario (Burghardt, 1981) and are strongly associated with the extent and arrangement of farm properties. In addition, the pattern of lots and concessions is usually quite distinct on aerial photographs, the property boundaries can be identified on the ground, and the size of lots make them well suited to 1:50,000 representation.

Agricultural land use intensity can be identified by reference to individual crops, but to do so is only relevant for one growing season. In order to assess intensity over several years, the sequence of crops, the frequency of each type and the proportion of total area devoted to each crop must be considered. The concept of the mix and proportion of crops within a mapping unit was designated as the 'cropping system'. Diagnostic criteria (crop areas) are quantifiable and can be identified through both aerial photo interpretation and field survey. In some cases cropping systems are directly related to crop rotations, while in others they may incorporate several or no crop rotation schemes. Nonetheless, cropping systems tend to remain fairly stable over time (Jankowski, 1975).

Characterization refers to the description of each map category on the basis of a number of pertinent features. In agricultural land use, the characteristics of primary interest are those related to the structure and operation of farms, and thus variables related to farm size, soil quality, cultivated area, capital investment, annual income and expenses, labour inputs, operator characteristics, and enterprise type were considered appropriate. The procedure chosen to acquire this data was farmer interviews, which were conducted following field survey, using a standardized and detailed questionnaire. The personal interview approach was adopted in order to ensure consistent replies, to encourage completion of all aspects of each questionnaire and to provide the surveyor with a better understanding of land use/farm type relationships. Standard computerized statistical analysis techniques were available to obtain arithmetic means, ranges, and standard deviations for each variable and cropping system. The mapped categories thus described were termed 'Agricultural Land Use Systems'.

2.3 The Study Area

The Regional Municipality of Ottawa-Carleton, situated south of the Ottawa River in Eastern Ontario, is a relatively large municipality with considerable agricultural activity. The main agricultural enterprises - dairy, beef, cash crops, hogs, and market gardens, are extensive and modern, even though the Region exhibits many characteristics of an urban fringe. The 1976 Census of Canada revealed 1962 farms with sales in excess of \$1200 per year, an average farm size of 82 ha and a total farmland area of 143 000 ha. This consisted of 75 000 ha of crops, 23 000 ha of improved pasture, 4000 ha of other improved land, and 41 000 ha of unimproved land. Seventy-four percent of all farmland was owned by the operator and 26 percent was rented (Statistics Canada, 1978b).

Approximately 52 percent of the Region's total area of 276 000 ha is CLI Class 1, 2 or 3 capability for agriculture, and the dominant subclass in these soils is excess soil water (Hoffman and Noble, 1975). Class 4, 5 and 6 soils account for 32 percent, with major restrictions due to low fertility, low moisture holding capacity, shallowness to bedrock, or excessive stoniness. Five percent of the total area is rated as Class 7 and the remaining 11 percent is organic soil.

The Ottawa-Carleton region lies within the 2500-2700 Corn Heat Unit area, the frost free period averages 142 days, and the average annual precipitation is 850 mm.

2.4 The Methodology

2.4.1 Classification Development

Establishing a classification for the cropping systems consisted of subdividing a wide range of activities (crop rotations, sequences, mixes) into a smaller number of distinctive, identifiable categories. Theoretically, there are at least as many individual schemes of crop production within an area as there are farmers, as each operator has a unique program of cropping activities.

However, in the preparation of a map the bounds to the amount of information that can be presented, and hence the number of distinctions that can be made, are set by the technical concerns of readability (number of categories) and scale (minimum map unit size). In this project, a legend of ten or fewer categories, with a minimum land area per map unit of approximately two hectares was considered appropriate.

Classification development began with a review of crop statistics and farm practices in Ottawa-Carleton. In 1976, the common field crops, with the percentage of cropland occupied, were as follows: hay, 51.5%; corn (fodder plus grain), 25.7%; and cereal grain (oats, barley, and wheat) 18.4% (Ontario Ministry of Agriculture and Food, 1976). In addition, improved and unimproved pasture occupied a large area. Ranked from high intensity to low, these crops follow the order corn, cereal grain, hay, improved pasture, and unimproved pasture.

The Nepean-Gloucester survey had shown that these crops were distributed quite irregularly over the landscape; in some areas large tracts (>40ha) of unimproved pasture dominated, while in others various mixes of crops or large uniform tracts of corn were present. The two extremes - corn and unimproved pasture - represented the two end points in the spectrum of land use intensity and thus determined the range of possibilities to be classified. There was an obvious distinction between cropping systems with corn and those without, but it was also quite obvious that there were considerable differences within these two broad categories, as the proportion of corn varied widely within the corn-based group, as did the proportion of hay in the second group. It was necessary, in order to make further realistic and logical subdivisions, to conduct detailed field work.

Field work began with a general assessment of the type of crops and the proportion of area devoted to each crop in a number of lots within the study area. Crop combinations were assessed for each parcel for two years; one through air photo interpretation (1975) and the other through field survey (1977), and the results were compared for all parcels. During this time

aerial photo tones and textures, crops, fields, cultivation practices, farm buildings, machinery and livestock were noted and soil and soil capability maps were consulted. General patterns began to emerge. In addition to parcels of only corn or rough pasture, combinations of corn, legume hay and cereal grain; corn, hay, cereal grain, and pasture; hay, cereal grain and pasture; and hay and pasture were recurrent and widespread. In a few cases corn or cereal grain was observed in only one of the two years under observation, and in several others the crop mix was completely different in the two years, but generally crop combinations within each parcel were similar in both years.

During this phase of the study it became evident that the standard 80 ha land parcel was not always appropriate as a mapping unit. Extremes in soils or apparent ownership subdivisions often created dramatically different patterns of land use within these blocks, while in other instances fields or farm lanes extended across the parcel boundaries. In many cases, these variations were associated with a distinction between agricultural and non-agricultural land use, but in others they were more subtle. In order to establish standard procedures of mapping unit delineation, as well as to develop the legend further, landowner contacts were initiated. These visits were informal and concentrated specifically on technical matters of land management and crop production. Landowners were asked to identify on aerial photos all parcels of land which they utilized, and further discussion of crop rotations, soil differences, crop mix and proportions and tenure situations was based on characteristics of those identified parcels.

With respect to mapping unit delineation, the most critical observation was that a farmer may manage some tracts of land quite differently from others, depending on one or more of several characteristics. The factors most often cited as determining cropping practices were: 1) soil quality, 2) distance from farmstead, 3) lease arrangements, and 4) physical barriers. For example, natural attributes of the soil (fertility,

droughtiness, wetness, structure, texture) may limit or enhance the production of specific crops; distance from the farmstead may cause excessive travel time for some crops and/or practices; short-term leases may induce annual crops, or clauses in a lease may restrict some practices; and physical barriers to vehicle or livestock movement may restrict certain activities. However, it was confirmed that a property of land uniform in each of these aspects was managed more or less uniformly, both within the area and from year to year. Certainly there is some variation, as in a change from oats to barley, or from improved pasture to hay, and there is a certain amount of year to year fluctuation in corn or cereal grain acreage, but major shifts in a cropping program appeared to be restricted to enterprise changes, tenure alterations and operator retirements.

The concept of a 'land parcel' as a representation for an area under uniform cropping practices was adopted, and guidelines for the delineation of land parcels were developed. Basically, the 80 ha lot served as a first level delimitation, and subdivision of that area was performed on the basis of air photo features and field observations. Lots were subdivided wherever physiographic features corresponded to a distinction between cultivated and noncultivated land, and wherever apparent ownership splits or physical barriers were accompanied by a difference in crops, crop mixes, or cropping practices. Amalgamation of lots was performed wherever fields, lanes or buildings extended across land survey lines and wherever field observations indicated common management on both sides. The most common land parcel size was 40 ha, the area of the standard 100 acre farm.

Concentration of field work in corn producing areas revealed three basic approaches to crop production. One was characterized by a total (or very nearly total) commitment to corn production year after year, the second related to concentration on corn production (but not to the exclusion of other crops), and the third was oriented toward an integrated cropping scheme in which corn played a complementary role in the total system. The most intensive of these three cropping systems was termed 'MONOCULTURE'.

It was distinctive on both the ground and on the aerial photos, and the main feature, which was the presence of only corn in both 1975 and 1977, became the primary "identifier" for mapping purposes. The diagnostic criterion was set at "greater than 90% corn", in order to accommodate small areas of grass or hay often found near buildings or in excessively wet areas. In this study, soybeans were considered equivalent to corn. (During the mapping phase, several parcels greater than 90 percent in cereal grain were identified and mapped as 'MONOCULTURE'.)

The distinction of cropping programs with concentration on corn from those with corn as a component was somewhat more difficult, as the mix of crops was very similar. Both systems used corn, legume hay, perhaps cereal grain, and usually some pasture. There was obviously a significant difference between some farms, particularly with reference to buildings, machinery, field size, and amount of corn, but on the other hand the proportion of corn within different land parcels defined a continuum from about 10% to 75%. Concentration on this aspect in discussions with appropriate farmers revealed a definite break between those who considered corn to be a supplement to forage as livestock feed and those who considered corn to be the primary feed. Those with proportionately less corn simply incorporated it into a regular crop rotation scheme, which typically involved corn for two or three years, followed by cereal grains and then hay for several years. Operators who concentrated on corn usually rotated a portion of their corn land to cereal grain and legume hay every year, but because of the high proportion, corn was grown almost continuously on some fields.

It was observed that the essential distinction between the two groups related to corn storage facilities, in that a typical "corn as supplement" operation had one medium sized silo and grew only enough corn to fill it. With a silo size of 4.5 x 18 m, (capacity 273t), and an average yield of 27t/ha, this amounted to approximately 10 ha of corn. If this entire amount were grown within a 40 ha parcel it would constitute 25% of the area, and

hence the cut-off point between the two systems was set at 30% corn. These two categories were labeled "MIXED" (diagnostic criterion 1-30% corn) and "CORN" (31-90% corn).

Examination of cropping systems without corn indicated a similar gradation of intensity. In these systems hay is the dominant crop produced, and the basic difference in operations relates to the type of forage grown. Legume hay (alfalfa, clover) is a high producing, high feed value, but relatively short-lived crop, whereas grass hay (timothy, brome, orchard, red-top) produces less volume and feed value each year, but over a greater span of years. The traditional procedure for hay cropping in Eastern Ontario involves underseeding a cereal grain crop with a mixture of legume and grass hay. After the grain crop, the legume species flourish and provide good hay for several years until succeeded by the grass species. Thus the level of intensity is indicated by the quantity and quality of each species in the system.

The lowest intensity system in this group consisted of unimproved or marginally improved grass pasture and usually related to tracts of rocky, sandy, or wet land. This category was termed "GRAZING". Separation of the remainder of the forage production systems was based on the evidence of inputs to crop quality maintenance, and resulted in two categories. The first, labelled "HAY", was reserved for land parcels which showed evidence of regular reseeding of at least a portion of the hay crop, and the second, "PASTURE", included parcels in which no evidence of recent cultivation existed. For diagnosis, evidence of regular or recent cultivation included the presence of cereal grain, legume hay, or summerfallow in either 1975 or 1977. There was some difficulty in classifying areas which had once been cultivated but had become visually similar to unimproved pasture, and a further criterion of evidence of mechanical harvesting of at least a portion of the grass crop was set for PASTURE in order to differentiate it from GRAZING.

Classification of the major agricultural cropping systems resulted in six categories: HORTICULTURE, CORN, MIXED HAY, PASTURE, and GRAZING systems. A modifier (S) for any parcel which consisted of small fields (≤ 4 ha) was included for identification of areas which had not undergone the modernizing process of field enlargement typical of full-scale, intensive farm operations. A classification of "Specific Land Use Types" was also incorporated. This related primarily to the non-agricultural component of the landscape, and most of the categories were adopted from the Nepean-Gloucester classification.

Throughout the classification phase, an attempt was made to establish category differentiation on the basis of a single, definitive parameter relating to the mix and proportion of crops within a mapping unit. In the case of the lower intensity systems, further reference to crop quality or harvesting method was required to accommodate the subtle differences. However, some subjectivity was required, due to either discrepancies between aerial photo and ground survey evidence, or to practical concerns of visibility, accessibility, or aerial estimations. In order to assist and standardize these subjective evaluations, a series of "identifiers" were compiled for each category. These amounted to a description of some typical visual features of each cropping system, as well as common relationships between aerial photo and ground survey evidence. A complete account of these visual characteristics and associated identification aids for each category is presented in Appendix A. Figure 2.1 presents an outline of the legend, with a brief description of each category.

2.4.2 Field Mapping

Field work consisted of collecting land use information and compiling land ownership maps. Land ownership information, which was required for reference and selecting interview locations, was recorded from municipal (Township) tax rolls on to 1:5000 scale maps obtained from the Provincial Tax Assessor's office.

<u>Category</u>	<u>Map Symbol</u>	<u>Description</u>
<u>Cropping Systems</u>		
Monoculture	P	Continuous cultivation of corn or cereal grains (Corn >90%)
Corn	C	A mixture of corn, cereal grain(s), hay and pasture. (Corn 31-90%)
Mixed	M	A mixture of corn, cereal grain(s) hay and pasture (Corn 1-30%)
Hay	H	A mixture of hay, cereal grain(s) and pasture
Pasture	HG	A mixture of hay and pasture
Grazing	G	Permanent pasture
<u>Specific Land Use Types</u>		
Abandoned	A1	Land unused at present and supporting only weeds and grass
Scrubland	A2	Long abandoned or unproductive land with grass, weeds, and scattered trees
Forest	Z	Woodland, closed canopy and trees >6 m
Reforestation	Zr	Artificially stocked tree plantations
Swamp, Marsh	X	Wetland - cattails, reeds, etc.
Built-up	B	Non-farm buildings and associated land
Recreational	R	Campgrounds, golf courses, etc.
Extraction (Sand & Gravel)	E1	Pits and quarries and associated stockpiles and roads. May be complexed with A1 or A2 (eg. E1-A1)
Extraction (Topsoil)	E2	Topsoil removal areas and associated stockpiles and roads. May be complexed with A1 or A2
Sodfarms	S	Commercial sod production including fallow and/or cover crops
Specialty Agriculture	K	Orchards, market gardens, garden plots and berries

FIGURE 2.1

Abbreviated Legend - Land Use Systems of
Ottawa-Carleton

The field project was organized with the author as project coordinator and team leader, a second team leader, and three assistants. In preparation for field work, the study area was divided and assigned to teams on the basis of townships, contact and arrangements for space were made with each Township Clerk, and field sheets were prepared. Field sheets consisted of 1:25 000 scale, 9" x 9" black and white prints obtained from the National Air Photo Library and covered with 4 ml cronaflex. Every second photo in a flight line was used.

On most days during the field season, five persons were involved in field work; one collecting land ownership information, and two teams in vehicles. The duty of the 'mapper' was to record information on field sheets, while 'drivers' assisted with crop identification. A system of revolving team members was set up to ensure consistency, and in addition several days each month were spent checking for consistency with previously mapped areas.

Two weeks were spent on training personnel and practising mapping. Training sessions involved road and survey map reading, aerial photo interpretation, crop identification, farm practices recognition and logistics. Practice mapping sessions were conducted in various locations within the study area, and a routine of mapping which included pretyping and field survey was established. Each day prior to field work, about one hour was spent pretyping several air photos.

Pretyping refers to the act of applying the classification scheme as much as possible prior to field survey work. In this project, pretyping of the field sheets was directed toward improving the efficiency of field time by delineating and classifying land use types which could be positively identified through aerial photo interpretation, and by establishing the boundaries of mapping units for the remainder of the area. The first aspect was a straightforward procedure of identifying land use types which related to land cover, while the process of delineating land parcels was more intricate.

The basic premise of land parcel delineation was the idea that the landscape is divided into ownership units on a more or less regular basis. Counties are divided into townships and townships into concessions, lots and half-lots, to give a basic pattern of 30-40 ha parcels. A certain amount of variation in lot size, shape and arrangement was required in order to 'fit' the straight line pattern of concessions and lots to the often irregular shape of townships, but nonetheless a documented pattern of land division was imposed on the landscape. This pattern can be observed on aerial photographs, and with the aid of a land survey map (Figure 2.2), can be related to features such as roads, fence lines, and buildings (Figure 2.3). The task of pretyping was to interpret the legal survey and landscape features in order to identify and record a pattern of land parcels.

Parcel delineation was based on land cover, physiography, lot and concession lines, and subdivisions of lots in that order of precedence. Woodland and other land cover types (built-up, swamp, excavation etc.) were delimited first, followed by delineation of large tracts of other uncultivated land (Figure 2.4). All distinctions at this stage were made without regard for property boundaries. Land parcel outlines were next defined along all concession and lot lines except where aerial photo interpretation indicated that ownership (or management) extended across those lines. The most definite indicator of common management was an individual field that crossed either a concession or a lot line (Figure 2.5), but other evidence included vehicle tracks radiating from both sides of a farm lane, tracks leading from one field to another, farm building complexes straddling a lot line, and roads slightly off the lot line. In some of these cases, the land parcel boundary could be placed in the appropriate location, such as the middle of the lot or along the road.

Land parcel identification through pretyping was taken further than lot and concession line separations. Many lots are sub-divided into two or more properties, and these divisions are often expressed in ways which can be interpreted from air photos. The most frequent division of lots,

FIGURE 2.2. Land Survey Map (Planning Department, Regional Municipality of Ottawa-Carleton. Scale 1:100,000).

FIGURE 2.3. Lot and Concession Lines (Air Photo A23968-65. Scale 1:25,000).

FIGURE 2.4 Forest and Uncultivated Land (Air photo A23967-146. Scale 1:25,000).

FIGURE 2.5 Fields Crossing Lot Lines. (Air photo A23968-54. Scale 1:25,000).

particularly in active farming areas, is into two 40 ha properties, with the division either longitudinal to give two 'long hundreds' (Figure 2.6) or lateral, resulting in two 'square hundreds' (Figure 2.7). The most common evidence of the need to subdivide was the existence of two or more recognizable farmsteads within a lot. Farmsteads typically cover at least one hectare, contain several buildings, have recognizable barn-yards and lanes, show evidence of vehicle or cattle movement and are located at least 100 m from the road. If only two building complexes were present, subdivision usually occurred along a line dividing the lot in half, but separations also depended on field size and shape, fieldwork patterns, fences, and vehicle and animal tracks. Dividing lines were normally situated along continuous fence lines, and ideally were based on several observations, all of which indicated the same location. Unless land parcel limits were very explicit, subdivision into parcels smaller than 40 ha was generally left for ground verification.

Field work was performed by teams of two persons (driver and mapper) travelling all roads in light duty trucks, checking pretyped land parcel delineations, adding or erasing lines as needed, and symbolizing all parcels according to the legend. Normally only one side of a road was mapped during a clockwise pass around the smallest land area that was entirely enclosed by roads (usually five lots). The use of binoculars, frequent stops and a magnifying glass kept the need for backtracking to a minimum, but considerable practice was required in order to correlate distances, angles and objects on the ground with appropriate locations on the air photos. Since many farms extend from one concession road to another and symbolization was performed only after each parcel had been observed from all possible vantage points, a simple code of checkmarks and lower case letters was used to indicate the crops in individual fields.

Realignment, addition or removal of land parcel boundaries during field survey followed the guidelines as set out for pretyping, but evidence of the need for and the location of dividing lines more often related to temporary

FIGURE 2.6 'Long Hundreds' (Air photo A23968-130. Scale 1:25,000).

FIGURE 2.7 'Square Hundreds' (Air photo A23191-147. Scale 1:25,000).

details of the day to day routine of farm operation. Tractor tracks and clods of mud or manure leading from one location to another, the type and size of buildings and machinery, distinctive crop varieties, fence type and condition, livestock type and breed, ditches and drainage tiles and cultivating/planting/harvesting methods were all used as clues in the identification of appropriate parcel boundaries. The task was relatively easy in active farming areas as subdivisions were not widespread beyond the half-lot level, but in areas of marginal farm productivity, particularly those close to or with easy access to the city, a wide variety of property sizes and shapes made the routine more difficult. In some cases of particularly troublesome interpretations, queries to residents or landowners were used in boundary identification.

Symbolization was usually quite definitive, but several conventions were required for assistance in the case of anomalies. In situations of major discrepancies in crop mix between 1975 and 1977, the 1977 situation was considered diagnostic, while in the case of minor variation (CORN vs MIXED, or MIXED vs HAY, for instance) the procedure was to calculate proportions on the basis of two year totals. Small (<4 ha) single-field mapping units required some subjective evaluation of the 'most appropriate' category, based on landform and neighbouring systems, while distinctions between abandoned land and reforestation, or between forest, swamp, and scrubland were not considered critical.

Changes which had occurred in the landscape since the date of aerial photography were recorded on the field sheets, often with short notes designed to aid in map compilation. Features such as road construction or upgrading, transportation and communications installations, and dams and flooded areas were recorded with accuracy sufficient to allow base map revisions. Before leaving a field sheet area, a check that all areas were completely enclosed and symbolized was performed. In some cases a positive classification could not be made (fallow land, or an obviously changing situation, for example), and these areas were outlined and noted as requiring a reassessment at a later date.

Compilation of preliminary maps consisted of transferring map unit boundaries and symbols to 1:50 000 scale base maps supplied by the Cartography Section, LRRI. The transfer was performed manually, and several days of field work were required for checking. The Regional map was prepared in three sheets: West Carleton-Goulbourn-March, Osgoode-Rideau and Nepean-Gloucester-Cumberland.

2.4.3 Farm Interviews

As a means of characterizing each cropping system, a process of collecting detailed information through farm interviews was initiated. It was felt that a personal interview approach would provide better response rates, more accuracy, and more consistent completion of all questions than would a mail-in questionnaire. Interviews would also enable the surveyor to develop an intimate and working knowledge of land management, thus assisting in the selection and analysis of characterization variables, as well as contributing to the compilation of a realistic and accurate map. Personal administration of a standard questionnaire to randomly selected groups of farms was selected as the format of this phase.

The questionnaire developed for use in the interviews was based on one set up by Professor J.A. Mage of the Department of Geography, University of Guelph, for use in detailed farm typology studies (Mage, 1978), with modifications to suit the area and the objectives of the survey. The questionnaire was designed to provide a detailed examination of a farm operation under the general headings of: farm location, farm size, land use, production, farm history, farm plans, farm enterprise, capital investment, income and expenses, farm labour, off-farm work, and operator characteristics. Sufficient space for notes and comments was included in each section. A copy of the questionnaire is included as Appendix B of this report.

A rough compilation of cropping systems on the ownership maps was performed in preparation for selection of farms. All properties greater

than four ha in size were given a number (two or more properties with identical ownership were given the same number), and from these all properties that were greater than 80% "pure" in any one cropping system were selected. A minimum of 20 properties were randomly selected from within each cropping system, as that was considered the minimum number required for statistical significance. Since many properties did not contain farmsteads, a convention of choosing the nearest farm unit with the same cropping system was adopted. Completed questionnaires were categorized according to the dominant cropping system (in area) within the farm, and a daily tally of completed interviews in each system was maintained. Additional properties were randomly selected as required.

The interview phase was initiated by testing the interview procedure at several farms, after which the questionnaire was modified slightly and an interview routine was formulated. Conducting an effective interview depended on: 1) being familiar with the local area; 2) remaining calm, organized and patient; 3) understanding farm jargon and material trade names; 4) having an idea of average figures and values; 5) being familiar with farm management and operations; and 6) being totally familiar with the questionnaire. The interviewer was required to establish credibility, extract and record pertinent information during the course of a general conversation, analyse partial responses and formulate corollary questions, and recognize abnormalities and seek clarification. A great deal of adaptability and resourcefulness was also required in order to cope with different personalities, time schedules and dogs.

Training team members for interview work included presenting a detailed explanation of the purpose and intent of each question, followed by one or two days assisting and being assisted in conducting interviews. This was a particularly trying time, as the presence of two people created difficulties in establishing a rapport with farmers, but it was considered essential in maintaining a standardized approach.

Preparation for each interview was a major consideration and involved the identification of the exact farm location on the air photos, the selection of surrounding air photo coverage, and the assembly of a blank questionnaire, soil or topographic map and utensils. Prior to approaching the farmstead, a review of air photos to determine the field layout, woodlots, ditches, severances, distant buildings, lanes, roads, crops and topography was performed, followed by a visual inspection of buildings, livestock, machinery, equipment and recent changes.

Contact usually began at the house, and involved an introduction by name, agency and nature of the visit. A brief and explicit review of the assistance being requested, an assurance of confidentiality, and an indication of an alternate time were offered. In order to avoid the termination of an interview mid-way through the questionnaire, an indication of the time involved and the type of questions to expect were always expressed. Reference to soil, land, crops, or maps set the stage for the visit, while liberal use of the air photos lent an air of 'science' and 'practicality' to a project that could be considered useless or even harmful.

Each interview began with the identification, on the air photos, of all land associated with the farm. Each parcel was outlined in pen, symbolized as either owned (O) or rented (R), and connected to the home farm with leaders (Figure 2.8). The air photo work set the stage for a land use assessment, which involved recording total land area, acreage of each crop and land use type, fertilizer application rates, crop yields, and off-farm crop sales, all as recorded or estimated for 1977. In cases where this amount of detail was not forthcoming, a total on-farm fertilizer use (in tons) and a total crop production figure was considered sufficient. A quick tally of crop acreages and comparison with total acreage was carried out in order to identify gross errors or miscalculations, and notes were taken during a discussion of crop rotations and their relationship to soil, land tenure and land location.

FIGURE 2.5 Farm Location (Air photo A23968-105. Scale 1:25,000)

Consideration of the entire farm as an economic unit was initiated through a series of questions pertaining to farm history, farm plans, and livestock management. The history and plans sections were designed to identify the farmer's commitment to farming, the traditions and motivations that influence him, and his management skill and objectives, while the livestock section revealed enterprise type and characteristics such as average annual carrying capacity, turnover, and live weight production. In many cases livestock (cattle in particular) are bought and sold at irregular intervals and weights and a review of livestock purchases and sales over the past several years was required. In other cases, such as dairy and feeder operations, it was essential to determine whether herd size was expanding, declining or being maintained.

Completion of the difficult financial section of the questionnaire was considerably enhanced with pertinent questions. For example, asking for an estimate of the total market value of all machinery and equipment could elicit any response from a presumably previously considered specific value to a vehement, "A lot!". In the latter case, rephrasing the question to deal with machinery item by item usually led to a satisfactory figure. There is a fairly short and standard list of equipment associated with each type of farm, and if the interviewer initiated the process by mentioning items (tractor 1, tractor 2, seeder, combine, etc.) the calculations took little time. Usually the eight or ten major items were covered individually and all additional pieces were considered as a group. Interview and practical experience were required to prevent overlooking items such as mix-mills, manure spreaders and workshop equipment. The preview of the farm while driving in often provided additional stimulus for completing the machinery inventory.

Land and building values were also difficult to determine, but again there were several alternatives. Some farmers had a definite figure that they would ask as a selling price for their farm, while others needed some prompting with average land and farm prices. A breakdown approach

considering such things as buildings, silos and accessory systems could be used and as a last resort, building dimensions and a list of the type and age of improvements were used for comparison with other estimates and prices. The required value for both machinery and land and buildings was a fair present (1977) market value, so insured value (usually low) or depreciated value (for accounting purposes) were not considered other than as a comparison with other known values.

Queries about 1976 income and expense figures were sometimes embarrassing, but most farmers were willing to provide some information, whether it was averages, rounded figures or official, documented calculations. Other cases ranged from estimates of expenses only, to the same figure for both expenses and income, to a flat refusal of any information. At the very least a percentage difference between income and expenses, an average profit margin, or an estimate of the value of major expenditures and the source of primary income was sought. In all cases, an indication of the probable accuracy of any figures (e.g. book value, projected, or guess), the year of applicability (if other than 1976), and any anomalies were noted. With reference to total annual expenses, it was important to determine whether capital cost allowance, interest charges, and allowances for home consumption were included in figures provided. If possible, a separate estimate of those values (especially capital cost allowance) was obtained.

Farm operators usually had little problem in calculating labour figures, provided they were prompted to think in terms of seasonal applications of operator, partner, family and hired labour. A figure of 365 days per year was usual for full-time livestock-based farm operators while for cash-croppers, responses such as "full-time from seeding until harvest, half-time for the rest of the year" were common. Labour supplied by spouses and children was recorded in terms such as "2 x 8 hrs/wk, plus two full-time haying for 2 weeks" or "son-25 hrs/wk plus full-time in the summer". Hired labour was often calculated through a total dollar value and an hourly wage,

but as an alternative, "1 man, year round, every 2nd weekend off and 3 weeks holidays" or "3 students, 10 days each, plus a total of 20 man-days off and on" was adequate. In the case of part-time farmers, units of discussion were apt to be hours per day or hours per week, and in all cases, working trades with neighbouring farmers did not constitute off-farm, custom, or hired labour.

One other essential aspect of the interview phase concerned the recording of extra information in the form of notes and figures. Operators who consulted their books or who were aware of prices, rates and capacities provided an opportunity to collect information for reference in standardizing the questionnaires. For example, any farmer who supplied the unit cost, rate of application, and total cost of a pesticide compound provided a means of expanding on one of those figures given by other farmers. Notes on such things as recent enterprise, land use, or areal changes; high or low yields, expenses, income or machinery values; and abnormal labour inputs were also required.

2.4.4 Questionnaire Analysis

Standardization of questionnaire data in preparation for analysis consisted of correcting all figures for each variable to a standard unit, imputing missing information wherever possible, and measuring and recording the distribution of cropping systems and soil capability classes for each farm interviewed. It had become apparent during interviews that categorizing questionnaires on the basis of the dominant cropping system within the farm was not appropriate, as it did not necessarily reflect the land use activities of the entire farm. Conversely, socio-economic data for the entire farm did not apply specifically to one cropping system. It was essential for analysis, therefore, that questionnaires were categorized on the basis of crop acreages according to the mapping criteria. Statistical analysis relied on the assumption that socio-economic characteristics of, for example, MIXED land parcels are the same as those exhibited by farms complying with the crop mix and proportion criteria of MIXED systems.

Re-classification of questionnaires on that basis resulted in an unbalanced data set, since farms utilizing only MONOCULTURE or GRAZING practices were relatively rare. Several more days were spent in the field attempting to find and interview such operators.

Field experience had also indicated that land referred to as 'rough', 'unimproved', or 'native' pasture served distinctly different purposes in various cropping programs. Farmers who relied on an active cropping rotation rarely considered rough pasture as an integral component of their land activities. Most often, rough pasture consisted of rented land at some distance from the home farm, and only a very small portion of total on-farm expenditures were directed toward the use of that land, even though the area could comprise 50 per cent or more of total farm size. On the other hand, farmers who utilized PASTURE and GRAZING systems directed a considerable portion of their expenditures to rough pasture. In order to make socio-economic parameters reflect cropping systems as closely as possible, the concept of "worked area" was adopted. Calculations for the variable 'Workarea' included cropland and improved pasture in MONOCULTURE, CORN, MIXED, and HAY systems, and cropland, improved and unimproved pasture in PASTURE and GRAZING systems.

Statistical Analysis System (SAS) procedures (SAS Institute Inc., 1979) provided a convenient and adaptable method of handling the 67 original variables in the creation of the 50-60 interim and derived variables required for analysis. A total of 47 variables documenting such components as physical characteristics, enterprise types, productivity, capital investment levels, labour inputs, annual income and expenses, and operator characteristics were considered as essential features of Agricultural Land Use Systems. Variables used in characterization analysis are presented in Figure 2.9.

Data analysis consisted of checks for errors, calculations of summary statistics (mean, minimum, maximum, standard deviation) and tests of

PHYSICAL CHARACTERISTICS

Farm size (ha)

Percent cultivated

Percent rented

Worked area (ha)

Percent owned land CLI

Classes 1 and 2

Percent rented land CLI

Classes 1 and 2

LIVESTOCK TYPES AND PRODUCTIVITY

Number of milkers

Number of beef feeders

Number of swine feeders

Number of beef cows

Number of horses

Total Animal Units^aAnimal units^a/ha

Nitrogen on corn (kg/ha)

Yield of grain corn (m³/ha)

Nitrogen on hay (kg/ha)

Yield of hay (t/ha)

OPERATOR CHARACTERISTICS

Operator age (yrs)

Operator education (yrs)

Operator farm experience (yrs)

Time farm under this management (yrs)

Time in this enterprise (yrs)

Time farm in family (yrs)

Operator off-farm work (% of year)

ANNUAL INCOME AND EXPENSES

Gross farm income (\$)

Gross margin (\$)

Net margin (\$)

Gross income/ha (\$/ha)

Operating expenses/ha (\$/ha)

Total expenses/ha (\$/ha)

Operating expenses(% of Income)

Total expenses (% of Income)

Net margin/ha (\$/ha)

CAPITAL INVESTMENT

Total farm value (\$)

Percent land and buildings

Percent machinery

Percent livestock

Total value/ha (\$/ha)

Land and building value/ha (\$/ha)

Machinery value/ha (\$/ha)

Livestock value/ha (\$/ha)

ANNUAL FARM LABOUR

Total farm labour (pd)

Total labour/ha (pd/ha)

Percent hired

Percent operator

Percent family

Net margin/labour unit (\$/pd)

^a Animal feed unit equivalents (Weaver et al., 1956)

FIGURE 2.9 Characterization Variables

significance between means. Error searches included a number of "IF...THEN..." statements (SAS Institute Inc., 1980, p. 113) designed to check one or more variables against others, while summary statistics, calculated by the 'MEANS' procedure, provided a description of all categories for each variable. Tests of significance by Duncan's Multiple Range Test provided first, an indication of those variables which reflect most completely the distinctions made during the mapping phase and second, an outline of the similarities and differences between cropping systems. Essentially, tests of significance provide an indication of the level of confidence by which a difference between class means can be assumed to be due to inherent features of each class, rather than to chance. Thus, by establishing a level of confidence of 95 per cent, the variables which define or 'characterize' one or several categories can be determined.

CHAPTER 3.

RESULTS AND DISCUSSION

3.1 The Map

Development of the classification, data collection, compilation, and preparation of preliminary maps had been completed within a year of project initiation. Figure 3.1 presents the duration and time schedule of each of the major components of map preparation. Data collection for the map progressed at a rate of 2600-3000 hectares per team per day and compilation at approximately 4500 hectares per person per day. Complete map coverage will be available in LRRI's publication "Agricultural Land Use Systems of the Regional Municipality of Ottawa-Carleton" and a copy of the West Carleton-March- Goulbourn sheet (Figure 3.2) is included in the back cover of this thesis.

An estimate of the accuracy of the map was compiled by calculating the portion of all interviewed farms that was mapped correctly according to information given by the farmers. The overall accuracy was determined to be 84 percent, with two primary causes of error: symbolization and boundary identification. Symbolization errors occurred primarily as a result of: 1) non-conformity with model types, such as a cropping scheme with corn only every other year, 2) failure to recognize associated parcels, such as

adjacent properties under the same management and 3) incorrect crop identification, such as failure to recognize corn on aerial photos. Boundary identification was most often in error in areas of irregular lot size and shape, such as along rivers and township boundaries, and in areas of extensive lot subdivision, such as near built up areas.

3.2 Questionnaires

Farmer interviews generally required 45 minutes to 1.5 hours each, and were carried out at an average rate of 3.2 per day (for schedule see Figure 3.1). Approximately 60 percent of the farmers contacted consented to an interview, and about 50 percent of those used the previous year's tax forms or other records as a source of information. A total of 164 questionnaires, subsequently reduced to 145 due to lack of or questionable data, were prepared for analysis. Standardizing and coding information from all questionnaires required two months.

Summary statistics of all characterization variables are presented in APPENDIX C while arithmetic means of several key variables are presented graphically in Figures 3.3-3.10. Several general trends were revealed by the summary statistics, the most obvious being the decline in the size of farm operations in a progression from MONOCULTURE to GRAZING systems. All variables which reflect the scale of farming (size, total investment, total expenses, gross income, total labour) support this gradation, indicating that the most intensive systems are also the largest. Capital investment per unit area, however, shows a reversal of that trend, indicating more efficient use of capital in the larger, more intensive farms. The smaller, less intense operations have a much greater portion of total investment devoted to land and buildings. Labour use shows a trend similar to capital investment, with each unit of area requiring less labour in the most intensive systems. Economic returns per area and per labour unit indicate the corn rotation systems as superior profit makers, while the poor financial situation of the low intensity systems is rationalized by high off-farm work figures.

FIGURE 3.1 Duration and Scheduling of Inventory Procedures

FIGURE 3.3 Farm Size

FIGURE 3.4 Total Farm Value

FIGURE 3.5 Total Farm Value per Unit Area

FIGURE 3.6 Total Annual Labour Input

FIGURE 3.7 Total Annual Labour Input per Unit Area

FIGURE 3.8 Net Margin per Unit area

FIGURE 3.9 Net Return per Labour Unit

FIGURE 3.10 Operator Off-farm Work

3.3 Characterization Variables

The results of Duncan's Multiple Range Test reveals the complexity of factors associated with agricultural production. The process of analysing that complexity in order to form an understandable model of each cropping system required a review of data in two phases. The first step, and one which identified those variables which differentiate the systems to the greatest extent, was a review of the distribution of significant differences within each variable. In other words, how well did each variable distinguish between systems? The second stage dealt more specifically with characterization by concentrating on each system, identifying those variables which distinguish it from others. Both types of assessment were based on the fact that significance between any pair of class means indicates a variable which distinguishes between the two systems, while no significant difference indicates a characteristic common to both. Section 3.3 presents a review of variables, while section 3.4 presents a characterization of each cropping system.

3.3.1 Physical Characteristics (Table 3.1)

The mean size of farms, which includes the total land area of each farm, follows the land use*intensity ranking order. However, farm size is not a particularly discriminating variable in that only two groups; large (MONOCULTURE and CORN) and small (all others) are statistically differentiated. The variable 'Worked area' indicates a further significant difference between MONOCULTURE and CORN. 'Percent cultivated' fails to make any distinctions among the four most intensive systems, but it does highlight the low values of PASTURE and GRAZING, while 'Percent rented' only distinguishes the corn systems from GRAZING.

The quality of land used in each system, as measured by the proportion of owned and rented land in CLI Classes 1 and 2, makes a distinction only between MONOCULTURE and all others.

Characteristic	Cropping System (Mean)					
	MONO	CORN	MIXED	HAY	PASTURE	GRAZING
Farm size (ha)	(235.8)	(171.5)	(104.8)	(75.9)	(60.3)	(41.5)
Area cultivated (%)	(88.6)	(77.5)	(77.1)	(75.1)	(59.8)	(39.2)
Area rented (%)	(41.2)	(29.5)	(25.3)	(15.9)	(10.5)	(0.0)
Worked area ² (ha)	(210.1)	(131.3)	(76.3)	(47.9)	(37.2)	(26.8)
Owned land CLI Classes 1 and 2 (%)	(84.7)	(53.2)	(41.8)	(38.6)	(28.2)	(26.2)
Rented land CLI Classes 1 and 2 (%)	(89.2)	(45.3)	(33.0)	(28.6)	(23.4)	(No Rented Land)

Notes 1 Underlined means are not significantly different.

2 Worked area for MONOCULTURE, CORN, MIXED and HAY includes cropland and improved pasture, for PASTURE and GRAZING it includes cropland, improved and unimproved pasture. (Section 2.4.4)

TABLE 3.1 Results of Test of Significance of Class Means; Physical Characteristics.

3.3.2 Livestock Types and Productivity (Table 3.2)

Mean numbers of milk cows are dramatically higher in CORN and MIXED than in the other systems, while beef and swine feeders distinguish MONOCULTURE. Beef cows and horses are distributed almost evenly among systems, although the number of cows in HAY is higher than in CORN, GRAZING or MONOCULTURE. GRAZING has more horses than all except PASTURE. Total 'animal feed unit equivalents' (Weaver et al., 1956) distinguishes CORN from all except MONOCULTURE and livestock density (animal units per worked hectare) is almost uniform among all systems.

Application rates of commercial nitrogen fertilizer on corn are significantly lower in MIXED than in the other corn-based systems, but yields show no significant variation. Nitrogen on hay identified MONOCULTURE as high while yields distinguish only CORN from PASTURE.

3.3.3 Capital Investment (Table 3.3)

'Total farm value' follows the land use intensity ranking from highest to lowest of: MONOCULTURE, CORN, MIXED, HAY, PASTURE and GRAZING, with statistically different values in each of the first two and significant difference between MIXED and the two lowest systems. However, the distribution of total farm value and land and building value on a per-hectare basis reveals the exact opposite in that the least intensive farms have the highest values. The total value per-hectare of GRAZING and PASTURE farms is significantly higher than MONOCULTURE, while land and building value per hectare of GRAZING is significantly greater than all except PASTURE. Land and building value per hectare of MONOCULTURE is significantly less than all three grass based systems. Machinery value per hectare is low in PASTURE and GRAZING and livestock value per hectare is low in PASTURE.

Land and building values as a percentage of total farm value (per hectare) show high values in the least intensive farms, with significant differences between the corn based and the grass based systems. The portion of total farm value represented by machinery is significantly greater in

Variable	Cropping System (Mean)					
	CORN	MIXED	MONO	HAY	PASTURE	GRAZING
Milkers (number)	(50.2)	(30.2)	(6.7)	(4.2)	(0.9)	(0.0)
Beef feeders (number)	MONO (94.4)	CORN (58.5)	MIXED (5.2)	GRAZING (4.0)	HAY (1.8)	PASTURE (0.0)
Swine feeders (number)	MONO (88.9)	MIXED (1.0)	GRAZING (0.8)	HAY (0.4)	PASTURE (0.4)	CORN (0.0)
Beef cows (number)	HAY (13.5)	PASTURE (10.3)	MIXED (4.8)	CORN (3.4)	GRAZING (1.4)	MONO (0.0)
Horses (number)	GRAZING (3.2)	PASTURE (2.6)	HAY (0.8)	MIXED (0.2)	CORN (0.1)	MONO (0.0)
Animal Units ³ (Total)	CORN (127.1)	MONO (103.8)	MIXED (59.5)	HAY (26.4)	PASTURE (17.2)	GRAZING (8.3)
Animal Units ³ (units/ha)	CORN (1.0)	MONO (0.8)	MIXED (0.8)	GRAZING (0.8)	HAY (0.6)	PASTURE (0.5)
Commercial nitrogen on corn (kg/ha)	MONO (119.0)	CORN (98.5)	MIXED (67.4)			
Yield of grain corn (m ³ /ha)	CORN (0.6)	MONO (0.6)	MIXED (0.5)			
Commercial nitrogen on hay (kg/ha)	MONO (42.6)	MIXED (12.5)	CORN (12.3)	HAY (6.5)	PASTURE (2.5)	
Yield of hay (t/ha)	CORN (14.6)	MIXED (12.5)	MONO (12.3)	HAY (11.2)	PASTURE (9.1)	

Note 3: Animal feed unit equivalents (Weaver et al., 1956).

TABLE 3.2 Results of Test of Significance of Class Means; Livestock Types and Productivity.

Variable	Cropping System (Mean)					
	MONO	CORN	MIXED	HAY	PASTURE	GRAZING
Total farm value ⁴ ('000\$)	(560.6)	(441.1)	(296.6)	(190.7)	(157.0)	(106.8)
Total farm value ⁵ (\$/ha)	GRAZING (5917.0)	PASTURE (4913.5)	HAY (4417.7)	MIXED (4302.2)	CORN (3993.7)	MONO (3049.7)
Land and buildings value ⁵ (\$/ha)	GRAZING (5132.9)	PASTURE (4307.2)	HAY (3462.6)	MIXED (3088.1)	CORN (2708.1)	MONO (1980.5)
Machinery value ⁵ (\$/ha)	CORN (728.6)	MIXED (690.7)	MONO (687.1)	HAY (549.3)	PASTURE (335.5)	GRAZING (211.4)
Livestock value ⁵ (\$/ha)	GRAZING (571.6)	CORN (557.0)	MIXED (523.4)	HAY (405.8)	MONO (382.1)	PASTURE (270.8)
Land and buildings (%)	GRAZING (89.4)	PASTURE (85.7)	HAY (79.0)	MIXED (70.5)	CORN (66.7)	MONO (64.6)
Machinery (%)	MONO (25.0)	CORN (18.6)	MIXED (16.6)	HAY (11.7)	PASTURE (7.6)	GRAZING (4.7)
Livestock (%)	CORN (14.7)	MIXED (12.9)	MONO (10.4)	HAY (9.3)	PASTURE (6.7)	GRAZING (5.9)

Notes 4. Includes Land and buildings, machinery, and livestock.

5. Per worked hectare.

TABLE 3.3 Results of Test of Significance of Class Means; Capital Investment.

MONOCULTURE than in any other, while PASTURE and GRAZING are significantly lower than the corn systems. The livestock component of total farm value is fairly consistent, but it does show a significant difference between the highest (CORN) and the three lowest (HAY, PASTURE and GRAZING).

3.3.4 Income and Expenses (Table 3.4)

Gross farm income, gross margin (income minus operating expenses) and net margin (income minus total expenses) show a gradation similar to intensity, with income and gross margin significantly higher in MONOCULTURE and CORN and net margin significantly higher in CORN than in all others. Gross income per worked hectare ranks the systems in the same order as intensity, but with significant difference only between the corn based systems and the grass based systems. Operating and total expenses per hectare show the order of systems as similar to that of intensity, but values are only significantly different between the highest and the lowest. Expenses (operating and total) as a proportion of income ranks the grass systems higher than the corn systems but the difference is significant only with respect to PASTURE. Net margin per hectare ranks the corn systems highest, and the difference is significant with respect to PASTURE and GRAZING. In fact, net margin is significantly lower in GRAZING than in all others.

3.3.5 Labour (Table 3.5)

Total labour inputs per farm reflect the land use intensity distribution with the exception that CORN ranks highest. The difference between corn based systems and those based on grass is significant, as is the difference between HAY and GRAZING. Labour application per hectare does not coincide with the intensity ranking, as HAY has a significantly higher mean value than CORN, and MONOCULTURE is lower than all but CORN. The proportion of total labour that is hired is significantly higher in MONOCULTURE than in all others and the proportion that is supplied by the operator is higher in GRAZING and lower in MONOCULTURE than in the others. The proportion that is contributed by other family members does not differ significantly between systems.

Variable	Cropping System					
	(Mean)					
Gross farm income ('000\$)	MONO (123.0)	CORN (102.3)	MIXED (40.9)	HAY (9.7)	PASTURE (4.7)	GRAZING (2.5)
Gross margin ⁶ ('000\$)	CORN (37.6)	MONO (32.5)	MIXED (16.9)	HAY (1.9)	PASTURE (-0.2)	GRAZING (-1.1)
Net margin ⁷ ('000\$)	CORN (25.6)	MONO (16.2)	MIXED (10.1)	HAY (0.8)	PASTURE (-0.7)	GRAZING (-1.1)
Gross income (\$/ha)	MONO (736.7)	CORN (714.8)	MIXED (534.2)	HAY (218.0)	PASTURE (133.8)	GRAZING (101.7)
Operating expenses ⁸ (\$/ha)	MONO (561.7)	CORN (404.3)	MIXED (322.1)	GRAZING (314.3)	HAY (175.8)	PASTURE (161.7)
Total expenses ⁹ (\$/ha)	MONO (646.5)	CORN (513.5)	MIXED (411.9)	GRAZING (314.3)	HAY (202.7)	PASTURE (175.4)
Operating expenses (% of income)	PASTURE (230.7)	GRAZING (104.4)	HAY (103.2)	MONO (72.2)	MIXED (61.7)	CORN (59.8)
Total expenses (% of income)	PASTURE (237.7)	HAY (119.1)	GRAZING (104.4)	MONO (86.9)	MIXED (80.7)	CORN (75.8)
Net margin (\$/ha)	CORN (201.3)	MIXED (122.3)	MONO (90.2)	HAY (15.4)	PASTURE (-41.6)	GRAZING (-212.7)

Notes

6. Gross income minus operating expenses.

7. Gross income minus total expenses.

8. Includes annual expenditures on goods and services.

9. Operating expenses plus capital cost allowance on buildings and machinery.

TABLE 3.4 Results of Test of Significance of Class Means; Income and Expenses.

Variable	Cropping System (Mean)					
	CORN	MONO	MIXED	HAY	PASTURE	GRAZING
Total farm labour ¹⁰ (pd/yr)	(850.2)	(788.9)	(681.2)	(469.4)	(304.9)	(186.0)
Total labour (pd/ha/yr)	HAY (13.5)	GRAZING (12.9)	MIXED (9.8)	PASTURE (9.8)	CORN (8.3)	MONO (4.8)
Hired labour (%)	MONO (47.9)	CORN (18.6)	MIXED (11.3)	HAY (10.7)	PASTURE (9.7)	GRAZING (0.0)
Operator labour ¹¹ (%)	GRAZING (88.6)	PASTURE (68.4)	HAY (68.1)	MIXED (67.4)	CORN (62.2)	MONO (37.1)
Family labour (%)	PASTURE (21.9)	MIXED (21.2)	HAY (21.2)	CORN (19.2)	MONO (15.0)	GRAZING (11.4)
Net margin per labour unit (\$/pd)	CORN (27.9)	MONO (20.5)	MIXED (12.2)	HAY (1.4)	PASTURE (-5.3)	GRAZING (-6.9)

Notes 10. Includes operator, partner, family and hired labour, (person-days/year).

11. Includes operator and partner labour.

TABLE 3.5 Results of Test of Significance of Class Means; Labour.

Net margin per total labour unit shows a significant difference between the three highly ranked corn-based systems and the other three, as well as between the most profitable (CORN) and the third most efficient (MIXED).

3.3.6 Operator Characteristics (Table 3.6)

None of the variables related to operator characteristics show the systems ranked in an order similar to that of intensity. The mean age of the farm operator is significantly higher in HAY than in all except PASTURE, while operator education is higher in GRAZING than in HAY and MIXED. Operator experience is greater in HAY than in MONOCULTURE and GRAZING, and the number of years in the present enterprise is significantly greater for MIXED farms than for any other. The length of time that the home farm has been in the family is significantly higher in HAY than in GRAZING, while the length of time it has been under the present management shows no difference among systems. The percentage of off-farm work in GRAZING and PASTURE is significantly higher than that in MIXED and CORN.

3.4 Systems Characterization

It is quite obvious, from the preceeding discussion of variation within each farm characteristic, that each cropping system is unique in terms of the manner in which all factors interact to produce an Agricultural Land Use System. There are characteristics which are common to all or several systems, just as there are characteristics which distinguish one system from all others. The greatest degree of differentiation occurs at the 'corn' vs 'no-corn' level, which probably identifies a significant separation between profitable, expanding and sophisticated land use activities and marginal, declining and precarious methods of production. The following section presents a description of the Agricultural Land Use System characteristic of each cropping system.

Variable	Cropping System (Mean)					
	HAY	PASTURE	MIXED	GRAZING	MONO	CORN
Operator Age (years)	(59.1)	(53.6)	(47.8)	(46.8)	(46.2)	(44.0)
Operator Education (years)	GRAZING (13.2)	MONO (12.8)	CORN (12.0)	PASTURE (11.3)	HAY (10.8)	MIXED (9.8)
Operator Farm Experience (years)	HAY (37.9)	MIXED (30.9)	PASTURE (27.3)	CORN (26.1)	MONO (23.1)	GRAZING (22.8)
Time farm under present management (years)	HAY (22.4)	PASTURE (21.7)	MIXED (18.0)	CORN (15.5)	GRAZING (15.2)	MONO (14.2)
Time in present enterprise (years)	MIXED (32.2)	HAY (18.3)	CORN (18.1)	PASTURE (15.3)	MONO (11.3)	GRAZING (8.2)
Time farm in family (years)	HAY (52.9)	MIXED (45.4)	PASTURE (42.8)	CORN (41.4)	MONO (33.4)	GRAZING (15.2)
Operator off - farm work (% of year)	GRAZING (45.6)	PASTURE (40.7)	MONO (22.7)	HAY (22.2)	MIXED (7.5)	CORN (2.5)

TABLE 3.6 Results of Test of Significance of Class Means; Operator Characteristics.

3.4.1 Monoculture.

Farms associated with this cropping system specialize in corn production, cultivating that crop continuously on the same fields for many years. They are usually large operations (236 ha), often consisting of numerous scattered properties, and relate to cash crop, or beef or hog feeder enterprises. Prime farmland is used almost exclusively, but high commercial fertilizer use results in only average ($0.6 \text{ m}^3/\text{ha}$) corn yields. MONOCULTURE farms are characterized by a low (65%) proportion of total investment devoted to land and buildings, and a high (25%) proportion to machinery. Land and building value per hectare is low, while machinery and livestock values per hectare are comparable to other systems. Gross income per hectare is high (534 - 737 \$/ha), as in all corn systems, but high expenses in MONOCULTURE farms result in only average (90 \$/ha) net margins. However, the size of these farms result in fairly high (\$16,000) net farm returns. This system is significant in the high proportion (48%) of labour hired and in the high level of labour efficiency, as indicated by low (5 pd/ha/yr) labour application rates and moderate (20 \$/pd) net returns to labour. MONOCULTURE is not unique in any operator characteristic considered, but it is associated with a moderate amount of operator off-farm work.

3.4.2 Corn

This system relates primarily to a rotational cropping program involving corn for several (5-7) years, followed by cereal grain, legume hay (3-5 years) and then corn again. Farms are typically large dairy or beef feeder operations and prime land, though dominant within such a farm, does not constitute significantly higher proportions than in other systems. High rates of commercial nitrogen fertilizer application (98.5 kg/ha) are used on corn, and average corn and hay yields are obtained. These large farms have a high (\$441,000) mean farm value, but a low (67%) proportion in land and buildings. Per hectare investment levels are generally comparable to the

other corn based cropping systems. Farms classified as CORN have a high mean income per hectare (\$715) and high total expenses (\$514/ha) but they show higher net margin per farm (\$25,600) and net margin per hectare (\$201) than any other system. Total labour use, consisting of moderate proportions of hired labour, is high (850 pd/yr) while per hectare labour application is similar to other systems. However, net return to labour (\$28/pd) is high. Operator characteristics of this system are not significant, but many farms are managed on a partnership basis, and off-farm work among the operators is low.

3.4.3 Mixed

Farms which utilize this cropping system are probably best described as 'average', as no physical characteristics are unique. However, in terms of size they are similar to the grass based systems rather than to the other corn systems. Typically MIXED farms rely on a crop rotation of corn (2-3 years), cereal grain (1 year), legume hay (3-7 years), and corn again, with the additional use of grass hay and/or pasture. CLI Classes 1 and 2 land usually form a portion of their land base, but in a proportion similar to all except MONOCULTURE. MIXED systems are characterized by medium sized (30 milker) dairy herds. Low levels (67.4 kg/ha) of commercial nitrogen fertilizer are sufficient to maintain corn yields at a level comparable to other systems. A moderate (\$296,600) total farm value is distributed amongst components in a manner similar to CORN and MONOCULTURE, while per hectare values are similar to all systems. Income and expense figures for MIXED fall approximately mid-way between the high values of MONOCULTURE and CORN, and the low values of HAY, PASTURE and GRAZING. Gross farm income is relatively low, but net margin per farm is significantly higher than the grass systems. On a per-hectare basis, income and expenses of MIXED farms are similar to those of CORN, resulting in a high (\$122) net margin per hectare. Total farm labour inputs are moderate but significantly higher than the grass-based systems, while the proportion of labour hired is comparable to all except the high value of MONOCULTURE. Labour application

rates (pd/ha/yr) are not distinctive for MIXED systems, and net return to labour is moderate and less than CORN. MIXED farms are distinctive in the length of time in the present enterprise, but not in other operator characteristics. Off-farm work is low.

3.4.4 Hay

The most productive of the non-corn systems, farms in this category use a traditional cropping program of hay and pasture, with periodic reseeding using a cover crop of cereal grain. Beef cow-calf operations are the most common, although several small dairy herds in the Region are maintained using this cropping system. Farm size is average (75 ha), and land quality is evenly distributed amongst all classes, except for the small amount of rented land which often consists of mainly poor agricultural land. Commercial fertilizer use on hay is average (6.5 kg/ha) and yields are average. Total farm value is low (\$190,700) and distributed somewhat heavily toward land and buildings in a manner similar to the other grass systems. Gross income and expenses and gross and net margin per farm are low, as are the per-hectare values, and HAY farms typically show a marginally positive net margin per hectare (\$15.38) and per farm. Total labour inputs per farm are low and the proportion that is hired is consistent with all systems except MONOCULTURE. Total labour applied per hectare is high (13.5 pd/ha/yr), but net margin per labour unit is low (\$41/pd). Farms of the HAY system are typically managed by older operators (59.1 yrs.), who perform a moderate amount of off-farm work.

3.4.5 Pasture

This system, which is relatively rare in the Ottawa-Carleton Region, represents a low level of intensity in that reseeding of hay crops is done only sporadically if at all. Farms are relatively small (60.3 ha), but land quality is not significantly lower than any system except MONOCULTURE. Beef

cows are prevalent and horses are often present. Moderate amounts of commercial fertilizer are used, but hay yields are not distinctive. A low (\$157,000) total farm value is distributed heavily (85.7%) toward land and buildings, and per hectare figures indicate a high concentration of land and building investment and low machinery values. Total and operating expenses per hectare are low, but gross income is also low and PASTURE farms exhibit a negative net margin (-\$41.63/ha). Total labour inputs are low, but labour inputs per hectare and the percentage of labour that is hired are consistent with those of most systems. However, net margin per labour unit is usually negative. Operator age is high (53.6 yrs) and the incidence of permanent off-farm work is high.

3.4.6 Grazing

The pasturing of livestock on native grass or old hay is a common occurrence in Ottawa-Carleton, but in most cases the practice represents a subsidiary portion of a more intensive operation. The few farms in which, GRAZING describes the sole land use activities generally relate to small (41.5 ha) 'hobby' operations based on a few beef feeders or, more often, horses. The entirely owned land of these farms does not correspond to particularly good or poor land, and production is based on natural conditions of growth and regeneration. Total per farm capital investment is low, (\$106,800) and mainly (89.4%) related to land and buildings. On a per-hectare basis land and building value is inordinately high, while machinery value is very low. Per hectare livestock values are quite similar to most other systems, due primarily to a few highly valued horses. Total and operating costs per hectare are not significantly higher, and income per hectare is not significantly lower than HAY and PASTURE systems, but the difference is enough to create a net margin situation which is dramatically low (-\$212.68/ha). As a result, farms in this category generally operate with substantial economic deficits. The small size of GRAZING farms require a low total labour input which is entirely supplied by the operator and his family, but on a per hectare basis labour inputs fall within the range of

most other systems. However, net returns to labour are very low (-\$6.89/pd). Operator characteristics are not definitive, although operator off-farm work is practically universal in this group.

3.5 Summary

Characterization of cropping systems demonstrates quite clearly the socio-economic features associated with each level of land use intensity. Some variables used in the analysis show almost no difference among systems, while others distinguish dramatic differentiation. Generally, economic characteristics reveal a strong contrast between cropping systems which include corn and those which don't, physical and labour characteristics contrast MONOCULTURE from all others and operator characteristics fail to show strong associations. In addition, many variables reveal further separations within these groups. In most cases the rank order of mean values is either the same as or directly opposite to the intensity ranking, but several variables (notably operator characteristics) do not conform to that order.

High intensity agricultural land use in the Regional Municipality of Ottawa-Carleton is associated with large farms with a high proportion of corn, high quality land, high total farm value, income and expenses, and specialized livestock production. Capital investment is weighted heavily toward machinery and fertilization is high, but corn yields are not relatively high. High intensity cropping systems are financially efficient, showing low capital investment and labour applications per hectare and high net margins per hectare and per labour unit. The large size and high net margins associated with these farms produce dramatic net farm revenues.

Low intensity cropping systems are characterized by small farms, diverse crop production routines, low farm values, low incomes and mixed livestock types. Capital investment is concentrated in land and buildings.

Farms in the group are financially marginal due to low incomes, and many show a net loss per farm, per hectare and per labour unit. Low intensity cropping is often associated with operator off-farm work.

CHAPTER 4.

CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The methodology of agricultural land use inventories as presented here was prepared in order to provide a workable routine of collecting, analyzing, and presenting information pertinent to rural land use planning. The original design and objectives of the research focussed on alleviating perceived limitations of more traditional 'land cover' and 'Census-data' maps and reports. Specifically, those limitations related to: 1) time specificity; 2) lack of socio-economic comparisons; 3) lack of consideration for management units; 4) unrealistic map unit boundaries; 5) lack of detail; and 6) location specificity. The present methodology proposed a map of land use intensity as indicated by cropping systems, supported by category characterization through detailed farm interviews.

It is evident that the success of this methodology depends to a considerable degree on the knowledge and experience of at least one individual. This is particularly so in the classification stage, when inherent features of agricultural activities must be recognized and interpreted in the field. Crop types, cultivation patterns, topographic

features, machinery, livestock and buildings all provide clues as to the relative level of land use intensity, and these clues are used in an agglomerative fashion to group the myriad of possibilities into a limited number of distinct categories. Familiarity with agricultural practices is also essential in order to initiate and conduct effective landowner interviews.

The expression 'land use intensity' as employed in this thesis can best be defined as the degree of alteration of the natural state undertaken to increase the productivity of a given area. For a small area and a single growing season, intensity is adequately expressed by the type of crop grown, but for larger areas and/or longer time periods intensity is a function of the distribution and frequency of different crops in a long term cropping routine. Cropping systems were identified and described on the basis of the mix and proportion of crops over a span of several years, and hence reflect land use intensity.

A number of characteristics of properties were identified as critical determinants of agricultural land use activities. Two of the most important: soil quality and physical barriers, were assessed on aerial photos and in the field in order to subdivide properties into land parcels which reflect actual land management units. The success of this procedure is attested to by the map accuracy, which shows that errors due to both boundary identification and symbolization resulted in an overall error rate of only 16 percent.

Classification of cropping systems on the basis of criteria related to land use intensity also reflects significant differences in social and economic characteristics. Each system is not significantly different from all others in all of the 47 variables considered, but similarly no two systems are alike in all ways. The greatest degree of differentiation occurs between systems with corn (MONOCULTURE, CORN, MIXED) and those without (HAY, PASTURE, GRAZING) while HAY and PASTURE exhibit the greatest degree of similarity. Generally, farm size, animal density, machinery value, income, expenses and net margin vary directly with intensity; land and building value per hectare and labour input per hectare vary inversely; and operator characteristics show no variation.

The mapping component of this inventory appears well suited to regional, planning oriented surveys. With only the simplest of tools (air photos, vehicles, light table) five workers were able to prepare a 1:50,000 scale map of 276 000 hectares in one field season. The techniques employed do not require specialized personnel, although a farm background and geographical training are beneficial. The validity of this map over a period of years could not be determined quantitatively, but reaction from farmers seems to indicate a relatively high degree of stability in cropping systems. However, change is inevitable, and land sales, construction, new crops and economic changes are bound to render the map out of date. It seems that 10 years of applicability is quite reasonable for a cropping systems map.

Clearly, cropping systems provide an excellent venue for both mapping purposes and socio-economic characterization. Although the degree of success in attaining all objectives as set forth for this methodology could not be absolutely ascertained, the results of this experimental effort indicate that minor refinements in techniques will produce a reliable and valuable inventory procedure.

Several problems associated with the technical operation of the inventory were encountered, but rather than jeopardize the use of the methodology, their occurrence provided the means of suggesting improvements for subsequent applications. Briefly, these problems related to: the need for selective remapping in light of later discoveries, difficulties in accomodating a random sample with efficient interviewing procedures, uneven subsample sizes, and map error. Suggestions for avoiding or alleviating these difficulties are presented in the final section.

4.2 Recommendations

Problems encountered during the survey were essentially the result of the experimental nature of the project and hence the experience gained can provide suggestions for their solution. It is an underlying objective of methodological research to build an improved routine through analysis of mistakes.

4.2.1 Recommendation 1. Sampling

The statistical bias presumably incorporated through personal selection of a nearby farm in replacement for a randomly chosen site which proved unavailable could be reduced by stratification of the total population according to township (or other applicable area) as well as by cropping system. The rationale for that approach relates to efficient use of field time, as excessive travel seriously reduces success. In other words, the surveyor must complete all interviews within a relatively small area before moving on. Hence a required number of interviews in each area must be established, and random selection within that area must be facilitated. However, some degree of personal selection must be permitted, as the difficulty in contacting farmers stipulates that an interview must be conducted if and when the opportunity arises.

4.2.2 Recommendation 2. Class Size

In order to reduce the class size variation experienced in this study, a procedure of priority interviews must be established. As determined during legend development and supported by interviews, many farmers utilize different cropping systems on separate land parcels. Therefore, parcels mapped as one system may be a portion of a farm which is classified differently for statistical analysis. Hence high priority in the form of persistence must be accorded to the least abundant systems, as a portion of those contacts will result in observations for other systems. Consequently, more time can be devoted to the less efficient task of interviewing rare farm types.

4.2.3 Recommendation 3. Map Error

The 16 percent error indicated for the map was caused to a considerable extent by the inability of the mappers to identify common management for separate land parcels. Prior knowledge of the tenure situation would reduce this problem, and it is suggested that land ownership information be acquired as the initial step in map work.

4.2.4 Recommendation 4. Contact with Landowners

Experience in Ottawa-Carleton indicated a basic requirement which cannot be overstressed; the need for early and consistent farmer contact. From legend development to characterization, the proper interpretation of results is dependent on a thorough understanding of farm management and cropping practices in the area. Without that dedication to detail, the exercise is liable to be compromised.

4.3 Further Research

The results of this study are sufficiently encouraging to warrant continued efforts to improve and expand the methodology. It is the author's opinion that this research proceed in two directions; testing the methodology in other agricultural settings, and adapting it to other sources of data. The first of these objectives can be accomplished by simply duplicating the procedure in areas dominated by other crops (fruit, vegetables, grain, for example), while the second requires some innovation. It seems likely that a similar methodology could be applied at a much smaller scale using remote sensing imagery and classes derived from combinations of cropping systems. Adaptation of field trial or Census data could reduce the need for such extensive interviews.

Finally, the author feels that a review of user requirements and survey results, such as has been undertaken for soil survey information (Ault, 1978) is of critical importance in realizing the full potential of Agricultural Land Use Systems information.

LIST OF REFERENCES

- ARDA, 1965. The Canada Land Inventory. Objectives, Scope and Organization. The Canada Land Inventory, Report No. 1, Department of Forestry, Publication No. 1088, Ottawa.
- Ault, Alla Margaret Weeks, 1978. Soils Information and Ecological Land Use Planning: A Case Study of the Regional Municipality of Ottawa-Carleton. M.A. Thesis, Department of Geography, Carleton University, Ottawa, Canada.
- Baker, Oliver E., 1926. Agricultural Regions of North America. Economic Geography, Vol. 2, No. 4, pp. 459-493.
- Barlowe, Raleigh, 1958. Land Resource Economics - The Political Economy of Rural and Urban Land Resource Use. Prentice-Hall, Inc., Englewood Cliffs, N.J.
- Beek, K.J., 1978. Land Evaluation for Agricultural Development. International Institute for Land Reclamation and Improvement (ILRI) Publication 23, Wageningen, The Netherlands.

Bull, G.B.G., 1956. Thomas Milne's Land Utilization Map of the London Area in 1800. *Geographical Journal*, Vol. CXXII, Part 1, pp. 25-30.

Burghardt, Andrew, 1981. The Survey Methods. *Canadian Geographer*, XXV, 1, pp. 77-93.

Clawson, Marion, and Charles L. Stewart, 1965. Land Use Information. A Critical Survey of U.S. Statistics Including Possibilities for Greater Uniformity. Resources for the Future, Inc., The Johns Hopkins Press, Baltimore, Maryland, U.S.A.

Coote, D.R., J. Dumanski, and J.F. Ramsey, 1981. An Assessment of the Degradation of Agricultural Lands in Canada. L.R.R.I. Contribution No. 118, Research Branch, Agriculture Canada, Ottawa.

Cornwall, Brooke, 1956. A Land Use Reconnaissance of the Annapolis-Cornwallis Valley, Nova Scotia, *Geographical Bulletin* 9, pp. 22-51.

Darby, H.C., 1970. Domesday Book - The First Land Utilization Survey. *The Geographical Magazine*, Vol. 42, #6, pp. 416-423.

Duckham, A.N., and G.B. Masfield, 1970. Farming Systems of the World. Chatto and Windus Ltd., London.

Dumanski, J., and R.B. Stewart, 1981. Crop Production Potentials for Land Evaluation in Canada. Research Branch, Agriculture Canada. Minister of Supply and Services, Canada.

Forward, Charles, N., and Charles W. Raymond, 1959. Small-scale Land Use Mapping from Statistical Data. *Economic Geography*, Vol. 35, No. 4, pp. 315-321.

Geographical Branch, 1960. Southern Ontario - Land Use Series S1, Scale 1:1,000,000 (Map). Department of Mines and Technical Surveys, Ottawa.

- Gierman, D.M., 1976. Rural Land Use Changes in the Ottawa-Hull Urban Region. Occasional Paper No. 9, Lands Directorate, Environment Canada.
- Hartshorne, Richard, and Samuel N. Dicken, 1935. A Classification of the Agricultural Regions of Europe and North America on a Uniform Statistical Basis. Annals of the Association of American Geographers, Volume XXV, Number 2, June, pp. 99-120.
- Hoffman, Douglas, W., and Henry F. Noble, 1975. Acreages of Soil Capability Classes for Agriculture in Ontario. ARDA Report No. 8, Rural Development Branch, Ontario Ministry of Agriculture and Food and Department of Regional Economic Expansion, Canada.
- Hudson, S.C., R.A. Stutt, Wm. Van Vleit, and J.L. Forsyth, 1949. Types of Farming in Canada, Minister of Agriculture, Publication 825, Farmers Bulletin 157.
- Huffman, E.C. and J. Dumanski, 1978. Land Use in Nepean and Gloucester Townships, Regional Municipality of Ottawa-Carleton, Ontario. In Report No. 47, Ontario Soil Survey, 1979.
- Irving, R.M. 1957. Factors Affecting Land Use in a Selected Area in Southern Ontario, (Louth Township, Lincoln County). Ontario Department of Agriculture.
- James, F. Maclaren, Ltd., 1976. Countryside Planning, A Pilot Study of Huron County. Ministry of Housing, Ontario.
- Jankowski, Wojciech, 1975. Land Use Mapping - Development and Methods. Polish Academy of Sciences, Institute of Geography and Spatial Organization, Geographical Studies No. 111. Poland.
- Jones, Wellington D., and V.C. Finch, 1925. Detailed Field Mapping in the Study of the Economic Geography of an Agricultural Area. Annals of the Association of American Geographers, Volume XV, pp. 148-157.

Krueger, Ralph, R., 1960. Changing Land Uses in the Niagara Fruit Belt. Geographical Bulletin 14, pp. 5-24.

Laut, Peter, 1974. A Geographical Analysis and Classification of Canadian Prairie Agriculture. Department of Geography, University of Manitoba, Winnipeg.

Lee, Chun-fen, 1944. Land Utilization in the Middle Grand River Valley of Western Ontario. Economic Geography, Vol. XX, No. 2, pp. 130-151.

Lewis, A.B., 1934. Methods Used in an Economic Study of Land Utilization in Tompkins County, New York, and in other Similar Studies in New York. Cornell University, Agricultural Experiment Station, Memoir 160, Ithaca, New York.

Mage, J.A., 1978. Development of a Scheme of Agricultural Typology for Canadian Conditions. Report prepared for Soil Research Institute, Agriculture Canada. Department of Geography, University of Guelph.

Marshall, I.B., J. Dumanski, E.C. Huffman, and P.G. Lajoie, 1979. Soils, Capability and Land Use in the Ottawa Urban Fringe, Ontario Soil Survey Report No. 47. Research Branch, Agriculture Canada and the Ontario Ministry of Agriculture and Food.

McArthur, I.S., and J. Coke, 1939. Types of Farming in Canada. Dominion of Canada, Department of Agriculture, Publication 653, Farmers Bulletin No. 77.

McClellan, J.B., 1965. The Land Use Sector of the Canada Land Inventory. Geographical Bulletin, Vol. 7, No. 2, Geographical Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

Nicholson, Norman L., 1955. Rural Settlement and Land use in the New Glasgow Region. Geographical Bulletin 7, pp. 38-64.

Nicholson, N.L., I.H.B. Cornwall and C.W. Raymond, 1961. Canadian Land Use Mapping. Geographical Paper No. 31, Geographical Branch, Department of Mines and Technical Surveys, Ottawa.

Ontario Ministry of Agriculture and Food, 1976. Agricultural Statistics for Ontario, 1976. Statistics Section, Economics Branch, Ontario Ministry, of Agriculture and Food, Publication 20.

Raymond, C.W., 1960. Agricultural Land Use in the Upper Saint John River Valley New Brunswick. Geographical Bulletin 15, pp. 65-83.

Reeds, L.G., 1946. Land Utilization in Central Ontario. Economic Geography, Vol. 22, pp. 289-306.

Ryerson, Robert A., and David M. Gierman, 1975. A Remote Sensing Compatible Land Use Activity Classification. Technical Note 75-1, Canada Centre for Remote Sensing, Department of Energy, Mines and Resources, Ottawa.

SAS Institute Inc., 1979. SAS User's Guide. SAS Institute Inc., Cary, North Carolina.

Sauer, C.O., 1919. Mapping the Utilization of the Land. The Geographical Review, Volume VIII, pp. 47-54.

Sauer, C.O., 1924. The Survey Method in Geography and Its Objectives. Annals of the Association of American Geographers, Volume XIV, pp. 17-33.

Scace, Robert C., 1981. Land Use Classification Systems: An Overview. Working Paper No. 14, Lands Directorate, Environment Canada.

Simpson-Lewis, Wendy, Jennifer E. Moore, Nancy J. Pocock, M.C. Taylor, and Hedley Swan, 1979. Canada's Special Resource Lands: A National Perspective of Selected Land Uses. Map Folio No. 4, Lands Directorate, Environment Canada, Ottawa.

- Stamp, L. Dudley, and E.C. Willatts, 1934. The Land Utilization Survey of Britain. An Outline Description of the First Twelve One-Inch Maps. London School of Economics (University of London).
- Stamp, L. Dudley, 1948. The Land of Britain. Its Use and Misuse. London, Longmans, Green and Co. Ltd.
- Stamp, Sir Dudley, (ed), 1966. A Glossary of Geographical Terms. L. Dudley Stamp, William Clowes and Sons, Limited, London and Beccles.
- Statistics Canada, 1978a. 1976 Census of Canada, Agriculture, Graphic Presentation. Catalogue 96-871, Minister of Supply and Services, Canada, Ottawa.
- Statistics Canada, 1978b. 1976 Census of Canada, Volume 12, Agriculture, Ontario. Catalogue 96-806, Minister of Supply and Services, Canada, Ottawa.
- Stewart, A. and W.D. Porter, 1942. Land Use Classification in the Special Areas of Alberta and in Rosenheim and Acadia Valley. Dominion of Canada - Department of Agriculture, Publication No. 731, Technical Bulletin No. 39.
- Troughton, Michael, J., 1975. Crop and Socioeconomic Types for Canadian Agriculture. Proceedings, American Association of Geographers, Volume 7, pp. 252-256.
- Van Valkenburg, S., 1950. The World Land Use Survey. Economic Geography, Vol. 26, No. 1, pp. 1-5.
- Veatch, J.O., 1941. Agricultural Land Classification and Land Types of Michigan. Special Bulletin 231, Michigan State College, East Lansing, Michigan.

Vink, A.P.A., 1975. Land Use in Advancing Agriculture. Springer-Verlag, Berlin. Heidelberg, Germany.

Weaver, John C., 1954. Crop-Combination Regions in the Middle West. The Geographical Review, Volume XLIV, Number 2, pp. 175-194.

Weaver, John C., Leverett P. Hoag, and Barbara L. Fenton, 1956. Livestock Units and Combination Regions in the Middle West, Economic Geography, Volume 32, pp. 237-259.

Whitaker, J.R., 1938. Agricultural Gradients in Southern Ontario. Economic Geography, Vol. 14, No. 2, pp. 109-120.

Whittlesey, Derwent S., 1925. Field Maps for the Geography of an Agricultural Area. Annals of the Association of American Geographers, Volume XV, pp. 187-191.

Wood, Harold, A., 1956. The St. Lawrence Seaway and Agricultural Geography in the Cornwall-Cardinal Area, Ontario. Geographical Bulletin 9, pp. 74-98.

1314

APPENDICES |

APPENDIX A

MAPPING LEGEND - LAND USE SYSTEMS OF OTTAWA-CARLETON

Cropping Systems

Monoculture, symbol 'P': continuous cultivation of corn or cereal grain, with little or no crop rotation. Corn and/or grain occupies greater than 90% of area in both 1975 and 1977. Parcels with less than 90% corn in 1975, but characteristic of monoculture system in 1977 are included. Usually large fields (>8ha), planted fencerow to fencerow (although actual fences are often absent) with patches of native grasses and sedges in excessively wet areas. Usually on good clay-loam soil, flat topography, no stones. Patches not sown to corn are unused rather than in hay or pasture. Older farm buildings within a parcel of this system are often unused and in poor repair, while active building complexes tend to be large grain storage and drying facilities, feedlots, or hog operations.

Corn, symbol 'C': associations of corn, cereal grain, hay and pasture, with corn comprising between 30 and 90% of total area. Corn area is 30-90% in either 1975 or 1977, with remainder of area in grain or hay and only a small amount of pasture, if any. Fields are generally large and fenced, but may be divided into two different crop areas. There is usually some change in location of crops between 1975 and 1977. That is, part of 1975's corn

acreage will be in hay or grain and some or all of 1975's hay acreage will be corn in 1977. In parcels where corn area is in the top of the range (75-90%) remainder of area may be all grain or all hay. Because of the crop proportions, some of the 1975 corn will also be corn in 1977. Hay is usually good quality alfalfa, and often shows evidence of chopped forage harvest. Air photo interpretation (A.P.I.) usually shows smooth, evenly textured fields, with a distinct difference between the light-toned fields of corn and the darker grain and hay. The system is usually on good, fairly level land and often has drainage ditches as field boundaries. Fields tend to be uniform in crop quality and generally weed free, and associated buildings are usually large, modern dairy operations. As with the monoculture system, parcels may contain old, unused farm buildings in poor shape. There may be instances of this system with quite different visual characteristics (i.e. small, treelined fields on rolling topography), but the crop mix and proportion is the same.

Mixed, symbol 'M': associations of corn, cereal grain, hay and pasture, with corn comprising up to 30% of total area. Hay is usually dominant in area and of good quality, but there must be evidence of corn in either 1975 or 1977 or both. Field size tends to be medium (4-8 ha) to small (4ha), and as such there are generally more fields within a given land area than is the case with either Monoculture or Corn systems. Field boundaries are often tree-lined, with good fences. The primary distinguishing feature of this system is the mix of crops, which are scattered in a somewhat random pattern within the land parcel. A.P.I. shows a variety of different patterns and tones from field to field, but each field is generally smooth textured and uniform. There is usually some change in crop location between 1975 and 1977. Pasture is included within the system except where a soil or topographic boundary indicates a land parcel of 'Grazing'. This system may occur on a variety of soil/land types, so visual characteristics may vary considerably. In some cases this system may involve continuous corn on one or two fields with grain, hay and pasture on the rest. Pasture in some form is almost always present, and often the property will contain a woodlot that may be grazed. In areas of good soil, fields have the clean, consistent, weed-free appearance of those in the Corn system, but in poorer areas crops may be quite variable. Mixed systems are

usually associated with older, traditional buildings (large, two storey frame, hiproofed barns) that have major improvements such as silos, steel grain bins, machine sheds, milk houses and stable cleaners. Unused farm buildings on the property are rare. Dairy farms and cow-calf operations are common.

Hay, symbol 'H': cereal grain, hay, and pasture in rotation. Hay is dominant, corn is absent, and evidence of grain cultivation and/or hay reseeding is present in either 1975 or 1977. This system is a slightly scaled down version of the Mixed system in that no corn is grown. Hay is usually good quality, often alfalfa or clover, which requires periodic reseeding with a cover crop of grain. Field size is medium to small, and a land parcel of this system may be comprised of one field only (hobby farms, forest indentations). Fence lines are often treed and usually cattle proof. A.P.I. of good quality land shows a smooth textured mix of two or three tones in separate fields, usually with machinery patterns and cattle tracks. This system is often associated with forest and poor quality land, and in these cases A.P.I. shows wet areas in fields and evidence of physiographic variation across the landscape. This is a traditional cropping system and as such is associated with large frame barns, usually without major improvements. It is particularly prevalent in areas characterized by estate development and hobby farms. As in the Mixed system, land parcels with a significant soil quality variation may show hay on the best land and pasture on the rest. In these cases, the hay and pasture may not be rotated regularly, but the hay shows signs of being periodically reseeded, (grain crop or good stands of alfalfa or clover).

Pasture, symbol 'HG': hay and pasture, but without crop rotation. This system is based on the utilization of established stands of grass for both hay and pasture. A very low intensity system, with the harvest of hay being the primary activity. There is no evidence of grain or hay reseeding in recent years, and as such, the fields are dominantly perennial grass (timothy and brome) and usually contain noticeable weeds and native vegetation. Usually the best fields are mechanically harvested once per year and then pastured, so by July or August the entire parcel may be pastured. The proportion of crops may vary, but usually about 50% of the

area is in hay and the rest is pasture. Fence lines are often original (trees, rails, stones), but are usually animal-proof. Fields tend to be small (4 ha) and often irregularly shaped to correspond to physical land characteristics. A.P.I. shows very little tonal difference from field to field, but textural differences between the smooth hay fields and rougher pasture may be discerned. Physiographic features such as low, wet areas, seasonal streams, and stratigraphic patterns are often visible on the air photos. This system is characteristic of marginal soil and as such is often associated with forest and/or abandoned fields. Pasture systems generally present an unkempt appearance due to the lack of inputs, and often show irregularly shaped land parcels due to new houses, forest, and scrubland. Farm buildings on this system are usually old frame structures, often in poor condition, or small aluminum or frame barns, often brightly painted. The pasture system is characteristic of urban-oriented rural areas (hobby, part-time farms) and often have a new house located on the property. This system may occur in areas of good land, in which case they are quite noticeable by the contrast with intensive farms nearby.

Grazing, symbol 'G': livestock grazing on permanent or native grass pasture. Visually, this system is characterized by perennial grass species, often with numerous weeds and native shrubs, and show very little evidence of machine activity. Land parcels of this system are bounded by animal-proof fences, but fence lines within the parcel are usually in poor repair and trampled by livestock. Grazing parcels often consist of small fields bounded by tree-lined stone or rail fences. Along the fence rows and in the fields are usually bare of branches three meters, and patches of bare, trampled earth surround the base of individual trees. Exterior fences are usually paralleled closely by paths, and fallen trees and branches remain lying in the field. The ground surface is often hummocky, particularly in wet areas, and the vegetation shows scattered patches of tall weeds and grass intermingled with close cropped grass areas. This system is usually associated with a lot of trees, and woodlots are open and trampled. A.P.I. shows a rough textured, gray tone for all fields, and cattle tracks and water holes are usually evident. Fields may be dotted with trees, naturally wet areas are usually visible as dark patches, and stratigraphic patterns are visible. Parcels of this system are

often of irregular shape due to the presence of forest, swamps, built-up areas, abandoned land and scrubland. They may consist of a large area of numerous fields, or they may be a single field of a hobby farm. The Grazing system may occur anywhere in the landscape, but it is more prevalent in marginal to poor land areas. On good soil the system is usually a single property with straight boundaries. Buildings range from old frame barns, to new, small frame or aluminum structures, often with a new house. In areas of very poor land the grazing system consists of natural rangeland, and parcel boundaries tend to follow natural features (rock outcrops, steep slopes, etc). In this case internal fence rows are usually non-existent, trees and forest are plentiful, and grass vegetation is sparse and native. These cases are rarely associated with any but abandoned buildings and are often quite remote.

Systems Modifier: the suffix 'S' is used to indicate small fields. In the original clearing and organization of farms, each property was usually divided into fields to accommodate different crops and livestock activities. Traditionally, a 100 acre property was divided into ten, 10-acre fields, with trees and fences between those fields. With the general expansion of farms and the acquisition of larger machinery, these ten-acre fields hindered the efficient use of implements in that excessive turning was required. "Snake" rail fences and trees also require a wide area, so modern farmers have cleared many of these fence lines, creating fields of from 10 to 80 hectares or more. The "S" modifier is used to indicate parcels in which fence line removal has not taken place, thus identifying areas of more traditional farming practices. The characteristic of small fields is generally associated with areas of marginal soil quality and usually with Hay, Pasture, and Grazing systems.

Specific Land Use Types

Abandoned Land, symbol 'A1': abandoned farmland. Land that has been farmed at some point in the past, but is now lying idle. This category is restricted to land that shows no woody growth (willows, trees, shrubs, etc.), but instead is characterized by tall grass and weeds. There is no

evidence of agricultural use at present, but fences and fence rows are still visible. Machinery patterns may still be visible on the ground or on air photos, but they are quite subdued. There is often vehicle tracks, either from the transport of farm machinery across the land or from recreational type activities such as 4-wheel drive, dirt bikes or snowmobiles. This category may comprise a large parcel of numerous fields, or it may be a single field, fairly smooth textured, with natural physiographic features visible. Ground checks must be done in order to distinguish A1 from hay or pasture. In some cases, 1975 may show signs of harvesting or cultivation, but 1977 reveals uncut weeds and grass. In this case, a ground check after haying season is warranted, and designation is based on that visit. This category is prevalent in poor soil areas and is often associated with a new or renovated house and an unused old barn. Boundaries of A1 map units often follow natural features such as forest edge on one or two sides and property boundaries on the others.

Scrubland, symbol 'A2': unused land, visually midway between A1 and forest. Often abandoned agricultural land that contains weeds, grass, willows, shrubs, and small trees. Also includes never used but open land such as on bedrock or light sand, where natural vegetation consists of thin grass, weeds, and scattered small trees. May also include patches of sparse bush or unproductive woodland. This category often follows natural features such as streams or barren ridges, and is often quite remote.

Forest, symbol 'Z': woodland, dense enough to have a closed canopy, with an average height of greater than 6 meters. Considered to be "productive" woodland, which implies trees of species and sizes as to be valuable for harvest and use either now or in the near future. Delineation is based primarily on A.P.I., which shows a solid mass of dark tones, grainy in texture. Often associated with scrubland around the perimeter, where trees thin out to a broken canopy.

Reforestation, symbol 'Zr': artificially stocked tree plantations, of whatever age. Mature stands are recognizable through A.P.I., but young trees must be identified on the ground. May be confused with A1 where weeds and grass are taller than seedlings, and all idle fields must be checked

closely for young trees. Planting furrows and mown strips between the rows are sometimes visible.

Swamp and Marsh, symbol 'X': areas unusable due to excessive wetness and characterized by cattails, reeds, sedges, willows, and seasonally open water.

Built-up, symbol 'B': buildings and associated areas such as lanes, lawns, parking lots and gardens. Included are all urban oriented structures (residential, commercial, industrial, utilities, transportation, institutional, and governmental) as well as commercial aspects of agriculture (machinery dealers, feed mills, greenhouses and service industries). Does not include farm buildings nor their associated houses, lawns, etc. In cases of multiple use, the most active, or the one which is a better indication of use takes precedence. For example, hydro lines across a land parcel are ignored. Details within this category are generalized; for example a vacant lot or small hay field surrounded by houses is included in the 'B'. Individual houses such as rural non-farm residences are ignored (minimum of 3 adjacent lots to warrant 'B').

Recreational, symbol 'R': areas of land devoted to recreational activities. The most common use of this category is for golf courses, campgrounds, ski areas, equestrian parks, and playing fields. Areas of recreational land use within an urban setting are included in the 'B' category, as are summer cottages and community centres. Areas used for recreation unofficially (such as abandoned pits with dirt bike trails) are not designated 'R', but instead fit the "excavation" or "abandoned" categories. Hobby farms and private equestrian training tracks are designated by the appropriate agricultural system.

Sand and Gravel Extraction, symbol 'E1': sand and gravel pits, rock quarries, and associated stockpiles and road-ways. Industrial complexes associated with pits and quarries are designated as 'B', and abandoned pits are complexed with the appropriate "abandoned" or "scrubland" symbol (eg. E1 A1).

Topsoil Extraction, symbol 'E2': topsoil excavation areas and associated stockpiles and roadways. Abandoned topsoil extraction areas are complexed with the appropriate symbol (eg. E2 A1).

Sodfarms, symbol 'SF': commercial sod production areas, including associated fallow land and cover crops.

Intensive Agriculture, symbol 'K': orchards, market gardens, garden plots, and berry patches. Household gardens and orchards (less than 10 trees) are not included. Garden plots are those set up by (usually) governments (NCC) and rented out to urbanites for home garden use.

APPENDIX B

INTERVIEW QUESTIONNAIRE

LAND USE SURVEY

CARLETON REGION

PART A. FARM LOCATION

- 1) Farm I.D. Number _____ Farm Type _____
- 2) Air Photo Reference _____
- 3) Distance to Centre _____
- 4) Driving Time to Centre _____
- 5) Distance to Paved Road _____
- 6) Farm Buildings _____
- 7) House Good _____ Fair _____ Poor _____ New _____
- 8) Soil Capability Class(es) _____ Land Assessment _____
- 9) Soil Type(s) _____
- 10) Operator: Owner _____ Tenant _____ Manager _____

COMMENTS:

PART B. FARM CHARACTERISTICS

Property Lines - identify on air photo:

- a) property owned and acreage
- b) property rented in and acreage
- c) property rented out and acreage
- d) linkage lines to main property

Identify fields which have been improved:

- T - tile drained
- D - ditched
- F - fence lines cleared
- Other - (subsoiled, leveled, etc.)

OR

- a) number of acres owned _____ Number improved _____
- b) number of acres rented in _____ distance _____ improved _____
- c) number of acres rented out _____

LAND USE - 1976

1)	Crop	Acreage	Yield	Fertilizer	% of crop sold
	Corn				
	Grain				
	Hay				
	Improved Pasture				
	Rough Pasture				
	Bush				
	Idle Land				
	Other				

TOTAL ACREAGE

FARM SIZE

2) In the last 10 years, or since you acquired this property, has your cropland expanded _____ or decreased _____.

If expanded, number of acres bought _____ rented _____ improved _____

If decreased, number of acres sold _____ rented out _____ idle _____

for farming _____ or other _____.

3) How much would you have to pay in this area to buy land _____
to rent land _____

FARM HISTORY

4) Is this your family homestead? Yes _____ No _____

5) Number of years in your family _____

6) When did you acquire this property? _____

7) Was the previous owner a full time _____ part-time _____ non-farmer _____

8) How many years of farming experience do you have? _____

9) How long have you been in this type of operation? _____

10) What schooling do you have? Grade _____ Secondary _____

College _____ University _____

11) Did you grow up on a farm? _____ Your wife? _____

12) Where were you born? _____ Your wife? _____

13) When were you born? _____ Your wife? _____

FARM PLANS

15) Is there a son or other relative who will likely take over the farm? _____

His present occupation _____

16) In the next 5 years do you plan to

expand your operation? _____ cut back your operation _____

maintain present level? _____ retire _____ quit farming _____

combine farming with off-farm work _____

use the farm for other purposes? _____ (topsoil, trout pond, riding stable etc.)

17) In the next 5 years do you plan to invest in new equipment?

Item

Cost

in repairs or additions to:

house _____ fences _____

barn _____ land _____ (tile drainage, clearing etc.)

18) Do you plan on selling land? No _____

in the next 5 years? _____ purpose _____

in the next 10 years? _____ purpose _____

Do you think you may be expropriated? Yes _____ No _____

2 2
OF / DE

FARM OPERATION

<u>19) Type</u>	<u>Number (July 1976)</u>	<u>Turnover (1976)</u>
Dairy cows		
Milkers		
Beef cows		
Calves		
Steers		
Heifers		
Sows		
Feeder hogs		
Weaner hogs		
Sheep		
Laying hens		
Turkey boilers		
Chicken broilers		
Horses		
Pleasure Horses		
Other		

20) Do you carry out any other farm activity?

sod (acres) _____ nursery _____ orchard _____

gravel pit _____ forest products _____ maple sugar _____

fur animals kind _____ number _____ value of each _____

other _____

21) Capital Values. What is the current market value of your:

Land and buildings _____ Machinery and Equipment _____
 Livestock and Poultry _____ TOTAL _____

22) Operating Expenses

Commercial fertilizer _____ Feeds _____
 Sprays (pesticides) _____ Veterinary _____
 Equipment upkeep _____ Fuel (motor) _____
 Custom work _____ Equipment rental _____
 Machinery & mortgage payments _____ Depreciation _____
 Land Rent _____ Property taxes _____
 Wages to hired help _____ Wages to family _____
 Other _____
 _____ GROSS _____

23) Do you share or own equipment on a cooperative basis? • No _____

Type(s) _____

24) Does the income from farm sales exceed the total farm family income from other sources? Yes _____ No _____

25) Gross Value of Products Sold Last Year (1976)

Total value of agricultural sales _____
 Fluid milk sales _____ Industrial Milk & cream _____
 Livestock a) _____ Crops a) _____
 b) _____ b) _____
 c) _____
 Poultry and eggs _____ d) _____
 Horses _____
 Other sales a) _____ b) _____

26) Has the total volume of products sold increased _____ decreased _____
 or remained the same _____ as previous year?

27) Labour Input on Farm

	OPERATOR	WIFE	OTHER FAMILY	HIRED HELP
			Number _____	(include partner here)
	Days/Week	Days/Week		
JAN - MARCH				
APRIL - JUNE				
JULY - SEPT				
OCT - DEC				
TOTALS				
Man-Days/Year				

28) Off-the-farm Work

Do you have a non-farm job in addition to operating your farm? No _____

	<u>Operator</u>	<u>Wife</u>
Type of work	_____	_____
Number of days/year	_____	_____
Place	_____	_____
Distance from farm	_____	_____
Years in present work	_____	_____
Years in similar work	_____	_____
Comments:	_____	

29) Custom work performed by you; number of days/year _____

30) Do you consider yourself a full-time _____ part-time _____ or
hobby farmer _____?

31) If full-time:

Have you considered off-farm work in addition to farming? Yes _____ No _____

If yes, what type of work would you look for? _____

Do you know of any off-farm jobs that are now available? _____

How far would you drive to work? _____

If part-time:

Why do you farm with off-farm work? _____

Could you stay in farming if you had to depend only on farm income?

What adjustments in your farming operation have you had to make since acquiring
off-farm work?

Has it reduced your farm income? _____

Do many of your farming neighbours work off the farm? _____

GENERAL

32) What is the main soil type on your farm? _____

33) How do you decide what kind and quantity of fertilizer to use?

34) Do you have your soil tested? _____

35) Is it particularly deficient in any way? _____

36) If so, are you doing anything to overcome these deficiencies? _____

37) What are your long range plans for your farm? _____

APPENDIX C

SUMMARY STATISTICS - LAND USE SYSTEMS OF OTTAWA-CARLETON

LABEL	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM
CROPPING SYSTEM=MONOCULTURE							
FARM SIZE (HA)	9	235.73	136.71	64.75	495.33	45.57	2121.81
AREA CULTIVATED (%)	9	88.59	9.65	71.47	99.70	2.88	797.29
AREA RENTED (%)	9	41.20	34.41	0.00	88.00	11.47	370.90
WORKED AREA (HA)	9	210.08	122.20	56.66	402.68	40.73	1990.76
OWNED LAND CLASS 1&2 (%)	9	84.67	32.35	0.00	100.00	10.78	762.00
RENTED LAND CLASS 1&2 (%)	6	89.17	11.20	73.00	100.00	4.57	535.00
MILK COWS (#)	9	6.67	20.00	0.00	60.00	4.67	60.00
FEEDER CATTLE (#)	9	94.44	187.82	0.00	450.00	62.61	850.00
FEEDER HOGS (#)	9	88.89	191.67	0.00	550.00	67.89	800.00
BEEF COWS (#)	9	0.00	0.00	0.00	0.00	0.00	0.00
HORSES (#)	9	0.00	0.00	0.00	0.00	0.00	0.00
ANIMAL UNITS (#)	9	103.78	124.48	0.00	315.00	41.49	934.00
ANIMAL UNITS (\$/HA)	9	0.83	0.95	0.00	2.55	0.32	7.48
NITROGEN ON CORN (KG/HA)	9	119.03	36.32	51.43	178.12	12.11	1071.26
GRAIN CORN YIELD (M3/HA)	6	0.60	0.06	0.54	0.70	0.03	3.61
NITROGEN ON HAY (KG/HA)	2	42.65	60.32	0.00	85.30	42.65	85.30
HAY YIELD (T/HA)	2	12.29	2.48	10.54	14.05	1.76	24.59
TOTAL FARM VALUE (\$)	9	560556.67	292245.86	253200.00	1153260.00	97415.29	5045010.00
TOTAL VALUE (\$/HA)	9	3049.72	1119.62	1555.41	4468.92	373.21	27447.47
LAND AND BUILDINGS (%)	9	61.60	15.99	43.57	93.28	5.33	581.42
MACHINERY (%)	9	24.96	13.40	9.87	48.10	4.47	224.66
LIVESTOCK (%)	9	10.44	12.41	0.00	29.44	4.14	93.92
LAND AND BUILDINGS (\$/HA)	9	1980.53	946.39	911.17	3604.08	315.16	17824.76
MACHINERY (\$/HA)	9	687.10	278.09	260.10	1123.17	92.70	6193.93
LIVESTOCK (\$/HA)	9	382.09	453.54	0.00	1242.97	151.19	3433.78
GROSS INCOME (\$)	9	123046.89	54623.15	22880.00	191217.00	18207.72	1107422.00
GROSS MARGIN (\$)	9	32497.11	14463.10	5300.00	57119.00	4821.03	292474.00
NET MARGIN (\$)	9	16180.33	8866.66	1500.00	33448.00	2955.55	145623.00
INCOME (\$/HA)	9	736.72	574.47	312.72	2126.53	191.49	6630.48
OPERATING EXPENSES (% OF INCOME)	9	72.25	9.57	53.21	85.85	3.19	650.27
TOTAL EXPENSES (% OF INCOME)	9	86.88	5.83	74.64	93.44	1.94	781.98
OPERATING EXPENSES (\$/HA)	9	561.70	517.44	230.58	1825.52	172.48	5055.26
TOTAL EXPENSES (\$/HA)	9	646.49	531.08	288.69	1946.82	177.03	5818.41
NET MARGIN (\$/HA)	9	90.23	54.94	24.03	178.71	18.31	812.07
TOTAL FARM LABOUR (PERSON-DAYS)	9	788.89	271.84	430.00	1145.00	90.51	7100.00
TOTAL FARM LABOUR (FD/HA)	9	4.77	2.33	1.83	9.21	0.78	42.73
HIRED LABOUR (%)	9	47.92	33.13	0.00	98.37	11.04	431.29
OPERATOR LABOUR (%)	9	37.08	20.44	11.63	63.37	6.81	333.75
FAMILY LABOUR (%)	9	15.00	19.60	0.00	44.34	5.53	134.96
NET RETURN TO LABOUR (\$/FD)	9	20.48	9.53	2.87	31.70	3.18	184.28
OPERATOR AGE (YRS)	9	46.25	9.65	35.00	63.00	3.22	416.00
OPERATOR EDUCATION (YRS)	9	12.78	2.33	9.00	16.00	0.78	115.00
OPERATOR EXPERIENCE (YRS)	9	23.11	8.39	9.00	30.00	2.80	208.00
THIS MANAGEMENT (YRS)	9	14.22	8.00	9.00	27.00	2.00	128.00
THIS ENTERPRISE (YRS)	9	11.33	3.57	5.00	14.00	1.19	102.00
IN FAMILY (YRS)	9	33.44	36.89	9.00	125.00	12.30	301.00
OPERATOR OFF-FARM WORK (% OF YEAR)	9	22.68	31.77	0.00	71.23	10.59	204.11

CROPPING SYSTEM=CORN							
FARM SIZE (HA)	30	171.50	134.41	40.47	749.38	24.54	5144.88
AREA CULTIVATED (%)	30	77.47	17.05	41.67	100.00	3.11	2324.05
AREA RENTED (%)	30	29.49	26.02	0.00	72.42	4.75	894.67
WORKED AREA (HA)	30	131.26	118.15	38.04	675.85	21.57	3937.73
OWNED LAND CLASS 1&2 (%)	30	53.23	30.97	0.00	100.00	5.35	1597.00
RENTED LAND CLASS 1&2 (%)	19	45.26	37.63	0.00	100.00	8.63	860.00
MILK COWS (#)	30	50.20	22.63	0.00	150.00	5.84	1503.00
FEEDER CATTLE (#)	30	58.53	220.06	0.00	1200.00	40.18	1756.00
FEEDER HOGS (#)	30	0.00	0.00	0.00	0.00	0.00	0.00
BEEF COWS (#)	30	3.40	2.24	0.00	36.00	1.69	102.00
HORSES (#)	30	0.10	0.40	0.00	2.00	0.07	3.00
ANIMAL UNITS (#)	30	127.09	143.27	10.80	840.00	26.15	3812.60
ANIMAL UNITS (\$/HA)	30	0.97	0.22	0.51	1.41	0.04	29.09
NITROGEN ON CORN (KG/HA)	30	98.51	43.31	18.82	180.63	7.91	2955.37
GRAIN CORN YIELD (M3/HA)	17	0.65	0.10	0.45	0.87	0.02	11.06
NITROGEN ON HAY (KG/HA)	30	12.29	22.61	0.00	112.90	4.13	368.79
HAY YIELD (T/HA)	30	14.58	4.47	5.02	25.09	0.82	437.53
TOTAL FARM VALUE (\$)	30	441070.00	203630.84	183500.00	1135000.00	37136.36	13232700.00
TOTAL VALUE (\$/HA)	30	3993.66	1256.25	1679.37	7294.10	229.36	119809.78
LAND AND BUILDINGS (%)	30	66.66	8.73	50.63	95.67	1.59	1999.91
MACHINERY (%)	30	18.60	7.54	6.38	31.12	1.38	558.15
LIVESTOCK (%)	30	14.73	3.74	7.17	23.85	0.68	441.95
LAND AND BUILDINGS (\$/HA)	30	2703.08	1092.45	1120.11	6218.69	199.49	81242.26
MACHINERY (\$/HA)	30	728.61	350.57	192.35	1482.58	64.00	21858.19
LIVESTOCK (\$/HA)	30	556.98	125.51	266.33	815.29	22.92	16709.33
GROSS INCOME (\$)	30	102317.00	122754.66	7395.00	699400.00	22411.50	3069534.00
GROSS MARGIN (\$)	30	37618.00	24809.16	-6246.00	124500.00	4529.51	1128540.00
NET MARGIN (\$)	30	25605.33	20931.63	-7446.00	102500.00	3830.70	781840.00
INCOME (\$/HA)	30	714.82	21.64	159.89	1181.77	40.10	21444.64
OPERATING EXPENSES (% OF INCOME)	30	59.83	27.65	32.34	184.46	5.05	1794.93
TOTAL EXPENSES (% OF INCOME)	30	75.77	27.40	45.22	200.69	5.00	2272.19
OPERATING EXPENSES (\$/HA)	30	404.34	157.53	92.53	932.75	29.75	12130.14
TOTAL EXPENSES (\$/HA)	30	513.53	171.85	213.45	961.75	11.74	15405.90
NET MARGIN (\$/HA)	30	201.29	129.53	-159.99	461.96	23.65	6038.74
TOTAL FARM LABOUR (PERSON-DAYS)	30	850.17	297.21	365.00	1580.00	54.26	25595.00
TOTAL FARM LABOUR (FD/HA)	30	8.30	3.40	1.17	17.27	0.62	248.95
HIRED LABOUR (%)	30	12.40	21.77	0.00	38.49	1.38	557.41
OPERATOR LABOUR (%)	30	12.40	21.77	0.00	100.00	1.38	1826.44
FAMILY LABOUR (%)	30	12.40	21.77	0.00	22.35	1.48	1826.44
NET RETURN TO LABOUR (\$/FD)	30	27.31	19.10	-19.01	77.07	3.70	977.34
OPERATOR AGE (YRS)	30	44.03	11.31	23.00	63.00	3.06	1341.00
OPERATOR EDUCATION (YRS)	30	11.97	2.19	8.00	17.00	1.10	356.00
OPERATOR EXPERIENCE (YRS)	30	26.10	11.51	8.00	48.00	2.11	783.00
THIS MANAGEMENT (YRS)	30	15.53	9.04	2.00	38.00	1.63	466.00
THIS ENTERPRISE (YRS)	30	18.07	13.40	2.00	50.00	2.10	542.00
IN FAMILY (YRS)	30	41.37	47.70	2.00	120.00	2.33	1241.00
OPERATOR OFF-FARM WORK (% OF YEAR)	30	2.51	15.40	0.00	71.23	0.33	5.34

LABEL	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM
CROPPING SYSTEM=MIXED							
FARM SIZE (HA)	48	104.76	50.14	20.23	232.70	7.24	5028.33
AREA CULTIVATED (%)	48	75.06	18.25	20.20	100.00	2.63	3603.05
AREA RENTED (%)	48	25.27	23.10	0.00	95.17	3.33	1219.07
WORKED AREA (HA)	48	76.29	36.61	20.23	181.88	5.28	3661.32
OWNED LAND CLASS 112 (%)	48	38.62	35.51	0.00	100.00	5.13	1854.00
RENTED LAND CLASS 112 (%)	34	32.97	37.22	0.00	100.00	6.38	1121.00
MILK COWS (#)	48	30.21	22.81	0.00	85.00	3.29	1450.00
FEEDER CATTLE (#)	48	5.25	17.04	0.00	100.00	2.46	252.00
FEEDER HOGS (#)	48	1.04	7.22	0.00	50.00	1.04	50.00
PIEF COWS (#)	48	4.85	10.98	0.00	50.00	1.59	233.00
HORSES (#)	48	0.23	0.83	0.00	4.00	0.12	11.00
ANIMAL UNITS (#)	48	59.53	30.47	11.20	152.00	4.40	2858.57
ANIMAL UNITS (\$/HA)	48	0.83	0.32	0.35	2.01	0.05	39.78
NITROGEN ON CORN (KG/HA)	48	67.40	35.47	0.00	156.80	5.12	3235.10
GRAIN CORN YIELD (M3/HA)	12	0.55	0.19	0.49	0.83	0.06	6.62
NITROGEN ON HAY (KG/HA)	48	12.47	23.76	0.00	125.44	3.43	598.35
HAY YIELD (T/HA)	48	12.47	3.68	6.02	23.08	0.53	598.60
TOTAL FARM VALUE (\$)	48	296637.50	127640.64	64550.00	668800.00	18123.34	14238600.00
TOTAL VALUE (\$/HA)	48	4302.20	1643.74	1188.13	10634.94	237.25	206505.61
LAND AND BUILDINGS (%)	48	70.55	9.78	38.75	92.59	1.41	3386.39
MACHINERY (%)	48	16.58	7.93	0.62	44.81	1.14	795.90
LIVESTOCK (%)	48	12.87	4.38	3.11	32.76	0.70	617.71
LAND AND BUILDINGS (\$/HA)	48	3088.11	1458.92	460.38	9847.17	210.58	148229.17
MACHINERY (\$/HA)	48	690.67	377.80	15.44	1774.93	54.53	33151.99
LIVESTOCK (\$/HA)	48	523.43	207.75	75.07	1329.38	29.99	25124.46
GROSS INCOME (\$)	48	40925.56	29030.25	2400.00	132700.00	4190.16	1964427.00
GROSS MARGIN (\$)	48	16950.88	15066.86	-2553.00	72600.00	2174.73	813642.00
NET MARGIN (\$)	48	10096.54	11512.70	-6073.00	58900.00	1661.74	484634.00
INCOME (\$/HA)	48	534.20	308.94	98.84	1345.30	44.57	25641.62
OPERATING EXPENSES (% OF INCOME)	48	61.73	23.22	32.78	167.17	3.35	2962.96
TOTAL EXPENSES (% OF INCOME)	48	80.66	23.89	35.21	177.50	3.45	3871.57
OPERATING EXPENSES (\$/HA)	48	322.10	212.57	63.00	873.39	30.68	15460.80
TOTAL EXPENSES (\$/HA)	48	411.87	241.48	97.02	1010.14	34.86	19769.74
NET MARGIN (\$/HA)	48	122.33	118.52	-150.06	501.86	17.11	5871.87
TOTAL FARM LABOUR (PERSON-DAYS)	48	681.19	304.78	160.00	1555.00	43.99	32627.00
TOTAL FARM LABOUR (FD/HA)	48	9.84	3.99	3.35	21.00	0.58	472.33
Hired LABOUR (%)	48	11.34	16.93	0.00	58.40	2.44	544.20
OPERATOR LABOUR (%)	48	67.43	23.59	23.47	100.00	3.40	3236.82
FAMILY LABOUR (%)	48	21.23	20.24	0.00	71.91	2.92	1018.98
NET RETURN TO LABOUR (\$/FD)	48	12.23	12.96	-21.69	44.29	1.97	596.85
OPERATOR AGE (YRS)	48	17.81	10.79	24.00	58.00	1.56	2295.00
OPERATOR EDUCATION (YRS)	48	9.83	2.16	9.00	15.00	0.31	472.00
OPERATOR EXPERIENCE (YRS)	48	30.92	13.54	6.00	50.00	1.91	1484.00
THIS MANAGEMENT (YRS)	48	18.04	12.39	0.00	50.00	1.79	366.00
THIS ENTERPRISE (YRS)	48	32.23	19.33	1.00	50.00	1.86	1547.00
IN FAMILY (YRS)	48	45.40	38.49	0.00	150.00	2.56	2179.00
OPERATOR OFF-FARM WORK (% OF YEAR)	48	7.51	20.32	0.00	92.19	2.96	360.27
CROPPING SYSTEM=HAY							
FARM SIZE (HA)	29	75.05	84.82	10.12	352.08	15.75	2176.45
AREA CULTIVATED (%)	29	77.15	19.87	34.93	100.00	3.65	2237.48
AREA RENTED (%)	29	10.49	21.51	0.00	73.77	3.99	304.28
WORKED AREA (HA)	29	47.91	44.00	9.31	218.54	9.17	1389.34
OWNED LAND CLASS 112 (%)	29	41.79	39.23	0.00	100.00	7.25	1212.00
RENTED LAND CLASS 112 (%)	29	28.57	48.80	0.00	100.00	18.44	200.00
MILK COWS (#)	29	1.21	10.29	0.00	38.00	1.91	122.00
FEEDER CATTLE (#)	29	1.79	7.68	0.00	40.00	1.43	52.00
FEEDER HOGS (#)	29	0.41	1.55	0.00	6.00	0.26	12.00
PIEF COWS (#)	29	13.55	16.37	0.00	51.00	3.04	393.00
HORSES (#)	29	0.83	2.16	0.00	10.00	0.40	24.00
ANIMAL UNITS (#)	29	26.39	21.60	0.00	71.40	4.01	745.28
ANIMAL UNITS (\$/HA)	29	0.60	0.42	0.00	1.38	0.08	17.50
NITROGEN ON CORN (KG/HA)	0						
GRAIN CORN YIELD (M3/HA)	0						
NITROGEN ON HAY (KG/HA)	29	5.49	14.91	0.00	47.67	2.77	189.16
HAY YIELD (T/HA)	29	11.19	3.20	4.52	19.07	0.59	324.64
TOTAL FARM VALUE (\$)	29	190682.76	153581.82	49300.00	728200.00	28515.68	5529800.00
TOTAL VALUE (\$/HA)	29	4417.71	1479.19	1899.91	9068.45	294.58	129113.60
LAND AND BUILDINGS (%)	29	79.00	10.65	54.03	94.94	1.98	2291.10
MACHINERY (%)	29	11.77	7.44	2.12	32.08	1.39	440.00
LIVESTOCK (%)	29	9.25	7.79	0.00	41.06	1.45	258.89
LAND AND BUILDINGS (\$/HA)	29	3462.61	1146.82	1437.65	6646.90	212.96	100415.71
MACHINERY (\$/HA)	29	549.32	510.51	105.99	2080.91	64.80	15930.35
LIVESTOCK (\$/HA)	29	105.78	411.41	0.00	2197.58	76.40	11767.54
GROSS INCOME (\$)	29	9666.07	12006.59	450.00	42500.00	2229.57	280316.00
GROSS MARGIN (\$)	29	1907.79	4501.10	-5592.00	17560.00	835.83	53326.00
NET MARGIN (\$)	29	804.41	4364.34	-10392.00	16000.00	810.19	23329.00
INCOME (\$/HA)	29	218.05	262.84	27.80	1105.43	48.81	4333.52
OPERATING EXPENSES (% OF INCOME)	29	103.18	59.04	51.57	337.78	10.66	992.08
TOTAL EXPENSES (% OF INCOME)	29	117.06	68.21	55.55	337.78	12.67	3452.78
OPERATING EXPENSES (\$/HA)	29	175.78	160.85	45.80	780.31	20.37	5067.43
TOTAL EXPENSES (\$/HA)	29	202.68	187.71	54.98	900.00	34.86	5877.00
NET MARGIN (\$/HA)	29	15.38	123.81	-298.58	455.84	32.99	445.92
TOTAL FARM LABOUR (PERSON-DAYS)	29	469.45	211.91	195.00	900.00	39.35	13514.00
TOTAL FARM LABOUR (FD/HA)	29	13.49	7.24	3.71	31.86	1.34	391.33
Hired LABOUR (%)	29	10.69	19.12	0.00	57.78	3.55	310.07
OPERATOR LABOUR (%)	29	68.12	25.85	0.00	100.00	4.90	1975.49
FAMILY LABOUR (%)	29	21.19	21.89	0.00	71.94	4.08	614.49
NET RETURN TO LABOUR (\$/FD)	29	1.41	9.70	-16.20	40.51	1.20	40.89
OPERATOR AGE (YRS)	29	59.10	9.46	38.00	75.00	1.76	1714.00
OPERATOR EDUCATION (YRS)	29	10.79	3.22	8.00	17.00	0.60	313.00
OPERATOR EXPERIENCE (YRS)	29	37.90	15.27	1.00	60.00	2.34	1099.00
THIS MANAGEMENT (YRS)	29	22.38	11.97	1.00	42.00	1.22	649.00
THIS ENTERPRISE (YRS)	29	18.28	15.41	1.00	50.00	2.86	530.00
IN FAMILY (YRS)	29	52.90	46.45	1.00	150.00	4.83	1534.00
OPERATOR OFF-FARM WORK (% OF YEAR)	29	22.29	31.58	0.00	58.49	5.86	642.84

LABEL	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM
CROPPING SYSTEM=PASTURE							
FARM SIZE (HA)	27	60.33	51.97	12.55	232.70	10.00	1628.99
AREA CULTIVATED (%)	27	59.76	26.26	13.04	98.04	3.05	1613.44
AREA RENTED (%)	27	15.93	27.00	0.00	100.00	5.24	430.21
WORKED AREA (HA)	27	37.16	23.52	12.14	115.34	4.53	1003.25
OWNED LAND CLASS 1&2 (%)	26	26.23	28.23	0.00	90.00	5.54	682.00
RENTED LAND CLASS 1&2 (%)	26	23.37	33.17	0.00	70.00	11.73	187.00
MILK COWS (#)	27	0.89	4.62	0.00	24.00	0.89	24.00
FEEDER CATTLE (#)	27	0.00	0.00	0.00	0.00	0.00	0.00
FEEDER HOGS (#)	27	0.41	2.12	0.00	11.00	0.41	11.00
BEFF COWS (#)	27	10.33	8.97	0.00	30.00	1.73	279.00
HORSES (#)	26	2.62	5.99	0.00	30.00	1.18	68.00
ANIMAL UNITS (#)	26	17.23	11.63	0.00	40.00	2.28	447.90
ANIMAL UNITS (#/HA)	26	0.48	0.30	0.00	1.26	0.06	12.36
NITROGEN ON CORN (KG/HA)	0						
GRAIN CORN YIELD (M3/HA)	0						
NITROGEN ON HAY (KG/HA)	27	9.14	7.67	0.00	28.85	1.48	266.88
HAY YIELD (T/HA)	27	2.46	3.36	1.51	14.05	0.65	64.87
TOTAL FARM VALUE (\$)	27	156977.78	30983.23	28000.00	377500.00	15385.23	4238400.00
TOTAL VALUE (\$/HA)	27	4913.47	2216.53	988.39	10678.10	426.57	132663.68
LAND AND BUILDINGS (%)	27	85.74	8.10	71.36	98.37	1.56	2314.85
MACHINERY (%)	27	7.60	6.04	0.57	24.61	1.15	205.16
LIVESTOCK (%)	27	5.67	4.46	0.00	14.98	0.96	179.99
LAND AND BUILDINGS (\$/HA)	27	4307.16	2189.83	705.99	10195.68	421.43	116793.35
MACHINERY (\$/HA)	27	335.52	314.37	21.68	1260.70	60.50	9058.93
LIVESTOCK (\$/HA)	27	270.79	188.14	0.00	791.98	36.21	7311.40
GROSS INCOME (\$)	27	4725.22	8320.94	0.00	30000.00	1254.95	127581.00
GROSS MARGIN (\$)	27	215.15	2740.78	-7100.00	8000.00	527.46	-5809.00
NET MARGIN (\$)	27	-702.56	2591.86	-8162.00	4100.00	198.30	-18969.00
INCOME (\$/HA)	27	133.82	211.00	0.00	950.37	40.61	3613.17
OPERATING EXPENSES (% OF INCOME)	23	230.66	405.03	43.29	1750.00	84.45	5305.10
TOTAL EXPENSES (% OF INCOME)	23	237.75	402.65	43.29	1750.00	83.96	5468.31
OPERATING EXPENSES (\$/HA)	27	161.71	184.95	13.06	804.65	35.59	4368.23
TOTAL EXPENSES (\$/HA)	27	175.45	205.40	13.06	887.01	39.53	4737.13
NET MARGIN (\$/HA)	27	-41.63	134.04	-634.21	140.71	25.80	-1123.95
TOTAL FARM LABOUR (PERSON-DAYS)	27	304.89	200.06	80.00	1080.00	38.50	8232.00
TOTAL FARM LABOUR (PD/HA)	27	9.79	6.35	2.75	34.21	1.28	264.34
HIRED LABOUR (%)	27	9.72	20.68	0.00	80.00	3.98	262.42
OPERATOR LABOUR (%)	27	56.41	26.98	15.28	100.00	5.19	1847.15
FAMILY LABOUR (%)	27	31.87	24.24	0.00	65.57	4.37	590.43
NET RETURN TO LABOUR (\$/PD)	27	-5.26	12.33	-51.33	8.00	2.37	-142.10
OPERATOR AGE (YRS)	27	53.43	12.45	33.00	95.00	2.40	1448.00
OPERATOR EDUCATION (YRS)	27	11.30	2.84	9.00	17.00	0.55	305.00
OPERATOR EXPERIENCE (YRS)	27	27.35	19.46	2.00	70.00	3.74	736.00
THIS MANAGEMENT (YRS)	27	31.74	16.75	1.00	55.00	3.22	587.00
THIS INTERFERENCE (YRS)	27	15.33	15.71	1.00	50.00	3.02	414.00
IN FAMILY (YRS)	27	42.78	25.45	1.00	140.00	8.75	1175.00
OPERATOR OFF-FARM WORK (% OF YEAR)	27	40.69	33.83	0.00	92.19	6.51	1098.63
CROPPING SYSTEM=GRAZING							
FARM SIZE (HA)	5	41.52	33.10	10.12	93.08	14.30	207.61
AREA CULTIVATED (%)	5	39.25	24.60	0.00	62.50	11.00	196.26
AREA RENTED (%)	5	0.00	0.00	0.00	0.00	0.00	0.00
WORKED AREA (HA)	5	26.79	17.32	4.45	50.59	7.97	133.96
OWNED LAND CLASS 1&2 (%)	5	28.20	33.15	0.00	71.00	14.83	141.00
RENTED LAND CLASS 1&2 (%)	0						
MILK COWS (#)	0	0.00	0.00	0.00	0.00	0.00	0.00
FEEDER CATTLE (#)	0	4.00	5.48	0.00	10.00	2.45	20.00
FEEDER HOGS (#)	0	0.80	1.79	0.00	4.00	0.80	4.00
BEFF COWS (#)	0	1.40	2.19	0.00	5.00	0.98	7.00
HORSES (#)	0	3.20	4.66	0.00	11.00	2.08	16.00
ANIMAL UNITS (#)	0	8.28	4.38	1.80	13.40	1.96	41.40
ANIMAL UNITS (#/HA)	0	0.77	1.00	0.04	2.47	0.45	3.84
NITROGEN ON CORN (KG/HA)	0						
GRAIN CORN YIELD (M3/HA)	0						
NITROGEN ON HAY (KG/HA)	0						
HAY YIELD (T/HA)	0						
TOTAL FARM VALUE (\$)	5	106825.00	48970.48	64525.00	188850.00	21900.26	534125.00
TOTAL VALUE (\$/HA)	5	5916.96	4339.87	3050.96	14494.46	2164.45	29584.80
LAND AND BUILDINGS (%)	5	89.38	6.10	82.33	98.99	2.73	446.88
MACHINERY (%)	5	1.69	4.17	0.53	10.94	1.86	23.46
LIVESTOCK (%)	5	5.93	6.06	0.58	16.12	2.71	29.66
LAND AND BUILDINGS (\$/HA)	5	5133.94	3846.11	2762.68	11933.64	1720.03	25669.69
MACHINERY (\$/HA)	5	211.39	143.69	19.77	380.15	64.26	1056.97
LIVESTOCK (\$/HA)	5	571.63	990.54	21.74	2336.19	442.98	2858.14
GROSS INCOME (\$)	5	2460.00	1702.35	0.00	4200.00	761.31	12300.00
GROSS MARGIN (\$)	5	-1062.00	1966.65	-4500.00	350.00	879.51	-5310.00
NET MARGIN (\$)	5	-1062.00	1966.65	-4500.00	350.00	879.51	-5310.00
INCOME (\$/HA)	5	101.66	102.50	0.00	259.45	45.84	508.32
OPERATING EXPENSES (% OF INCOME)	4	104.38	13.04	88.33	118.10	4.52	417.54
TOTAL EXPENSES (% OF INCOME)	4	104.38	13.04	88.33	118.10	4.52	417.54
OPERATING EXPENSES (\$/HA)	5	314.34	403.40	29.65	1010.85	180.41	1521.72
TOTAL EXPENSES (\$/HA)	5	314.34	403.40	29.65	1010.85	180.41	1521.72
NET MARGIN (\$/HA)	5	-212.68	446.71	-1010.85	9.61	199.77	-1063.39
TOTAL FARM LABOUR (PERSON-DAYS)	5	180.00	108.36	100.00	365.00	48.46	930.00
TOTAL FARM LABOUR (PD/HA)	5	12.94	15.02	1.98	39.31	6.72	64.71
HIRED LABOUR (%)	5	0.00	0.00	0.00	0.00	0.00	0.00
OPERATOR LABOUR (%)	5	88.57	25.56	42.86	100.00	11.43	442.86
FAMILY LABOUR (%)	5	11.43	25.56	0.00	57.14	11.43	57.14
NET RETURN TO LABOUR (\$/PD)	5	-6.89	11.03	-25.71	0.96	4.93	-34.46
OPERATOR AGE (YRS)	5	46.80	12.44	30.00	63.00	5.36	234.00
OPERATOR EDUCATION (YRS)	5	13.20	3.83	8.00	17.00	1.71	66.00
OPERATOR EXPERIENCE (YRS)	5	22.80	18.32	4.00	48.00	8.19	114.00
THIS MANAGEMENT (YRS)	5	15.20	15.99	4.00	43.00	7.15	76.00
THIS INTERFERENCE (YRS)	5	9.20	3.77	4.00	14.00	1.69	41.00
IN FAMILY (YRS)	5	15.20	15.99	4.00	43.00	7.15	76.00
OPERATOR OFF-FARM WORK (% OF YEAR)	5	45.59	28.73	0.00	68.49	12.85	227.95

45°31'

30'

25'

AGRICULTURAL LAND USE SYSTEM OF THE REGIONAL MUNICIPALITY OF OTTAWA-CARLETON

4 of

SYSTÈMES D'UTILISATION DES TERRES DE LA MUNICIPALITÉ RÉGIONALE D'OTTAWA-CARLETON ONTARIO

45° 31'

30'

AGRICULTURAL LAND USE SYSTEMS OF REGIONAL MUNICIPALITY OF OTTAWA-CARLETON

SYSTÈMES D'UTILISATION DES TERRES DE MUNICIPALITÉ RÉGIONALE D'OTTAWA-CARLETON ONTARIO

159

25'

1:50,000
1:50,000
1:50,000

Aylmer Island

6 of 10

20'

AGRICULTURAL LAND USE SYSTEMS

MONOCULTURE SYSTEM —	Continuous cultivation of corn or cereal grain, without crop rotation. This system is restricted almost exclusively to land of Class 1 or 2 soil capability for agriculture. Farms on average are the largest in the region and are often composed of numerous scattered parcels of owned and rented land. High fertilizer application rates are used to maintain average crop yields but crop specialization keeps capital investment at moderate levels. Labour requirements are low. The monoculture system is usually associated with enterprises such as beef feedlots, feeder hog operations, or feed mills.
CORN SYSTEM	— Corn, cereal grain, hay and pasture in rotation, with corn comprising between 30 and 90% of total acreage. This system is concentrated on Class 1 and 2 soils, but Class 3 and 4 soils may form a significant portion of individual farms. Farm units tend to be compact, and most incorporate some rented land. Fertilizer use is universal, but application rates are moderate, capital investment per acre is very high, and labour input is moderate. Most farms are moderate in size, with intensive land use. Fully mechanized dairy operations with relatively large herds are common.
MIXED SYSTEM	— Corn, cereal grain, hay and pasture in rotation, with corn comprising less than 30% of total acreage. Farm characteristics are similar to those of the corn system except that land quality, capital investment, and animal density are appreciably lower. There is less utilization of rented land.
HAY SYSTEM	— Hay, grain and pasture in rotation, with hay dominant in area. Owned land in this system has a moderately high proportion of Class 1 and 2 soils, while the small area of rented land is almost exclusively Class 5, 6 or 7. Fertilizer application rates and crop yields are average, capital investment is moderate and labour inputs are very high. Farms are generally small, compact dairy or mixed beef operations.
PASTURE SYSTEM	— Hay and pasture in approximately equal proportions but without crop rotation. Production is based on utilization of established stands of perennial grass and forage. Land quality is approximately 50% Classes 1 to 4, and 50% Classes 5 to 7. Fertilizer use on hay is slightly above average, yields are slightly below, capital investment is low, and labour input is low. Farms are characteristically small mixed beef, sheep or horse operations.
GRAZING SYSTEM	— Livestock grazing on permanent or native grass pasture, with minimal cultivation and mechanical harvesting. Land quality is generally poor, capital investment is very low, and labour input is low. This system usually occurs as an adjunct to a more intensive system, but may comprise the entire land use of a part-time farm. These part-time farms are small, have a variety of livestock types, and rarely incorporate rented land.

Modifier—(S) Small, irregular shaped fields, generally less than 4 ha. in size

SPECIFIC LAND USE TYPES

SPECIALTY AGRICULTURE (orchards, market gardens, etc.)
SOD FARMS
ABANDONED FARMLAND (weeds, grasses, willows, and small trees)
SCRUBLAND (unproductive—bedrock, sand, etc.)
WOODLAND (continuous cover over 6 metres in height)
REFORESTATION
SWAMP or MARSH
BUILT UP (urban related uses, industrial, etc.)
RECREATION (parks, golf courses, etc.)
EXTRACTION (sand and gravel)
EXTRACTION (top soil)

NOTE: Mapping units with blank colour boxes do not occur on this sheet

MONOCULTURE

MAIS

CULTURE MIXE

FOIN

PÂTURAGE

SYSTÈME PAS

AGRICULTURE

GAZONNIÈRE

FRICHES (ma)

BROUSSAILLE

FORÊT (fronda

REBOISEMEN

MARÉCAGES

ZONES D'AMÉ

LOISIRS (parcs

SYSTÈMES DE CULTURE

MONOCULTURE

Culture ininterrompue de maïs ou de céréales, sans rotation. Ce système est presque exclusivement réservé aux terres dont les possibilités agricoles correspondent à celles des classes 1 ou 2. Ces fermes sont en moyenne les plus étendues dans la région et comptent souvent un grand nombre de parcelles dispersées de terres louées ou en propriété. S'il faut appliquer de fortes doses d'engrais pour maintenir le rendement à un niveau moyen, la somme de capitaux à investir demeure quand même moyenne en raison de la spécialisation des productions. Ce système exige peu de main-d'œuvre. Une exploitation en monoculture est habituellement associée à des spéculations comme des parcs d'engraissement, des établissements de naisseurs de porcs ou des usines d'aliments composés.

- Rotation maïs, céréales, foin et pâturage, le maïs occupant entre 90 et 90% des surfaces cultivées. Les sols appartiennent surtout aux classes 1 et 2, quoique une proportion importante de la surface cultivée de chaque ferme puisse être constituée de sols des classes 3 et 4. Ces exploitations sont en général d'un seul tenant et comptent pour la plupart un peu de terres louées. Elles font toutes usage d'engrais, encore qu'à doses modérées, le coût en équipement par unité de surface est très élevé et l'apport en main-d'œuvre moyen. La plupart des exploitations sont de dimensions moyennes et pratiquent une culture intensive. Il est assez fréquent de rencontrer des entreprises laitières entièrement mécanisées, possédant des troupeaux relativement grands.

CULTURE MIXTE

- Rotation maïs, céréales, foin et pâturage, les surfaces sous maïs représentent moins de 30% de la superficie totale. Ces fermes présentent les mêmes caractéristiques que celles décrites, au paragraphe précédent, exception faite de la qualité des terres, des investissements et de l'importance des troupeaux qui sont sensiblement inférieurs. Le système culture mixte comporte moins de terres louées.

- Rotation foin, céréales et pâturage, avec dominance de foin. Les terres exploitées en propre englobent une proportion moyennement forte de sols des classes 1 et 2, tandis que les étendues restreintes de terres louées se rattachent presque exclusivement aux classes 5, 6 ou 7. Ce système demande une fumure et des frais d'équipement modérés mais les besoins en main-d'œuvre sont très élevés. Les rendements sont moyens. Ces fermes sont habituellement de petites exploitations d'un seul tenant du type laitier ou un mélange laitier-boucherie.

PÂTURAGE

- Proportion approximativement égale d'herbages en foin et en pâturage, maïs sans rotation. La production repose sur l'emploi de peuplements établis d'herbages pérennantes. Une moitié des terres environ appartient aux classes 1 à 4 et l'autre, aux classes 5 à 7. Les quantités d'engrais à appliquer sont légèrement supérieures à la normale, et les rendements, légèrement inférieurs. Le système nécessite peu d'investissements et de main-d'œuvre. Ces fermes sont habituellement de petites exploitations mixtes boeufs, moutons ou chevaux.

SYSTÈME PASTORAL

- Paissance du bétail sur des herbages permanents ou naturels, exigeant très peu de travail du sol et de récolte mécanique. Les terres sont habituellement de qualité médiocre, le système exige très peu de capital d'équipement et peu de main-d'œuvre. Il vient habituellement compléter une exploitation plus intensive, mais peut constituer également la seule affectation de la terre dans une exploitation à temps partiel. Ces exploitations à mi-temps sont petites, possèdent un cheptel diversifié et ne comportent que rarement des terres louées.

Modificateur—(S) champs de petite superficie et de forme irrégulière, généralement inférieurs à 4 hectares

SYSTÈMES PARTICULIERS D'UTILISATION DES TERRES

AGRICULTURE SPÉCIALE (vergers, jardins maraîchers etc.)

SAISONNIÈRES

SAISONS (mauvaises herbes, graminées, saules et arbustes)

SAISONS (terres incultes-rocs, sable etc.)

SAISON (frondaison continu de plus de 6 mètres de haut)

BOISEMENT

SAISONS ou MARAIS

SAISONS D'AMÉNAGEMENT (urbain, industriel, etc.)

12 of

cultivation and mechanical harvesting. Land quality is generally poor, capital investment is very low, and labour input is low. This system usually occurs as an adjunct to a more intensive system, but may comprise the entire land use of a part-time farm. These part-time farms are small, have a variety of livestock types, and rarely incorporate rented land

Modifier—(S) Small, irregular shaped fields, generally less than 4 ha in size

SPECIFIC LAND USE TYPES

- SPECIALTY AGRICULTURE (orchards, market gardens, etc.)
- SOD FARMS
- ABANDONED FARMLAND (weeds, grasses, willows, and small trees)
- SCRUBLAND (unproductive—bedrock, sand, etc.)
- WOODLAND (continuous cover over 6 metres in height)
- REFORESTATION
- SWAMP or MARSH
- BUILT UP (urban related uses, industrial, etc.)
- RECREATION (parks, golf courses, etc.)
- EXTRACTION (sand and gravel)
- EXTRACTION (top soil)

NOTE Mapping units with blank colour boxes do not occur on this sheet

- PÂTURAGE
- SYSTÈME
- AGRICULTURE
- GAZONNEMENT
- FRICHES
- BROUSSAILLES
- FORÊT (naturelle)
- REBOISÉMENT
- MARÉCAIRES
- ZONES D'ÉPURATION
- LOISIRS
- EXTRACTION (sable et gravier)
- EXTRACTION (topsoil)

NOTE: Les superficies d'

16 of

KEY MAP LIEU DE LA CARTE

mais sans rotation. La production repose sur l'emploi de peuplements établis d'herbages pérennantes. Une moitié des terres environ appartient aux classes 1 à 4 et l'autre, aux classes 5 à 7. Les quantités d'engrais à appliquer sont légèrement supérieures à la normale, et les rendements, légèrement inférieurs. Le système nécessite peu d'investissements et de main-d'œuvre. Ces fermes sont habituellement de petites exploitations mixtes : boeufs, moutons ou chevaux.

SYSTÈME PASTORAL

Paissance du bétail sur des herbages permanents ou naturels, exigeant très peu de travail du sol et de récolte mécanique. Les terres sont habituellement de qualité médiocre, le système exige très peu de capital d'équipement et peu de main-d'œuvre. Il vient habituellement compléter une exploitation plus intensive, mais peut constituer également la seule affectation de la terre dans une exploitation à temps partiel. Ces exploitations à mi-temps sont petites, possèdent un cheptel diversifié et ne comportent que rarement des terres louées.

Modificateur—(S) champs de petite superficie et de forme irrégulière, généralement inférieurs à 4 hectares.

SYSTÈMES PARTICULIERS D'UTILISATION DES TERRÈS

AGRICULTURE SPÉCIALE (vergers, jardins maraichers etc.)

GAZONNIÈRES

FRICHES (mauvaises herbes, graminées, saules et arbustes)

BROUSSAILLES (terres incultes-roc, sable etc.)

FORÊT (frondaison continu de plus de 6 mètres de haut)

REBOISEMENT

MARÉCAGES ou MARAIS

ZONES D'AMÉNAGEMENT (urbain, industriel, etc.)

LOISIRS (parcs, terrains de golf, etc.)

EXTRACTION (sable et gravier)

EXTRACTION (terre de surface)

superficies qu'indiquent des boîtes en blanc n'apparaissent pas sur cette feuille

Roads		Routes
Main highways		Routes principales
Secondary		Routes secondaires
Other roads		Autres routes
Cart track, trail		Chemin de terre, sentier
Railways		Voies ferrées
Multiple track		Voies multiples
Single track		Voie unique
Horizontal control point		Repère planimétrique
Boundaries		Frontières
Thematic		Frontière thématique
International		Frontière internationale
Provincial		Frontière provinciale
County		Frontière de comté
Township		Frontière de canton
Indian Reserve		Frontière de réserve indienne
Power transmission line		Ligne de transport d'énergie
Intermittent or indefinite stream		Cours d'eau intermittent ou indéfini

170f

18 of

Field survey conducted by the Land Resource Research Institute, Research Branch, Canada Agriculture in 1977

Compiled, drawn and published by the Cartography Section, Land Resource Research Institute, Research Branch, Agriculture Canada 1980
 Base information and printing supplied by the Reproduction and Distribution Division, Surveys and Mapping Branch, Energy, Mines and Resources Canada

10'

200/20

45°05'

50'

75°47'

WEST CARLETON, MARCH, GOULBOURN TOWNSHIPS

Field survey conducted by the Land Resource Research Institute, Research Branch, Canada Agriculture in 1977.

Travaux de terrain réalisés en 1977 par l'Institut de recherches sur les terres
Direction générale de la recherche du ministère de l'Agriculture du Canada

Compiled, drawn and published by the Cartography Section, Land Resource Research Institute, Research Branch, Agriculture Canada 1980
Base information and printing supplied by the Reproduction and Distribution Division, Surveys and Mapping Branch, Energy, Mines and Resources, Canada

Compilation, cartographie et publication par la section de la cartographie de l'Institut de Recherche sur les Terres, Direction de la Recherche, Agriculture Canada 1980. Renseignements de base et impression fournis par la Direction des lèves de la cartographie, division de la Reproduction et de la Distribution, Énergie, Mines et Ressources, Canada

END

1	0	4	1	0	9	H	8	4
---	---	---	---	---	---	---	---	---

FIN