LOW AGRICULTURAL SOIL CAPABILITY AND FARMING PRACTICE: A CRITICAL EVALUATION OF CLASS 6 SOILS LOCATED IN HURON AND BRUCE COUNTIES, ONTARIO

by

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ABSTRACT

Soil capability and agricultural land use are generally assumed to be strongly related. This thesis investigates the use of soils rated as class 6 for agriculture by the Canada Land Inventory against a set of expected relationships reflecting the low agricultural capability rating of these soils. Analysis has been performed at two scales: the regional and farm level. The results indicate that a large proportion of class 6 soils and farms located on them, support viable agriculture. This tends to discount the expected set of relationships between soil capability and agricultural land use.

The study was conducted in a five township, rural area, straddling the boundaries of Huron and Bruce Counties. Primary data was obtained from 236 personally administered farm interviews. For analysis purposes, the farmers were subdivided into three groups: those operating primarily class 1 soils; those with substantial acreages of class 1 and 6 soils and those with predominantly class 6 soils. The group of farmers on class 6 soils was further subdivided into those with and those without substantial farm involvement.

The study provides the following major findings:

1) Agriculture in the five townships of the study area did not differ substantially from 8 surrounding townships with higher soil capability.

2) Within the study area, approximately two-thirds of the land rated as 6 contained ongoing agricultural production. This land tended to be in an improved state, intensively cropped and with relatively high yields.

3) A large portion of class 6 farms did not differ substantially from class 1 farms. Many class 6 farms were large scale, intensive and productive farm units.

These results point to an apparent misclassification of Donnybrook Sandy Loam Soils by the CLI, and bring into question the utility of the CLI as used at the level of the individual farm unit. Use at this level requires verification through supporting field checks and the explicit recognition of certain weaknesses of the CLI.

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CHAPTER I

INTRODUCTION

Rural and agricultural land use is strongly related to the inherent capabilities of the soil to support agricultural production. Soils have different intrinsic characteristics, including those such as fertility and drainage, that contribute to different levels of capability under the same mode of production. In these terms, the concept of soil capability for agriculture has been formalized to mean that, other things being equal (i.e. similar levels of secondary inputs, including managerial ability) there will be a steady decline in productivity along a scale from high to low soil capability. Given that this relationship exists, the capability rating of soils as they vary spatially should help to predict and explain regional variation, not only of specific crops on particular soils, but also the viability of differing crop systems and enterprise types in terms of potential and actual productivity. Spatial variation in agricultural land use occurring at the national, regional and local level should stem from differing levels of productivity associated with individual soil types. In turn, this variation in productivity should reflect in differing levels of income and the economic viability of individual farm units.

The general assumption, that soils, agricultural

land use and farm viability are intrinsically related, has provided a primary rationale for the study and mapping of individual soil types. The resulting inventories of soil types and capability are based on the refinement of both classification and interpretation and are the product of an iterative process which involves detailed survey and testing procedures. The validity of the classifications are determined through empirical testing at various scales and differing locations.

In the Canadian context, the study of soils and the resulting farm land evaluation has followed a typical, if unique, pattern. Within Ontario, the detailed mapping and taxonomic* classification of soils has occurred largely with respect to phase, type, series and association** (Canada Soil Survey Committee, 1978, 11; Hoffman and Richards,

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* Taxonomic-classification systems based on the inherent properties of the objects classified (Canada Soil Survey Committee, 1978, 11).

** Phase-a phase is a subdivision of a soil type used to show variations from the normal in topography, stoniness or erosion (Hoffman and Richards, 1954, 32-33)).
Type-the soil type is the principle unit of mapping consisting of a series name plus the textural class name derived principally from the texture of the Al horizon.
Series-the soil series is a group of soils with genetic horizons similar in differentiating characteristics and arrangement in the soil profile and developed from a particular type of parent materials.
Association-soil associations consist of groups of soils which are found together, forming a significant landscape. The variables of soil texture, topography, drainage, surface reaction and stoniness contribute to the delineation of soil associations (Soil Associations of Southern Ontario, Report No. 30, 1964, 5-7).

1954, 32-33). Soil surveys have been developed on an individual county basis and at various scales, primarily since 1945. The soil surveys for Huron and Bruce Counties, for example, were completed in 1952 and 1954, respectively, at a scale of 1:63,360 and 1:95,040 (Hoffman and Richards, 1954; Hoffman and Richards, 1952). The original soil surveys also provided some initial insight into local suitability for various crops. A more detailed evaluation of the soils' capability appeared in the Canada Land Inventory (CLI) Soil Capability Classification for Agriculture begun in 1964 and largely completed by 1970.

The CLI represents an evaluation of some of Canada's major natural resources, including the capability of the land to support forestry, recreation and wildlife, and of particular significance to this study, an assessment of soil capability for agriculture. The broad objectives of the CLI have been to classify lands based on inherent capability; to obtain a firm estimate of the location and extent of each capability class; and to foster the use of the CLI materials in regional planning (Department of Regional Economic Expansion, 1970).

The inventory of soil capability for agriculture is available on maps developed at a variety of scales (ranging from manuscript maps at 1:50,000 to the provincial scale of

1:1,000,000) and statistical totals (including a computerized base) indicating the location, quality and extent of soils suitable for the production of most annual field crops, forage, improved pasture and native grazing. The information has been tabulated at the township level and may be utilized by all levels of government. It is deemed particularly useful in the delineation of agricultural and submarginal lands; consolidation of farms into viable units; evaluation of the assessment base and to indicate where non-agricultural expansion might take place without unduly affecting agricultural production (Environment Canada, 1975; 1978, 7).

Several other studies and inventories complement the CLI and contribute to its verification. These include renewed taxonomic mapping of Ontario's soils, at the improved scale of 1:25,000, by the Ontario Institute of Pedology. Eventually, this work should result in a more accurate and detailed mapping of Ontario's soils, providing the basis for updating both the soil surveys and the CLI (Van den Broek, 1981). Supplementing the CLI is the rating of landscape units by the Ontario Land Inventory (OLI). While not as detailed as the CLI, it provides some insight into the physiographic and soil characteristics of a given area. The CLI rating of soil capability has also been enhanced through the development of agro-climatic measures

which facilitate the rating of soils on a composite capability-phenological basis (Nowland and Williams reported by Simpson-Lewis, 1979).

The perceived reliability of the CLI is based largely on empirical studies which have measured crop yields, productivity and economic factors and correlated them with soil capability classes (Hoffman, 1972; Anderson, 1971; Noble, 1965 and the Committee on Farm Assessment and Taxation, 1969). CLI soil classes 1-4 are considered to be best utilized by annual cropping, although class 4 has severe limitations, and classes 5 and 6 are only suited to forage crops or permanent pasture. Given this situation, one would expect that agricultural land use would bear a close relationship with soil capability and studies at the township and regional level have shown this relationship to be relatively precise (Troughton and Da Silva, 1978).

The development and testing of the CLI rating of soils for agricultural capability has occurred primarily at the regional level, although practical applications, including severance policy, are made at the farm level. The lack of study at the farm level reflects the general absence of detailed farm data and concern over the applicability of the CLI at this level. In the context of agricultural geography (Troughton, 1970) and in light of the use being

made of the CLI, however, study at the individual farm level is appropriate. Study at this level most closely reflects the interaction between human and physical features, in that the decisions of the individual farm operator are most likely to reflect the constraints resulting from variations in the capability of the land base. Despite the fact that the CLI was designed for use at the regional level, it is being widely applied at the level of the individual farm unit, where its use has the greatest chance of producing erroneous results. Problems of scale, accuracy and applicability are most likely to emerge where the user is unaware of the CLI weaknesses.

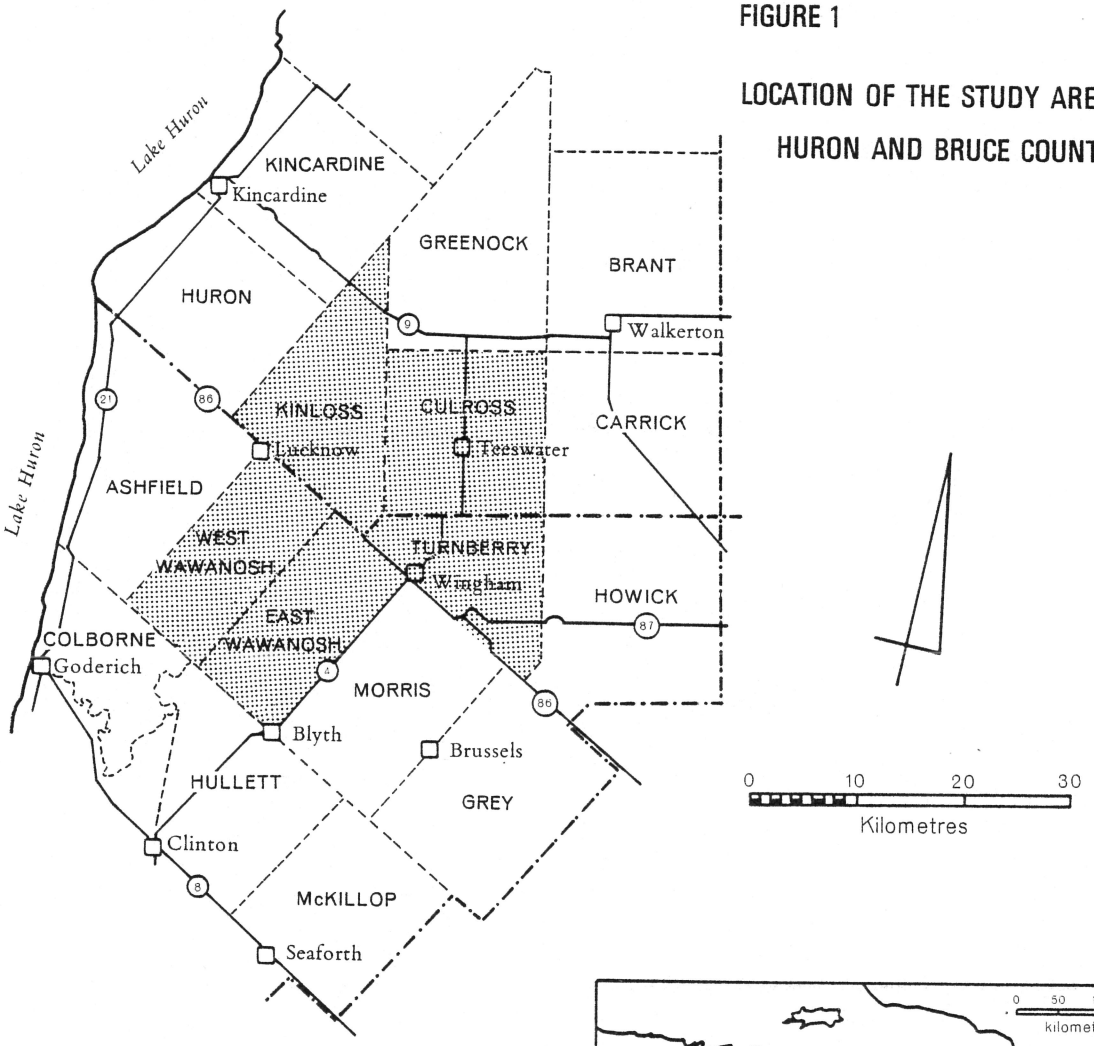
The study seeks to investigate general problems associated with the CLI and to carry out an investigation of an important regional anomaly. The class 6 soils* of the study area (Figure 1) comprise one of a few pockets of low capability soils interspersed within areas of high capability and located within Southern Ontario and as such form a major regional anomaly. Class 6 soils, the lowest class of mineral soils with agricultural capability, are generally considered to be capable of supporting only perennial forage crops (Environment Canada 1978, 24). These soils are generally characteristic of areas such as

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* Reference to class 6 soils in the study area implies the composite rating of $6^{t}_{s}6\,4^{f}_{m}4$.

FIGURE 1

LOCATION OF THE STUDY AREA IN HURON AND BRUCE COUNTY



W. CALDWELL

the fringe of the Canadian Shield, where large tracts of low capability land exist, and the farmed area has become increasingly marginal for agriculture, with large scale farm abandonment having occurred (Parson, 1975; Maxwell, 1966). However, land use on the low capability soils in northern Huron and southern Bruce Counties exhibit certain agricultural practices which one would not normally expect in an area categorized primarily as class 6. This situation calls for investigation and should provide the basis for detailed empirical testing at the individual farm level. The current use of the CLI at this level, and the resultant problems, further indicate the need for re-examination.

The original soil surveys of Huron and Bruce Counties (Hoffman and Richards, 1952; 1954) identified the soils rated as class 6 by the CLI as primarily Donnybrook sandy loam soils and at that time they were chiefly used for general farming with fair yields of cereal grains, hay and pasture. This is an apparent contradiction of what one would expect given the CLI definition of class 6 soils. This is especially true if capability as measured in actual use or yield does not correspond with the actual CLI rating.

The author's personal knowledge of the area supports the view espoused by the original soil surveys and therefore, suggests the need for re-evaluation of the CLI

classification. This provides the initial incentive for an investigation based on the 5 township study area.

The study area (Figure 1), as a whole, also represents an area relatively remote from major urban centers, and therefore, one in which the pattern of agricultural land use is expected to correlate most directly with soil capability. Consequently, the current land use of these class 6 soils should reflect a level of farm activity, determined largely by soil capability and prevailing agricultural economic circumstances. The investigation of the current land use of these soils allows a detailed empirical evaluation of the CLI with respect to a regional anomaly. This forms the first major objective of this thesis.

The capability of soils for agricultural production tends to vary spatially. Where substantial differences in soils exist, agricultural practices and production will likely differ. Such variation may exist at the township and sub-township level. An evaluation of land use as it varies spatially with soil capability forms the second major objective of this thesis.

Given that differences in land use are likely to occur with differing soil capabilities, it is logical to

expect that individual farms would exemplify differing characteristics based on this parameter. Consequently, by conducting empirical studies at the individual farm level some of these relationships should be demonstrated. The actual impact of the soil base on the farm unit may be examined in terms of land use, operation and output. The third major objective, therefore, is to identify and evaluate relationships between low capability soils and the individual farm operation.

A final objective is to comment upon the accuracy of the CLI for use in detailed planning. Given the practical uses being made or asked of the CLI this has implications for agricultural land evaluations, as part of overall rural land use planning and resource management.

Expected Relationships

The logic of the definitions of the CLI soil capability classes (Appendix I) supported by previous empirical findings suggests the major expected relationship that soils identified as class 6 will display limited and marginal agricultural activity.

Amplified, this expected relationship will be reflected operationally in the following manners:

1) Class 6 soils will support low intensity land uses, including large proportions of woodlot, scrub, waste and unimproved pasture;

2) Class 6 soils will have inputs of low intensity including tenure (more non-farm and part-time farm operations), the land base (farm size), enterprise types and fertilizer application rates;

3) Class 6 soils will have low levels of productivity. Total output and output per acre in terms of crop yield and economic status will be low.

Spatially, the above relationships will be found at two distinct scales:

1) soil capability will affect agricultural activity at the regional level, resulting in significant differences between the study area and the surrounding townships of higher soil capability;

2) differences which reflect soil capability will exist between individual farms, specifically between those with a Class 6 soil base and those with a Class 1 soil base.

Study Sequence

This thesis seeks to investigate the agricultural impact of low capability soils at two scales: the regional and the farm level, and to identify the physical, operational and economic parameters of land use at each scale. The concepts, theory and application of soil and land evaluation, including the CLI, are of central importance and are discussed in Chapter II.Thereafter, Chapter III provides an overview of the study area, including a description of its agricultural and physical parameters, while Chapter IV sets out the empirical framework in terms of its methodology and testing procedures. Substantive results are then presented sequentially in the following four chapters. Chapters V and VI report on the findings dealing with land use at the regional or aggregate level. Chapter V consists of a township level analysis using census data, whereas Chapter VI utilizes aggregate data obtained through farm administered questionnaire interviews which provide detailed information on the overall land use and productivity of class 6 soils. Chapters VII and VIII deal with the effect of soil capability at the level of the individual farm unit. Chapter VII consists of a detailed investigation comparing the sample of Class 6 and Class 1 Farms, while Chapter VIII investigates those Class 6 Farms which demonstrate

characteristics of viable agriculture. Both Chapters VII and VIII employ a wide range of operational variables in the analysis. The final chapter, Chapter IX, provides the opportunity to summarize the empirical findings, and to discuss their significance, including the implications for agricultural land evaluation and rural land use planning.

CHAPTER II

AGRICULTURAL LAND EVALUATION IN CANADA

Of central importance to this thesis are the concepts of land and soil classification, especially as they relate to the Canada Land Inventory rating of soils for agricultural capability. Prior to any analysis of the hypothesized relationships, it is necessary to examine the conceptual basis of the CLI ratings. Thus, this chapter focuses on the development of the CLI, its methodology and assumptions. Review of empirical research, especially as it pertains to the establishment of productivity relationships, is part of the discussion of the utility of the CLI in rural land use planning. The chapter concludes with a summary of the problems and limitations associated with soil capability ratings.

Antecedents to the Canada Land Inventory Soil Capability for Agriculture

Inventories of biophysical resources stem largely from the realization of the need for a clear understanding of physical and biological factors which are of significance in the rural environment (Lassey, 1977). Land classification in agricultural areas, especially in the context of land use mapping and planning, has been of particular importance (Jankowski, 1975). In this context, land classification is the grouping of land according to its

suitability for the production of various agricultural crops.

In the classification of land it is customary to distinguish between physical, economic and social factors (Jacks, 1946). The physical characteristics are combined in the factor soil, which includes geology, climate and topography - variables which cannot be significantly altered by man. Given that such a physical classification has a degree of permanence, it may be used to determine the inherent suitability of differing areas to agricultural production over the long term (Dion, 1962).

Within Canada, much agricultural settlement occurred without scientific evaluation of the ability of the soil to sustain agricultural production. In some areas, initial settlement was followed by rapid farm abandonment, indicating these areas were not suitable for viable agricultural production (Parson, 1975). As early as 1917, Thomas Adams, having witnessed this occurrence, encouraged the classification and planning of land according to its physical character and economic use (Adams, 1917). However, the development of soil surveys and the evaluation of agricultural soil capability was a slow process. In Canada, the soil capability classification system for agriculture was developed by the National Soil Survey Committee in association with the federal-provincial ARDA Administration. The actual classification system was predated in Ontario by

soil surveys (which began as early as 1914) and a provincial program in 1926. Already in 1935 there was federal-provincial agreement on the need to upgrade survey and classification procedures. Until well after World War II, however, there were different systems in use in each province, although the general concepts had been borrowed from the U. S. Soil Conservation Service (Jacks, 1946). The final scheme for capability classification of agriculture emerged through federal-provincial consultation which reduced the U. S. system from 8 to 7 classes. In Ontario, an interesting development at the same time and which resembles the CLI system was the work of G. Angus Hills (1952;1960). The Multiple Land-Use Plan for the Glackmeyer area in the Cochrane District of Northern Ontario was one of the first Canadian projects to employ a system of capability ratings in a planning context. Hills approach included site regions and land classification for agriculture, forestry, wildlife, fish and recreation and was subsequently used in the Land Use Plan for the Tweed forest District (Keenan,1964).

The Establishment of The Canada Land Inventory

The CLI developed out of the Resources for Tomorrow Conference held in 1961, at which it was affirmed that there was a need "to complete a countrywide assessment of resource supplies which may be set against long-term assessment of

resource needs" (Resources for Tomorrow, Volume 3, 1961, p. 479). These sentiments represented the opinions of each of a series of resource committees, including forestry and recreation. From the agricultural perspective it was felt that such an inventory would assist in deciding what marginal agricultural land should be reforested; what cultivated land should be regrassed; and what agricultural lands were so valuable that they should be protected from industry, suburban sprawl, highways and airports (Dion, 1962, p. 71). Associated with this, it was felt that the quality of land for crop production should be evaluated in order to stop the indiscriminate transformation of agricultural land into alternate uses (Resources for Tomorrow, Volume 1, 1961, p. 71). The CLI gained official status on October 3, 1963, reflecting the need for a composite scheme of land evaluation as expressed at the Resources for Tomorrow Conference, and by the Senate of Canada Special Committee on Land Use (McClellan, no date, p. 1).

The CLI was set up and administered as a joint provincial-federal project: established at the national level and implemented by the provinces. Established under the Agricultural Rehabilitation and Development Act (ARDA, 1961), the CLI at the federal level has been under the jurisdiction of the Department of Forestry and Rural

Development; the Department of Regional Economic Expansion, and most recently Environment Canada.

The CLI Soil Capability Classification: A Methodology

The mapping of CLI Classes, while considering climatic factors, largely reflects the systematic soil surveys. In Ontario, these began in 1927-1928 and the most recent was completed in the early 1970's. Most of Ontario's soil surveys were completed at a scale of either 1:63,360 or 1:126,720 and provided some insight into soil capability and existing land use. The link between these soil survey maps and the CLI exists in that the soil series is the areal unit used generally for the designation of capability class on published maps (Hills, 1970, p. 107).

On each of the soil series in the counties of Ontario, 10 sample 100 acre plots were established and analyzed at a scale identifying 2 1/2 acre blocks. This was conducted using air photographs at 1:15,840 to establish the soil variation within cartographic units at the 1:63,360 or 1:126,720 scales. A rating was devised which was then used to describe the capability of each of the soil series, presented on manuscript maps at a scale of 1:50,000 (Hoffman, 1981, personal communication). From this base, CLI information has been generalized at various scales, notably the published maps at 1:250,000 and 1:1,000,000.

Reflecting the model developed by the U.S. Soil Conservation Service, with its 8 capability classes (Jacks, 1946, p. 42-45), the CLI rating specifies a total of 7 rated classes on mineral soils and 1 organic soil category. The ratings of mineral soils are modified by 13 subclasses (Appendix I). With the exception of class 1 soils which have no physical limitations, the class rating reflects the general suitability of soils for agriculture through a grouping of subclasses with a similar degree of limitation or hazard (Department of Regional Economic Expansion, 1965, p. 3). In general, the first four mineral classes are considered to be capable of sustained production of commonly cultivated field crops (albeit, with differing levels of productivity). Classes 5 and 6 are restricted to forage crops or permanent pasture, and class 7 soils have no capability for agricultural production (Table 1). Attempts to classify organic soils have met with only limited success. Their evaluation is difficult because of their variable nature and the high capital costs associated with their development, which means most remain undeveloped The productivity of these soils in certain areas (such as the Holland Marsh), however, has resulted in their being perceived as having some capability.

The capability subclasses consist of thirteen different criteria which describe the same kind of

TABLE 1

The Canada Land Inventory and the
Definitions of the Agricultural Capability Classes

Class	Definition
1.	Soils in this class have no significant limitations in use for crops.
2.	Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.
3.	Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices.
4.	Soils in this class have severe limitations that restrict the range of crops or require special conservation practices or both.
5.	Soils in this class have very severe limitations that restrict their capability to produce perennial forage crops, and improvement practices are feasible.
6.	Soils in this class are capable only of producing perennial forage crops, and improvement practices are not feasible.
7.	Soils in this class have no capability for arable culture or permanent pasture.

* More detailed definitions, including those of the subclasses, are included in Appendix I.

(Source: Department of Regional Economic Expansion, 1965, p. 5-9.)

agricultural limitations applied to classes 2 through 7 (Appendix I). The capability subclasses include adverse climate (c), undesirable soil structure and/ or low permeability (d), erosion (e), low fertility (f), innundation by streams or lakes (i), moisture limitations (m), salinity (n), stoniness (p), consolidated bedrock (r), adverse soil characteristics (s), topography (t), excess water (w) and cumulative minor adverse characteristics (x) (Department of Regional Economic Expansion, 1969, p.9-11). The degree and severity of these limitations contribute to the delineation of the actual capability class. As an example, a slope of 31 to 60% results in an area being categorized as class 6 (Department of Regional Economic Expansion, 1969, 16). Together, the class and subclass allow the map user to assess the degree and type of limitation necessary for broad land use planning and the appraisal of conservation needs (Department of Regional Economic Expansion, 1969, p. 3). Specifically, the composite rating of $6^{t6}_{s}\ 4^{f4}_{m}$ implies that 60% of the area is categorized as class 6, with limitations of topography and adverse soil and 40% is class 4 with limitations of low fertility and moisture.

The CLI Soil Capability Classification: Assumptions

The assumptions upon which the CLI soil capability ratings are based play an important role in the classification. The assumptions are as follows:

(1) the classification system is interpretive, combining the effects of climate and soil for the production of common field crops (excluding specialty crops such as fruit and tobacco);

(2) good soil management practices under a largely mechanized system are assumed;

(3) soils within one capability class are similar with respect to the severity of the limitation, although the type of limitation is not necessarily the same;

(4) if property improvements by the farmer are feasible, the classification is made assuming that these have been completed;

(5) distance to markets, road conditions, location, size of farms, ownership characteristics, cultural patterns and the ability of the individual farmer are not factors considered in the capability rating;

(6) capability ratings are subject to change as new information becomes available or as major reclamation or other works are completed (Simpson-Lewis, 1979, p. 3; Department of Regional Economic Expansion, 1965, p.5).

The Soil Capability Ratings and Productivity Relationships: Empirical Testing

The definitions of individual capability classes suggest a positive relationship between soil capability and agricultural productivity. This relationship has been calibrated in Southern Ontario through the research of Noble (1965) and the Committee on Farm Assessment and Taxation (1969) who related soil capability to general economic parameters, including farm size and farm value and by Anderson (1971) and Hoffman (1972) who evaluated the physical relationship of soil capability to crop yields (Table 2). Da Silva (1975) has provided an evaluation of capability related to total physical productivity on a township basis.

Research carried out by Noble (1965) in Eastern Ontario led to the establishment of comparative acreage requirements. These results suggest a strong link between soil capability and agricultural viability, in that as soil capability diminishes, progressively larger acreages are required to obtain levels of output similar to class 1 soils. The results of a study conducted by the Committee on Farm Assessment and Taxation (1969) tend to endorse Noble's results. In this study, the assessed value of farmland was shown to decrease with diminishing capability, thereby

TABLE 2
Soil Capability Equivalents and Indices

Soil Capability Classes	Class 1 Acreage Equivalent		Assessment Schedule of Soil Class Values			Performance Based on Forage Yield		Performance Based on Crop				
	Acres	Index	$ per Acre 1966	1970	Index	Ave. Yield Lbs. Forage Dry Matter Per Acre	Index	Performance Indices Grain/Barley/Oats		Corn	Index	Range
1	100	1.00	159	200	1.00	9.43	1.00	1.00	1.00	1.00	1.00	–
2	115	.87	147	185	.92	7.56	.80	.77	.83	.81	.80	.03
3	133	.75	115	145	.72	6.20	.66	.59	.64	.69	.64	.04
4	(303)	.33	48	60	.30	5.48	.58	.43	.47	.59	.49	.06
5	(400)	.25	24	30	.15	5.08	.49	–	–	–	–	
6	(500)	.20	16	20	.10	4.20	–	–	–	–	–	
7	–	–	12	15	.07	3.00	–	–	–	–		

Sources: Noble, 1965, 9. Committee on Farm Assessment & Taxation 1969, 59. Anderson, 1970, 38. Hoffman, 1972, 91–2.

(Source: Troughton & Da Silva, 1978)

suggesting possible reductions in agricultural productivity.

Studies by Anderson (1970) and Hoffman (1971; 1972) demonstrate a direct link between soil capability and crop productivity. As shown in Table 2, the relationship between soil capability and the calculated index is remarkably similar for these individual studies. Anderson's results suggest productivity on lower capability soils based on the measure of forage crops, whereas Hoffman found no evidence of classes 5, 6 or 7 being used for common field crops. In fact, the Center for Resources Development, using the CLI and yield information, has deduced that profitable production of common field crops even on class 2 soils, given the 20% decrease in productivity between class 1 and 2, may be questionable and "there is little doubt at all that class 4 land cannot be the basis for profitable agriculture when only common field crops are grown" (1972, p 282).

By utilizing the indices developed by Noble, the Committee on Farm Assessment and Taxation, Anderson and Hoffman (Table 2), Troughton and Da Silva (1978) produced a composite assessment of total productivity with soil capability at the township level within Southern Ontario. With few exceptions, this established that soil capability is highly related spatially to total agricultural

productivity. Anomalies which appeared were areas with relatively high productivity on low capability soils (specialty crops including tree fruits and tobacco) and some townships with lower productivity than expected, based on their capability. The latter included areas in Bruce and Grey counties.

In some respects, the productivity values discussed above and displayed in Table 2 have contributed to the acceptance of the CLI and the faith which has been placed in it. To a certain degree, capability has been interpreted as a surrogate for productivity and has helped identify the potential production of a given area. This is of particular significance when planning land use, in that when the supply of a resource is fixed and its demand is increasing, it then becomes possible to evaluate how the resource should be used (Center for Resources Development, 1972, p. 272; Hoffman, 1971 p. 44).

The Canada Land Inventory and Land Evaluation

The utility of the CLI is evident at differing scales and in various situations. Designed for use primarily at the national, provincial and regional level, the CLI has become an important tool in resource management and rural planning down to a local site level. The CLI also

serves as a frame of reference for government policy and guidelines, fostering an appraisal of the agricultural resource base, providing basic documentation of the area and extent of high capability soils. At the national level only 5% of Canada's land area is free from severe limitations (classes 1-3) and in total only 0.5% of Canada's land area is class 1 and of this more than 1/2 is located in Southern Ontario (Simpson-Lewis, 1979, p. 8). In addition, more than 50% of Canada's class 1 agricultural land is located within a 50 mile radius of Canada's Census Metropolitan Areas (Lang, 1980, p. 164; Center for Resources Development, 1972, p. 109). Furthermore, an Agroclimatic Resource Index (ACRI) developed by Nowland and Williams (reported by Simpson-Lewis et. al. 1979; McCuaig and Manning, 1982) evaluates soil capability in the context of a sensitive climatic rating reflecting frost free days, moisture availability and growing degree days. This merging of climate and soil information enhances the significance of those high capability soils located in Southern Ontario and Quebec. Given this information, the importance of agricultural land for agricultural production, and in particular the high capability agricultural areas, may be considered at the national, provincial and municipal levels.

Regional Analysis And Resource Management

"In the past, one of the factors that inhibited the task of formulating province-wide land use plans was the lack of standardized criteria for evaluating the potential of the land base itself for agriculture, forestry, wildlife and recreation" (Department of Regional Economic Expansion, 1970,p. 7). With the CLI this problem, is at least partially eliminated. The Critical Capability Area maps (at a scale of 1:1,000,000) identify areas that have a high capability for one or more resource uses, indicating the most productive areas and those best suited for a range of activities. This composite evaluation should be considered prior to the implementation of any major planning or development project (Lands Directorate, Environment Canada, 1979). In addition, the designation of Agricultural Land Reserves (ALR's) in British Columbia by the B. C. Land Commission Act is another example of the regional utility of the CLI (Gertler, 1975, p. 123; Pierce, 1981). ALR's include class 1 to 4 agricultural lands in most parts of the province and class 1 to 6 in ranching areas (Rees, 1977, p. 31-35).

More complex than the Critical Capability mapping is the Land Capability Zoning completed at a scale of 1:250,000 (for limited sectors of Canada). Designed to

depict the relative capability of an area according to biophysical data, the zoning maps integrated five basic capability classifications to reflect not only the capability but also the economic and social returns expected from a given land use (CLI Lands Directorate, Environment Canada, 1970).

Using a similar type of analysis, conservation authorities and other provincial and federal agencies have evaluated resource and land use proposals in the context of soil capability. An important element of the Wingham District Land Use Strategy, for example, is the analysis of capability and the desirability of pursuing the resource conservation, resource production and recreational programs of the Ministry on lower capability agricultural lands (Ontario Ministry of Natural Resources, 1980, p. 13).

Rural Land Use Planning:

It is generally felt that the relationship between soil capability and the needs of agricultural land users must form the basis for rural land use planning and controls. This opinion has been voiced by the Ontario Federation of Agriculture (Brown, 1976, p. 35); county planners (Davidson, 1976, p. 112) and the Ontario

Government (1978). The view of the Ontario Government, that provincial planning and land use policies must ensure that as much land as possible with the capability for agriculture is kept available for future needs, is not surprising considering the proximity of some of the best agricultural land to the urban areas of Ontario (Government of Ontario, 1978, p. 4).

The objective of preservation of agricultural land has been supported by encouraging the municipalities of Ontario to incorporate such concerns into their local planning. The Foodland Guidelines (1978, p. 5), the major policy statement of the Ontario Government on planning for agriculture, state that the following lands should be inventoried and identified as part of the background information for an official plan, and as the first step in the preservation of agricultural land:

> "High priority agricultural lands include the following:
>
> 1. All lands which have a high capability for the production of specialty crops due to special soils or climate.
>
> 2. All lands where soil classes 1, 2, 3 and 4 predominate as defined in the Canada Land Inventory of Soil Capability for Agriculture.
>
> 3. Additional areas where farms exhibit characteristics of ongoing viable agriculture.
>
> 4. Additional areas where local market conditions ensure agricultural viability where it

might not exist otherwise" (Government of Ontario, 1978, p. 9).

In some respects the CLI has facilitated the development of strong land use planning policies supportive of agriculture in Southern Ontario (Davidson, 1982). By providing details of the quality and quantity of agricultral land being removed from production (in association with census materials) the CLI has fostered research and provided information supportive of the movement to preserve agricultural lands.

Severance policy is another example of the utilization of the CLI at the local level, encouraged by the Ministries of Housing (1975) and Agriculture and Food (The Foodland Guidelines, 1978) and, as a result, is frequently incorporated within local Official Plans. In the Oxford County Official Plan (1980) for example, the severance policy makes it very difficult to obtain a severance on good quality agricultural land but relatively easy on low capability soils. Concern for soil capabilty is also reflected in the severance policies of Huron, Bruce and Kent Counties, among others (Ministry of Housing, 1980).

The severance policy of individual townships and its compliance with the Foodland Guidelines is monitored by the Foodlands Development Branch of the Ministry of

Agriculture and Food. This branch also comments on soil capability at Ontario Municipal Board hearings where agricultural land is an issue (Jim Miller, Verbal Communication, 1981).

Although the CLI is not used directly in tax assessment it does serve as a model for the detailed method of evaluation carried out at the individual farm level (Tasker, 1981). Utilizing a seven-class system, with class restrictions and limitations similar to the CLI, assessors are able to rate individual properties (Noble, 1977). Relationships between market value and the individual classes have been developed and applied to assessment.

The Canada Land Inventory Assessment of Soil Capability for Agriculture: Some Limitations and Problems

The CLI represents the best aggregate source of land use capability data available at national, provincial, and for most local levels. However, benefits from its use are most likely to occur if the user is fully aware of its limitations. These limitations, however, are not always appreciated nor readily apparent. Although the CLI classification is intended to represent only one of several criteria in categorizing agricultural areas, it has sometimes been interpreted as more significant than was

originally intended and has been used beyond its original purpose (Simpson-Lewis, et.al, 1979, p. 8; Hills, 1970, p. 108). This is especially critical given that the CLI is a national scheme frequently used at the local level. Several limitations of the CLI soil capability classification have been pointed out and include the following:

1) Soil capability does not indicate the current land use (Lang and Armour, 1980).

2) By not considering location, access to markets, farm size or ownership, the soil capability rating is not necessarily coincidental with the best economic use under prevailing conditions (Lang and Armour, 1980).

3) The capability rating is national in scope but differences which exist at the local level may be more significant for local planning than differences across the country. For example, if class 3 land is the best available land locally, this may be more significant for the local planner than its rating against class 1 land in the next province (Lang and Armour, 1980).

4) Because the CLI program was conducted on a provincial basis, anomalous variations may occur between provinces. Simpson-Lewis has identified potential

differences because of the failure of the CLI to fully incorporate climatic differences, such as those highlighted by William's Agroclimatic Resource Index (ACRI) (Lang and Armour, 1980; Simpson-Lewis, 1979, p. 5 and 15).

5) Another criticism is that because of the reconnaissance nature of the CLI program, land areas were not mapped and described specifically for detailed levels of land use planning, but rather for regional planning purposes. For example, because of the CLI general overview perspective, the classification system rates the dominant capability of a parcel of land overlooking small areas which may be of significance at a more detailed level of planning. This point, which relates to the scale of the CLI information, has been debated. On one hand, mapping at a scale of 1:50,000 should be adequate to serve as a useful tool for planning at the township level, since an area as small as 25 acres can be identified (Government of Ontario, Foodland Guidelines, 1978, p. 7;27). Nevertheless it has been suggested that the scale of the CLI is inadequate when considering land use planning at the farm level (Altenberg, 1975, p. 269). The link which exists between the original surveys and the CLI also serves to highlight this inadequacy. As noted earlier, the county soil surveys were the basis for the CLI soil classification for agriculture. Consequently, it is logical to assume that in those counties

where the soil survey maps were prepared at a scale of 1:126,720 the CLI information, even though it is presented at a scale of 1:50,000 may be no better than the 1:126,720 scale. In addition, it should be remembered that the soil surveys were conducted over a period exceeding 40 years, thereby incorporating significant differences in mapping based on changing information, techniques and personnel.*

6) Cartographic limitations also exist in that only a limited amount of information can be displayed on the individual maps. In some instances both the number of classes and subclasses have been reduced, resulting in less than a complete information base (Hoffman, 1981; Department of Regional Economic Expansion, 1965, p. 18).

7) Finally, the evaluation of the severity of limiting factors may introduce inaccuracies into the rating of soils. As soil capability diminishes, an increasingly large number of more severe limitations affect the soil's rating. As a result, the evaluation of lower capability soils is somewhat more subjective, especially where a composite rating results.

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* Renewed mapping on a county basis by the Ontario Institute of Pedology should upgrade the quality of soil maps available (Van den Broek, 1981).

Some of the problems identified above have been exemplified by Hills (1970, p. 107; 146) and Mage (1980, p. 19) who have identified areas omitted from classification or misclassified. Van den Broek (1981) also encountered situations where, as a result of the scale at which the survey was conducted, an individual property has apparently been misclassified.

On a provincial and township basis Troughton and Da Silva (1978) have identified both areas of low capability with high productivity based on the productivity of certain specialty crops and areas of high capability with low productivity reflecting differing levels of intensity of capital investment and specialization existing in different parts of the province. In a study conducted by J. R. McLean (1977) an area of relatively low capability (capability classes 3 to 6) did not differ substantially from an area of higher capability, leading McLean to suggest that output, as the prime indicator of farm value, could be modified by the ability and knowledge of the individual farmer as expressed through capital intensity, maintenance and land conservation. McLean also points out that farmers may not necessarily aim to maximize yields, but rather maintain a level and type of production similar to the agricultural system of the area in which they are located.

Given the situations cited above and the context whereby the CLI is used at various scales, the potential exists for the development of planning policies and strategy based on information containing inherent weaknesses. For example, a more open severance policy could be based on the granting of non-farm severances on lower capability soils and if areas of higher capability are interspersed the policy could have a detrimental impact on agriculture. Such problems are most likely to occur at the farm level if the planning process fails to acknowledge the CLI limitations. These include problems of scale, where boundaries of the soil capability units may contain inaccuracies and where individual farm boundaries bear no resemblance to the pattern of soil capability. Furthermore, a composite rating containing 2 capability classes and several limiting factors introduces problems of interpretation, including the significance of the differing classes and limiting factors.

However, if the objectives of rural land use policy are as David Brown of the Ontario Federation of Agriculture has stated, "to preserve and encourage a profitable agricultural industry in Ontario, to preserve as much high class agricultural land as is possible within the province and to allocate it to agriculture for the continued production of food and fibre; to ensure an adequate supply of high quality food, now and in the future without an undue

reliance on imports; ...to assure that agriculture continues to be located on productive land that can be operated as viable and progressive farms and as profitable business; to protect farmers from harassment and complaint from non-farm encroachment into agricultural areas" (Brown, 1976), then a comparative rating of soil capability is required. Although there are problems with the CLI, it nevertheless remains the most detailed, accurate and accessible information which is available throughout the settled parts of Canada. The key, therefore, is to utilize the CLI within the confines of its limitations and intended use.

Based on an iterative process and detailed empirical studies, the CLI has attained a degree of validity encouraging its use, in some instances beyond its original design. Use at the level of the individual farm is one instance where the effect of soil capability has not been thoroughly investigated. Consequently, the study of the relationship between soil capability and the farm unit constitutes an important rationale for this study. The following chapter introduces the study area, establishing the basis for the examination.

CHAPTER III

THE STUDY AREA: A PROFILE

East Wawanosh, West Wawanosh and Turnberry, located in the northern portion of Huron County, and Kinloss and Culross, situated in the adjacent southern portion of Bruce County (Figure 2), contain one of Ontario's largest areas of class 6* soils south of the Canadian Shield. Within this unit, a large area of class 6 soils constitutes a significant regional anomaly within Southern Ontario (Figure 3). The primary orientation of this thesis is towards the study of agriculture on these soils and the observed use of adjacent class 1 soils.

The major objective of this chapter is to describe the study area in terms of its physical and human characteristics as they pertain to the anticipated relationships between particular soil type and capability situations and agricultural land use.

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* Class 6 within the study area implies the composite rating of class $6^{t6}_{s}4^{f4}_{m}$, as rated by the CLI soil capability classification for agriculture.

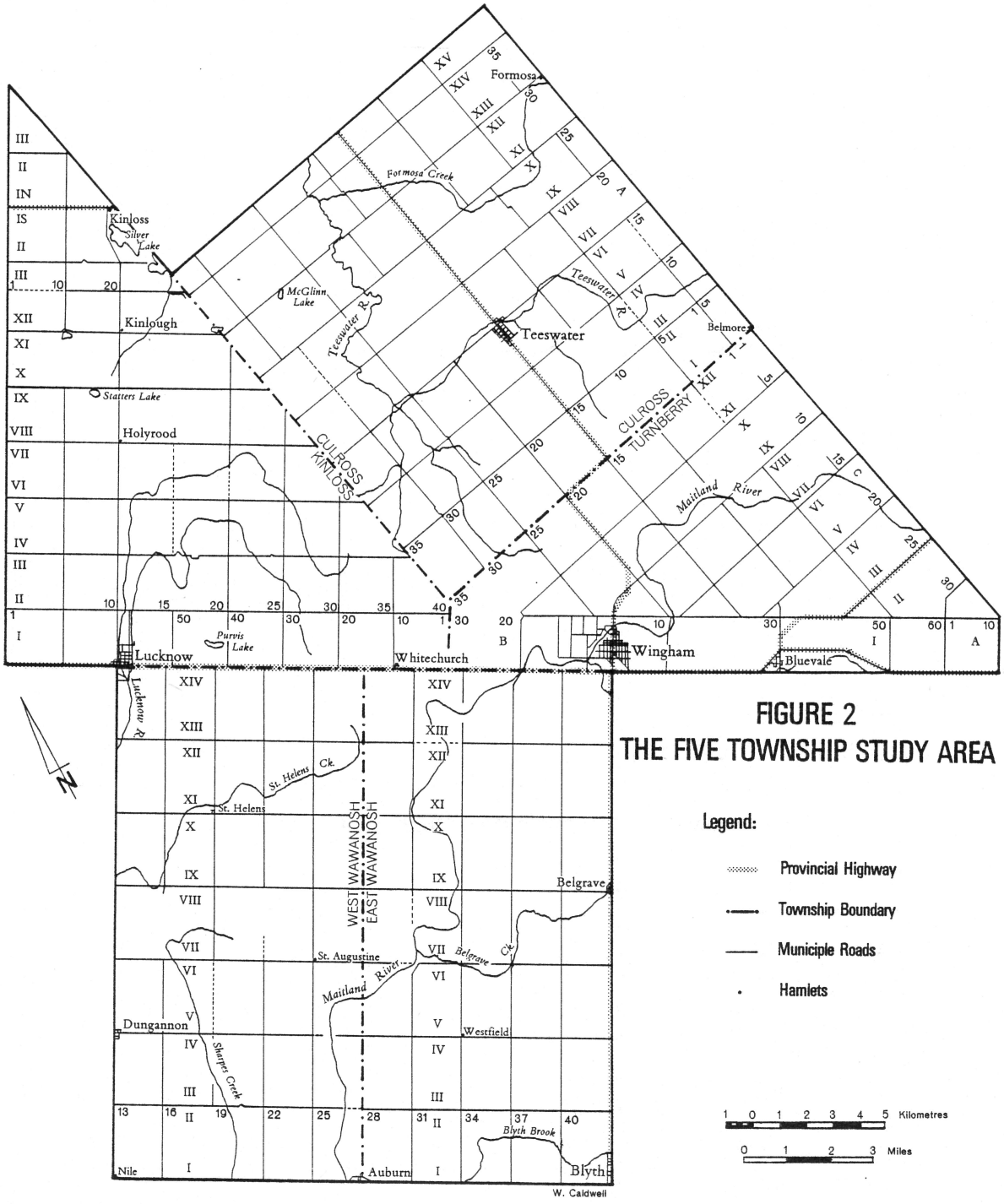


FIGURE 2
THE FIVE TOWNSHIP STUDY AREA

Legend:

- Provincial Highway
- Township Boundary
- Municiple Roads
- Hamlets

1 0 1 2 3 4 5 Kilometres

0 1 2 3 Miles

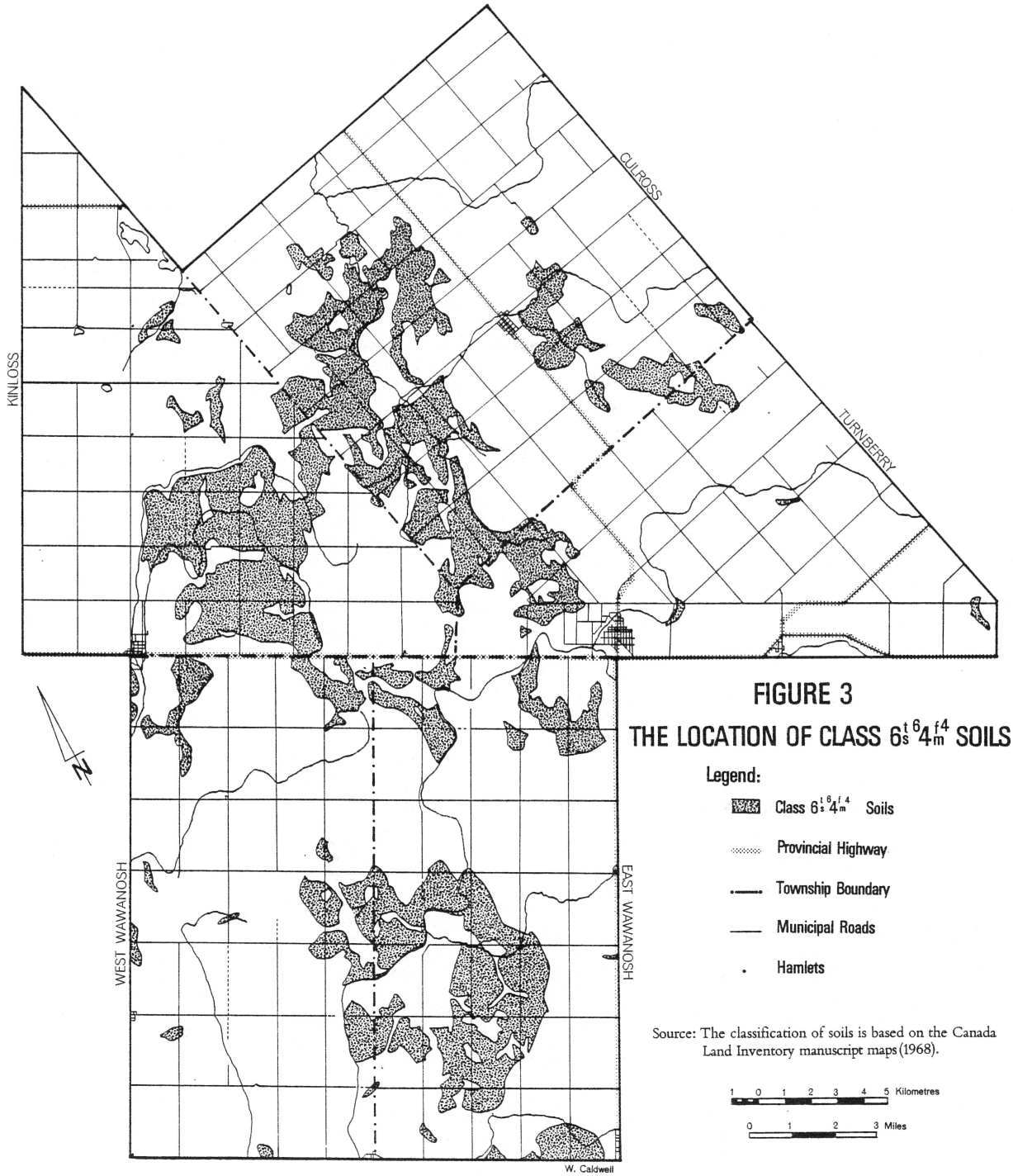


FIGURE 3
THE LOCATION OF CLASS $6_s^{t6}4_m^{f4}$ SOILS

Legend:

- Class $6_s^{t6}4_m^{f4}$ Soils
- Provincial Highway
- Township Boundary
- Municipal Roads
- Hamlets

Source: The classification of soils is based on the Canada Land Inventory manuscript maps (1968).

1 0 1 2 3 4 5 Kilometres

0 1 2 3 Miles

The Physical Characteristics of the Study Area as They Pertain to Agriculture

In total, the five townships have a combined area of 91,910 hectares (227,017.7 acres)* which represents 12.5% of the total area of Huron and Bruce Counties (Ministry of Intergovernmental Affairs, 1980). The overall maximum dimensions of the study area are approximately 44 kilometers north-south and 36 kilometers east-west.

The Climate of the Study Area

Most of Huron and Bruce Counties, including the study area, are part of the Huron Slopes climatic region of Southern Ontario (Brown, McKay and Chapman, 1968). As such, the length of the growing season (195 days); the period of frost free days (135 days); the amount of precipitation (81-99 cm. annually) and the temperature regime (Table 3) facilitates the growth of many crops common to Southwestern Ontario (Brown, McKay and Chapman, 1968). It should be noted, however, that some variations will exist in the study

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* Appendix II includes conversion factors from Imperial to Metric. Most sources of published agricultural data (including the 1971 and 1976 Census) and the questionnaire interview data retain Imperial measurements, particularly of area (acres) and crop yield (bushels/ acre). Consequently, the analysis and other uses of census data retain these measurements.

TABLE 3

Selected Characteristics of Climate
in the Study Area
(Huron Slopes)*

	Huron Slopes
Altitude (metres above sea level)	338.3
Mean Annual Temperature (Degrees Celsius)	6
Mean Daily Maximum Temperature (Degrees Celsius)	
-January	-2
-April	11
-July	26
-October	14
Mean Daily Minimum Temperature (Degrees Celsius)	
-January	-10
-April	0
-July	13
-October	4
Mean Date of Last Frost in Spring	May 20
Mean Date of First Frost in Fall	Sept 30
Mean Annual Frost Free Period (Days)	135
Start of Growing Season	Apr 17
End of Growing Season	Oct 31
Mean Annual Length of Growing Season	195
Mean Annual Growing Degree Days	3200
Mean Annual Precipitation (cm)	88-90
Mean Annual Snowfall (cm)	279
Mean Annual Potential Evapotranspiration (cm)	58
Mean Annual Actual Evapotranspiration (cm)	56
Mean Annual Moisture Deficiency (cm)	3
Mean Annual Water Surplus (cm)	41

Source: Brown,McKay and Chapman, 1968, Table 12.

*See Appendix II for metric conversion factors.

area, given local differences in latitude, altitude and distance from Lake Huron.

Although the climate of the study area is intermediate among the climatic zones of Southern Ontario, it constitutes part of Canada's optimum agroclimatic area. This is summarized in William's Agroclimatic Resource Index (ACRI) which incorporates the variables of moisture, temperature and the frost free period (reported by Simpson-Lewis, 1979). Southern Ontario and Quebec are the only areas in Canada with an ACRI value in excess of 2.5, and it is noteworthy that a sizeable proportion of the study area falls into a category exceeding this value. In fact, the entire study area, with a value exceeding 2.0, is considered as a critical agroclimatic resource area (Simpson-Lewis, 1979, 17). This reflects the ability of the study area to grow a wide range of crops, including corn, wheat, barley and beans.

Physiography and Relief

The topography of the study area is largely a product of glacial processes which have left a varied landscape. The three physiographic regions covering the study area are the Huron Slopes, Horseshoe Moraines and the

Teeswater Drumlin Field (Chapman and Putnam, 1966). The resultant landscapes consist of drumlinized and undrumlinized till plains, till and kame moraines, spillways, eskers, drumlins and peat and muck deposits and are generally flat to rolling with some areas demonstrating a hummocky or rugged appearance. This is easily distinguished in the attached topographic mapping of the study area (Appendix VII). The overall variation in relief is reflected by the range in elevation as it varies with distance from Lake Huron, from a minimum of less than 825 feet in West Wawanosh Township, to a maximum of more than 1175 feet above sea level in both Turnberry and East Wawanosh Townships (Appendix VII).

The drainage of the study area is through a series of rivers and streams which drain into Lake Huron (Figure 2). Most prominent among these are the Maitland, Lucknow and Teeswater Rivers (Appendix VII). In sum, the total area has the benefits of a fairly effective and well dispersed drainage network, facilitating natural drainage and aiding in the effectiveness of artificial tiling.

The results of the physiography and climate are certain localized problems which may interfere with agricultural production. In some instances, there are problems with steep slopes, stoney materials and drainage.

These problems are reflected in the individual soil types and ratings. In general, however, the study area is suitable for agricultural production.

Soils

One of the most significant variables determining agricultural viability and of particular significance to this report is the distribution of soil types. In general, all of the soils within the study area are part of the Grey-Brown Podzolic Great Soil Group (Hoffman and Richards, 1952). The major soil associations (Table 4) which cover the study area are comprised of soil series which tend to have uniformly high suitability for agriculture (such as the Harriston Loam, Huron Clay Loam and Teeswater Silt Loam). The one major exception is the Dumfries Association which is comprised primarily of Donnybrook Sandy Loam soils.

As noted in Chapter II, the mapping of the CLI soil capability rating for agriculture utilized boundaries established in the original mapping of soil series. Consequently, it is interesting that those soils rated as class 1 by the CLI were also considered as good cropland by the original soil surveys and were generally assessed as having good drainage, few stones, and undulating to rolling

TABLE 4

Soils and Soil Capability of the Study Area*

Dominant Textural Groupings	Major Soil Associations	Dominant Soil Series	Soil Type	Natural Drainage	Topography	Stoniness	Suitability for Cropland	Dominant CLI Soil Capability
Medium Textured Soils Formed on Till	Guelph	Harriston	loam	good	strongly undulating to rolling	slightly stoney	Good	$1^{8}3^{t2}$
	Guelph & Honeywood	Teeswater	silt loam	good	undulating	usually stonefree	Good	1
		Harriston	loam	good	strongly undulating to rolling	slightly stoney	Good	$1^{8}3^{t2}$
Medium & Coarse Textured Soils Formed on Coarse Stoney Till	Dumfries	Donnybrook	sandy loam	good	strongly rolling to hilly	moderately to very stoney	Fair to Poor	$6^{6}_{s}4^{f4}_{m}$
Fine Textured Soils Formed on Till or Lacustrine Sediments	Huron	Huron	clay loam and silt loam	good	rolling to undulating	slightly stoney	Good	$1^{6}3^{t4}$
	Perth	Perth	clay loam and silt loam	Imperfect	undulating	slightly stoney	Good to Fair	1
Moderately Fine Tectured Soils Formed on Till Sediments	Honeywood	Teeswater	silt loam	good	undulating	usually stonefree	Good	1
Organic Soils	Muck	Muck	variable	poor	depressional	stonefree	Sub-marginal	Organic

* The majority of these soils are part of the Grey-Brown Podzolic Great Soil Group.

Adapted from: Hoffman and Richards (1952); Hoffman and Richards (1954)

: Canada Department of Agriculture; Soil Associations of Southern Ontario (1964)

: ARDA Soil Capability for Agriculture, 1968, 40 P/11; 40 P/13; 40 P/14; 41 A/3; 41 A/4.

topography (Table 4). In contrast, Donnybrook Sandy Loam soils rated as $6_s^{t6}\,4_m^{f4}$ by the CLI were considered in the soil surveys as fair to poor cropland and were strongly rolling to hilly with many stones (Table 4). Given that this soil survey rating of fair to poor cropland ranks fourth out of six groupings, with two lower ratings of poor and submarginal, this implies relatively more productive cropland than does the CLI rating of $6_s^{t6}\,4_m^{f4}$.

The overall high capability rating of the study area is shown by the 66% of all soils classified in the prime agricultural classes of 1, 2 or 3 (Table 5) (Simpson-Lewis, 1979, 5). This compares to 86.6% in Huron; 56.4% in Bruce and 70.2% for the 2 counties combined. Conversely, the low proportions of class 6 land in Huron and Bruce (2.4% and 2.1% respectively) contrast the relatively high percentages in the study area, ranging from a low of 4.4% in Turnberry to a high of 13.8% in Kinloss Township, with a study area mean of 10.0%. In total, the study area, which encompasses 12.6% of the total area of the two counties, has nearly 56% of the total amount of class 6 land. The major limiting factors within the study area are topography (t), affecting 22.5% of the land area; and soil limitations (s) (involving problems with two or more of: soil structure, fertility, moisture, or salinity) affecting 20.6% of the area (Table 5).

TABLE 5

The Average of Soil Capability Classes in the Study Area

Area	Class 1 Acres	%	Class 2 Acres	%	Class 3 Acres	%	Class 4 Acres	%	Class 5 Acres	%	Class 6 Acres	%	Class 7 Acres	%	Organic Acres	%	Totals
Huron	421,177	50.1	207,046	24.6	100,347	11.9	16,590	2.0	40,743	4.8	20,468	2.4	0	0	34,589	4.1	840,960
Bruce	300,002	30.0	181,152	18.1	82,660	8.3	20,477	2.0	105,065	10.5	21,035	2.1	225,597	22.6	64,332	6.4	1,000,321
Cty.Total	721,179	39.2	388,198	21.1	183,007	9.9	37,067	2.0	145,808	7.9	41,503	2.3	225,597	12.3	98,921	5.4	1,841,280
Townships																	
E.Wawanosh	19,325	44.7	1,540	3.6	6,785	15.7	4,210	9.7	4,670	10.8	5,645	13.1	–	–	1,025	2.4	43,200
W.Wawanosh	23,810	55.1	1,220	2.8	7,020	16.2	1,500	3.5	3,675	8.5	1,955	4.5	–	–	4,030	9.3	43,210
Turnberry	22,555	59.6	450	1.2	4,070	10.8	1,205	3.2	2,500	6.6	1,680	4.4	–	–	5,375	14.2	37,835
Kinloss	20,214	41.0	6,044	12.3	5,859	11.9	4,666	9.5	1,984	4.0	6,821	13.8	–	–	3,672	7.5	49,260
Culross	26,075	44.7	2,435	4.2	5,635	9.7	5,270	9.0	3,170	5.4	7,140	12.2	130	.2	8,450	14.5	58,305
Total	111,979	48.3	11,689	5.0	29,369	12.7	16,851	7.3	15,999	6.9	23,241	10.0	130	.1	22,552	9.7	231,810

Sub Classes (Limitations)

Area	Excess Water	Topography	Stoniness	Adverse Soil Characteristics	Bedrock
Huron	144,160	108,780	6,208	3,910	–
Bruce	156,040	73,115	61,585	156,290	225,220
Cty.Total	300,200	181,895	67,793	160,200	225,220
Townships					
E. Waw.	2,175	12,240	2,365	11,395	–
W. Waw.	1,215	9,000	515	3,910	–
Turnberry	580	5,685	638	3,525	–
Kinloss	3,590	13,715	675	16,035	–
Culross	3,710	11,630	675	12,955	130
Total	11,270	52,270	4,868	47,820	130

Source: ARDA Report No. 8; Acreages of Soil Capability for Agriculture in Ontario (1975)

In general, the physical characteristics of the study area are very supportive of viable agriculture. A good climate and a large area of high capability soils encourage intensive agricultural production. Although general conditions are favourable, the suitability of the Donnybrook soils for agricultural production based on the original soil surveys must be questionned, given their classification of $6^{t6}_{s}\,4^{f4}_{m}$ by the CLI.

The Canada Land Inventory: Class $6^{t6}_{s}\,4^{f4}_{m}$: A More Detailed Description

A classification of soil as $6^{t6}_{s}\,4^{f4}_{m}$ by the Canada Land Inventory infers an area of marginal agriculture. Given that class 6 soils have severe limitations, confining production to perennial forage crops, with improvement practices not feasible, and that class 4 soils have severe limitations restricting the range of crops or requiring special conservation practices, the presence of any viable, intensive agriculture would be surprising. In fact, in the view of S. Rodd (1976) an area of class 4 land 2 miles wide, is virtually hopeless for farming in most parts of Southern Ontario. Furthermore, a Report of the Center for Resources Development (1972) concluded that class 4 soils cannot be the basis for profitable production of common

field crops and went as far as suggesting that class 2 soils cannot be used for the profitable production of common field crops.

Indeed, the trend in many parts of Eastern Canada, including Ontario, where large sections of low capability lands were settled for agriculture, has been for much of that land to revert back to non-agricultural uses (Parson, 1975; Maxwell, 1966). Given the ongoing processes of increasing scale, capital intensification and specialization associated with the industrialization of agriculture, marginal areas may have an increasingly difficult time remaining competitive with high capability areas (Troughton, 1981). However, while most documentation of land use activities on marginal land has occurred on extensive areas of low capability soils, notably in fringe areas of the Canadian Shield, the study area is primarily of high capability interspersed with sizeable tracts of low capability soils (Figure 3). In addition, the area is agroclimatically suited to a wide range of crops (Simpson-Lewis, 1979).

As illustrated in Table 5 and Figure 3, the largest extent of class 6 soils occurs in the townships of East Wawanosh, Kinloss and Culross, reflecting the location of the Wawanosh Moraine (Chapman and Putnam, 1966). Although

the soils are somewhat dispersed there are essentially three large blocks: much of the southwestern portion of East Wawanosh Township, bounded approximately by concessions 3 to 8 and lots 28 to 37, forms the first; the other two major blocks occur in Kinloss, covering much of concessions 1 through 6 and lots 12 to 27, and in Culross, covering a strip approximately 3 km. wide in the west of the township, including concessions 1 through 11 and lots 17 to 35 in the north and lots 28 to 35 in the south (Figure 3). The overall extent of these areas of low capability soils mean that they are easily detected at the provincial CLI mapping scale of 1:1,000,000.

The CLI designation of class 6 soils is at least partially justified in that the Ontario Land Inventory (OLI) has mapped out units at a scale of 1:250,000 which show a similarity to the mapping of class 6 soils. On the OLI maps, the areas which are class 6 on the CLI maps show up generally as: "Sand with other materials: Deep". Historically, these poorer quality lands have been recognized going back to the period of initial settlement* (Robertson, 1960: first published 1906).

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* In 1901 in a "Report of County Valuators" in a discussion of Culross Township it was recognized that "there is a very rough strip of about two miles and a half along the western boundary, which reduces the average rate per acre very considerably, while being very hilly it grows fair crops" (Robertson, 1960).

The rating of the Donnybrook sandy loams as $6_s^{t\,6}\,4_m^{f\,4}$ stems from the severity of the limiting factors. As the rating itself indicates, the limiting factors consist of adverse topography (t), soil characteristics (s), low natural fertility (f) and a low moisture holding capacity (m). The Donnybrook sandy loam soils, according to the soil surveys (1952 and 1954), are largely cleared and used for general farming. Based on the Crop Adaptability Ratings presented in the two soil surveys, Donnybrook soils are "fair" for the growth of alfalfa, red clover, timothy and pasture; "fair to poor" for wheat and oats, and "poor" for corn and barley. Improved productivity may be obtained, however, through the use of fertilizer (Huron County Soil Survey, 1952, p. 53). Yields for the growth of wheat, oats, mixed grain and hay in Bruce County (1954) show a substantial difference between the Donnybrook soils and the other major soils in the study area which the CLI has rated as class 1 (Table 6).

According to the County Soil Surveys, a fairly large proportion of the Donnybrook soils were used for permanent pasture, because their complex topography made them susceptible to erosion and complicated attempts to strip crop or practice contour cultivation. Nevertheless, it was reported that crop rotation on the more gradual slopes, combined with keeping the soil under cover for

TABLE 6

Yields per Acre of Selected Crops
by Soil Series

Soil Series	Wheat (bushels)	Oats (bushels)	Mixed Grain (bushels)	Hay (tons)
Combined Average of Harriston, Teeswater, Huron and Perth Soils	43.8	56.3	55	2.3
Donnybrook	15	25	20	1

Source: Adapted from the Soil Survey of Bruce County 1954, Table 19.

extended periods of time, helped to maintain the soil for general farming (Hoffman and Richards, 1952; 1954).

In some areas, undergrazing resulted in the growth of thorn trees, thereby reducing the value of the land for pasture. The fertilizer requirements of the soil, plus the need for organic matter, also acted as a deterent to farming. Conversely, rapid internal drainage and spring runoff allowed early spring cultivation, an advantage over other heavier more poorly drained clay soils (Hoffman and Richards, 1952; 1954). It is interesting to note that although several major problems are associated with the soil (including relatively low yields), the Crop Adaptability Rating as given in the soil surveys, does not coincide with the CLI's definition of class 6 soils.

Historical Development

The study area was part of the Queens Bush, an area which witnessed the last major wave of rural settlement in Southern Ontario and was settled largely by people of Scottish and Irish ancestory (Scott, 1966). Within the study area, the first township to be surveyed was Wawanosh in 1836. Using the 2,400 acre Sectional System, the township consisted of a regular pattern of 200 acre lots with dimensions of 66.67 chains by 30 chains (Dean, 1969,

plate 99). Due primarily to administrative problems associated with the township's large size, the single township of Wawanosh was split into the separate townships of East and West Wawanosh in 1866 (Scott, 1966, 192-193). The three remaining townships of Culross, Kinloss and Turnberry were all surveyed using the 1,000 acre Section Special method in 1849, 1852 and 1853 respectively (Dean, 1969, Plate 99). The result of this survey system was a series of 100 acre lots with dimensions of 20 chains by 50 chains. In all five townships, the survey pattern resulted in a regular grid network of lots, concessions and sideroads laid out with little regard to local variation in the physical landscape.

Settlement Characteristics

Initial settlement of the five townships took place during the decade 1851-1861 (Robertson, 1960; Scott, 1966). The distribution of lots, farmsteads and settlement was established according to the pattern of survey, with little regard to the actual lay of the land and resulted in most farmers owning 100 acres, with frontage on a concession road. As a result of this grid network and survey pattern, it was not uncommon for an individual farm unit to possess a range of physiographic units and soils with differing capabilities. Possibly, in instances where good and poor

soils existed side by side, the original survey system may have inhibited the use of high capability soils and in other instances it may have fostered the use of low capability soils, depending on the relative location within the farm unit. In some instances where land is of poor quality, farm abandonment or changing land use* may have occurred. The above is partially reflected in the attached topographic map which shows the location of farmsteads and wooded areas (Appendix VII). In some instances, areas of low capability soils (Figure 3) are cleared with a regular pattern of farmsteads, whereas in other areas they are totally wooded, thereby suggesting limited agricultural use.

Throughout the entire area, however, the recent processes associated with the modernization and industrialization of agriculture have resulted in the consolidation of many farm units. Whereas prior to World War II agriculture in Southwestern Ontario tended to consist of relatively labour intensive mixed livestock operations, recent intensification trends, including mechanization and specialization, have produced a reduction in Ontario's farm

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* During the course of the interviews several farmers related that some of the more hilly areas with class 6 soils had in the past produced good yields of crops (such as grain). This occurred, however, when horses were used and with the mechanization of agriculture, these areas have either reverted to pasture or else have been abandoned or reforested.

population. Increasing scale of operation has transformed farms into fewer capital intensive units of production. In Bruce and especially Huron, there has also been an increasing trend towards cash cropping. Frequently, these changes have resulted in a fragmented layout of farm parcels.

Associated with the initial growth of the farm community was the development of a fairly regular network of hamlets, villages and towns (Figure 2 and Table 7), which served primarily as local service centers. Indeed, many of the settlements which have survived, while having changed in some respects, still retain the service of the agricultural sector as their primary function.

Rural Characteristics

Within a study area which demonstrates the characteristics of a rural and agricultural community, economic conditions will more likely reflect agricultural realities (Ontario Department of Agriculture, Publication 68, 1). The rural nature of an area may be evaluated in several ways, including the distance from major urban centers and the demographic and economic composition of the local area.

TABLE 7

Incorporated and Unincorporated Settlements
Within or Adjacent to the Study Area (1976)

Settlement	Population
Wingham	2,871
Lucknow	1,127
Teeswater	988
Blyth	866
Formosa*	395
Wroxeter*	287
Auburn*	222
Dungannon*	208
Belgrave*	204
Bluevale*	204
Whitechurch*	134
Belmore*	96
Kinloss*	60
Nile*	60
Holyrood*	55
Kinlough*	49

* denotes unincorporated settlement.

Source: 1976 Census.

The five study townships combined have a total population of 7,035 with a density of 19.8 people per square mile (Table 8). This compares with the value of 40 people per square mile for the two counties of Huron and Bruce. While the five townships have 12.5% of the total area of the two counties, they only have 6.2% of the area's total population. In fact, Turnberry is the only township which has a density exceeding 25 people per square mile, a value which Russworm has used to delineate the distinction between rural and semi-rural (in his categorization of rural, semi-rural, semi-urban and urban municipalities) (Yeates, 1975). The rural nature of the area is emphasized by the fact that nearly 50% of the township's population is rural-farm, compared to 21.6% for the two counties.

The direct impact of major urban centers on the study area, in terms of land use, is unlikely to be great. At the county level, the largest centers (Goderich, Kincardine and Walkerton (1976)), are all under 7,500 in population and are at some distance from the study area. The closest major urban centers are Kitchener-Waterloo and London with respective CMA populations of 287,801 and 283,668 (1981), but both are approximately 80 kilometers straight line distance from the nearest portion of the study area. Moreover, their populations are most likely to be attracted to recreational developments along the Lake Huron

TABLE 8

The Population and Population Density of the Study Area

	Population	Density (Sq.Miles)	Farm Population	Farm Population as % of total
Huron County	56,007	42.6	14,139	25.2
Bruce County	57,472	36.8	10,370	18.0
County Total	113,479	40.0	24,509	21.6
East Wawanosh	1,154	17.2	704	61.0
West Wawanosh	1,302	19.7	658	50.5
Turnberry	1,503	26.6	490	32.6
Kinloss	1,301	17.4	628	48.3
Culross	1,775	19.6	979	55.2
Township Total	7,035	19.8	3,459	49.2

Source: 1976 Census.

shore. In support, a study of absentee ownership covering the study area (Mage, 1980; 1981), shows that only 7.6% of the total land base is owned by non-residents (Foreign, Non-Ontario Canadian and Non-local Ontario) (Table 9). As a result, one may conclude that the use of land is most likely to reflect the economies of the local agricultural system and the values of the local population.

Agriculture, as the most extensive industry within Huron County and the southern portion of Bruce County, receives full recognition and support in the respective County Official Plans. The almost total dominance of the agricultural industry within the study area tends to justify this emphasis. In 1976, 922 farms existed in the study area with an average farm size of 205.1 acres. The major agricultural activities included the rearing of hogs, and beef and dairy cattle, along with the growing of hay, pasture, corn and mixed grain. The overall extent and intensity of agricultural production would appear to correspond with that typical of Southwestern Ontario (see Chapter V).

In summary, the study area as a whole appears to have a land base, climate and infrastructure supportive of viable agriculture. The applicability of this statement, to those soils identified as class 6 must, however, be

TABLE 9

Non-Resident Ownership in the Study Area
(Foreign; Non-Ontario Canadian and Non-local Ontario)

	Acres	Percent
Turnberry	2,899	8.5
East Wawanosh	2,450.4	6.0
West Wawanosh	2,619.5	6.4
Culross	4,120.4	7.9
Kinloss	3,813.8	9.2
Total	15,903.1	7.6

Source: Mage, 1981, Adapted from Tables 1, 2, and 3.

questioned. The study of agricultural land use on these soils provides the basis for this research. The following chapter sets forth the methodology used in this study.

CHAPTER IV

THE RESEARCH METHODOLOGY

This thesis seeks to establish the expected relationship that class 6 soils in the study area will display limited and marginal agricultural activity. Specifically, it is anticipated that class 6 soils will have low intensity inputs resulting in low intensity land uses and low levels of productivity. Essentially, these relationships are expected to apply at both regional and farm levels. The following discussion sets out the methodology and research techniques utilized in the study of the expected relationships, including the scales of investigation; sample identification; the questionnaire, and the methods of data analysis.

Scales of Investigation

The analysis of expected relationships occurs at both the regional and farm level. The data utilized for study at the regional level consists primarily of published census materials detailing agricultural activity for the counties and townships. This information forms the basis for Chapter V. Farm based data derived from a set of personally administered questionnaire-interviews provides

for detailed examination of land use at the local level. Chapter VI utilizes the measures of cropping and yield by soil capability obtained from questionnaire results mapped on aerial photographs. Chapters VII and VIII use the questionnaire derived data to specifically investigate the relationships between soil capability and land use as it varies on a farm by farm basis.

Sample Identification

The study area consists of the five townships of Culross, Kinloss, Turnberry, East Wawanosh and West Wawanosh (Figure 2). Within the study area, this thesis focuses on those soils classified as $6^{t6}_{s}\ 4^{f4}_{m}$ by the CLI rating of soil capability for agriculture (Figure 3). In order to evaluate farm units with this rating it was necessary to first identify them by establishing the cadastral base of each individual township. This involved contacting township clerks and reviewing the assessment rolls, which provided property descriptions and details of ownership. Utilizing this cadastral base in conjunction with 1:50,000 CLI soil capability maps allowed the identification of those farms (and their owners) which contain substantial portions of class 6 soils. The farm survey component was limited to those individuals who owned 10 or more acres of land.

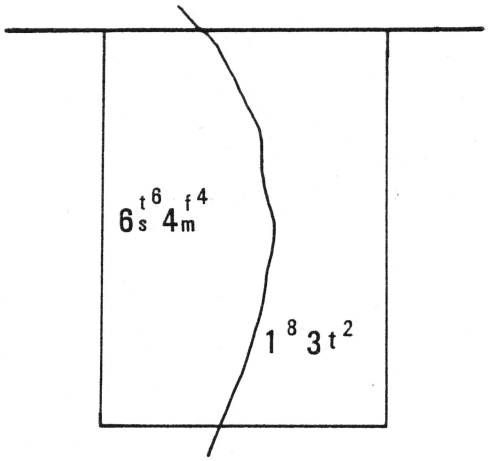
Farm Unit Classification

An important element of the study was the grouping of individual farms based on soil capability. The distribution of soils resulted in farms having various acreages of differing soil capabilities. This factor complicated the comparison of individual farms based on soil capability. Consequently, three methods were devised to permit the classification and relative rating of individual farms based on soil capability class acreages and which took into account the effect of a composite capability rating such as $6_s^{t6}\,4_m^{f4}$, as follows:

1. Total farm acreage may be broken down into total acreages under each soil capability class. A 200 acre property of class $6_s^{t6}\,4_m^{f4}$, for example, was assumed to have 120 acres of class 6 soils and 80 acres of class 4 soils. Multiplying the 2 values together and dividing by the total acreage produced a comparative rating of 5.2 (Figure 4). Rented acreage was also considered to be part of the farm unit and was incorporated within these calculations. Although these values may be somewhat misleading when compared to the CLI capability class definitions, they provide a relative rating of individual farm units taking into account the total soil base.

FIGURE 4

METHODS OF RATING INDIVIDUAL FARMS BY SOIL CAPABILITY



80 acres $6_s^{t\,6}\,4_m^{f\,4}$

75 acres $1^{8}\,3^{t\,2}$

Method 1

80 acres $6_s^{t\,6}4_m^{f\,4}$ =class 6= .6×80=48×6=288

=class 4= .4×80=32×4=128

75 acres $1^{8}3^{t\,2}$ =class 1= .8×75=60×1=60

=class 3= .2×75=15×3=45

521 521/155=3.36

The farm rating is 3.36

Method 2

		Average Index	
class 6 = 48	×	.25	=12
class 4 = 32	×	.43	=13.76
class 1 = 60	×	1.0	=60
class 3 = 15	×	.69	=10.35
			96.11

96.11/155= .62

The farm rating is .62

2. The second method for appraising individual farms utilizes indices from empirical studies (Table 2) to establish an average index value for individual classes (Table 10). Although there is some variability among the results, with Anderson's forage yields indicating higher productivity on lower capability soils, the average index reflects not only crop yields, but also assessment values and measures of individual farm productivity. The average values were then employed in a manner similar to that utilized for Method 1 (Figure 4 - Method 2).

In both Method 1 and Method 2 organic soils were assumed to have productivity levels similar to class 6 soils. Although there is little documentation discussing the use or productivity of these soils, they are generally considered to have low levels of productivity when existing in an undrained state. This is reflected in an analysis of the 2,384 acres of organic soils which were examined within the study area (5.4% of the total acreage). In total, nearly 75% of this acreage fell into the land use categories of bush, scrub, waste and other. Only 8% of the organic area was cropped; 15% was in hay or pasture and the remaining 3% was rented out.

The two methods outlined, while useful for the comparison of individual townships (Chapter V), are less

TABLE 10

Composite Productivity Index*

	Noble	Committee On Farm Assessment	Anderson	Hoffman	Average Index
Class 1	1.0	1.0	1.0	1.0	1.0
Class 2	.87	.92	.8	.8	.85
Class 3	.75	.72	.66	.64	.69
Class 4	.33	.3	.58	.44	.43
Class 5	.25	.15	.53	N.A.	.31
Class 6	.20	.1	.44	N.A.	.25

* Based on Previous Research conducted by Noble (1965); Committee on Farm Assessment and Taxation (1969); Anderson (1971) and Hoffman (1972)

satisfactory when comparing individual farms. While properties with large proportions of class 6 or class 1 soils are easily distinguished, this is not the case for those properties with a mixture of soils. When a combination of soils exists, the resulting value tends to mask the type and proportion of soil. In response to the inadequacies of these two methods the following third alternative was developed to define distinct groups of farms.

3. Three separate and distinct farm groups were defined as follows: 1) farms having 75% or more of their soils classified as class 1; 2) farms with between 25% and 75% of their soils rated as class 1 and between 25% and 75% rated as class 6 and 3) farms with 75% or more of their soils classified as class 6.

Using this framework, an attempt was made to interview virtually all farmers owning substantial acreages of class $6_s^{t6}4_m^{f4}$ soils, rating them accordingly. As a result, a number of farmers with both class 6 and 1 soils were interviewed (group 2). Also, a control group of class 1 property owners were interviewed. In total, information was collected for 236 property owners. The initial data base for East Wawanosh Township was obtained in the summer and fall of 1979, with an update in the fall of 1981. Much

of this information constituted the basis for an earlier study (Caldwell, 1980). Data for the other four townships was gathered in the fall of 1980. In total, information was collected for an area covering 42,497 acres. Of this, approximately 23,133 acres (54.4%) fell under the CLI category of $6^{t6}_{s}\,4^{f4}_{m}$; 15,614 acres (36.7%) were primarily class 1 and the remaining 3,750 acres (8.8%) consisted of classes 2, 3, 4, 5 and organic soils.

The Questionnaire and Its Administration

The purpose of the questionnaire-interviews was to provide detailed information allowing for analysis of the expected relationships. As such, the questionnaire administered to the individual farmers (Appendix III) was structured to obtain information in four main areas, namely:

1) Information on the farmers' personal characteristics, including age and occupation.

2) The operational characteristics of the farm unit, including such variables as crop acreage and enterprise type.

3) Measures of farm inputs and outputs including property improvements (reflecting investment) and gross farm

income (i.e. overall viability and productivity).

4) The perceptions of the proprietor towards his property. This included the limitations and problems discussed with respect to the soil surveys and the CLI classification (Chapter II).

An essential part of the questionnaire was the use of reproductions of aerial photographs*. On this medium, it was possible to record individual crops, their yields and fertilizer application rates on a field by field basis. As a result, where different capability soils existed over a given property unit, it was possible to segregate the results based on the CLI capability ratings (Chapter VI).

In total, 152 basic variables were obtained for each farmer interviewed (Appendix IV). This total number was inflated to 256, however, by the creation of variables to accommodate the total number of potential crop and yield combinations by soil capability class. As a result, 131 of the total 256 variables created deal with crop acreage and yield for rented or owned property.

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* Obtained from the Maitland Valley Conservation Authority and the Wingham District Office of the Ministry of Natural Resources.

Questionnaire Returns

On a township by township basis, the largest number of interviews were conducted in East Wawanosh, Culross and Kinloss (Table 11). This distribution reflects the concentration of class 6 soils in these three townships. Those individuals living outside the study area were contacted by mail with a response rate of approximately 50%.

The control group, comprised of individuals owning class 1 soils, serves as a standard against which class 6 landowners might be compared. In total, 59 of 93 interviews conducted in East Wawanosh were of individuals with soils classified as $1^{8}3^{t2}$. While 177 landowners with some class 6 soils were interviewed, the actual amounts of these soils varied. This resulted from the uneven distribution of soils and the tendency of many farmers to own more than 1 parcel of land, thereby reducing the relative proportion of class 6 soils in the context of the entire farm unit. The result was a sizable number of farmers owning a combination of class 1 and 6 soils.

Methods of Data Analysis

To analyze and interpret the considerable amount of data collected, computer-based statistical analysis of the

TABLE 11

The Number of Interviews Conducted Per Township

Township	Number	Percent of Total
East Wawanosh	93	39.4
West Wawanosh	26	11.0
Turnberry	17	7.2
Culross	53	22.5
Kinloss	47	19.9
TOTAL	236	100.0

coded responses was utilized through the facilities of the University of Western Ontario's Social Science Computing Laboratory and by means of the subprograms of the Statistical Package for the Social Sciences (S.P.S.S.) (Nie, 1975). The analysis of the expected relationships (Chapter I) was accomplished using the following subprograms:

Crosstabs - A crosstabulation is a joint frequency distribution based on two or more classificatory variables (Nie, 1975, p. 218). The dominant test of statistical significance was chi square.

Condescriptive - Condescriptive computes descriptive statistics for continuous interval-level data (Nie, 1975, p.185). The mean, standard deviation and variance are statistics computed by this program.

Frequencies - Subprogam Frequencies computes and presents one-way frequency distribution tables (Nie, 1975, p. 194). A number of descriptive statistics are also computed.

T-Test - Subprogram T-Test computes student's T and probability levels for testing the significance of the difference between two sample means (Nie, 1975, p. 267).

Discriminant Analysis - Discriminant analysis is a statistical technique which attempts to distinguish between two or more separate groups, by mathematically weighting and linearily combining the discriminant variables (Klecka, 1975, 435). Ideally if significant differences exist between the groups based on a combination of these variables, discriminant analysis will separate the total population into their respective (original) groupings. If confidence is expressed in these variables, one may classify new cases based on the discriminating functions.

The analysis of the expected relationships was applied at differing scales and uses differing elements of the data. Chapter V approaches the expected relationships at the regional level, utilizing census data for both the counties and townships, whereas Chapters VI, VII and VIII use information derived from the detailed farm interviews. In Chapter VI the interviews furnish crop acreage, yield and fertilization information obtained on a field by field basis by soil capability class, while Chapter VII approaches the expected relationships by investigating the full range of operational characteristics at the individual farm level. Chapter VIII consists of analysis of a subgroup of class 6 farms demonstrating characteristics of viable agriculture.

CHAPTER V

AN ANALYSIS OF AGRICULTURE AND SOIL CAPABILITY AT THE REGIONAL LEVEL

A major objective of this thesis is to investigate the role of low capability soils within an area of generally high capability. It was hypothesized that the areas of low soil capability would exhibit limited and marginal agricultural activity, resulting in a less intensive agricultural system, including more extensive land use patterns and lower overall productivity.

In an initial effort to identify differences attributable to soil capability, this chapter examines census data at the county and township level. First, selected variables are contrasted between Huron and Bruce Counties* and the study area. This stage involves a comparison of the 1971 and 1976 Census of Agriculture. A second stage of analysis is a comparison of the 5 township study area with the 8 surrounding "higher capability

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* In order to eliminate the effect of those townships in Bruce County which are not extensively used for agriculture, those townships with less than 50% of their total area (as given in ARDA Report No. 8, 1975) in an improved state (1976 Census) were dropped from the sample. Consequently, the results from the 5 northern townships of Albemarle, Amabel, Eastnor, Lindsay and St. Edmunds were dropped from the county total.

townships" of Ashfield, Colborne, Hullett, Morris, Howick, Carrick, Kincardine and Huron. In each analysis*, the operational characteristics of the farm (including tenure, farm size, livestock and machinery), along with the inputs and outputs of the farm are examined.

Prior to proceeding with the analysis above, it is important to establish that there are two overriding factors which dictate that certain variation should exist within the two counties, thereby affecting local agriculture. In the first instance, if all other things were equal, one would expect a reduction in the productivity of agricultural land, including the yield of certain crops, as one moves north through Huron County and into Bruce County. This continuum would reflect declining agroclimatic conditions associated with changing latitude, including a decrease in the number of growing degree days and heat units (Brown, McKay and Chapman, 1968). Consequently, given its intermediate location, one would expect the levels of productivity and thus land use intensity in the five township study area, to lie somewhere between those of Huron and Bruce Counties.

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* It should be noted that there are some problems associated with the use of census data in this instance, in that land which was not part of a census farm is not accounted for by the census.

Secondly, if all other factors were equal, agricultural land use and the intensity of use should vary according to differing type and amounts of soil capability classes. Specifically, there should be a marked reduction in productivity and land use intensity in those areas with significant concentrations of class $6^{t6}_{s}\,4^{f4}_{m}$ soils. Combined, the above two factors should produce a continuum of land use, productivity and intensity reflecting the combined variables of climate as it varies from south to north and soil capability as it varies locally.

A Comparison of Huron and Bruce Counties With the Study Area

Huron and Bruce Counties generally form part of the intensive and viable agricultural economy of Southwestern Ontario. The study area, however, given its relatively large concentrations of class $6^{t6}_{s}\,4^{f4}_{m}$ soils is expected to show some variation from this general trend. The following comparison of selected variables from the 1971 and 1976 Census of Agriculture seeks to identify these differences, where they exist, against a review of some of the trends which have affected agriculture in the whole area.

Tenure, Number and Size of Farms

The majority of the farms in the study area, in Huron and in Bruce, are owner operated (Table 12). There appears, however, to be a trend towards increasing numbers of part-owner/ part-tenant farms which may, in part, reflect the relative costs of owning and renting land and increasing intensification.

One of the most noticeable and significant trends has been the substantial increase in farm size between 1971 and 1976 (Table 12). In 1976, farms in Huron, Bruce and the study area had average acreages of 195.6, 214.4 and 205.1 acres respectively, compared to 176.4, 194.2 and 192.2 acres in 1971. In particular, there has been a general reduction in the number of farms less than 10 acres (possibly reflecting the change in the definition of a census farm) and an increase of approximately 5% in the proportion of farms larger than 240 acres (Table 12).

Land Use

Accompanying changes in farm size have been significant changes in the use of farm land. The total area under crops in the study area, for example, has increased from 44.8% of the total area in 1971 to 54.2% in 1976, with

TABLE 12

Huron, Bruce, Study Area Comparison:
Tenure and Farm Size (1971 and 1976)*

	Total Area	All Census Farms	Farm Population	Non-Resident	Tenure: % of Total Owner	Tenant	Part-Owner Part-Tenant
1971							
Huron	742,965	4,213	16,800	7.6	69.7	2.8	20.0
Bruce**	568,388	2,927	11,742	5.5	75.7	2.2	16.6
Study Area	201,009	1,046	4,224	6.2	74.1	2.6	17.1
1976							
Huron	727,346	3,718	14,139	6.4	66.2	3.2	24.2
Bruce	547,021	2,551	9,338	6.2	67.2	2.7	23.9
Study Area	189,074	922	3,459	5.7	66.4	2.8	25.2

Size of Farm (acreage class) as % of Total

	Under 10	10-69	70-129	130-179	180-239	240-399	400-559	560+
1971								
Huron	3.5	10.3	28.2	17.0	18.8	16.5	4.2	1.5
Bruce	2.2	7.7	27.6	16.9	18.6	19.2	5.8	2.0
Study Area	4.6	8.6	24.2	15.8	20.3	19.7	4.9	1.9
1976								
Huron	2.8	10.2	24.7	17.2	18.0	19.2	5.2	2.7
Bruce	1.1	6.9	25.9	16.0	17.8	21.3	7.7	3.3
Study Area	1.8	6.7	24.4	17.5	18.1	22.7	6.3	2.5

* The information presented in Tables 12 to 16 was obtained from the 1971 and 1976 census of agriculture, and as such, only includes values for those properties classified as census farms.
In 1971, a census farm was defined as a ranch or agricultural holding of 1 acre or more with sales in excess of $50.00. and in 1976, a census farm was defined as a ranch or agricultural holding of 1 acre or more with sales in excess of $1,200.00.

** The values for Bruce County do not include those 5 townships which have less than 50% of their total area in an improved state (The Bruce Penninsula). This applies for Tables 12 through 16.

a corresponding drop in the area of improved pasture (Table 13). The distinctions in the area under crops also illustrates the more intensive nature of agriculture in Huron County (70.8%) than in Bruce (52.8%) or the study area (54.2%).

A universal trend between 1971 and 1976 was the reduction in unimproved land. The proportion of unimproved land in the study area dropped from 24.9% to 23.0% (Table 13). This value is substantially larger in the study area (23%) than in either Huron (14.9%) or Bruce (17.5%), possibly reflecting the study area's concentration of low capability soils.

The actual use of crop land also illustrates changes which have occurred between 1971 and 1976, as well as certain distinctions between Huron, Bruce and the study area (Table 13). The major cropping changes involved substantial increases in the acreages in corn for grain and ensilage and decreases in the proportion of mixed grains and tame hay. This tends to reflect the general market conditions, including the increasing value of corn as a cash, or fodder crop.

The greatest distinctions between the three areas is in the larger concentrations of more specialized or

TABLE 13

Huron, Bruce, Study Area Comparison:
Land Use Including Crops (1971 and 1976)

	Total Area	Improved (% of Total) Under Crops	Pasture	Summer Fallow	Other	Unimproved (% of Total) Woodland	Other
1971							
Huron	742,965	60.1	19.4	.6	2.2	9.2	8.5
Bruce	568,388	44.2	32.0	.8	2.0	11.3	9.8
Study Area	201,009	44.8	27.9	.4	2.0	13.6	11.3
1976							
Huron	727,346	70.8	11.8	.3	2.1	8.5	6.4
Bruce	547,021	52.8	27.6	.5	1.7	9.9	7.6
Study Area	189,074	54.2	20.1	.4	2.3	12.8	10.2

Selected Field Crops (% of Total)

	Wheat	Oats	Barley	Mixed Grain	Total Tame Hay	Grain Corn	Ensilage Corn	Oats for Fodder	Other
1971									
Huron	3.6	3.7	11.6	23.7	25.7	20.1	11.4	.1	.1
Bruce	1.3	2.7	7.9	27.4	45.0	4.6	10.7	.2	.2
Study Area	.9	2.7	9.1	25.7	38.8	10.4	12.0	.1	.3
1976									
Huron	7.1	2.3	8.9	16.1	22.0	28.7	14.3	.1	.4
Bruce	1.6	1.6	5.6	21.6	40.8	10.1	17.6	.4	.6
Study Area	.5	1.7	7.7	19.4	34.6	18.9	16.9	.1	.1

intensive crops in Huron. These include larger concentrations of wheat, barley, grain corn and white beans. Conversely, there are greater concentrations of mixed grain, hay and ensilage corn in Bruce and the study area. The study area generally assumed an intermediate position between Huron and Bruce Counties. While this may reflect certain variables, including soil capability, this likely indicates the greater concentration of livestock in Bruce and the study area compared to significant areas of cash cropping in South Huron.

Livestock

Between 1971 and 1976 there were substantial increases of approximately 30-33% in the average numbers of cattle (beef and dairy) per farm (Table 14). The largest concentrations of cattle (1976) occurred in Bruce, with an average 87.5 cattle per farm, followed by the study area (72.9 cattle per farm) and Huron (56.6 cattle per farm). During the same time period, however, the number of pigs per farm tended to remain steady while the numbers of sheep and poultry diminished. In general, in each of these situations the study area had a value intermediate to that of Huron and Bruce.

TABLE 14

Huron, Bruce, Study Area Comparison:
Livestock (1971 and 1976)

	Livestock: Average Numbers per Census Farm					
	Cattle		Pigs	Sheep	Hens & Chickens	
	Total	Milk Cows			Total	Hens & Pullets
1971						
Huron	43.3	8.1	48.6	1.9	611.2	187.4
Bruce	64.0	9.1	35.6	2.6	110.9	62.7
Study Area	56.9	9.6	39.5	2.3	463.9	131.2
1976						
Huron	56.6	8.5	50.8	1.5	577.2	184.6
Bruce	87.5	9.9	25.8	2.1	209.3	53.7
Study Area	72.9	10.9	39.7	1.6	326.4	80.7

Farm Capital and Machinery

The influx of capital into the agricultural sector also reflects the trend towards increasing intensification (Table 15). In total, average farm capital investment increased by 209.9% over the five year period between 1971 and 1976 within the five study townships. On a per farm basis, the average values for Huron County ($213,261.1) are somewhat higher than those for the study area ($183,045) or Bruce County ($170,047.1). This again substantiates the intermediate position of the study area between Huron and Bruce. Obviously, however, major capital intensification has occurred in all three areas.

Value of Products Sold

The average value of produce sold per farm in the two counties and the study area reveals that the majority of farms are relatively intensive and large scale farm units (Table 16). While the increased value of production per farm between 1971 and 1976 was due partially to inflation, the actual distinctions between Huron, Bruce and the study area remained similar. In 1976, 86.9% of Huron's farms grossed in excess of $5,000, compared to 84.2% of those in Bruce County and the study area.

TABLE 15

Huron, Bruce, Study Area Comparison:
Farm Capital (1971 and 1976)

	Total Value	Farm Capital (Average $ Per Farm) Land and Buildings	Machinery & Equipment	Livestock & Poultry
1971				
Huron	64,530.1	41,391.4	10,387.9	-
Bruce	61,232.8	37,016.6	9,011.8	-
Study Area	59,075.4	34,983.7	8,936.1	-
1976				
Huron	213,261.1	160,806.3	28,073.3	24,381.5
Bruce	170,640.5	129,842.0	23,204.4	29,596.5
Study Area	183,047.1	132,131.0	23,069.3	27,977.1

TABLE 16

Huron, Bruce, Study Area Comparison:
The Value of Agricultural Products Sold (1971 & 1976)

	Value of Agricultural Products Sold (% of Total) Under $2500	$2500-$4999	$5000 & Over	
1971				
Huron	15.4	10.9	73.7	
Bruce	18.0	11.2	70.8	
Study Area	19.0	11.2	69.8	
			$5000-$9999	$10,000 & Over
1976				
Huron	4.6	8.4	12.5	74.4
Bruce	5.7	10.1	16.0	68.2
Study Area	6.3	9.5	14.9	69.3

In summary, the intensity of agricultural production in the study area tends to be somewhat lower than in Huron as a whole and somewhat higher than in Bruce, thereby reflecting a decreasing level of intensity from Huron County through Bruce County. One cannot conclude, however, that these differences in farm size, land use, capital value and value of production are a product of soil capability. They may also reflect climatic factors and market conditions. Obviously, a finer scale of analysis is required.

A Comparison of the Study Area and Surrounding Townships

To reduce the problem of the county scale being too gross to properly distinguish any differences which might have occurred owing to soil capability, a more detailed comparative analysis was undertaken between the five study townships and eight adjacent townships*. The latter set of townships consists of Ashfield, Colborne, Hullett, Morris, Howick, Carrick, Kincardine and Huron (Figure 1) which have a considerably lower proportion of their area occupied by low capability soils. Low capability soils are defined as

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* The township of Grey was not included as it only shares a boundary of approximately 1 mile with Turnberry Township. In order to eliminate possible complications resulting from large concentrations of organic soils, Greenock Township was also omitted.

consisting of classes 4, 5, 6, 7 and organic soils while classes 1, 2 and 3 are generally regarded as prime agricultural lands (Simpson-Lewis, 1979). Low capability soils in the study area occupy 34% of the total land base compared to only 12.7% in the surrounding townships (Table 17). (Class 6 soils in the five township study area and surrounding townships occupy 10.0% and 1.8% respectively).

The individual townships have also been rated, using two of the methods outlined in Chapter 4 for rating individual farms (Figure 4). According to these methods the surrounding townships have a composite farmland index of .831 (rating of 2.13) and the study townships have an index of .715 (rating of 2.72) (Table 17). The differences in the composite index suggest that measures of intensity and productivity for the study townships should be approximately 86% that of the 8 surrounding townships. Given the greater concentrations of low capability soils in East Wawanosh, Culross and Kinloss, it is also expected that these three townships in particular will demonstrate characteristics linking soil capability to land use. In order to emphasize these expected correlations the information from the census has been handled on either a per farm or per acre basis. It was expected that the variables most likely to distinguish between the two samples would include farm size, land use, crop types, livestock, capital value and the value of

TABLE 17

The Study Area and Surrounding Townships:
Land Capability Characteristics*

	8 Surrounding Townships	5 Study Townships	3 Study Townships with the largest Proportion of Low Capability Soils
Total Acres	474,950	231,810	150,765
% Classified as 1, 2 or 3	87.3	66	62.3
% Classified as 4,5,6,7 or 0	12.7	34	37.7
% Classified as 6	1.8	10	13.0
Composite Rating of CLI Information**	2.13	2.7	-
Composite Index**	.831	.715	-

* Source: Soil Capability Classes for Agriculture in Ontario (Environment Canada, Ontario Ministry of Agriculture and Food, 1975).

** Using the method outlined in Chapter IV

products sold.

Farm Size and Land Use

The findings of several studies, and in particular, those of Noble (1965), suggest that low capability farms will require larger acreages in order to produce levels of output similar to those with high capability soils. Consequently, the study area, with its lower capability soils, is expected to have larger sized farms than is the case in the surrounding townships. In general, the progression in average farm size (Table 18) from 195.7 to 205.1 to 210.2 acres for the surrounding townships, the study area and the three lowest capability townships respectively, tends to reflect this relationship.

The differences in farm size are given greater significance by the fact that 86.9% of the total area of the 8 surrounding townships is classed as census farm land, whereas only 81.6% of the study area falls into this category (Tables 17 and 18). This suggests some distinction between the two areas in terms of the amount of land suitable for agricultural production.

In addition to farm size, various land use characteristics suggest distinctions between the study area

TABLE 18

The Study Area and Surrounding Townships Comparison: Farm Size and Land Use (1976)*

	The 8 Surrounding Townships	The Study Area Townships	Kinloss, Culross and East Wawanosh**
Total Area	412,771	189,084	128,019
Total # Census Farms	2,109	922	609
Average Acreage	195.7	205.1	210.2
Average Improved Acreage	165.5	158.0	162.9
	Improved and Unimproved as a % of Total		
Improved Area Under Crops	64.9	54.2	55.1
Improved Pasture	17.2	20.1	19.9
Other & Summer Fallow	2.4	2.7	2.5
Unimproved-Woodland	8.3	12.8	12.6
Unimproved-Other	7.1	10.2	9.9

* The information in Tables 18 through 23 is based on the 1976 Census of Agriculture. All terms are used in the context of Census definitions.

** Kinloss, Culross and East Wawanosh are listed separately as the three townships with the largest concentrations of low capability soils. This applies to Tables 18 through 23.

and the surrounding townships. The actual area which is improved, for example, diminishes from 84.5% of the total area of the surrounding townships' to 77% of the study area townships, with an average improved acreage per farm of 165.5 and 158.0, respectively. Although these values may be complicated by the fact that they reflect a wide range of soil types as well as numerous other local factors, they do tend to suggest that while the average farm size is larger in areas with low capability soils, the actual amount of land available for agriculture on a per farm basis may be smaller. It was expected that farmers with low capability soils might have acquired larger acreages of arable land in order to compensate for this deficiency. In the event they have not, and the capability classification is correct, this would suggest an overall reduction in output and viability of many farms in the study area.

While the average value of farmed acreage and of cropped area per farm at the township level were not quite as expected, the proportions of the townships which are unimproved do reflect the assessed rating of soil capability (Table 18). The larger area of unimproved land in the study area (23%), compared to the surrounding townships (15.4%), means that a larger part of the former is unsuitable for

agricutural production*.

Crops

The actual proportion of land in individual crops was also expected to vary between the study area and the 8 surrounding townships based on the differing soil capability ratings. As expected, the extensive land uses of improved pasture and tame hay were slightly more dominant in the 5 township study area (20.1% and 34.6% respectively) compared to the surrounding townships (17.2% and 28.7%) (Tables 18 and 19). Conversely, the proportions of more intensive crops, such as grain corn (21.2% vs 18.9%) and small grains (33.2% vs. 29.3%) were higher in the high capability townships than in the lower capability study area. The greater proportions of hay and ensilage corn in the five study townships (51.5%) compared to the surrounding townships (44.7%) may reflect a greater concentration of livestock in the former.

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* It is probable that a sizeable proportion of the unimproved land is unimproved by choice (such as productive woodlots).

TABLE 19

The Study Area and Surrounding Townships Comparison: Selected Crops as a Percent of Total (1976)

Selected Crops	8 Surrounding Townships	5 Study Townships	Kinloss, Culross and East Wawanosh
Wheat, Oats, Barley, Mixed Grain	33.2	29.3	28.3
Total Tame Hay	28.7	34.6	35.4
Grain Corn	21.2	18.9	18.7
Ensilage Corn	16.0	16.9	17.3
Other + Oats for Fodder	.9	.2	.3

Livestock

In as much as the entire area of northern Huron and southern Bruce is considered to be important for livestock production, the actual concentrations of grazing livestock were expected to be somewhat higher in an area of low capability soils due to its greater suitability for pasture and forage crops*. This relationship was investigated using the number of animals per acre and the number of animals per improved acre (Table 20). The value of cattle per acre suggests that the study area and its surrounding townships were virtually identical, whereas the value per improved acre suggests that cattle are somewhat more dominant in the study area (46/100 improved acres) than in the surrounding townships (42/100 improved acres). Conversely, pigs and poultry have a slightly greater concentration in the surrounding townships, although the difference in terms of animal units is minimal (Agricultural Code of Practice, 1976). So that while some variability exists between the individual types of livestock, the overall difference is not substantial.

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* This expected relationship is less applicable where intensive, specialized feedlot operations have been established.

TABLE 20

The Study Area and Surrounding Townships Comparison: Livestock Per Acre and Improved Acre (1976)

	8 Surrounding Townships	5 Study Townships	Kinloss, Culross and E. Wawanosh
Livestock/ Total Acre			
Total Cattle	.36	.36	.37
Dairy Cattle	.05	.05	.05
Pigs	.23	.19	.19
Sheep	.01	.01	.01
Total Hens & Chickens	2.5	1.6	.62
Total Hens & Pullets	.68	.39	.21
Livestock/ Improved Acre			
Total Cattle	.42	.46	.48
Dairy Cattle	.06	.07	.07
Pigs	.28	.25	.25
Sheep	.01	.01	.01
Total Hens & Chickens	2.9	2.1	.81
Hens & Pullets	.81	.51	.27

Capital Value

The variable capital value as given in the census includes investment in land, buildings, machinery, equipment and livestock. Treated on a per farm and per acre basis, capital value represents the relative intensity of land use in an area. In the higher capability townships a total capital value per farm of $200,973.6 ($1026.8/ acre) exceeds that of the 5 study townships by nearly $18,000 ($134.3/acre) (Table 21). Most of this difference results from the levels of capital value in land and buildings. A likely explanation is the larger proportion of unimproved land present in the low capability areas, which reduces the average land value on a per farm and per acre basis.

Machinery

Machinery, which represents a large investment of capital, is another variable which indicates the intensity of agricultural operations. Tractors, combines and hay balers are all important inputs into the agricultural operation, however, interpretation may vary. For example, the number of tractors per 100 acres (Table 22) suggests lower overall intensity/ capability of the study area (1.05 tractors/ 100 acres) compared to the surrounding townships (1.12 tractors/ 100 acres). Given, however, that a larger

TABLE 21

The Study Area and Surrounding Townships Comparison: Capital Value (per Farm and Per Acre) (1976)

	8 Surrounding Townships	5 Study Townships	Kinloss, Culross and E. Wawanosh
Total Capital Value/Farm	200,973.6	183,046.05	184,508.01
Total Capital Value/Acre	1026.8	892.5	877.72
Capital Value Land and Buildings/Acre	755.1	643.7	626.9
Capital Value Machinery and Equipment/Acre	131.4	112.5	116.2
Capital Value Livestock and Poultry/Acre	140.4	136.4	134.7

TABLE 22

The Study Area and Surrounding Townships Comparison: Farm Machinery (1976)

	8 Surrounding Townships	5 Study Townships	Kinloss, Culross and E. Wawanosh
Farm Machinery # of Units/ 100 acres			
Tractors	1.12	1.05	1.06
Grain Combines	.17	.14	.14
Hay Balers	.28	.28	.3
Farm Machinery # of Units/100 Improved Acres			
Tractors	1.32	1.36	1.37
Grain Combines	.21	.14	.18
Hay Balers	.33	.37	.38
Farm Machinery # of Units/100 Acres Under Crop			
Tractors	1.73	1.92	1.93
Grain Combines	.27	.27	.25

proportion of the study area is occupied by unimproved land, the actual intensity of agricultural land use in terms of the availability of machinery per 100 improved acres and per 100 acres of cropland suggests a somewhat different relationship. The values of the number of tractors per 100 acres of improved land (1.36 vs. 1.32) and cropland (1.92 vs. 1.73) for example, are actually larger for the study area. In addition, the number of hay balers per 100 acres was higher in the study area, although this was expected, given the greater emphasis on hay and livestock (cattle) in this area. Furthermore, the value for the number of grain combines per 100 acres of cropland (.27) is identical in the two areas.

Value of Products Sold

A prime measure of agricultural production is gross farm income. Although the census information is aggregated, it does provide a comparative measure of economic viability. In total, 73.4% of the farmers in the 8 surrounding townships in 1976 had a value of products exceeding $10,000 compared to 69.3% in the 5 study townships and 70.0% in the

3 lowest capability townships (Table 23). At most, these differences indicate a slight trend and may equally reflect other variables such as tenure or farm size (for example, 8.6% of the farms in the study area are less than 70 acres in size compared to 6.4% in the surrounding townships).

Summary

Assuming that soil capability is a strong factor influencing land use, substantial differences were expected to distinguish the 8 surrounding townships (with relatively high soil capability) from the 5 study area townships. The results, however, while establishing that minor differences in some variables do exist (i.e. cropping patterns, capital value and the value of products sold), which lend limited support to the hypothesis, overall the results were inconclusive. Consequently, the differences cannot be stated to be a product of soil capability, but rather may result from a combination of inter-related operational variables such as farm size, tenure and market conditions, which in turn may or may not relate to soil capability.

The conclusion of the regional investigation set out in this chapter is that census data provides no substantive evidence of a strong relationship between soil capability ratings and land use in this area. The results,

TABLE 23

The Study Area and Surrounding Townships Comparison: The Value of Products Sold (1976)

Value of Products Sold ($) (% of Total Farms)	8 Surrounding Townships	5 Study Townships	Kinloss, Culross & E. Wawanosh
1,200-2,499	4.8	6.3	6.9
2,500-4,999	9.0	9.5	7.4
5,000-9,999	12.8	14.9	15.8
10,000 and over	73.4	69.3	70.0

comparing the study area with both Huron and Bruce Counties and the surrounding townships, rather than indicating a truly anomalous position for the study area, suggest only minor differences. If major differences do exist, they must be at the individual farm level. The following chapter commences this analysis by investigating crop type, yield and fertilization as it varies with soil capability. This information has been gathered on a field by field basis at the farm level.

CHAPTER VI

FARM OPERATION AND CAPABILITY RELATIONSHIPS: PART I: CROP TYPE, YIELD AND FERTILIZATION

The major expected relationship - that class 6 soils would display limited and marginal agricultural activity - was anticipated at both the regional and farm level. At the farm level, crop distribution and productivity are expected to relate directly to soil capability. Where soil capability is low it is anticipated that large acreages of unimproved and unproductive land will dominate. This will involve low intensity land uses and where agriculture is practiced, low yielding crops. Where crop yields on low and high capability soils are similar, this will only occur where substantial inputs such as very large applications of fertilizer* have occurred. This expectation reflects the results of previous research (Hoffman, 1972; Anderson, 1971) and the definitions of the soil capability classes. Using detailed information obtained through interviews, the variables of crop type, acreage, yield and fertilization have been placed in an aggregate form, corresponding with the soil capability units.

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* Given that class 6 soils by definition cannot be feasibly improved, the effect of fertilizer is questionable.

The Sample

The most appropriate data for evaluating the expected relationship at the farm level consists of detailed farm derived data. The farm sample, derived from 236 questionnaire-interviews, provides a wide range of critical items which are conducive to testing of statistical significance and which are not normally available through published sources. An integral part of the questionnaire interview process was the recording of detailed field by field information, including crop type, acreage, yield and fertilization onto aerial photographs at scales of 1:5,000 and 1:10,000. This information, when mapped on a field by field basis on aerial photographs, may then be aggregated for all 236 interviews and reflects not property units, but rather, the expanse of the individual soil capability units.

Soil Capability and Land Use

The detailed farm interviews conducted throughout the five township study area provided detailed crop and yield information for different soil capabilities. In total, information exists for 15,614 acres of class 1 soils (primarily class $1^{8}3^{t2}$); 23,133 acres of class 6 soils (primarily class $6^{t6}_{s}4^{f4}_{m}$) and 3,750 acres of additional land.

Owned Land

The area and distribution of crops for class 1 and 6 soils were significantly* different (chi square significant at .001 level). The proportion of all class 1 soils cropped is 63.4% (68.9% if rented land is included) compared to 42.7% (51% including rented land) for class 6 soils (Table 24). Therefore, in terms of the acreage cropped, class 1 soils are used more intensively. The distribution between the total improved area is somewhat less (reflecting the larger proportion of improved pasture on class 6 soils), with 66.8% of class 6 land improved, compared to 79.6% of class 1 land (these values assume that land rented out is improved). Conversely, a larger proportion of class 6 land is unimproved. In total, 31.5% of class 6 soils are unimproved (including unimproved pasture, woodlot, scrub and waste) compared to 16.6% of class 1 land. If one were to assume that the 16.6% of class 1 land were constant throughout the area, (relating to original settlement and the preservation of farm woodlots), then one could argue that approximately 15% of class 6 soils could not be used for agriculture. Of note is that a greater proportion of class 6 soils are rented out, possibly reflecting a differing ownership situation, or a more

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* The use of the word "significant" in the analysis implies tests of statistical significance.

TABLE 24

Farm Sample:
Crop Type and Acreage
by Soil Capability Class

	CLI Soil Capability Class											
	1		6		2 & 3		4 & 5		0		Total	
Crop Type	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Grain Corn	2972	19.8	2552	12	67	5.3	-	-	46	2	5637	14.1
Ensilage Corn	1433	9.5	1293	6.1	100	7.9	7	5.1	72	3.2	2905	7.3
Mixed Grain	1423	9.5	1618	7.6	78	6.2	9	6.5	61	2.7	3189	8.0
Wheat	55	.4	46	.2	-	-	16	11.6	-	-	117	.3
Barley	868	5.8	395	1.9	33	2.6	6	4.3	4	.2	1306	3.3
Oats	20	.1	37	.2	8	.6	-	-	7	.3	72	.2
White Beans	180	1.2	-	-	-	-	-	-	-	-	180	.4
Soybeans	20	.1	-	-	-	-	-	-	-	-	20	.05
Hay	2560	17.0	3139	14.7	232	18.4	23	16.7	92	4.1	6046	15.1
Improved Pasture	1484	9.9	3328	15.6	124	9.8	20	14.5	228	10.1	5184	13.0
Unimproved Pasture	48	.3	513	2.4	19	1.5	-	-	38	1.7	618	1.5
Woodlot	1801	12.0	4561	21.4	343	27.1	51	37.0	1332	58.8	8088	20.2
Scrub-Swamp	649	4.3	1639	7.7	110	8.7	6	4.3	282	12.5	2686	6.7
Summer Fallow	115	.8	39	.2	10	.8	-	-	-	-	164	.4
Other	584	3.8	393	1.8	90	7.1	-	-	36	1.6	1103	2.8
Rented Out	823	5.5	1761	8.3	50	4.0	-	-	67	3.0	2701	6.7
Total	15035		21314		1264		138		2265		40016	

chi square computed for Class 1 and Class 6 was significant at .001 level.

fragmented pattern of suitable arable land available at the farm level.

As expected, there is a smaller proportion of field crops and a larger proportion of improved and unimproved pasture on class 6 soils than on class 1 soils (Table 24). For example, grain corn and ensilage corn, being more intensive crops in terms of their required investment in capital and labour (Ontario Department of Agriculture and Food, 1969), occupy 29.3% of the class 1 land base compared to 18.1% of the class 6 land base. Other crops such as mixed grain, barley, beans and hay demonstrate a similar pattern. By comparison, there is nearly 6% more class 6 soil occupied by improved pasture than class 1 soil.

The values for class 2 and 3, 4 and 5 and organic soils also reflect expected trends. Classes 2,3 and 4,5 demonstrate diminishing values when compared to class 1 and a significantly higher proporion of woodlot (27.1% and 37.0% respectively). The general unsuitability of organic soils for agriculture is reflected in the fact that 83.1% of these soils are occupied by either pasture, woodlot or scrub and waste.

Rented Acreage

At the farm level, rented land may represent an important addition to the total land base available for agriculture. As mentioned previously, 5.5% and 8.3% of class 1 and 6 land respectively is rented out, and the values in Table 25 give an indication of the use of these rented soils. In general, grain corn and pasture are more dominant on rented class 6 soils than on rented class 1 soils, whereas ensilage corn, mixed grain, barley and hay are more prevalent on rented class 1 soils. With the exception of the relative dominance of pasture as a rented crop on class 6 soils (35.5% on class 6 vs 24.4% on class 1 soils) it is somewhat difficult to explain the pattern evident in Table 25. It appears that rented class 6 soils are not cropped substantially different from rented class 1 soils.

While the differences between class 1 and 6 soils for both owned and rented land are noteworthy, what is more significant is the contrast between the existing and expected use of class 6 soils. Given the definition of class 6 soils (Appendix I) and the findings of Hoffman (1972) and others, the presence of such a large proportion of improved land was unexpected (28% in corn and small grains; 30.3% in improved pasture and hay and 8.3% which is

TABLE 25

Farm Sample:
Crop Type and Acreage of Rented Soils by Soil Capability Class

	CLI Soil Capability Class							
	1		6		Others		Total	
	Acres	%	Acres	%	Acres	%	Acres	%
Grain Corn	138	23.8	509	28.0	28	33.7	675	27.2
Ensilage Corn	45	7.8	117	6.4	-	-	162	6.5
Mixed Grain	102	17.6	262	14.4	17	20.5	381	15.4
Wheat	-	-	-	-	-	-	-	-
Barley	30	5.2	53	2.9	38	45.8	121	4.9
Oats	-	-	-	-	-	-	-	-
White Beans	-	-	-	-	-	-	-	-
Hay	123	21.2	233	12.8	-	-	356	14.3
Improved Pasture	141	24.4	580	31.9	-	-	721	29.1
Unimproved Pasture	-	-	65	3.6	-	-	65	2.6
Total	579		1819		83		2481	

chi square calculated for Class 1 and 6 was significant at .001 level.

rented out). Whereas the improvement of a minor proportion of class 6 land would not have been surprising, these lands, in fact, demonstrate characteristics of intensive agricultural activity. Although the acreages used for agriculture ensure neither farm viability nor high levels of productivity, one may deduce that these soils are agriculturally viable to the extent that they continue to be used. It is expected, nevertheless, that the crops (such as grain corn, mixed grain and barley) grown on class 6 soils will have substantially lower yields.

Yield by Soil Type

The actual productivity of class 1 and 6 soils may be evaluated through a comparison of crop yield information. The results of previous studies, combined with the CLI definitions, predict a very marked contrast in productivity between the two soil groups. While the sample size is not large enough to be conclusive and the reliability of the data depends on the farmers who supplied it, the data is probably more reliable than most sources of published data, and provides an insight into the relative productivity of soils in this area. The sample results (Table 26) are, however, very close to the yields for Huron and Bruce Counties provided by the Ministry of Agriculture and Food for 1981 (Table 27).

TABLE 26

Farm Sample:
Crop Yields on Class 1 and Class 6 Soils

Crop Type	Class 1 Soils Yield (bushels/acre)	Class 1 Soils No. of Samples	Class 6 Soils Yield (bushels/acre)	Class 6 Soils No. of Samples
Grain Corn	85.25	28	81.0	23*
Mixed Grain	77.88	16	65.84	25**
Barley	65.9	13	66.6	8***

Using t test for 2 samples

* t value = .876 (49 degrees of freedom) is not significant.
** t value = 3.22 with 39 degrees of freedom and is significant at .005 level.
*** Given that Class 6 yield exceeds Class 1 yield, there is no significant difference.

TABLE 27

Crop Yields in Huron and Bruce Counties (1980)

Crop Type	Yield/Acre Huron County	Yield/Acre Bruce County
Grain Corn (bushels)	87	85
Ensilage Corn (tons)	14	13
Mixed Grain (bushels)	72	69
Barley (bushels)	67	62
Winter Wheat (bushels)	67	52

Source: 1980-81 Agricultural Statistics, prepared by The Ontario Ministry of Agriculture and Food

Using a t-test for two samples, the average yields of grain corn, mixed grain and barley were compared for those crops grown on class $1^{8}\,3^{t2}$ and $6^{t6}_{s}\,4^{f4}_{m}$ soils (Table 26). Surprisingly, only the results for mixed grain were significantly different for the two soil types (77.9 bushels/acre from class 1 soils and 65.8 bushels/acre from class 6 soils). For grain corn and barley, given the yield information, there is no statistical basis for assuming there will be a difference between the two groups. In addition, the yield from ensilage corn for class 6 soils (15 tonnes per acre from 7 samples) is somewhat higher than the county average (Table 27).

Productivity as measured by crop yield does not reflect the expected difference between low and high capability soils. Assuming the yield information to be representative of the different soil types, productivity is not, in this particular instance, closely related to the CLI assessment of agricultural capability. The only possible explanation other than some error in the CLI, is some major change in agricultural management, the most likely of which is a massive input of fertilizer on class 6 soils.

Fertilizer*

One of the major assumptions of the CLI is that good soil management, under a largely mechanized system of agriculture, is practiced. In addition, the validity of the productivity relationships which have been developed (example Hoffman, 1972) are based on the assumption that similar levels of input existed for each individual class. In this context, one plausible explanation for the relatively high yields received on class 6 soils is that they received significantly greater inputs or specialized management practices. The one input most likely to cause this variation and one which is appreciated and frequently varies at the individual farm level is the rate of fertilizer application. That is, an individual farmer may attempt to compensate for low soil capability with significantly larger inputs of fertilizer.

The results presented in Table 28, however, indicate that of the three crops for which adequate data was available, only hay had significantly larger applications of fertilizer on class 6 soils (187.1 lbs) than on class 1 soils (151.1 lbs). This probably reflects a decision by the

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* It is realized that in addition to the amount of fertilizer applied, it's analysis and type is equally important. The former variable was chosen, however, owing to its general comparability.

TABLE 28

Farm Sample:
Class 1 and 6 Soils:
The Average Rates of Fertilizer Application (In lbs./acre)

Crop Type	Class 1 Soils		Class 6 Soils	
	lbs. of Fertilizer Applied	# of Samples	lbs. of Fertilizer Applied	# of Samples
Mixed Grain	206.9	16	200.4	27*
Grain Corn	297.5	16	302.1	28**
Hay	151.1	9	187.1	19***

Using t test for two samples

* given that class 1 values exceed those for class 6 there is no significant difference

** t value = .179 (42 degrees of freedom) is not significant

*** t value = 1.741 with 26 degrees of freedom and is significant at .05 level.

farm operator that the low fertility of these soils requires a larger input of fertilizer in order to provide an adequate yield. The application of fertilizer on mixed grain and grain corn were virtually identical on class 1 and 6 soils (200 and 300 lbs. per acre, respectively, on mixed grain and grain corn). This suggests the farm operator finds little difference in the fertilizer requirements of these two crops for class 1 and 6 soils. This is reinforced by the similar yields obtained on the two soil types as previously outlined.

This chapter was based on detailed local data obtained through interviews, and as such, represents a highly reliable source. In this light, the results of this chapter are both significant and surprising. As expected, differences with respect to cropping practices existed between class 6 and class 1 soils. Surprising, however, was that two-thirds of class 6 soils existed in an improved state. Consequently, although used somewhat differently from class 1 soils, their use was markedly different from the definition of class 6 soils, and from what the results of previous studies would suggest. This may partially reflect the class 4 element of the composite rating, although any indication of viable returns in terms of yield was not expected. The results indicate, however, that of the three crops tested (grain corn, mixed grain and barley)

only mixed grain differed significantly between class 1 and 6 soils (although mixed grain yields on class 6 soils were a respectable 65.8 bushels/acre). In search of an explanation for these results it was anticipated that fertilization may have been significantly higher on class 6 soils. Of the three crops studied, however, (grain corn, mixed grain and hay) only hay received significantly higher rates of fertilizer application on class 6 soils. Obviously, therefore, there are significant areas of class 6 soils with the capacity to support certain levels of intensive and possibly viable agriculture. This conclusion highlights the need for evaluating the impact of class 6 soils at the level of the individual farm unit and forms the basis for the following chapter.

CHAPTER VII

FARM OPERATION AND CAPABILITY RELATIONSHIPS: PART II: THE INDIVIDUAL FARM UNIT

The individual farm constitutes the fundamental operational production unit of Canadian agriculture. It is at the farm level where individual decisions concerning the type and method of agricultural production are formulated and applied. Therefore, land use patterns may be judged as being the direct result of the farm operator's decisions, made in an attempt to maximize and make viable his operation, under the constraints of available resources and information. One of the most fundamental of these resources is the land base and its capability to support agricultural production. As a result, one may expect differences in land use based on the variation of soil capability at the individual farm level. Specifically, this would include low levels of intensity of land use; inputs and productivity on lands of low capability.

It was anticipated that class 6 soils would display limited and marginal agricultural activity, evident at both the regional and farm level. This chapter concentrates on the operational aspects of land use as they vary at the level of the individual farm. Essentially, the hypothesis was evaluated under the following 5 subheadings:

1) It was anticipated that the land base, which includes such variables as farm size and rented acreage, would vary substantially between class 1 and class 6 soils. This would reflect the non-viability of class 6 soils for agriculture and their utilization for other purposes.

2) Tenure, which relates primarily to the ownership and operation of land, was expected to vary between class 6 farms, owned primarily by individuals with only a minor interest in farming and the predominantly full-time farmer on class 1 soils.

3) The operational and land use characteristics of the farm unit, which include inputs; crops; livestock and enterprise type, were also expected to reflect the limited use of class 6 soils in an intensive agricultural framework.

4) In general, the outputs of the farm unit, such as farm income, were expected to be low, reflecting the non-viability of class 6 farms for agricultural production.

5) As a result of the limitations associated with the rating of class 6 soils, it was expected that the perceptions of the owners of these soils would reflect an awareness of the limited capability of the soil for agriculture.

It was anticipated that the cumulative effect of the analysis of the above variables as summarized through the use of the statistical procedure of discriminant analysis would indicate a clear distinction between those farms with a class 1 soil base and those with a class 6 soil base.

The Sample Groups

Although many methods for classifying and rating individual farm units exist, there are essentially three classes of farms in the study area based on soil capability. These groups are as follows:

1) Farms with 75% or more of their total owned and rented land base classified by the Canada Land Inventory as class 1 - hereafter referred to as Class 1 Farms* and operated by Class 1 Farmers.

2) Those farms with more than 75% of their total owned and rented area classified by the Canada Land Inventory as $6\,{}^{t6}_{s}4^{f4}_{m}$ - hereafter referred to as Class 6 Farms and operated by Class 6 Farmers.

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* These properties referred to as farms may or may not be operated as such.

3) Farms which contain a substantial mixture of class 1 soils (ranging between 25% and 75% of the total farm land base) and class 6 soils (ranging between 25% and 75% of the total farm area) - hereafter referred to as Mixed Farms and operated by Mixed Farmers.

The result is three distinct groups of farms consisting of 197 cases and representing approximately 83.5% of the initial interview sample. As illustrated in Table 29 (a cross-tabulation of the proportion of class 1 soils by the proportion of class 6 soils, on a farm by farm basis), approximately 92% of Class 1 Farms have no class 6 soils, and 81% of those with more than 75% class 6 soils have no class 1 soils. In total, the sample of 197 is broken down into 61 Class 1 Farms ; 85 Class 6 Farms and 51 with a substantial proportion of class 1 and 6 soils (Mixed Farms). Those farms (a total of 39) not classified into one of the three groups and which have been omitted from the study, had substantial acreages of other soil types, much of it organic, making classification difficult.

The Land Base

The land base includes the acreage and number of parcels owned and rented. It represents an important

TABLE 29

Farm Sample:
Breakdown of Soil Capability by Farm Type

		The Number of Properties with the Following Percent of Class 6 Soils					
		0	1-24	25-49	50-74	75-100	Total
The Number of Properties with the following Percent of Class 1 Soils	0	0	0	8	16	69*	93
	1-24	0	0	2	13	16*	31
	25-49	0	0	14**	18**	0	32
	50-74	0	0	19**	0	0	19
	75-100	56***	5***	0	0	0	61
Total		56	5	43	47	85	236

* comprises class 6 farms
** comprises mixed farms
*** comprises class 1 farms

element of the agricultural system and was expected to vary with soil capability.

Owned Acreage:

It was anticipated that the owned acreage of farms would vary with soil capability. Given the low capability of class 6 soils, farm size will either not be related to agriculture (thereby resulting in a small farm size) or otherwise will involve large acreages, representing an attempt to compensate for the soil's low capability.

The results presented in Table 30 reflect essentially two trends. The first is that Class 6 Farmers compared to Class 1 Farmers tend to own both larger proportions of small holdings (20% of Class 6 Farms are 75 acres or less compared to 8.2% for Class 1 Farms) and large holdings (9.4% of Class 6 Farms exceed 375 acres compared to 6.6% of Class 1 Farms). A second finding is that the average owned acreage per farm type for Class 1, Mixed and Class 6 is 168.4, 205.4 and 177.0* respectively (Appendix VI). These trends may reflect the lower absolute capability of class 6 land as reflected in small non-viable (for

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* These values are based on assessment information and values provided later are based on questionnaire results.

TABLE 30

Farm Sample:
Area Owned by Farm Type

Farm Type	Percent Occurrence by Acreage Class						
	10-25	26-75	76-150	151-250	251-375	376-500	500+
Class 1	1.6	6.6	50.8	24.6	9.8	6.6	0
Mixed	0	7.8	33.3	29.4	19.6	9.8	0
Class 6	4.7	15.3	44.7	15.3	10.6	3.5	5.9
Total	2.5	10.7	43.7	21.8	12.7	6.1	2.5

chi square significant at .05 level

TABLE 31

Farm Sample:
The Number of Parcels Owned by Farm Type

Farm Type	Percent Occurrence by Number of Parcels Owned			
	1	2	3	4 or more
Class 1	68.9	23.0	6.6	1.6
Mixed	54.9	27.5	15.7	2.0
Class 6	75.3	17.6	4.7	2.4
Total	68.0	21.8	8.1	2.0

chi square is not significant at .05 level

agriculture) units and large units which have attempted to attain viability through large scale, land intensive farm units. In all instances, the dominant property size is between 75 and 150 acres, thereby reflecting the original survey of the area into 100 acre lots. A large proportion of Class 6 Farms do, however, appear to have an adequate owned acreage to support viable agriculture.

Parcels Owned

It was anticipated that Class 6 Farms would seldom be comprised of more than 1 parcel unit, based on the assumption that these soils would have only limited agricultural use. Those farmers owning class 1 soils were more likely to possess more than one property owing to their extensive involvement in agriculture. In total 31.2% of Class 1 Farmers own more than 1 parcel of land, compared to 24.7% of Class 6 Farmers (Table 31). Although 45.1% of Mixed Farmers own more than 1 property, these individuals have considerable portions of class 1 and 6 land and are by definition more apt to have 2 distinct property units.

Rented Land

Given that it was expected that only a small proportion of Class 6 Farmers would be involved in agriculture, it was anticipated that in only a few instances would rented lands be part of the operational unit. It should be recognized, however, that although owned land is the major constituent of land used by most farm units, the addition of rented land, where available, can supplement the total land base of an individual farm.

Contrary to the expected relationship, rented land adds substantially to the total land base available for Class 6 and Mixed Farmers (Table 32). While only 8.2% of Class 1 Farmers rent land, 37.3% and 23.5% of Mixed and Class 6 Farmers, respectively, rent additional property. Furthermore, Class 1 Farmers on the average, rent 4.05 acres; Class 6 Farmers 16.99 acres and Mixed Farmers 30.1 acres of land (Appendix VI).

This somewhat unexpected pattern indicates that a larger than anticipated proportion of Class 6 Farms consists of actual farm units. In addition, there must be a supply of land available, which may be rented. This supply will exist in the form of numerous low capability (and hence low rent), non-viable agricultural units, which are interspersed with farming units of Class 6 or Mixed Farm type. A 100 acre farm, for example, with 20 workable acres is not apt to

TABLE 32

Farm Sample:
Area Rented by Farm Type

Farm Type	Percent Occurrence by Acreage Class				
	No Rented Acreage	1-25	26-75	76-150	More Than 150
Class 1	91.8	3.3	3.3	1.6	0
Mixed	62.7	3.9	17.6	13.7	2.0
Class 6	76.5	5.9	11.8	3.5	2.4
Total	77.7	4.6	10.7	5.6	1.5

chi square significant at .05 level

be viable; however, rented to a local farmer, this 20 acres may be an important addition to his operation. This opinion, that low capability soils are available and attractive to neighbouring farmers, is endorsed by the fact that 74.4% of all rented land, for which the survey produced information, consisted of low capability (class $6^{t6}_{s}\ 4^{f4}_{m}$) agricultural land (Table 25). The overall affect of this is that low cost land* is readily available to those individuals farming in an area of low capability due to a sizeable group of owners with minimum farm involvement.

Summary - Land Base

The results of this section dealing with the land base indicate that the three farm groups are significantly different with respect to their owned and rented acreages. The distinctions are not, however, as clear cut as anticipated. The amount of land rented and the number of parcels owned by Class 6 Farmers indicates at least some level of agricultural activity.

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* An average value of approximately $22.00/acre was paid for class 6 land which was rented, based on 5 samples ranging in price from $15 to $33 per acre compared to an estimate of $40-$80 for class 1 land, depending on its location (class 1 rental estimate provided by Stan Poquette, 1981, of the Ministry of Agriculture and Food).

Tenure

Tenure may also be used to examine the farm orientation of the individual proprietor (See Appendix V for detailed definitions of the tenure types). It was anticipated that only a small proportion of Class 6 Farmers would demonstrate significant levels of farm involvement, reflecting the general unsuitability of class 6 soils for agriculture.

In general, the 8 tenure classes identified in Table 33 may be grouped into those with significant involvement in farming and those with minor or no involvement. Individuals with significant involvement in farming consist primarily of full-time farmers, part-time farmers (local and non-local jobs) as well as non-residents with significant farm involvement. Of those individuals with Class 1 Farms, 88.6% have a significant involvement in farming; while 82.3% of those with Mixed Farms and 68.1% of Class 6 Farmers may be so classified.

Furthermore, 60.7%, 52.9% and 37.6% of Class 1, Mixed and Class 6 Farmers, respectively, are classified as full-time. While there are substantial differences between the three groups, it is surprising that 37.6% of the owners of low capability class 6 soils are able to support

TABLE 33

Farm Sample:
Tenure Type* by Farm Type

% of Total

Farm Type	Full Time Farmer	Part Time Farmer Local Job	Part Time Farmer Non-local Job	Resident Nonfarm	Resident Minor Farm	Non-Resident	Non-Resident Some Farm	Government
Class 1	60.7	14.8	13.1	3.3	6.6	1.6	0	0
Mixed	52.9	15.7	7.8	5.9	0	9.8	5.9	2.0
Class 6	37.6	18.8	8.2	12.9	5.9	12.9	3.5	0
Total	48.7	16.8	9.6	8.1	4.6	8.6	3.0	.5

chi square significant at .05 level

* See Appendix V for detailed definitions of the Tenure Types

themselves as full-time farmers.

Of note is the fact that there is virtually no difference in the proportion of part-time farmers between the three groups (approximately 25%). This is surprising, in that farmers on low capability soils would be expected to seek out off-farm employment to supplement their income. Non-resident land ownership does tend to reflect soil capability, with 16.4% of Class 6 Farms owned by non-residents, compared to 15.7% of those with Mixed Farms and only 1.6% of those with Class 1 Farms. This may have resulted from lower capability soils, having certain characteristic amenities and a lower agricultural value making them more attractive to individuals not interested in their agricultural potential*.

One may deduce from the above that there are certain distinctions between the farms composed of class 1 soils and the farms composed of class 6 soils. Class 1 Farms would appear to have a greater capacity to support viable agriculture. Nevertheless the large proportion of individuals with farms located on class 6 soils and with a

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* Troughton (1976) has established that individuals with limited agricultural involvement frequently purchase rural properties for amenity and aesthetic reasons, and that amenity includes such landscape characteristics as rolling topography, wooded areas and wetlands.

significant involvement in farming (68.1%) runs contrary to the literature and other published findings. These findings suggest that there are essentially two types of class 6 properties: those which appear to be viable farm units (running contrary to the CLI definition of class 6 soils), and a second group, with very limited agricultural use which appears to correspond with the anticipated relationships. This phenomenon is discussed in detail in Chapter VIII.

Off-Farm Employment and Retirement

Off-farm employment and retirement are closely linked to the tenure situation. Given, however, the low capability of class 6 soils to support viable agriculture, it was anticipated that Class 6 Farmers would supplement their income through off-farm employment. The differences between the three farm groups in terms of off-farm employment are not significant (Table 34). In collaboration with the proportion of individuals retired (Table 35), however, a somewhat different situation is evident. In total, 59.7% of Class 6 Farmers are employed off the farm either part-time or full-time, or are semi or fully retired. This compares to 37.7% of Class 1 Farmers. Furthermore, 31.3% of Class 6 Farmers, compared to 21.3% of Class 1 Farmers, have full-time off-farm employment. These two

TABLE 34

Farm Sample:
Off-Farm Employment by Farm Type

Farm Type	No Off Farm Employment %	Off-Farm Employment Part Time %	Full Time %
Class 1	70.5	8.2	21.3
Mixed	60.0	20.0	20.0
Class 6	60.2	8.4	31.3
Total	63.4	11.3	25.3

chi square is not significant at .05 level

TABLE 35

Farm Sample:
Retirement Status by Farm Type

Farm Type	Not Retired %	Semi-Retired %	Fully Retired %
Class 1	91.8	3.3	4.9
Mixed	88.0	6.0	6.0
Class 6	80.0	5.9	14.1
Total	85.7	5.1	9.2

chi square is not significant at .05 level

variables suggest that a larger proportion of Class 6 Farmers depend to a greater extent upon non-farm income, possibly reflecting the effects of lower soil capability.

Operational and Land Use Characteristics

Agricultural viability is largely determined by the inputs of the farm operator under the constraints of the resources at his disposal. The inputs into the agricultural system may include labour, capital (including machinery) and the decisions of the farm operator. The result is a pattern of land use, including crops and livestock, which has evolved under the guidance of the farm operator. Given that the landowner is the principle agent of decision making, it was anticipated that his investments into the property and the resultant pattern of land use would reflect major distinctions in soil capability.

Inputs of Labour

The infusion of labour at the farm level reflects a major input contributing to the viability of an individual farm and also suggests certain returns to the farmer which justify the labour input. Consequently, it was anticipated that the intensity of labour inputs on Class 6 Farms would

be considerably less than on Class 1 Farms.

The distinctions in the full-time farm labour commitment between the three groups are of significance (Table 36). For example, 52.9% of Class 6 Farms have a full-time labour commitment compared to 76.7% of Class 1 Farms. This distinction is further emphasized by the fact that Class 1, Mixed and Class 6 Farms have on the average 1.317, 1.392 and .871 full-time labourers respectively (Appendix VI).

The distribution of part-time labour, however, is not as pronounced as that of full-time labour (Table 36). Compared, 55.0% and 49.4% of Class 1 and Class 6 Farms, respectively, have part-time labour. These rather minor differences are further emphasized in that Class 1, Mixed and Class 6 Farms have an average per farm part-time labour force of .867, .961 and .788 individuals respectively (Appendix VI).

The inputs of part-time labour suggest that the three groups are similar, while the inputs of full-time labour suggest that they are significantly different. This implies that a larger proportion of Class 1 and Mixed Farms are viable entities, even though the relatively large number of Class 6 Farms providing full-time employment is in itself

TABLE 36

Farm Sample:
Full-Time and Part-Time Farm Workers by Farm Type

	Number of Full-Time Farm Workers (% of Total)					Number of Part-Time Farm Workers (% of Total)			
Farm Type	0	1	2	3	4+	0	1	2	3+
Class 1	23.3	28.3	41.7	6.7	0	45.0	35.0	10.0	10.0
Mixed Class 1&6	27.5	23.5	39.2	3.9	5.9	49.0	27.5	5.9	17.6
Class 6	47.1	23.5	25.9	2.4	1.2	50.6	29.4	12.9	7.1
	34.7	25.0	34.2	4.1	2.0	48.5	30.6	10.2	8.2

Chi square significant at .05 level.

surprising.

Machinery Inputs

It was expected that, given the increased intensity of agriculture practiced on class 1 land, the use of tractors in terms of their number and size would be significantly greater on Class 1, as compared to Class 6 Farms (Table 37). Tractors, more than any other piece of farm machinery, represent a substitution of capital for labour. In addition, given their almost universal use throughout the study area, they serve as a useful means with which mechanical intensity may be measured.

The number and size of tractors is somewhat similar on Class 1 and Mixed Farms compared to Class 6 Farms which have fewer and less powerful tractors on a per farm basis (for example, on Class 6 Farms there is an average of 1.5 tractors less than 100 horsepower, compared to 2.07 on Class 1 Farms). In addition, given the smaller average size of Class 1 Farms (Appendix VI) there is obviously a greater concentration of tractors on a per acre basis on high capability soils. Surprisingly, however, the concentration of tractors in excess of 100 horsepower is virtually identical for Class 1 and Class 6 Farms (.18 tractors per farm). This suggests that while there are some differences

TABLE 37

Farm Sample:
Size and Number of Tractors by Farm Type

Tractors Owned	Number of Tractors	Farm Type Class 1	Mixed	Class 6
With Less	0	34.4	56.9	55.3
Than 50	1	32.8	25.5	24.7
Horsepower	2	26.2	13.7	11.8
(% of total)	3+	6.6	3.9	8.3
Average Number Tractors Owned (Less than 50 H.P.)		1.05	.65	.75
With Horsepower* from 50-99	0	34.4	23.5	51.8
	1	37.7	37.3	24.7
(% of total)	2	19.7	33.3	20.0
	3+	8.2	5.9	3.5
Average Number Tractors Owned (50-99 H.P.)		1.02	1.24	.75
With 100 or More Horsepower	0	83.6	82.4	88.2
(% of total)	1	16.4	17.6	9.4
	2+	0	0	2.4
Average Number Tractors Owned (100-150 H.P.)		.16	.18	.14
Average Number Tractors Owned (150+ H.P.)		.02	.06	.04
Total No. Owned*	0	8.2	15.7	22.4
	1	23.0	7.8	28.2
(% of total)	2	26.2	37.3	23.5
	3	23.0	25.5	17.6
	4	16.4	7.8	4.7
	5+	3.2	5.9	3.6
Average Number of Tractors/Individual/ Farm Type		2.25	2.13	1.68

* chi square significant at .05 level

between the individual farm types, there is still a relatively large concentration of tractors on Class 6 Farms, suggesting a group of relatively intensive farm operations.

Custom Work

As an alternative to purchasing expensive farm machinery, many farmers use custom work. Custom work represents a substitution of capital for labour and owned machinery, and indicates that many individuals cannot afford to own and operate some of today's more expensive farm machinery. Consequently, it was expected that low capability farms on which machinery was used would show a greater reliance on custom operations.

Of the 6 custom work activities monitored (Table 38), cultivating and sowing grain were the only two hired by a larger proportion of Class 6 Farmers than by Class 1 Farmers. One cannot, therefore, on the basis of these results, conclude that Class 6 Farmers were forced by economic circumstances to use custom work rather than own machinery.

TABLE 38

Farm Sample:
Custom Work Used by Farm Type*

Farm Type	Combining %	Cultivating %	Sow Grain %	Sow Corn %	Bale Hay %	Spray Crops %
Class 1	60.4	1.9	14.9	37.8	13.0	38.5
Mixed	51.2	2.4	19.5	26.8	5.7	16.7
Class 6	58.3	6.9	22.2	34.0	12.2	30.0

chi square not significant at .05 level

* does not include those people not requiring a given mode of custom work

Selected Property Improvements*

It was expected that the investment of new capital into a property would reflect the orientation of Class 1 as opposed to Class 6 Farms. Class 1 Farmers were expected to make agriculturally oriented investments whereas those on class 6 soils were not. Improvements occurring on an individual farm represent an input of capital, and in turn may reflect differing levels of intensity.

In general, a larger proportion of Class 1 Farmers have built new silos (34.4%) and new barns (31.1%) and removed fences (63.9%) in the last 10 years, than have Class 6 Farmers (Table 39). Conversely, more new houses have been erected (13.4%) and more trees planted (20.0%) on Class 6 Farms than on Class 1 Farms**.

The above is also reflected in the significant relationship shown in Table 40, which indicates the number of silos and granaries per property. In total, 55.3% of Class 6 Farms do not have a silo or steel granary present

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* Although the installation of drainage tile distinguished the three groups, this variable was not discussed as it reflects more than anything, the relative ease of natural drainage occurring on different soil types (example, Donnybrook Sandy Loam).

** These trends are similar to those occurring on hobby farms (Troughton, 1975).

TABLE 39

Farm Sample:
Selected Property Improvements Over the Last 10 Years
By Farm Type

Farm Type	New* Silo %	New House %	New Storage Facilities %	New** Barn %	Fence* Removal %	Trees*** Planted %	Land Cleared %
Class 1	34.4	6.6	29.5	31.1	63.9	4.9	27.9
Mixed	41.2	5.9	33.3	9.8	73.5	13.7	23.5
Class 6	14.6	13.4	23.2	14.6	45.8	20.0	17.6

* chi square significant at .005 level
** chi square significant at .01 level
*** chi square significant at .05 level

TABLE 40

Farm Sample:
The Number of Silos and Granaries Present by Farm Type

Farm Type	Number Owned (% of Total) 0	1	2	3	4 or more
Class 1	24.6	19.7	23.0	18.0	14.8
Mixed	23.5	35.3	17.6	17.6	5.9
Class 6	55.3	21.2	10.6	7.1	5.9

chi square significant at .001 level

compared to only 24.6% of Class 1 Farms which lack such structures.

One may conclude from the above that Class 6 Farms tend to have a different orientation than Class 1 Farms, as reflected in the tendency to invest in new housing. However, a relatively large number of Class 6 Farms demonstrate certain characteristics of agricultural viability. This again suggests that two types of Class 6 Farms exist: those which are part of the agricultural system and those which fit the expected mold of Class 6 Farms.

Crops and Livestock

The distribution, type and extent of crops and livestock in association with enterprise type, reflect varying levels of intensity owing to different labour and capital requirements. When considering livestock, dairy cattle and pigs are more labour intensive than beef cattle (Table 41). In addition, certain crops, such as corn and white beans, are more labour demanding than others, such as hay. There are also differing levels of capital investment required for various crops and livestock types. It was expected that both the occurrence and intensity of the cropping pattern would vary with soil capability.

TABLE 41

Yearly and Quarterly Labour Requirements for Livestock and Selected Crops on Ontario Farms

	Labour Index per Head				
	Total	Jan/Feb/Mar	Apr/May/June	July/Aug/Sept	Oct/Nov/Dec
Dairy Cattle					
Cow and following	1.0	.28	.25	.21	.27
Beef Cattle					
Beef Cow & Calf	.2	.07	.05	.02	.07
Purchased Calf	.06	.02	.01	.01	.02
Purchased Yearling (kept for 10 months)	.08	.03	.02	.01	.01
Wintering-steer calves (7 months)	.04	.02	.01	-	.01
Pasturing season-steers (6 months)	.017	-	.004	.008	.004
Sheep					
Ewe (with lamb)	.09	.04	.03	.01	.02
Swine					
Sow & young pigs to market wt.	.69	.17	.17	.17	.17
Sow & young pigs sold as weiners	.40	.10	.10	.10	.10
Feeder Hogs/10 hogs	.24	.06	.06	.06	.06
Poultry					
Laying Hens/100 hens	1.07	.26	.27	.27	.27
Selected Field Crops			Labour Index per Acre		
Corn, Silage	1.0	.05	.28	.29	.37
Corn, Grain	.73	.01	.28	.03	.41
Hay	.67	.04	.27	.35	.01
Spring grain	.73	.00	.23	.37	.13
White beans	1.0	.00	.33	.45	.21
Soy beans	.60	.00	.36	.08	.16

Source: Adapted from Farm Economics, Co-operative & Statistics Branch, O.D.A. & F.; Crop Enterprise Studies, Farm Economics, Co-operative & Statistics Branch, O.D.A & F., 1969.

Crops: Type and Acreage

It was expected that farms comprised of class 1 soils would be part of the intensive and viable agricultural system congruent with agriculture practiced in Southwestern Ontario. As such, relatively intensive field crops would dominate. Conversely, class 6 soils as defined by the Canada Land Inventory were expected to be limited to the production of perennial forage crops, with grazing the dominant agricultural activity. On this basis, it was anticipated that Class 6 Farms would demonstrate limited and marginal cropping.

The significance and extent of individual crops, reflects varying levels of intensity associated with differing soil capabilities. Although Table 42 reflects the general trends presented in the previous chapter, there are some further distinctions. First, Class 1 Farms have larger proportions of their area in intensive crops including corn, grain and beans, whereas Class 6 Farms tend to be occupied by larger proportions of pasture, woodlot, scrub and waste, with more land rented out. In addition, the proportion of individuals growing the major agricultural crop types is substantially less on Class 6 Farms than on Class 1 Farms (although the average acreage for those actually growing these crops tends to be larger for Class 6 Farms) (Table

TABLE 42

Farm Sample:
Percent of Total Area in a Given Crop by Farm Type

Farm Type	Grain Corn	Ensilage Corn	Mixed Grain	Wheat Barley Oats	White Beans & Soy Beans	Hay	Improved Pasture	Unimproved Pasture	Woodlot	Scrub Swamp	Summer Fallow & Other	Unaccounted For	Rented Out
Class 1	21.1	9.6	10.8	5.3	1.9	15.1	9.1	.2	9.9	4.0	3.4	4.3	5.4
Mixed Farms													
Class 1 Element	16.2	8.3	5.8	8.1		16.8	10.0	.6	13.6	3.1	2.0	11.8	3.6
Class 6 Element	16.3	6.8	8.5	3.5		17.8	17.1	1.4	16.3	4.2	2.5	.9	4.4
Total for Mixed	17.0	7.6	7.6	5.5		15.6	15.6	1.1	15.5	3.5	1.8	5.8	3.2
Class 6	12.1	5.5	7.1	1.6		12.1	14.6	2.1	21.5	8.7	1.9	3.3	9.3

43). For example, whereas 62.3% of Class 1 Farmers grow grain corn compared to 30.6% of Class 6 Farmers, the class 6 element have an average acreage of 63.6 compared to 55.5 for the 62.3% of Class 1 Farmers growing grain corn. A similar pattern exists for ensilage corn, barley and improved pasture.

The above trends are also evident in the average values per farm presented in Appendix VI (including the total owned and rented acreage). While the proportion of land occupied by a given crop may vary, the actual difference in the acreage of an individual crop is somewhat less evident, owing to the differing farm size. Grain corn and mixed grain, for example, occupy 36.2, 18.5; 38.8, 17.2 and 22.1 and 13.0 acres respectively for Class 1, Mixed and Class 6 Farms.

Of note was the use made by the Mixed Farmers of their respective soil types. Whereas it was anticipated that farmers with a mixture of the two soil types would concentrate more intensive cropping on higher capability soils, there appears, in fact, to be only minor variations in the actual cropping pattern (Table 42). Although the differences in the area unaccounted for (11.8% for class 1 soils vs. .9% for class 6 soils) may have skewed the results, the only other difference exceeding 5% is the area

TABLE 43

Farm Sample:
Percentage Occurrence and Average Acreage of
Selected Crops by Farm Type

Farm Type	Percent of Each Farm Type Growing Crop and its Average Acreage													
	Grain Corn		Ensilage Corn		Mixed Grain		Barley		White Beans		Hay		Improved Pasture	
	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
Class 1 (on Class 1 Owned Property)	62.3	55.5	45.9	34.8	54.1	32.2	24.6	33.7	9.8	30.0	65.6	38.5	55.7	26.6
Mixed**														
On Class 1 Owned Property	37.3	40.6	35.3	21.7	27.5	19.7	21.6	33.0	-	-	60.8	25.9	39.2	23.7
On Class 6 Owned Property	41.2	34.3	29.4	20.1	31.4	23.7	19.6	12.5	-	-	58.8	26.1	54.9	27.0
Class 6 (on Class 6 Owned Property)	30.6	63.6	18.8	48.9	38.8	27.0	7.1	36.7	-	-	56.5	34.3	54.1	40.7

* the average value has been calculated only for those individuals growing the crop

** the values presented for mixed farms reflect the separate values for the two soil types

in improved pasture, which occupies 17.1% of class 6 land compared to 10% of class 1 land. The fact that 38.4% of the class 1 element is occupied by corn or another grain crop, compared to 35.1% for class 6 land, suggests that Mixed Farmers either do not perceive a distinction between class 1 and 6 land, or else crop it as if there was no distinction. This opinion is endorsed by the values in Table 43, which indicate that the proportion of Mixed Farmers growing crops and the average area in that crop is similar for the two soil classes comprising these farm units.

Non-Usable Acreage

In response to the question "How many acres of your property are non-usable because of soil fertility, stones, excess moisture, inadequate moisture, slope, soil structure or erosion?" Class 6 Farmers, as opposed to Class 1 Farmers, were expected to have large proportions of non-usable land. This variable is based on the owner's perception of his property and is not intended to include productive woodlot.

Although there are some noticeable differences, these are not significant at the .05 level (Table 44). For example, 62.1% of all Class 1 Farmers compared to 21.3% of Class 6 Farmers perceive all of their property as being usable. Although this difference seems important, the fact that 93.1% of Class 1 Farmers perceive less than 25% of

TABLE 44

Farm Sample:
Non-Usable Acreage by Farm Type

Farm Type	Percent Occurrence by Acreage Class						
	0	1-5	6-15	16-25	26-50	51-75	76 or larger
Class 1	62.1	6.9	20.7	3.4	3.4	0	3.4
Mixed	40.0	26.7	23.3	3.3	6.7	0	0
Class 6	21.3	25.5	23.4	10.6	12.8	2.1	4.3
Total	37.7	20.8	22.6	6.6	8.5	.9	2.8

chi square is not significant at the .05 level

TABLE 45

Farm Sample:
Livestock Activity by Farm Type

Farm Type	Livestock Type					
	Pigs %	Horses* %	Dairy %	Poultry %	Beef %	Sheep %
Class 1	34.4	21.3	24.6	16.4	59.0	1.6
Mixed	33.3	3.9	21.6	11.8	60.8	-
Class 6	29.4	16.5	17.6	21.2	49.4	4.7

* chi square significant at .05 level

their property as being non-usable compared to 80.8% of Class 6 Farmers diminishes the significance of the above results. That is, while a much larger proportion of low capability farms have non-usable acreages, the actual significance in terms of total acreage is less than originally anticipated.

Livestock: Type and Number

It was expected that livestock type and concentration would vary with soil capability. This was expected to reflect the ability of Class 1 Farms to support larger concentrations of livestock than on Class 6 Farms, and the likelihood of more intensive livestock types (reflecting differing capital and labour inputs) being located on Class 1 Farms. Specifically, this may include beef on class 6 farms where pasture is expected to dominate and hogs, which require large inputs of labour and capital on Class 1 Farms.

The results in Table 45 indicate that the presence of horses are the only livestock which differ significantly among the three farm types. While the proportion of farms with beef, dairy and pigs tends to decline from Class 1, through Mixed to Class 6 Farms the distinctions are minor.

The actual variation in the intensity of livestock production, however, suggests a somewhat different

relationship. Farms on class 1 and mixed soils have substantially larger numbers of dairy cattle (9.5 and 8.4 cows, respectively, per farm) and hogs than on Class 6 Farms (3.18 cows per farm) (Appendix VI), whereas the number of beef cows and stockers sold is higher on Class 6 and Mixed Farms than on Class 1 Farms. The yearly production of market cattle, however, does not vary greatly between the three groups, with Mixed Farmers marketing 37.4 cattle, compared to 29.4 and 24.0 for Class 1 and Class 6 Farmers, respectively.

The actual intensity of livestock operations is best measured, however, in terms of the number of livestock handled by those individuals engaging in a particular livestock activity. The average number of market hogs sold annually, and the average number of dairy cows owned per farm engaged in these activities (Table 46) demonstrates a consistant decline from Class 1 Farms to Mixed Farms to Class 6 Farms. In contrast, beef cattle have larger concentrations of beef cows owned, stockers sold and cattle marketed annually on Class 6 and Mixed Farms than on Class 1 Farms,

The above trends suggest that Class 1 Farms, owing to concentrations of labour and capital intensive hog and dairy operations, are somewhat more intensive, compared to Class 6 and Mixed Farms where beef farming is of greater importance.

TABLE 46

Farm Sample:
The Proportion of Farmers Involved in a Given Livestock Type, Production* and Herd Size by Farm Type

Farm Type	Selling Market Hogs		Sows		Dairy Cows		Beef Cows		Stockers Sold		Market Cattle Sold	
	%	#	%	#	%	#	%	#	%	#	%	#
Class 1	27.9	656.1	22.9	43.2	23.0	41.4	19.7	21.1	11.5	25.6	47.5	65.6
Mixed	31.4	493.8	19.6	51.7	21.6	38.9	27.5	32.7	27.5	59.0	37.3	100.4
Class 6	24.7	385.7	12.9	28.1	12.9	19.4	28.2	23.3	23.5	46.9	31.8	77.7

* The values for the number of livestock are averages computed for those farmers involved in that livestock type.

Enterprise Type

Enterprise type* measures the dominant agricultural activity of a farm unit. It was anticipated that Class 6 Farms would largely fall into categories of limited agriculture, and where Class 6 Farms were involved in agriculture, their use would reflect their suitability for pasture. Conversely, Class 1 Farms would consist of intensive and specialized agricultural types. Unexpectedly, a large proportion of Class 6 Farms fall into one of the major agricultural categories (Table 47). In total, 81.9%, 78.5% and 65.9% of Class 1, Mixed and Class 6 Farms, respectively, fall into the major categories of dairy, beef, hogs, cash grain, mixed general and mixed livestock. There is, however, a significantly greater emphasis on the more intensive dairy and hog operations on Class 1 Farms, whereas beef and the mixed general and livestock enterprises are proportionately and relatively, more significant on Class 6 and Mixed Farms.

Lending some credence to the expected relationship is the large proportion of Class 6 and Mixed Farms involved in the renting of land or with no agricultural income. In general, the above trends reflect several possible

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* See Appendix V for a more detailed definition of enterprise type.

TABLE 47

Farm Sample:

Enterprise Type by Farm Type

Farm Type	Enterprise Type (% of Total)								
	Dairy	Beef	Hogs	Cash Grain	Mixed Livestock	Mixed General	Rents Land Out	Other, (Including Poultry & Sheep)	No Agricultural Income
Class 1	18.0	31.1	13.1	3.3	14.8	1.6	4.9	13.1	.0
Mixed	11.8	27.5	5.9	3.9	19.6	9.8	11.8	5.9	3.9
Class 6	7.1	28.2	9.4	5.9	10.6	4.7	15.3	10.6	8.2
Total	11.7	28.9	9.6	4.6	14.2	5.1	11.2	10.2	4.6

chi square is not significant at .05 level.

conditions. In the first instance, these trends suggest that class 6 soils are less suitable to certain intensive agricultural operations, such as dairy and hogs. Secondly, there is a relatively greater concentration of beef, mixed livestock and mixed general on low capability soils, possibly suggesting lower land values and in turn their enhanced status for pasturing and forage crops.

Summary - Operational and Land Use Characteristics

Many of the results in this section run contrary to the expected relationships which were based on the CLI definition of class 6 soils. Generally, it was expected that Class 6 Farms would display limited, if any, agricultural use. Contrary to this expectation, a large proportion of these farms demonstrated characteristics of viable agriculture.

More than half of the Class 6 Farms had a full-time labour commitment which was involved in the growing of crops and raising of livestock in concentrations normally not associated with class 6 soils. These results are evident in the analysis of enterprise type which indicated that while distinctions exist, a large proportion of Class 6 Farms are part of the agricultural system. These results lead to the

conclusion that the most significant distinctions exist not between Class 1 and 6 Farms, but rather between those Class 6 Farms which fit the expected pattern (small-scale non-viable units) and those which demonstrate characteristics of ongoing viable agriculture (Chapter VIII).

Measures of Output

The annual output from a farm unit reflects its productivity and the intensity of operation. As such, it was expected that Class 6 Farms would exhibit low levels of output, whereas Class 1 Farms would be highly productive and Mixed Farms would assume an intermediate position.

While relative measures of output, such as yearly production of livestock and crop type, have already been presented, gross farm income constitutes the most encompassing measure of output. Gross farm income reflects the productivity, intensity and viability of the farm unit. A second means of evaluating the relative intensity of a farm unit is through a property's value as assessed for taxation purposes. Both of these measures are considered on a per farm and per acre basis.

Farm Derived Income

It was anticipated that Class 6 Farms would have characteristically low farm incomes, whereas incomes on Class 1 Farms would be significantly higher. In general, these trends do exist (Table 48) although the results for Class 1 and Mixed Farms are quite similar. Whereas 19.4% of Class 1 Farms gross less than $10,000 annually, 38% of Class 6 Farms fall into this category. Furthermore, the majority of Class 1 Farms (54.3%) gross in excess of $50,000, compared to only a quarter (24%) of Class 6 Farms. Despite this pattern, however, it is obvious that there is a substantial proportion of Class 6 Farms which exhibit characteristics of fairly intensive agricultural land use (for example, 44% of Class 6 Farms gross in excess of $25,000).

On a per acre basis the distinction between gross farm income for Class 1, Mixed and Class 6 Farms is not as great as previous research (example, productivity measures in Table 11) would suggest (Table 49). At $312.2/ total acre and $461.3/ improved acre Class 6 Farms gross 79.3% and 91.9%, respectively, of the Class 1 Farm value. These values suggest that farms on low capability soils are nearly as productive as farms on high capability soils. Given, however, that the value for Class 6 Farms is skewed by

TABLE 48

Farm Sample:
Gross Farm Income by Farm Type

Farm Type	Agricultural Income	Income Category (% of Total) $1 -2499	$2500 -4999	$5000 -9999	$10000 -24999	$25000 -49999	$50000 -74999	$75000 -99999	$100000 -14999	$150000 +
Class 1	0	8.7	4.3	6.5	17.4	8.7	17.4	8.7	17.4	10.9
Mixed	11.1	0	3.7	3.7	11.1	18.5	14.8	14.8	3.7	18.5
Class 6	14.0	16.0	6.0	2.0	18.0	20.0	2.0	6.0	4.0	12.0
Total	8.1	9.8	4.9	4.1	16.3	15.4	10.6	8.9	8.9	13.0

chi square significant at .05 level

TABLE 49

Farm Sample:
Gross Farm Income on a Per Acre and Improved Acre Basis
By Farm Type

Farm Type	Gross Farm Income/Acre $	% of Class 1 Value	Gross Farm Income/Improved Acre ($)	% of Class 1 Value
Class 1	393.6	100%	501.9	100%
Mixed	335.9	85.3	404.4	80.6
Class 6	312.2	79.3	461.3	91.9
Not Including Those Properties Grossing in Excess of $250,000 annually				
Class 1	316.1	100	407.1	100
Mixed	274.0	86.7	328.9	80.8
Class 6	216.7	68.6	331.3	81.4

several farms with very high incomes, the gross income per acre was recalculated, not including those farms grossing in excess of $250,000 (Table 49). Having discounted these farms with very high gross incomes, Class 6 Farms still grossed 68.6% ($216.7/ acre) of the Class 1 Farm value per acre and 81.4% ($331.3) per improved acre. Obviously, even using these conservative values for output (as measured in terms of gross farm income and gross farm income per acre), the differences between Class 1 and Class 6 Farms are not nearly as significant as anticipated.

Market Value Assessment

A secondary measure of relative output (and input) is market value assessment, which reflects the assessed value of land and buildings. It was anticipated that market value assessment would reflect actual productivity and soil capability, as well as farm viability and intensity of operation, thereby varying with soil capability. Given that assessment in Huron County is a fraction of 1975 market values, and assessment in Bruce is based on full 1972 market value, the former was chosen to give a somewhat larger and more diverse sample.

While total property values are useful in terms of identifying the scale of operation, the best comparative information consists of average per acre values (Table 50). While 17.1% of Class 6 Farms have assessed values at $250/ acre or less, compared to 5.0% for Class 1 Farms and 63.3% of Class 1 Farm values exceed $500/ acre, as opposed to 36.5% for Class 6 Farms, the results are not statistically different. At best a trend exists as exemplified by the average assessed total value of $91,661.5 for Class 1 Farms, $88,312.3 for Mixed Farms and $76,338.8 for Class 6 Farms ($596.6; $553.3 and $522.8/ acre, respectively) (Table 51).

Summary - Output

The above results suggest that while there are some distinctions in output between Class 1 and Class 6 Farms as measured by gross farm income and the assessed market value, these differences were not significant. In fact, they vary considerably from the average index advanced in Table 11, which suggests that if class 1 soils have an index of 1.0, class 6 soils would have an index of .25. The results presented in this section on output suggest that two types of Class 6 Farms exist: those with high incomes on a per farm and per acre basis and those with low incomes. The assessed market values also reflect this trend. Those with

TABLE 50

Farm Sample:
Assessed Property Values Per Acre by Farm Type

Farm Type	Assessed Values Per Acre Class (% of Total)				
	$0-249	$250-499	$500-749	$750-999	$1,000 or Larger
Class 1	5.0	31.7	45.0	13.3	5.0
Mixed	16.6	33.3	37.5	4.2	8.3
Class 6	17.1	46.3	26.8	2.4	7.3
Total	11.2	36.8	37.6	8.0	6.4

TABLE 51

Farm Sample:
Assessed Market Values for
East Wawanosh, West Wawanosh and Turnberry by Farm Type

Farm Type	Average Assessed Value	Average Per Acre Value	Sample Size
Class 1	$91,661.5	$596.6	57
Mixed	$88,312.3	$553.5	22
Class 6	$76,338.8	$522.8	39

a high assessed market value will consist of arable land, with a large investment in buildings, as opposed to those with a low market value, and limited agricultural potential.

Perceptions

Based on the Canada Land Inventory rating of Donnybrook Sandy Loam soils as $6_s^{t6}\ 4_m^{f4}$ and the original soil surveys, it was expected that the owners of properties with this soil would perceive the limitations of topography, adverse soil characteristics, low fertility, moisture (droughtiness, caused by a low water holding capacity), stoniness and erosion; - problems which the CLI subclasses and the original soil surveys mention. Inquiries were also made concerning the land owner's perception of excess moisture. An attempt was made to evaluate the severity of these limitations through the detailed farm interviews (Appendix III).

In order to compensate for these limitations, farmers may utilize differing land use practices. The County Soil Surveys (1952 and 1954), for example, mention that it is adviseable to keep Donnybrook soils under permanent pasture for extended periods of time, owing to their susceptibility to erosion. In addition, it is mentioned that they are not suited to contour cultivation

and strip cropping, because of their complex topography.

The result of the above was an expectation that Class 6 Farmers would perceive the limitations of their property and as a result would implement differing land use practices.

Perceived Limitations

In response to the question: "Are the following limitations a problem on your property: soil fertility, stoniness, excess moisture, inadequate moisture, topography, soil structure and erosion?", it was anticipated that more Class 6 than Class 1 Farmers would rate it as a significant problem. The results, however, (Table 52) do not indicate a significant difference between the three groups. While certain trends do exist, in that more Class 6 than Class 1 Farmers perceive topography as a problem, in some instances the results were inverse to the expected pattern (for example, a larger proportion of Class 1 Farmers view stones as a problem). Furthermore, other variables, such as moisture conditions, reflect the feeling among some Class 6 Farmers that because of their soils good natural drainage they have an advantage over their neighbours on higher capability soils, who frequently require expensive

TABLE 52

Farm Sample:
Limitations for Agriculture and the Perception of These Limiting Factors by Farm Type

Limitation	Severity of Limitation			
	No	Minor	Moderate	Major
Soil Fertility	%	%	%	%
Class 1	75.0	10.7	14.3	0
Mixed	78.7	10.6	10.6	0
Class 6	70.4	18.5	7.4	3.7
Stoniness				
Class 1	18.8	43.8	31.3	6.3
Mixed	31.9	42.6	21.3	4.3
Class 6	22.4	34.5	27.6	15.5
Excess Moisture				
Class 1	43.3	26.7	20.0	10.0
Mixed	42.6	42.6	8.5	6.4
Class 6	39.7	46.6	10.3	3.4
Inadequate Moisture				
Class 1	81.5	18.5	0	0
Mixed	78.3	21.7	0	0
Class 6	74.5	20.0	5.5	0
Topography				
Class 1	50	21.4	21.4	7.1
Mixed	26.1	52.2	15.2	6.5
Class 6	29.1	38.2	21.8	10.9
Soil Structure				
Class 1	71.4	14.3	10.7	3.6
Mixed	90.9	4.5	4.5	0
Class 6	88.2	5.9	5.9	
Erosion				
Class 1	72.4	20.7	6.9	0
Mixed	89.1	4.3	4.3	2.2
Class 6	66.7	24.1	5.6	3.7

chi square values are not significant at .05 level

systematic tile drainage.

Selected Farm Practices

Given the expected nature of low capability soils, it was anticipated that this might cause some impact on localized land use practices. In fact, however, the only significant difference exists for crop rotation, where 100% of Class 1 Farmers claim to practice it, compared to 80.4% of Class 6 Farmers (Table 53). This latter figure, however, may largely be attributed to individuals who maintain their property in permanent improved pasture and hay. While certain trends for contour plowing, summer fallow and soil tests may be discerned, they are inconclusive, providing only minor evidence suggesting that Class 1 and Class 6 Farmers manage their property differently.

Comparative Farm Rating

When individual farmers were asked to rate their farms on a scale of 1 to 7 with 1 being representative of the best land in the area and 7 being associated with the very poorest, it was expected that despite certain bias, the landowners would rate their farms in general accordance with the CLI classification.

TABLE 53

Farm Sample:
Selected Farming Practices* by Farm Type

Farm Type	Percentage of Total Practicing: Contour Plowing	Crop** Rotation	Summer Fallow	Soil Test	Different Rates of Fertilizer Application
Class 1	29.0	100.	6.3	59.4	N.A.
Mixed	16.3	85.1	5.4	44.4	47.5
Class 6	20.4	80.4	16.3	53.6	58.3

* applies to those engaged in agriculture
** chi square significant at .05 level

The results presented in Table 54, do in fact, indicate a significant difference between the individual groups and the rating of their farms. Respectively, the owners of Class 1, Mixed and Class 6 Farms, for example, rated 90.0%, 69.8% and 54.2% of their farms as having agricultural capability of 3.5 or higher. Furthermore, 13.6% of Class 6 Farmers rated their farm as 6 or poorer, while no individuals in the other 2 groups rated their property this poorly. Despite the statistically significant difference between the two groups, however, it is important to note the relatively high rating associated with Class 6 Farms and the relatively low rating associated with Class 1 Farms. While this may be a problem of scale (i.e. rating based on their own local perceptions) or bias, it may also reflect the use of the farm as opposed to the land base itself. It may also indicate that, in some instances the CLI has either over rated or under rated the capability of certain lands.

Summary - Perceptions

The information presented in this section on perceptions indicates that there are some distinctions between Class 1, Mixed and Class 6 Farms. Certain limitations, such as topography, are more noted by Class 6

TABLE 54

Farm Sample:
Farm Ratings on a Scale of 1 to 7 by Farm Type

Farm Type	Individual Rating of Property 1.0 & 1.5	2.0 & 2.5	3.0 & 3.5	4.0 & 4.5	5.0 & 5.5	6.0 & 6.5	7.0 & 7.5
	Percent of Total						
Class 1	18.2	51.5	21.2	3.0	6.1	0	0
Mixed	7.0	32.6	30.2	23.3	7.0	0	0
Class 6	1.7	18.6	33.9	25.4	6.8	8.5	5.1
Total	7.4	31.1	29.6	19.3	6.7	3.7	2.2

chi square significant at .05 level

Farmers and a larger proportion also perceive their property as having low soil capability.

The most important results, however, are those which indicate that 54.2% of Class 6 Farmers perceive their property as having a capability of 3.5 or higher. This reinforces earlier findings outlined in this chapter, suggesting that there are two types of Class 6 Farmers: those who participate in the intensive agricultural system typical of the area, and those who utilize their land in a manner consistent with the CLI definition of class 6 soils.

A Composite, Comparative Assessment: Discriminant Analysis

Discrimant analysis is a statistical technique which attempts to distinguish between two or more separate groups. If significant differences exist between the groups based on a selection of variables the technique will verify this. On this basis, given the significant differences which were expected between Class 1 and Class 6 Farms, it was anticipated that discrimant analysis would clearly define and segregate the sample into its respective groups.

The variables chosen for discriminant analysis were those which the original hypothesis suggested would vary directly with soil capability. These included gross farm

income, tenure, enterprise type, total owned and rented acreage, total improved acreage and total acreage (owned) in field crops. Utilizing these variables, individual classification scores were computed and the cases were converted into probabilities of group membership.

Reinforcing earlier results, however, few of the variables selected were statistically significant in terms of their ability to distinguish the groups (Table 55). In fact, gross farm income was the only variable significant at the .05 level.

Based on the six variables considered, only 49.24% of the cases predicted group membership corresponded with the actual group membership (Table 55). While the majority (68.9%) of Class 1 Farms were correctly classified, only 45.1% of Mixed Farms and 27.6% of Class 6 Farms were correctly categorized. The results actually suggest that 25.9% and 36.5% of Class 6 Farms would be more aptly classified as Class 1 and Mixed Farms respectively. Those individuals owning class 6 land and who were incorrectly classified, probably correspond with the recurrent nearly two-thirds of the class 6 population, who have a significant involvement in farming (Table 33), with large gross farm incomes (Tables 48 and 49) and relatively large acreages in crops (Tables 42 and 43). Those Class 6 Farms, predicted by

TABLE 55

Farm Sample:
Results of Discriminant Analysis

Variable	Wilks Lambda	F-Ratio	Significance
Gross Farm Income	.93097	4.449	.0137
Enterprise Type	.95425	2.877	.0602
Improved Area	.96541	2.150	.1210
Total Owned and Rented Area	.96192	2.375	.0974
Tenure	.95674	2.713	.0704
Area in Field Crops	.98442	.9497	.3897

Classification Results:
Actual By Predicted Group Membership

Actual Group	Predicted Group Membership (% of Total)		
	Class 1	Mixed	Class 6
Class 1	68.9	14.8	16.4
Mixed	33.3	45.1	21.6
Class 6	25.9	36.5	37.6

discriminant analysis as being Class 1, were largely farm oriented, with high gross farm incomes and large acreages of improved land.

Also, it is surprising that 16.4% of Class 1 Farms are predicted as being Class 6 Farms. An inspection of these 10 properties indicated a "typical" Class 6 Farm as originally expected: low income, sizeable unimproved acreages and limited farm involvement.

Summary

This chapter has investigated the relationship between soil capability and the farm unit. Throughout, an attempt was made to search for those differences which might distinguish Class 1 from 6 Farms and substantiate the class 6 designation. While some level of agricultural activity on Class 6 Farms was anticipated, the extent and intensity to which it did occur, was not.

Consistently, a large proportion of Class 6 Farms demonstrated characteristics of large scale intensive and viable agriculture. On the basis of tenure, enterprise type, crops, livestock, machinery and gross farm income, these farms did not appear to differ markedly from those located on class 1 soils. This sizeable group of legitimate

farm units runs contrary to most published reports and literature concerning low capability soils and especially the CLI's interpretation of the same. These farm units existed in contrast to those which fit the expected mold of Class 6 Farms. This latter group being primarily non-farm and non-productive.

The analysis of the expected relationships has consistently yielded unexpected results. The most significant differences in land use appear to exist between those Class 6 Farms which are apparently viable and those which demonstrate limited and marginal agricultural activity. The following chapter, in a final attempt to verify the hypothesis, investigates those Class 6 Farms which appear as part of the intensive agricultural system of Southwestern Ontario.

CHAPTER VIII

FARM OPERATION AND CAPABILITY RELATIONSHIPS:

PART III: A MORE DETAILED ANALYSIS OF CLASS 6 FARMS

A large proportion of the farms in the study area with class 6 soils demonstrate characteristics normally associated with farms on higher capability soils. This finding negates many of the expected relationships initially hypothesized. Within the sample of Class 6 Farms there is a wide range of agricultural practices and land use. Some farms appear marginal for agriculture and are used as such, while others do not appear to differ substantially from those which are on class 1 soils. This chapter attempts to evaluate these seemingly viable farm operations in an attempt to more precisely determine the impact of class 6 soils and the response of the farm operator.

The Sample

In order to distinguish those Class 6 Farms which exhibit certain characteristics of viability from those which do not, the following criteria were utilized. Class 6 Farms with significant farm involvement were deemed to be those comprised of at least 75 acres grossing a minimum of

$10,000* and operated on either a full-time, part-time (local and non-local) or non-resident, some-farm basis - hereafter referred to as Selected Class 6 Farms. Based on these fairly rigid conditions, 55.3% of all Class 6 Farms (a total of 47) may be considered as being substantive farm operations. These farms were compared with all Class 1 Farms and also with those Class 1 Farms meeting the same rigid conditions used for classifying Class 6 Farms (tenure, property size and gross farm income) - hereafter referred to as Selected Class 1 Farms. This latter sample consists of 46 farms representing 75.4% of all Class 1 Farms.

Selected Operational Characteristics

The individual farm constitutes the most basic unit of agricultural production. As such, it was anticipated that Selected Class 6 Farms, while demonstrating certain conditions of viability, would also display certain characteristics illustrating their low soil capability. In general, while Selected Class 6 Farms are somewhat larger than Selected Class 1 Farms in terms of total acreage, their average improved acreage and acreage in crops is similar (Table 56). In addition, while there appears to be a

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* In those instances where gross farm income was missing, the value of livestock production and cash cropping was totalled and used as a surrogate for gross farm income.

TABLE 56

Selected Farm Sample:
Mean Values of Selected Variables

	Selected Class 6 Farms	All Class 1 Farms	Selected Class 1 Farms
Acreage Owned	225.2	168.4***	195.5
Acreage Rented	22.2	4.05*	5.4**
Improved Owned Acreage	148.6	131.5	155.6
Acreage of Crops Grown on Owned Land	75.6	80.3	98.1
Acreage of Crops Grown on Owned and Rented Land	91.8	84.4	103.5
Non Useable Acreage	10.2	9.9	7.3
Minimum Length of Farm Ownership	11.7	11.9	12.4
Maximum Length of Farm Ownership	14.0	13.57	14.4
Number of Tractors Owned	2.38	2.28	2.65
Farm Rating 1-7	3.36	2.30*	2.31*
Number of Dairy Cows	5.8	9.5	12.1
Number of Beef Cows	11.51	3.9**	5.16
Number of Stockers Sold	19.51	2.9***	3.72
Total Number of Cattle Finished Yearly	39.48	29.41	38.93
Total Estimated Value of Income from All Livestock/Farm	75,743.33	61,798.28	78,301.74

Difference in Means using T-Test (2 tailed test)
(Comparing Class 6 with Class 1 Values)

* significant at .001 level
** significant at .01 level
*** significant at .05 level

(1) Selected Class 6 and Selected Class 1 farms are defined as at least 75 acres large, with a gross farm income of $10,000 or more and they are owned and operated by either a full-time farmer, part-time farmer, or non-resident, with some farm involvement. This applies for Tables 56 through 61.

somewhat different emphasis on livestock type (Selected Class 6 Farms have a greater emphasis on beef/ cow-calf operations, while Selected Class 1 Farms have, on the average more dairy cattle) the differences in terms of the total value for livestock are only minor (an average of $75,743.33 on Selected Class 6 Farms compared to $78,301.74 for Selected Class 1 Farms).

As previously discussed, tenure, enterprise type and gross farm income are important in describing and analysing the farming community. This information, presented in Tables 57, 58 and 59, demonstrates that the few differences which occur between Selected Class 6 and Selected Class 1 Farms are not statistically significant. For example, there is a slightly greater concentration of part-time farming on Selected Class 6 Farms (31.9%) than on Selected Class 1 Farms (21.7%) (Table 57). In addition there is a somewhat greater concentration of beef farming on Selected Class 6 Farms (44.7% vs. 39.1%) and a slightly larger grouping of dairy farming on Selected Class 1 Farms (21.7% vs. 12.89%) (Table 58). Furthermore, while gross farm income demonstrates a greater amount of variation (31.4% of Selected Class 1 Farmers gross less than $50,000 compared to 60% of Selected Class 6 Farmers) the results are still not statistically different (Table 59). In fact, these results indicate that all of the farms generally

TABLE 57

Selected Farm Sample:
Tenure Type by Selected Class 1 and 6 Farms

Farm Type	Full-Time Farmer	Part-Time Farmer Local Job	Part-Time Farmer Non-local Job	Non-Resident Some Farm
	%	%	%	%
Selected Class 1	78.3	8.7	13.0	0
Selected Class 6	66.0	21.3	10.6	2.1
Total	72.0	15.1	11.8	1.1

Chi square not significant at .05 level.

TABLE 58
Selective Farm Sample:
Enterprise Type by Selected Class 1 and 6 Farms

Farm Type	Enterprise Type (Percent of Total) Dairy	Beef	Hogs	Sheep	Cash Grain	Mixed Livestock	Mixed General	Other
Selected Class 1	21.7	39.1	15.2	2.2	2.2	19.6	0	0
Selected Class 6	12.8	44.7	12.8	2.1	2.1	14.9	8.5	2.1
Total	17.2	41.9	14.0	2.2	2.2	17.2	4.3	1.1

Chi square not significant at .05 level.

TABLE 59

Selective Farm Sample:
Gross Farm Income by Selected Class 1 and 6 Farms

Farm Type	Gross Farm Income (Percent of Total)						
	$10,000 -24,999	$25,000 -49,999	$50,000 -74,999	$75,000 -99,999	$100,000 -149,999	$150,000 -249,999	$250,000+
Selected Class 1	20.0	11.4	22.9	11.4	20.0	8.6	5.7
Selected Class 6	26.7	33.3	3.3	10.0	6.7	10.0	10.0
Total	23.1	21.5	13.8	10.8	13.8	9.2	7.7

Chi square is not significant at .05 level.

demonstrate high incomes commensurate with the modern and intensive agriculture practiced in Southwestern Ontario.

Crops and Their Distribution

The distribution of crops on Selected Class 6 versus Class 1 Farms is another variable which does not show a great deal of variation. The information presented in Table 60 reveals that at least 72.3% of the area of Selected Class 6 Farms is in active agricultural production, compared to 78.5% of Class 1 Farms (Table 42). Furthermore, the total proportions of individual crops are quite similar for Class 1 and Selected Class 6 Farms. Consequently, the results directly contradict the CLI definition of class 6 soils which states that "soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible" (Environment Canada, 1978, 24).

Perceptions Towards the Land Base

The limitations of soil fertility, erosion, stoniness, inadequate moisture, topography and soil structure, as documented by the CLI and the original soil surveys, would be viewed, one would expect, as fairly major problems by Selected Class 6 Farmers. In reality, however, a majority of these farmers do not view fertility, erosion,

TABLE 60

Selective Farm Sample:
Crops Grown on Selected Class 6 Farms

Crop Type	CLI Component of Class 6 Farms and Rented Land									
	Class 6		Class 1		Other		Rented		Total	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Grain Corn	1631	17.1	31	14.2	26	6.0	169	20.3	185	16.8
Ensilage Corn	743	7.8	40	18.3	13	3.0	20	2.4	816	7.4
Mixed Grain	781	8.2	63	28.8	18	4.2	139	16.7	1001	9.1
Wheat	22	.2							22	.2
Barley	185	1.9							185	1.7
Hay	1484	15.5	26	11.9	4	.9	194	23.3	1708	15.5
Improved Pasture	1490	15.6	12	5.5	38	8.8	285	34.3	1825	16.5
Unimproved Pasture	181	1.9			13	3.0	25	3.0	219	2.0
Woodlot	1755	18.4	21	9.6	260	60.0			2036	18.4
Scrub/Swamp	757	7.9	21	9.6	46	10.6			824	7.5
Summer Fallow	30	.3							30	.3
Other	119	1.2	2	.9					121	1.1
Unaccounted For	40	.4	3	1.4	11	2.5			54	.5
Rented Out	343	3.6			4	.9			347	3.1
Total Acres	9561		219		433		832		11,045	
% of Total	86.6		2.0		3.9		7.5			

inadequate moisture or soil structure as problems (Table 61). The remaining variables of stoniness and topography are viewed, at worst, as a minor problem by the majority of Selected Class 6 Farmers. Furthermore, 60.6% of Selected Class 6 Farmers view their property as having a soil capability of 3.5 or higher. If these views are valid, one must seriously question the validity of the CLI low capability rating of the land on these farms as $6_s^{t6}\ 4_m^{f4}$.

Based on the results presented in this chapter, one may conclude that a substantial proportion of farms in the study area with class 6 soils, known as Selected Class 6 Farms, are not significantly different from the norm of Class 1 Farms. These Selected Class 6 Farms are mapped (Figure 5), thereby identifying their extent and location. The distribution of farm and non-farm properties as presented in Figure 5 indicates that the farms are distributed throughout the 5 townships. There does, however, appear to be a slight clustering of the non-farm properties, suggesting that the severity of the limiting factors (t, s, f and m) may vary spatially. It should be noted that substantially larger areas of class 6 soils and farms are used for agricultural production, however, as part of Mixed Farms, they are not displayed on Figure 5.

TABLE 61

Selective Farm Sample:
Limitations and Farm Rating by Selected Class 6 Farms

Severity of Limitation	Limitation (Percent of Total) Soil Fertility	Erosion	Stoniness	Excess Moisture	Inadequate Moisture	Topography	Soil Structure
No	73.5	61.8	22.9	34.3	70.6	17.6	87.9
Minor	17.6	29.4	42.9	54.3	20.6	47.1	6.1
Moderate	5.9	8.8	22.9	8.6	8.8	29.4	6.1
Major	2.9	-	11.4	2.9	-	5.9	-

	Rating on Scale of 1-7 by Farm Owner				
	1 & 1.5	2 & 2.5	3 & 3.5	4 & 4.5	5+
Percent of Total (Class 6 Farms)	3.0	18.2	39.4	33.3	6.1

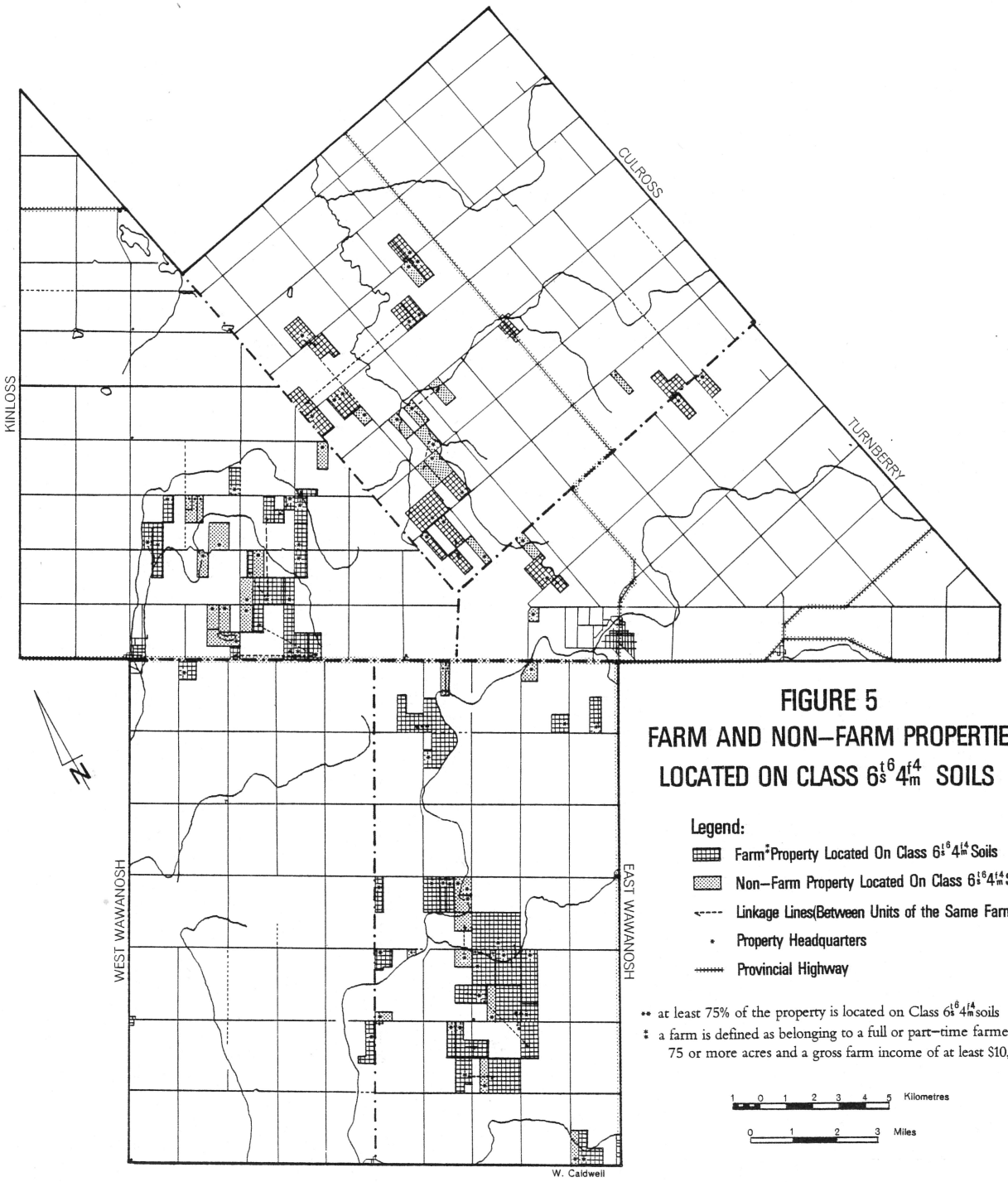


FIGURE 5
FARM AND NON–FARM PROPERTIES** LOCATED ON CLASS $6^{t6}_{s}4^{f4}_{m}$ SOILS

Legend:

- Farm*Property Located On Class $6^{t6}_{s}4^{f4}_{m}$ Soils
- Non–Farm Property Located On Class $6^{t6}_{s}4^{f4}_{m}$ Soils
- Linkage Lines(Between Units of the Same Farm)
- Property Headquarters
- Provincial Highway

** at least 75% of the property is located on Class $6^{t6}_{s}4^{f4}_{m}$ soils

* a farm is defined as belonging to a full or part–time farmer, with 75 or more acres and a gross farm income of at least $10,000.

1 0 1 2 3 4 5 Kilometres

0 1 2 3 Miles

Summary

The results of the analysis of this chapter indicate that with few exceptions, Selected Class 6 Farms are not significantly different from the control group of Class 1 Farms. In fact, for those variables for which the mean was calculated and tested (comparing Selected Class 6 Farms with all Class 1 Farms), they were only significantly different for acreage owned, acreage rented, number of beef cows, number of stockers sold and the owners rating of his own property on a scale from 1 to 7 (Table 56). For each of these variables, with the exception of farm rating, the class 6 value was significantly larger than the class 1 value. Furthermore, when comparing the Selected Class 6 Farms with the Selected Class 1 Farms, the two samples were only significantly different for rented acreage and the farm rating. This latter point suggests that Selected Class 6 Farmers perceive their property as having somewhat lower capability, although the overall production of livestock and its total value does not reflect this perceived difference.

In conclusion, this chapter has established that a substantial number of Selected Class 6 Farms differ only slightly from a similar sample of Selected Class 1 Farms. These farms tend to be full-time or part-time, large scale, capital intensive, livestock oriented and with a

distribution and proportion of crops similar to that of the area in general. The expected pattern of land use, based on the CLI definition of class 6 soils and previous research, have been contradicted. These findings suggest either an error in the CLI mapping, methodology, interpretation, or classification techniques for lower capability soils, or a group of farmers who for one reason or another are able to utilize their land as if it possessed higher soil capability. The actual significance of these results and their possible explanation are dealt with in the concluding chapter.

CHAPTER IX

SUMMARY AND CONCLUSIONS

One of the factors generally assumed to control the use of agricultural land is the ability of a given soil type to support agricultural production. Consequently, the spatial variation of such agricultural parameters as crop type, enterprise type and the tenure situation may be linked to soil type. Furthermore, when expressed on a relative scale reflecting its capability for agricultural production, soil type can reflect the expected suitability and viability of differing modes and methods of agricultural production.

The Canada Land Inventory has formalized the above relationships. Soils have been rated on a scale from 1 to 7 reflecting their relative capability to support agricultural production under similar levels of management. This inventory has been verified by several empirical studies (Noble, 1965; Hoffman, 1972; Anderson, 1971 and Troughton and Da Silva, 1978).

The research which comprised this thesis has progressed on the assumption that soil capability influences agricultural land use and that the CLI represents a reliable system of land evaluation. This general assumption has

contributed to the following set of objectives and expected relationships as they apply to the study area (Figure 1).

The main objectives of this thesis were to identify the role of low capability soils within the following situations:

1) The study area constitutes a regional anomaly in which there is a sizeable extent of low capability soils within an area of generally high capability.

2) The impact of soil capability may be evaluated within the study area as it varies spatially.

3) Soil capability and its effect may be evaluated for the individual farm unit.

A final objective, not yet discussed is to evaluate the impact of these findings as they relate to rural land use planning and resource management.

These objectives were manifested in the major expected relationship that soils identified as class $6_s^{t6}\ 4_m^{f4}$ would display limited and marginal agricultural activity. Operationally, this relationship was expected to result in the following:

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These objectives were manifested in the major expected relationship that soils identified as class 6_s^{t6} 4_m^{f4} would display limited and marginal agricultural activity. Operationally, this relationship was expected to result in the following:

1) Class 6 soils would be dominated by low intensity land uses, such as woodlots, scrub and unimproved pasture.

2) Class 6 soils would have low intensity inputs, as demonstrated by a wide range of operational variables including tenure, the land base and enterprise type.

3) Class 6 soils would have low levels of productivity, reflected in crop yield and total output.

Spatially, these relationships were expected to occur both at the regional and individual farm level.

Summary of Results

Contrary to the expected set of relationships, soils rated as $6_s^{t6}\,4_m^{f4}$ by the CLI were in many instances utilized in a manner consistent with and comparable to the intensive agriculture practiced on class 1 soils. Although in some instances inconclusive trends existed lending some credence to the hypothesis, class 6 soils were in the majority of instances utilized in a manner inconsistent with the definition of their classification..

Distinctions between the counties of Huron and Bruce and the study area were minimal (Chapter V). In fact, the differences which did occur, such as land use and cropping patterns, were partially a function of changing climatic factors with latitude in that the study area (Figure 1) consistently demonstrated levels of intensity and agricultural use less intensive than Huron but more intensive than Bruce.

The study area, like Huron and Bruce, has been affected by those factors such as increasing farm size and increasing investment that have affected agriculture throughout Southern Ontario. A comparison of the 1971 and 1976 census (Tables 12 through 16) indicates that the counties and study area have been affected by similar rates of change. Given the distinctions in soil capability, the expectation that the processes associated with increasing mechanization and intensification would affect the areas differentially is unfounded.

In many respects, data at the county level when compared with data from the study area is inadequate to establish a relationship with soil capability. Consequently, in an attempt to avert this situation, the study area was compared to those townships of higher capability adjacent to it. This comparison yielded some

distinctions for certain variables such as cropping patterns (Table 19) and capital value (Table 21). For other variables such as livestock (Table 20) and machinery (Table 22), however, the results were inconclusive. These results tend to support the findings of Troughton and Da Silva (1978) which indicated that the relationships between soil capability and productivity were not as expected in this portion of Southern Ontario.

The inadequacies of census data emphasize the utility of using more local information detailing the distribution of crops; their productivity and the rate of fertilizer application (Chapter VI). This element of the research most closely resembles that conducted by Anderson (1971) and Hoffman (1972) in that it considers crop yield information. The results of Chapter VI go a step further, however, in that they document crop type (Table 24) and fertilizer application rates (Table 28). While certain trends and some statistically significant differences existed, the results contradicted the expected relationships by indicating that class 6 soils are utilized and form part of the agricultural resource base.

Although the distribution of individual crops yielded significant distinctions between class 1 and 6 soils, class 6 soils in the study area were used in a manner

inconsistent with their definition and previous research. In fact 66.8% of class $6_s^{t6}4_m^{f4}$ soils are in an improved state (Table 24) compared to 79.6% of class 1 soils. This large proportion of improved class 6 soils partially negates the expected relationship.

It was anticipated that the productivity of class 6 soils in terms of crop yield would differ substantially when compared to class 1 soils (Table 26). The results, however, indicated that the differences between the yields for grain corn and barley for class 1 and class 6 soils were not significant. While the differences for mixed grain were significant the difference in yield was only 12 bushels per acre (77.9 vs. 65.8 bushels). These results indicate that not only are large acreages of class 6 soils in production, but they are also highly productive.

Given the relatively high yields obtained on class 6 soils, it was anticipated that the one possible explanation would be a massive input of commerical fertilizers. The differences in fertilizer application rates (Table 28), however, for mixed grain and grain corn were not significant. Of the three crops tested only hay had a significantly higher application rate on class 6 soils. One may conclude on this basis that sizeable acreages of class 6 soils are relatively productive and have

similar levels of inputs when compared to class 1 soils.

The above results tend to discount the expectation that class 6 soils will display limited agricultural activity, with low productivity and large concentrations of unimproved land. While it is evident that a certain proportion of the land fits this description, it would appear that approximately two-thirds does not. Instead, this sizeable proportion appears to be part of the viable and productive agriculture common to Southwestern Ontario.

The sample of individual farms resulted in three separate groups defined by the proportion of class 6 and class 1 soils. Respectively, these three groups consisted of Class 1 Farms composed almost entirely of class 1 soils, Class 6 Farms comprised of class 6 soils and Mixed Farms consisting of a combination of class 1 and 6 soils. The distinctions between these three groups, resulting from anticipated differences in the land base, tenure, operational and land use characteristics, output and the perceptions of the owner were not clear (Chapter VII). This resulted largely from the fact that there were essentially two types of Class 6 Farms. The first of these two groups consisted of properties which fit the anticipated mold of Class 6 Farms, with limited agricultural use. The second group of Class 6 Farms, however, did not differ

substantially from those which had a class 1 soil base. They tended to be large scale, intensive and apparently viable farm units (Chapter VIII).

The acreage owned and rented by Class 6 Farmers (Tables 30 and 32); the tenure situation (Table 33); labour and machinery inputs (Tables 36,37 and 38); concentrations and type of crop, livestock and enterprise type (Tables 42,43,45,46 and 47); farm derived income (Tables 48 and 49) and market value assessment (Tables 50 and 51) indicate that in many instances Class 6 Farms constitute large scale, intensive and apparently viable farm units. This is reflected in the perceptions of Class 6 Farmers. Whereas it was expected that Class 6 Farmers would perceive their property as having significant limitations, their perceptions of these limitations did not differ substantially from those of Class 1 Farmers (Table 52). Furthermore, in terms of farm practice, Class 6 Farmers manage their property in a manner similar to Class 1 Farmers (Table 53). The results of these views are espoused in the owner's rating of his property on a scale of 1 to 7 (Table 54). While significant differences did occur, 54.2% of Class 6 Farmers rated their property as having a capability rating between 1 and 3.5. This indicates an important distinction between the owner's view of class 6 soils and the assessed value of $6_s^{t6}\,4_m^{f4}$.

The use of a statistical technique termed discriminant analysis reinforces the above findings. In fact, this technique suggests that 72.4% of Class 6 Farms are more aptly classified as Class 1 or Mixed Farms.

The results of Chapter VII indicated that a distinct difference existed between properties with a class 6 soil base. Chapter VIII, in an attempt to investigate this distinction, used relatively stringent criteria to identify 55.3% of all Class 6 Farms as having significant farm affiliation. This grouping of Selected Class 6 Farms was quite like a similar grouping of Selected Class 1 Farms. In terms of income, tenure, crops, livestock and enterprise type (Tables 56, 57, 58, 59 and 60) there were no substantial differences between the Selected Class 6 and Selected Class 1 Farmers.

Conclusions

The results discussed above and in Chapters V, VI, VII and VIII do not substantiate the expected relationships outlined in Chapter I. These expected relationships were based on the CLI class definitions, CLI literature and previous studies. The low capability rating of $6_s^{t\,6}\,4_m^{f\,4}$ is largely unfounded given the current types and productivity of agriculture practiced on these soils. There are several

possible explanations for these anomalous results. Additional limitations and assumptions have been discussed in Chapter II.

These results suggest that there has been an error either in the mapping or the CLI evaluation of Donnybrook sandy loam soils. This may have occurred during the initial soil surveys of the area (1952 and 1954) or it may have occurred during the establishment of the $6^{t6}_{s}\ 4^{f4}_{m}$ rating of soil capability by the CLI (as outlined in Chapter II).

The rating of Donnybrook sandy loams as $6^{t6}_{s}\ 4^{f4}_{m}$ appears to inadequately delineate the differences which occur on this soil type. For example, where the topography was hilly, land use tended to coincide with the expected land use pattern; where it was more gently rolling, relatively intensive agriculture dominated. This is partially reflected in the topographic map of the area attached as Appendix VII, showing the location of farmsteads, wooded areas and topographic variation.

Certain economic and land use factors may have contributed to the persistence of farming on class 6 land. The absence of large scale urban pressures on this land may have kept it in agricultural production, whereas in other areas it might have reverted to recreational or hobby farm

uses. Furthermore, the lower purchase or rental costs of this land as reported by some farmers may enhance its viability for agriculture. In the long run, however, the cost of land would become secondary to the cost of production, in that continued agricultural use requires that the farm output cover the cost of inputs and provide at least some profit to the farm operator.

The relative location of class 6 soils interspersed with areas of high capability lands may also have contributed to their viability. The infrastructure existing to support the wider agricultural system is an advantage frequently unavailable in areas where there are sizeable concentrations of class 6 soils. In addition, farmers in those adjacent areas of high capability soils will possess the knowledge and experience critical for viable agriculture. Although the impact of this on the land use of class 6 soils is questionable, sizeable acreages of class 6 soils are owned by many farmers who also own class 1 soils (for example, Mixed Farms).

The results presented indicate that farming practices on class 6 soils do not differ substantially from those on class 1 soils. Nevertheless, the emphasis on livestock and the tendency to keep sizeable acreages in woodlot is an approach to agricultural production desirable

on lower capability soils. That is, the ability of the farmer, in collaboration with a host of factors other than soil capability, can significantly influence, if not dictate, the viability of a farm operation. This conclusion coincides with that of McLean (1977). Given the yield and productivity values, however, it would seem unlikely that genuine class 6 soils could economically attain such high levels of productivity.

Implications

The findings of this study suggest more than just a regional anomaly or a misclassification by the Canada Land Inventory. Given the results of this thesis and other examples of misclassification noted by Hills (1970), Mage (1980) and Van den Broek (1981), one must question the appropriateness of land use policies formulated in isolation of factors other than soil capability. While it is not the intent of this thesis to dispute the utility of the CLI or the advantages associated with the use of a system of soil capability rating, the possibilities of erroneous results from the use of the CLI should be noted. Land use and resource planning (including severance policy and the Ontario Hydro study of hydro corridors (1982)) need to recognize this possibility.

The results of this thesis point to the appropriateness of the Government of Ontario's "Foodland Guidelines" (1978) listing of lands with agricultural potential. These include specialty crop lands; class 1 to 4 soils; areas where local market conditions ensure agricultural viability and additional areas where farms exhibit characteristics of ongoing viable agriculture. The significance of this last criterion, in light of the inadequacies of the CLI in the study area, needs to be recognized.

The results of this study also highlight the need for detailed local land use studies in the context of rural planning. Furthermore, they demonstrate the utility and urgency with which the renewed mapping and evaluation of soils by the Ontario Institute of Pedology should proceed. Finally, these results suggest that given the inadequacies of the CLI, federal, provincial and municipal policy decisions must encompass a broader range of variables than soil capability. In some instances, existing land use and productivity requires greater emphasis, while others should stress agroclimatic factors which enhance the utility of soil capability measures. In summation, soil capability information should not be utilized at the local level without supporting field checks and at the provincial level, soil capability should not be considered in isolation of other factors.

APPENDIX I

DEFINITIONS OF SOIL CAPABILITY CLASSES AND SUBCLASSES

Class 1

Soils in this class have no significant limitations for crops. These deep soils are level or have very gentle slopes, are well to imperfectly drained and have a good water-holding capacity. They are easily maintained in good tilth and productivity, and damage from erosion is slight. They are moderately high to high in productivity for a wide range of field crops adapted to the region.

Class 2

Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. These deep soils have a good water-holding capactity, can be managed with little difficulty and are moderately high to high in productivity for a fairly wide range of field crops. The moderate limitations of these soils may be any one of a number of factors including mildly adverse regional climate, moderate effects of erosion, poor soil structure or slow permeability, low fertility correctable with limited application of fertilizer and lime, gentle to moderate slopes, or occasional overflow or wetness.

Class 3

Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices. Under good management these soils are fair to moderately high in productivity for a fairly wide range of field crops adapted to the region. Conservation practices are more difficult to apply and

maintain. Limitations are a combination of two of those factors described under class 2, or one of the following: moderate climatic limitations; moderately severe effects or erosion; intractable soil mass or very slow permeability; low fertility; moderate to strong slopes; frequent overflow or poor drainage resulting in occasional crop damage; low water-holding capacity or slow in release of water; stoniness sufficiently severe to seriously handicap cultivation and necessitating some clearing; restricted rooting zone; or moderate salinity.

Class 4

Soils in this class have severe limitations that restrict the range of crops, or require special conservation pratices, or both. Such soils are suitable for only a few crops, or the yield for a range of crops is low, or the risk of crop failure is high. Limitations include the adverse effects of a combination of two or more of those described in class 2 and 3, or one of the following: moderately severe climate; very low water-holding capacity; low fertility difficult or unfeasible to correct; strong slopes; severe past erosion; very intractable mass of soil or extremely slow permeability; frequent overflow with severe effects on crops; severe salinity causing some crop failures; extreme stoniness requiring considerable clearing to permit annually cultivation; and very restricted rooting zone, but more than 30 cm. of soil over bedrock; or an impermeable layer. Limitations may seriously affect timing and ease of tillage, planting, harvesting, and maintenance of conservation practices. Soils have low to medium productivity for a narrow range of crops but may have higher productivity for a specially adapted crop.

Class 5

Soils in this class have very severe limitations that restrict their capability to produce perennial forage crops, and improvement practices are feasible. Soils have such serious soil, climatic, or other limitations that they are not capable of use for sustained production of annual field crops. These soils may be improved by the use of farm machinery for the production of native or tame species of

perennial forage plants. Limitations include the adverse effects of one or more of the following: severe climate; low water-holding capacity; severe past erosion; steep slopes; very poor drainage; very frequent overflow; severe salinity permitting only salt tolerant forage crops to grow; and stoniness or shallowness to bedrock that make annual cultivation impractical. Some soils can be used for cultivated field crops provided unusually intensive management is used. Cultivated field crops may be grown in class 5 areas where adverse climate is the main limitation, but crop failures occur under average conditions. Some of the soils in this class are also adapted to special crops such as blueberries, orchard crops, or the like, requiring soil conditions unlike those needed by the common crops.

Class 6

Soils in this class are capable only of producing perennial forage crops, and improvement practices are not feasible. Soils have some natural sustained grazing capacity for farm animals but have such serious soil, climatic, or other limitations as to make impractical the application of improvement practices that can be carried out in class 5. Soils may be placed in this class because their physical nature prevents improvement through the use of farm machinery, or the soils are not responsive to improvement practices, or because of a short grazing season, or because stock watering facilities are inadequate. Limitations include the adverse effects of one or more of the following: very severe climate; very low water-holding capacity; very steep slopes; very severely eroded land with gullies too numerous and too deep for working with machinery; severely saline land producing only edible, salt-tolerant native plants; very frequent overflow allowing less than 10 weeks effective grazing; water on the surface of the soil for most of the year; and stoniness or shallowness to bedrock that makes any cultivation impractical.

Class 7

Soils in this class have no capability for arable culture or permanent pasture. The soils or lands in class 7 have limitations so severe that they are not capable of use for arable culture or permanent pasture. All classified areas (except organic soils) not included in classes 1 to 6 are placed in this class. Capability Subclasses

Subclasses are divisions within class that have the same kind of limitations for agricultural use. Thirteen different kinds of limitations are recognized at the subclass level. A brief discussion of these subclasses and their letter designation on maps follows.

Adverse Climate (C)

This subclass denotes a significant adverse climate for crop production, as compared to the "median" climate which is defined as one with sufficiently high growing-season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

Undesirable Soil Structure and/or Low Permeability (D)

This subclass is used for soils difficult to till, or which absorb water very slowly, or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

Salinity (N)

This subclass includes soils with enough soluble salts to adversely affect crop growth or restrict the range of crops that may be grown. Such soils are not placed higher than class 3.

Stoniness (P)

This subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

Consolidated Bedrock (R)

This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than about one metre from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

Adverse Soil Characteristics (S)

On the 1:250,000 scale capability maps, this subclass will be used in place of subclasses D, F, M and N either individually or collectively. On larger scale maps, it may be used in a collective sense for two or more of these subclasses.

Topography (T)

This subclass is made up of soils where topography is a limitation. Both the percentage of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

Excess Water (W)

Subclass W is made up of soils where excess water, other than that brought about by inundation, is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

Cumulative Minor Adverse Characteristics (X)

This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not enough to affect the class rating.

Source: Simpson-Lewis, et.al. Canada's Special Resource Lands, Environment Canada, Ottawa, 1979.

APPENDIX II

Conversion Factors from English to Metric

To Find:	Multiply:	By:
Centimetres	inches	2.54
Metres	feet	.3048
Metres	yards	.9144
Kilometres	miles	1.609344
Square Metres	square feet	.0929
Square Metres	square yards	.83613
Hectares	acres	.405

Temperature Conversions:

$F = 1.8(C) + 32$
$C = .56(F - 32)$

APPENDIX III

THE QUESTIONNAIRE USED FOR THE COLLECTION OF DATA

1. Name:_____

2. Marital status: [ ] Single (including separated and divorced)
   [ ] married

3. Principle Residence:

Twp.	Lot	Conc.	Acreage of Principle Residence	Length of Ownership	Family Farm (yes or no)

4. Additional Properties Owned:

Twp.	Lot	Conc.	Acreage of Property	Length of Ownership

5. Properties Rented

Twp.	Lot	Conc.	Acreage of Property	Rent/Acre	Number of Years Rented

6. Do you hold a job outside of your farm operation? [ ] no;
   Number of days per year___; Occupation_____;
   Location of Employment_____.

7. Does your spouse hold a job off the farm? [ ] no;
   Number of days per year___; Occupation_____;
   Location of Employment_____.

8. Do you consider yourself to be retired? [ ] no [ ] yes

If you own property but do not farm it, nor have any livestock, please skip to question number 20.

9. What type of farming are you engaged in? _____

10. Family Labour: Members of Family (14 years or older) working on your farm...[ ] Fulltime; # of people __ and # of weeks part-time___

11. Hired labour: [ ] Fulltime; # of people __ and # of weeks part-time___

12. Pigs: Total number of sows: _____
    Yearly production of market hogs: _____
    Percentage of feed purchased:
    [ ] 0-24 [ ] 25-49 [ ] 50-74 [ ] 75-100

13. Horses: Total # owned for commercial purposes____; as pets____
    Percentage of feed purchased:
    [ ] 0-24 [ ] 25-49 [ ] 50-74 [ ] 75-100

14. Dairy: Total number of dairy cows:_____
Are heifer calves kept as replacement stock?
[ ] yes [ ] no
Are calves vealed? [ ] yes [ ] no
Are calves finished to market weight? [ ] yes [ ] no
Percentage of feed purchased:
[ ] 0-24 [ ] 25-49 [ ] 50-74 [ ] 75-100

15. Poultry: Type_____; Number of yearly production_____
_____; _____
Percentage of feed purchased:
[ ] 0-24 [ ] 25-49 [ ] 50-74 [ ] 75-100

16. Beef: Total number of cows producing calves:_____
Total number of calves sold as stockers:_____
Total number of cattle finished yearly:_____
Percentage of feed purchased:
[ ] 0-24 [ ] 25-49 [ ] 50-74 [ ] 75-100

17. Sheep: Total number of ewes producing lambs:_____
Yearly production of marketed lambs:_____
Percentage of feed purchased:
[ ] 0-24 [ ] 25-49 [ ] 50-74 [ ] 75-100

18. Other livestock (please specify):_____

19. Which of the following crops do you grow? What is their acreage and yield? (Place this information along with fertilizer application rates and analysis on the accompanying photo of you farm).

Crop	Owned Acreage		Yield		Rented Acreage		Yield
	class	class	class	class	class	class	class
Grain corn	.....	.....	.....	.....	.....	.....	.....
Ensilage corn	.....	.....	.....	.....	.....	.....	.....
Mixed grain	.....	.....	.....	.....	.....	.....	.....
Wheat	.....	.....	.....	.....	.....	.....	.....
Barley	.....	.....	.....	.....	.....	.....	.....
Oats	.....	.....	.....	.....	.....	.....	.....
White beens	.....	.....	.....	.....	.....	.....	.....
Soybeans	.....	.....	.....	.....	.....	.....	.....
Hay	.....	.....	.....	.....	.....	.....	.....
Improved Pasture	.....	.....	.....	.....	.....	.....	.....
Unimproved Pasture	.....	.....	.....	.....	.....	.....	.....
Woodlot	.....	.....	.....	.....	.....	.....	.....
Scrub/Waste/ Swamp	.....	.....	.....	.....	.....	.....	.....
Summer fallow	.....	.....	.....	.....	.....	.....	.....
Other (specify)	.....	.....	.....	.....	.....	.....	.....

Proportion of agricultural income derived from cash cropping (as a %):____

20. What is the horsepower of the tractors you own: ___,___,___

21. Do you hire someone to:
custom combine your grain,
corn or beans?..... [ ] yes [ ] no
cultivate your fields..... [ ] yes [ ] no
sow your crops..... [ ] yes [ ] no
cut your silage..... [ ] yes [ ] no
bale your hay..... [ ] yes [ ] no
spray your crops..... [ ] yes [ ] no

22. Buildings built in the last 10 years: [ ] house [ ] storage facilities [ ] silos [ ] barns (specify type:_____)

23. Presence of specialized farm buildings: [ ] hog [ ] beef (including feedlot & pole barn) [ ] dairy [ ] poultry

24. Dimensions of barns:_____;_____;_____ Number of silos:____; Number of steel graineries and feed storage bins____.

25. If drainage tile has been installed in the last ten years, specify amount: [ ] none [ ] 1-4999 feet [ ] 5000-19999 feet [ ] 20000-49999 feet [ ] more than 50000 feet

26. Do you rent out any of your property or buildings:
[ ] yes [ ] no
If yes, [ ] house [ ] barn [ ] property (lot___; conc.___; acreage___)

27. Have fences been removed in the last 10 years to increase field size? [ ] yes [ ] no Estimate total length:____.

28. Total area cleared of woodlot, scrub or swamp in the last ten years:___.

29. Total area planted in trees in the last ten years:___.

30. Total acreage of: Productive woodlot___; non-productive woodlot___. Has timber been marketed in the last ten years? [ ] yes [ ] no

31. Do you consider any of the following conditions to be problems on your property?

	no	minor	moderate	major	solution
soil fertility					
stoniness					
excess moisture					
inadequate moisture					
topography (slope)					
soil structure					
erosion					

32. How many acres of your property are non-useable because of 1 or more of the above factors? (not including productive woodlot):_____

33. When you purchased your property, what was the going

rate/acre for the best quality agricultural land in this area?____ Would you mind reporting the price/ acre which you paid for your property?____

34. Do you practice:

contour plowing	[ ] yes	[ ] no
crop rotation	[ ] yes	[ ] no
summer fallow	[ ] yes	[ ] no
soil test	[ ] yes	[ ] no

35. Do you apply different amounts of fertilizer on some fields because of differences in natural fertility?
[ ] yes [ ] no

36. If the best land in the township is rated as number 1 for farming and land which is so poor that it cannot be used for farming is rated as number 7, how would you rate you property?_____

37. Would you mind giving an estimate of your yearly gross income derived from farming?_____
Contribution of agriculture to your total net income expressed as a percent:_____

38. Number of years of formal education:_____

39. Your age:____

APPENDIX IV

LISTING OF VARIABLES CODED FOR EACH FARM

1 Identification Number
2 Tenure Type
3 Age
4 Education
5 Marital Status
6 Family Farm
7 Township
8 Concession
9 Lot
10 Acrege owned
11 Parcels owned
12 Maximum period owned
13 Minimum period owned
14 Total assessed tax value
15 Assessed value per acre
16 Number of properties rented
17 Rented acreage
18 Rent paid per acre
19 Off-farm employment
20 Occupation
21 Number of days employed
22 Distance to work
23 Spouse employed
24 Spouse occupation
25 Number of days spouse employed
26 Distance to work
27 Retired
28 Enterprise type
29 Number full-time farm workers
30 Number full-time family
31 Number hired full-time
32 Number part-time farm workers
33 Number part-time family
34 Number weeks part-time family
35 Number part-time hired
36 Number weeks hired part-time
37 Presence of pigs
38 Number sows
39 Weiner pigs sold
40 Hogs-yearly production
41 % feed purchased (hogs)
42 Horses present
43 Number horses - commercial
44 Number horses - pets
45 % feed purchased (horses)
46 Dairy presence

47 Number dairy cows
48 Heifers for replacement
49 Calves vealed
50 Calves sold at market weight
51 % feed purchased (dairy)
52 Presence of poultry
53 Poultry - type
54 Poultry - significance
55 % feed purchased (poultry)
56 Beef - presence
57 Number beef cows
58 Number stockers sold
59 Market cattle - yearly production
60 % feed purchased (beef)
61 Sheep presence
62 Number ewes
63 Lambs - yearly production
64 % feed purchased (sheep)
65 Other - type
66 % feed purchased (other)
67 Cash cropping as a % of income
68 Number tractors owned
69 Number tractors 0-49 H.P.
70 Number tractors 50-99 H.P.
71 Number tractors 100-149 H.P.
72 Number tractors 150+ H.P.
73 Custom combining
74 Custom sow grain
76 Custom sow corn
77 Custom cut silage
78 Custom bale hay
79 Custom spray crops
80 Agricultural buildings present
81 Number silo/grainery present
82 New house
83 New silo/grainery
84 New storage facility
85 New barn
86 Amount drainage tile installed
87 House rented
88 Barn rented
89 Amount of fence removed
90 Land cleared - acreage
91 Trees planted - acreage
92 Timber marketed
93 Gross farm income
94 Agriculture as a % of income

The acreage and yield of the following crops grown on owned and rented land is stored for differing soil capabilities (Variables 95 - 226):

Grain corn
Ensilage corn
Wheat
Barley
Oats
Mixed grain
White beans
Soy beans
Hay
Improved pasture
Unimproved pasture
Woodlot
Scrub/ waste/ swamp
Summer fallow
Other
Unaccounted for
Rented out

Fertilizer application rates on class 6 land:

227 - grain corn
228 - mixed grain
229 - hay

Fertilizer application rates on class 1 land:

230 - grain corn
231 - mixed grain
232 - hay

233 Specialized buildings - hogs
234 Specialized buildings - dairy
235 Specialized buildings - beef
236 Specialized buildings - poultry
237 Number silos
238 Number graineries and bins
239 Problems with - soil fertility
240 - stones
241 - excess moisture
242 - inadequate moisture
243 - topography
244 - soil structure
245 - erosion

246 - non-useable acres
247 - non-useable acres (% of total)
248 Price of best farmland
249 Price of your farmland
250 Year purchased
251 Contour plowing
252 Crop rotation
253 Summer fallow
254 Soil test
255 Difference in fertilizer
256 Farm rating (scale of 1 - 7)

APPENDIX V

DEFINITIONS OF TENURE AND ENTERPRISE TYPES

Tenure

The following tenure types were identified, primarily on the basis of residence, gross farm income and the presence or absence of off farm employment.

1) Full-time farmers, in addition to being employed "full-time" as farmers, were required to have a gross farm income of at least $2,500 (or the equivalent in produce). Considering the seasonality of farming, however, it was determined that a farmer could work up to 20 days per year, off the farm, without affecting his full-time status.

2) Part-time farmers, with local jobs (Bunce, 1976), required a gross farm income of at least $2,500; however, they also received income from sources other than their own farms. The part-time farmers, with a local job, by definition, held their job at distances less than 3 miles from their place of residence (for example, custom work or machinery repair). Those individuals who considered themselves to be retired, and met the income guidelines, were considered to be part-time farmers with local jobs.

3) Part-time farmers, with non-local jobs (Bunce, 1976) held their non-farm jobs at distances greater than 3 miles from their places of residence, or worked in the town of Wingham or one of the major villages. They also required at least $2,500 worth of gross farm income.

4) A fourth tenure type is identified as residents, non-farm. This group includes those individuals residing in the study area who have no agricultural income other than from the rental of their property.

5) The resident, minor-farm type, consists of those people living in the township who have a very minor engagement in agriculture. In addition to income from the rental of their property, this group may have an agriculturally derived income of up to $2,500.

6) The sixth tenure type consists of non-resident landowners, who in addition to possibly renting their property, have no agricultural income.

7) Non-residents who have an agricultural income from their property are classified as non-resident, some farm. This group of non-residents carries on farming on a part-time basis, usually commuting on weekends from an urban center, where they have full-time employment. Included within this category are properties where a manager is employed by the non-resident landowner. This category does not include full-time and part-time farmers who live and farm in adjacent townships and also farm property within the study area.

Enterprise Type

Another variable requiring the careful establishment of an operational definition was enterprise type. The 1976 census assigned an individual farm to a given enterprise type if 51% or more of that farm's income was derived from that enterprise type. However, in this case, given the clarity of data, it was decided that 66% would be a more satisfactory delineation of enterprise type. Not only does this definition identify the more specialized agricultural operations, but it also reflects the more diverse elements of many farms as represented in the mixed enterprise categories. In all, the following enterprise types were identified: dairy; beef; hogs; poultry; sheep; cash crop; mixed general; rents land; no agricultural income and other. The first six of these enterprise types are self explanatory; however, the remaining types require further clarification. Mixed livestock indicates that 2 or more livestock types were required to account for 66% of a farmer's income. Similarily, mixed general indicates a mixture of cash crop and livestock. The rents land category implies that 66% of

an individual landowner's income was acquired from the rent of his property, whereas the no agricultural income category is indicative of those landowners who had no income either from the rent of their property or from the sale of produce. The final category, other, includes all those who did not fit into any of the previous categories. Generally, it identified those individuals with no major identifiable source of agricultural income, and several individuals with horses.

APPENDIX VI

Mean Values of Selected Variables Per Farm by Farm Type

	Farm Type		
	Class 1	Mixed	Class 6
Acreage Owned	168.4	205.4	177.0
Number of Sows	9.4	10.1	3.6
Yearly Production Hogs	172.1	154.9	95.3
Beef Cows	3.9	9.0	6.6
Yearly Production Cattle	29.4	37.4	24.0
Number of Stockers Sold	2.9	15.4	11.0
Dairy Cows	9.5	8.4	3.2
Number Full-time Workers	1.317	1.392	.871
Number Part-time Workers	.867	.961	.788

APPENDIX VI (cont'd)

Mean Values of Selected Variables Per Farm by Farm Type

	Grain Corn	Ensilage Corn	Mixed Grain	Wheat	Barley	Oats	White Beans	Soy Beans	Hay	Improved Pasture	Unimproved Pasture	Woodlot	Scrub Swamp	Summer Fallow	Other	Unaccounted For	Rented Out	Totals Owned & Rented Land
Class 1 Farms																		
Class 1 Land	34.6	16.0	17.4	.5	8.3	.3	3.0	.3	25.3	14.8	.3	16.8	6.6	1.4	4.5	7.4	9.2	166.7
Class 6 Land	–	–	–	–	–	–	–	–	–	.5	–	.2	.2	–	–	–	–	.9
Class Other Land	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rented Land	1.6	.4	1.1	–	–	–	–	–	.6	.4	–	–	–	–	–	–	–	4.1
Total	36.2	16.4	18.5	.5	8.3	.3	3.0	.3	25.9	15.7	.3	17.0	6.8	1.4	4.5	7.4	9.2	171.7
Mixed Class Farms																		
Class 1 Land	15.1	7.7	5.4	.5	7.1	–	–	–	15.7	9.3	.6	12.7	2.9	.6	1.3	11.0	3.4	93.3
Class 6 Land	14.1	5.9	7.4	.2	2.5	.3	–	–	15.4	14.8	1.2	14.1	3.6	–	2.2	.8	3.8	86.3
Class Other Land	1.6	1.8	1.4	.1	.1	–	–	–	2.4	5.5	.4	8.5	1.5	–	.1	1.4	.2	25.0
Rented Land	8.0	2.0	3.0	.5	1.3	–	–	–	2.1	5.9	.4	–	–	–	–	–	–	23.2
Total	38.8	17.4	17.2	1.3	11.0	.3	–	–	35.6	35.5	2.6	35.3	8.0	.6	3.6	13.2	7.4	227.8
Class 6 Farms																		
Class 1 Land	.4	.5	.7	–	–	–	–	–	.3	.3	–	.5	.8	–	.4	.00	1.0	4.9
Class 6 Land	19.4	9.2	10.5	.3	2.6	–	–	–	19.4	22.0	3.4	34.8	14.6	.4	2.6	.7	15.9	155.8
Class Other Land	.3	.2	.2	–	–	–	–	–	.05	.8	.2	3.9	.5	–	–	5.3	.00	11.45
Rented Land	2.0	.2	1.6	–	–	–	–	–	2.3	3.4	.3	–	–	–	–	–	–	9.8
Total	22.1	10.1	13.0	.3	2.6	–	–	–	22.1	26.5	3.9	39.2	15.9	.4	3.0	6.00	16.9	181.95

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