The Development of a Soil-Water Management Plan for the Subescarpment of the Turtle River Watershed Conservation District

by

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THE DEVELOPMENT OF A SOIL-WATER MANAGEMENT PLAN FOR THE SUBESCARPMENT OF THE TURTLE RIVER WATERSHED CONSERVATION DISTRICT

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ABSTRACT

The Manitoba escarpment is an area characterized by erosion and decreased agricultural productivity. The Turtle River Watershed Conservation District has the authority and responsibility to control and maintain the productive land base along the east side of Riding Mountain National Park. The subescarpment region of the Turtle River watershed is a unique region in terms of physiography, geology, and land use. The Turtle River Watershed Conservation District Board may develop and evaluate conservation techniques specifically for the subescarpment region.

The primary objective of this study is to evaluate the environmental effectiveness, social acceptance, and economic feasibility of various remedial soil-water management techniques for the subescarpment of the Turtle River watershed. Forty-three farmers in the subescarpment region were interviewed to obtain data concerning prevalent farming practices and attitudes. The environmental effectiveness of each soil conservation technique was determined through a literature search. Social acceptability and economic feasibility data regarding the techniques were analyzed by computer programs.

Upon analyzing the data, the various cultural practices could be listed, in descending order of their probability of

being incorporated into the subescarpment region, as follows:

1. minimum use of summerfallow;
2. adequate fertilizer application;
3. maximization of forages;
4. grassed waterways;
5. woody vegetation along streams;
6. shelterbelts;
7. cover crops;
8. contour tillage; and
9. zero tillage.

Many recommendations were directed at improving public awareness concerning the on-farm benefits of the various cultural practices. These recommendations were developed to stimulate erosion control in the subescarpment region of the Turtle River watershed.

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Chapter I

INTRODUCTION

1.1 PREAMBLE

The Turtle River Watershed Conservation District Board (T.R.W.C.D.B.) is concerned with the maintenance of a productive land base by controlling wind and water erosion. The Board also recognizes that the Turtle River watershed is contributing to the siltation problem of Dauphin Lake.

The siltation is being caused by erosion in the watershed and is leading to an increased turbidity load in Lake Dauphin (Manitoba Water Commission, 1973:6). The increased turbidity is leading to decreased fisheries production and increased algae growth (Manitoba Water Commission, 1973:6). These effects are consequently damaging recreational opportunities for local residents and tourists as well as the winter commercial fishing industry on Dauphin Lake (Penner, 1982:1).

The T.R.W.C.D.B. is presently developing a management plan that may solve these resource problems. This practicum presents guidelines that may be incorporated into a management plan for the subescarpment region of the Turtle River watershed (Figure 1).

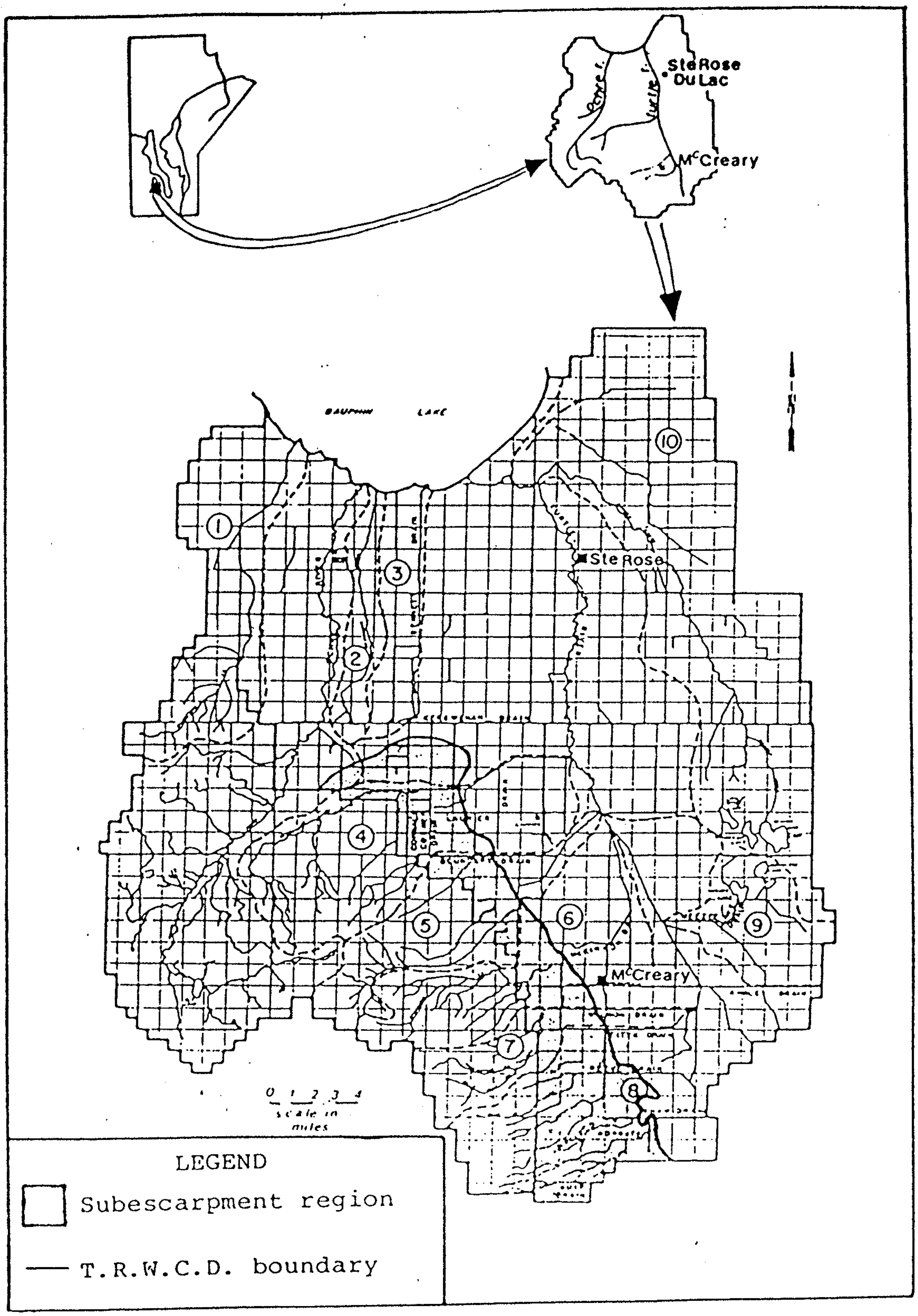


Figure 1
Location of subescarpment region

Source: Water Resources Branch (1979, Figures 1 and 6)

The T.R.W.C.D.B. has considered a variety of soil-water management techniques to alleviate soil erosion and increase agricultural productivity. To appropriately apply soil-water management techniques, the Board must recognize that the Turtle River watershed (T.R.w.) consists of areas with specific physiographic characteristics. The most appropriate techniques can then be integrated into a management plan for the subescarpment region.

Such a management plan must consist of agricultural techniques which are applicable in terms of environmental effectiveness, social acceptability, and economic feasibility to be useful to the individual farm operator and the public in general. This study evaluates these three feasibilities thus will be useful in the development of management plans for not only the T.R.W.C.D.B. but for other agencies that manage soil and water resources.

1.2 GLOSSARY OF TERMS AND LIST OF ABBREVIATIONS

Adequate fertilizer application- is a soil erosion control technique which employs the use of fertilizer to stimulate initial and subsequent growth of seedlings. This stimulated growth provides a healthy vegetative cover early in the cropping year which is essential to reduce runoff and thus erosion.

Escarpment region- is a narrow region of the Turtle River watershed ranging between 360 and 600 meters (1200 and 2000 ft.) above sea level (A.S.L.).

Lowland region- includes the area in the Turtle River watershed below the 300 meter (1000 ft.) A.S.L. contour.

Protected area- refers to an area that has been designated to be managed primarily for its beneficial effects for resource conservation.

Returns to all labor and management- is an indication of the returns to the farm operator's labor and management, assuming that the farm operator supplied all the labor required in the operation of the enterprise (Longmuir _et_ _al_., 1978:34). The term indicates the returns to an enterprise assuming all labor and management costs are zero. Stated another way, the term indicates the returns when all costs except labor and management are considered.

Subescarpment region- is a physiographic region of the Turtle River watershed that is located between the 300 meter and 360 meter (1000 and 1200 ft.) contours (A.S.L.). In this study, the subescarpment will be defined as the transition zone between the escarpment and lowland regions encompassing land from the 1000 foot (300 m) (A.S.L.) contour interval, west to the eastern boundary of Riding Mountain National Park (Figure 1). The subescarpment region is the study area.

S.A.S.- refers to Statistical Analysis System, a computer software system for data analysis.

Soil-water management plan- is a program of action involving recommendations to decrease erosion and increase agricultural productivity. This plan will incorporate a variety of soil-water management techniques.

Soil-water management techniques- are methods of accomplishing a reduction in soil and water related problems such as erosion and sedimentation. These techniques will be analyzed as to their environmental effectiveness, social acceptability, and economic feasibility.

T.R.W.C.D.B. or Board- refers to the Turtle River Watershed Conservation District Board.

T.R.w.- refers to the Turtle River watershed.

1.3 PROBLEM STATEMENT

Carlyle (1980:255) notes that the Manitoba escarpment is an area comprised of severe environmental problems caused by a combination of adverse physical characteristics and inappropriate land use. One such environmental problem, soil erosion, is evident on the slopes of Riding Mountain National Park (Carlyle, 1980:261). Conservation practices intended to reduce water erosion depend largely upon agricultural land use (Water Resources Division, 1977:14).

Most agricultural development in the T.R.W.C.D. has occurred in the lowland region, but in the last 30 years there has been an encroachment into the subescarpment and parts of the escarpment region (Water Resources Branch, 1979:3). The predominant steep slope and sandy-loam soil make this region highly vulnerable to erosion when land is cleared or cultivated improperly.

Proper soil-water management techniques can reduce soil erosion and consequently improve agricultural productivity if appropriately applied to the physiographic characteristics of the land. The T.R.W.C.D.B. may have to recommend different techniques for the subescarpment than for adjacent regions because of the unique combination of slope, soil, and geology in the subescarpment.

With the encroachment of agriculture into the subescarpment there is a need to analyze management techniques in terms of environmental effectiveness, social acceptance, and economic feasibility.

It should be noted, however, that the subescarpment is not the only area of soil erosion or decreased agricultural productivity. Both the escarpment region and the lowland region represent other areas requiring erosion control implementations. More emphasis will be placed on the subescarpment region, however, because of its unique physiographic characteristics.

1.4 RESEARCH OBJECTIVES

The primary purpose of this research is to evaluate the environmental effectiveness, social acceptability, and economic feasibility of soil-water management techniques in the subescarpment of the Turtle River watershed. The results of the evaluation may then be integrated into a district management plan. Specific objectives of this study are:

1. to describe and assess the nature and extent of soil-water management problems in the subescarpment;

2. to evaluate remedial agricultural techniques in terms of their environmental effectiveness, social acceptance, and economic feasibility; and

3. to incorporate these remedial measures into a set of management guidelines to be used in the development of a management plan for the subescarpment of the Turtle River watershed.

1.5 METHODS

A review of related literature (Chapter II) provides a thorough understanding of the processes of erosion and a detailed description of the techniques effective in reducing erosion.

The parameters of major soil-water management problems in the subescarpment were determined by means of a resource inventory and are presented in Chapter IV. A subunit map, depicting areas with similar physiographic characteristics of slope and agriculture capability, was developed. Information related to land use and soil-water management techniques, that are potentially useful to alleviate erosion, was obtained. Geologic and demographic data were gathered and interpreted regarding their impact and influence on the study. Areas affected by soil erosion were identified by air-photo interpretation and ground truthing and were demarcated on a map. A literature search was performed to obtain information regarding effects and influences of specific soil-water management techniques.

Environmental and socio-economic feasibility analyses concerning the potential soil-water management techniques and general attitudes to conservation were performed. Social and economic data were gathered by personal interviews with private landowners.

Social data were interpreted by a S.A.S. program. Economic data were analyzed by a Budgetary Crop Simulator program (computer program). This model represents an efficient vehicle for providing economic indicators of specific farm enterprise operations.

Specific soil-water management techniques were then recommended (Chapter VI) to stimulate the development of projects and incentive programs that may reduce erosion and increase agricultural productivity. Further research areas arising from this study are also presented in Chapter VI.

1.6 DELIMITATIONS

The author assumes that the placement of farm units from subunit three to subunit two will not adversely affect the data analysis.

Treatment of sheet and wind erosion are superficial because of the inherent difficulties of problem identification. Major soil-water management problems are primarily focused upon rill and gully erosion. Despite this emphasis on the erosion aspects of soil-water management, other water and land related concerns have been dealt with to some extent.

Zero tillage was not practiced in the study area, thus economic data concerning this practice were extracted from external (outside the study area) sources.

Chapter II

REVIEW OF RELATED LITERATURE

Literature concerning erosion has expanded considerably in the last decade. The growing concern for erosion control and the presently increasing awareness of the limited land resource base is the probable cause for the extensive literature.

The understanding of erosion problems and processes garnered by a thorough literature review is essential to apply proper soil-water management techniques to specific areas and situations.

2.1 SOIL EROSION PROBLEMS

Soil erosion occurs primarily by the action of wind and water on inadequately protected soil surfaces (P.F.R.A., 1982:45). The direct or on-site damages associated with soil erosion include loss of valuable topsoil; organic degradation; loss of soil structure and plant nutrients; reduced yield potential and crop quality; and clogged drains, outlets and channels (Soil Conservation Committee, 1980).

Soil deterioration is occurring as a result of intensive tillage, resulting in the loss of organic matter (Coote *et al.*, 1981:vi). Coote *et al.* (1981:vi) also state that excessive summerfallow seems to be the chief cause of soil fertility loss and structure deterioration. The Soil Conservation Committee (1980) concludes that soil erosion from agricultural land is associated with inadequate cropping systems and soil management techniques (such as summerfallow) which often are not synonymous with soil conservation.

The United States has responded to the problem of soil erosion through an intensive program of farm conservation planning which has been underway for 40 years (P.F.R.A., 1982:45). In Canada, however, soil erosion has not been as well recognized by researchers and farmers (Agricultural Institute of Canada, 1980 in P.F.R.A., 1982:45). Most provinces have extensive areas affected by erosion (Coote, 1980:12). In Manitoba, approximately 1.8 million hectares (4.5 million acres) of land are subject to wind and water erosion (Slevinsky, 1984:1). The Soil Conservation Committee (1980) states that, in Manitoba, the most severe erosion occurred on the rolling topography of the subescarpment.

There is an apparent agreement in the literature that soil erosion is a problem in Manitoba (subescarpment areas) and Canada as well as the United States. The understanding of the individual processes of erosion is necessary to identify problem parameters.

Soil erosion by wind can occur when soil is dry, finely aggregated, loose and unvegetated (Soil Conservation Committee, 1980). The P.F.R.A. (1982:54) states that wind erosion is not uniform on uneven topography (such as in the subescarpment of the T.R.W.C.D.). Although of some significance, wind erosion does not appear to be a major problem in the subescarpment of the T.R.W.C.D. (Water Resources Branch, 1979:27).

Erosion by water is widespread and is a frequently recognized manifestation of soil degradation (Coote et al., 1981:6). The primary factors determining the extent, rate, and type of soil erosion by water can be categorized into three broad groups.

2.1.1 Soil Susceptibility

Coote et al. (1981:6) define soil susceptibility as the soil's resistance to disaggregation by raindrops. Smith and Wishmeir (1962) in P.F.R.A. (1982:57) state that soil susceptibility is governed by soil characteristics such as infiltration, permeability, and texture. Soils in the subescarpment region vary in texture from sandy loam to silty clay thus allow for good drainage (Water Resources Branch, 1979:9). The intense rainfall in the subescarpment often exceeds the infiltration rate however, thus resulting in runoff (P.F.R.A., 1982:57). In general, soil high in silt (much like the T.R.W. subescarpment soils) is very erodible (Wischemeier and Mannering, 1969 in P.F.R.A., 1982:57). The resistance of soil to detachment and transport by water is greatly influenced by slope steepness, length, and configuration.

2.1.2 Slope Steepness, Length and Configuration

The subescarpment region of the T.R.w. is characterized by numerous alluvial fans and well defined stream channels at moderate gradients (Water Resources Branch, 1979:9). Sheet, rill, and gully erosion are soil erosion processes that represent a very serious detriment to the maintenance of soil fertility and productivity (Seecharan, 1980:19). Such erosion is evident on rolling topography where slope steepness, length, and configuration play an important role. Doug Kozusko (Personal Communication, 1982) states that rill and gully erosion are evident in the T.R.W.C.D. subescarpment region. Land use also influences soil erosion.

2.1.3 Land Use

Inappropriate land use practices on the Manitoba escarpment and subescarpment have exacerbated soil erosion problems (Carlyle, 1980:257). Agricultural development has encroached into the subescarpment and parts of the escarpment regions of the T.R.W.C.D. (Water Resources Branch, 1979:10).

Land clearing on slopes causes increased erosion and flooding (Manitoba Department of Mines, Natural Resources and Environment (M.D.M.N.R. and E.), no date). Increased clearing promotes an increase in loss of vegetative cover and residue and an increase in the frozen layers of the soil profile, which in turn increases soil susceptibility to erosion (Coote *et al*., 1981:6). The erosion and flooding induce farmers to clear more land (M.D.M.N.R. and E., no date). The cyclical process can be altered via the implementation of appropriate conservation programs and soil-water management techniques (M.D.M.N.R. and E., no date).

2.2 SOIL-WATER MANAGEMENT TECHNIQUES

The major inputs required to prevent or reduce soil erosion are proper land use and appropriate cultural techniques (Manitoba Institute of Agrologists, 1980:45). Specific techniques will be dealt with individually with regard to their characteristics and environmental effectiveness. One cultural technique that may be useful to reduce erosion is the elimination of bare summerfallow.

2.2.1 Elimination of Bare Summerfallow

The Manitoba Department of Mines, Resources and Environmental Management (M.D.M.R. and E.M.), (1974:13) states that reduced summerfallow reduces water eroding effects while decreasing the rate of decomposition of soil organic matter. Eliminating summerfallow also decreases the accumulation of salts at or near the soil surface (M.D.M.R.and E.M., 1974:21).

Many types of conservation tillage farming systems, including zero tillage and minimum tillage, retain mulch that can reduce erosion and consequently increase agricultural productivity (Unger and McCalla, 1980 in P.F.R.A., 1982:59). Seecharan (1980:49) states that fallowing enhances the breakdown of organic matter and the conversion of organic nitrogen to nitrate which can be used by plants. Repeated fallowing, however, will deplete the organic matter content to a level where, even after fallowing, nitrogen supplies are inadequate to meet the needs of the crop thus resulting in reduced yields (Seecharan, 1980:49).

Where summerfallowing is necessary, soils should be tilled shallowly and as infrequently as possible because tillage brings salts to the surface (M.D.M.R. and E.M., 1977:21).

Although conservation tillage reduces soil erosion and increases water infiltration, a higher level of management skill is required as compared to conventional tillage because tillage equipment adjustment and weed control are more difficult (P.F.R.A., 1982:60).

Reduction of summerfallowing to coincide with increased fertilizer usage is often recommended (Seecharan, 1980:49).

2.2.2 Adequate Fertilizer Application

The use of fertilizers involves a high cash outlay but the returns in terms of benefits from the increased crop yields compensate for the additional cost (Seecharan, 1980:49).

The Manitoba Institute of Agrologists (1980:45) states that a significant proportion of high intensity rainfall in Manitoba occurs early in the growing season. Fertilizers permit an early establishment of vegetation in the spring which retards erosion and reduces runoff during a critical period. The Manitoba Institute of Agrologists (1980:45) notes that, fertilizer application, in addition to large increases in yield, reduced runoff by 90% and reduced soil losses by more than 90% during a three-year test on oats in Manitoba. On wheat plots the runoff was reduced by 15% and soil loss by 40% (Manitoba Institute of Agrologists, 1980:45).

Other cultural practices that may be incorporated into most farm operations are cover crops and strip cropping.

2.2.3 Cover Crops and Strip Cropping

Cover crops add fibre and improve the physical condition of the soil while protecting the soil from erosion (P.F.R.A., 1982:16). The M.D.M.R. and E.M. (1977:59) and the P.F.R.A. (1982:61) state that fall rye or spring grains seeded into erodible soils during August or September reduce both wind and water erosion. Seecharan (1980:79) notes that retention of crop residues serves to reduce runoff and water erosion.

The M.D.M.R. and E.M. (1977:17) notes that strip cropping is the process of retaining strips of wind-resistant crop, arranged at right angles to prevailing winds, to reduce wind velocity at the soil surface and the distance travelled by wind across exposed soil. Strip cropping is very useful on sloping lands to prevent water and wind erosion while increasing water infiltration (P.F.R.A., 1982:61).

Two cultural practices that may be as useful (as cover crops and strip cropping) on sloping lands are contour farming and terracing.

2.2.4 Contour Farming and Terracing

Seecharan (1980:82) recommends that tilling of the soil across slopes (contour farming) and especially in strips (strip cropping) should be encouraged to reduce erosion on sloping land. Contour farming is a simple technique requiring only a little extra time from the farmer while often resulting in increased yields.

Terraces are effective erosion controls but are expensive to construct, require maintenance, and have a limited life expectancy (Mitchell, 1980 in P.F.R.A., 1982:62). P.F.R.A. (1982:62) states that terraces have a limited application on steeply sloping silty soils such as the Pembina escarpment and Riding Mountain subescarpment in Manitoba.

Another soil-water management technique that may be important in the development of a soil-water management plan is grassed waterways.

2.2.5 Grassed Waterways

Grassed waterways are broad, shallow grass-lined channels designed to conduct runoff away from farmland while resulting in minimal erosion (P.F.R.A., 1982:62). The M.D.M.R. and E.M. (1977:13) states that grass or other vegetation reduces the velocity of water thus inhibiting the effectiveness of erosive power and ultimately preventing gully formation. The Manitoba Institute of Agrologists (1980:44) recommends that the burning of vegetation in waterways should be discouraged.

Another erosion control technique that maintains a vegetative cover on the land is the use of forages.

2.2.6 Maximum Use of Forages

Good vegetative cover such as forage on the land is the most permanent and effective way to control wind erosion (Agricultural Research Service, 1972:4). The M.D.M.N.R. and E. (no date) notes that the establishment of forage crops not only deters soil erosion but also enhances productivity of the land. Forage crops planted in rotation with other crops will help to improve soil structure (Upper Thames River Conservation Authority, Spring 1981). P.F.R.A. (1982:78) notes that the inclusion of annual or perennial forages in the cropping sequence is one activity that will maintain the indigenous and active pool of organic matter content at as high a level as economically and practically feasible.

P.F.R.A. (1982:79) states that for significant benefits to soil tilth, organic matter, and reduced nitrogen fertilizer requirements, a rotation involving one-third of the farm in forage-cropped for six years is usually required. Although this type of rotation technology offers excellent erosion control and increased agricultural productivity, it is seldom economically feasible unless a farmer is engaged in a livestock enterprise (P.F.R.A., 1982:79).

A common technique which also offers excellent erosion control and increased agriculture productivity is the maintenance of windbreaks.

2.2.7 Windbreaks

The most common wind barrier is shelterbelts, which consist of plantings of trees and shrubs (Agricultural Research Service, 1972:13).

Windbreaks help to reduce wind erosion by lowering the windspeed to their leeward side and by reducing field width. (P.F.R.A., 1982:62). Windbreaks reduce soil erosion and stress to crops and have been shown to increase crop yields (Upper Thames River Conservation Authority, Fall 1981). Vegetative wind barriers such as shelterbelts are designed to reduce the force of the wind in specific locations and in doing so often provide the following:

1. erosion control by decreasing the velocity of the wind at field level;
2. improved crop yield and quality;

3. catchment of snow to reduce drifting problems; and

4. aesthetic value. (Ontario Ministry of Natural Resources, no date:24).

The P.F.R.A. (1982:62) notes that the effectiveness of these barriers is influenced by the wind velocity and direction as well as the shape, height, width, and porosity of the windbreak. The close spacing required and the variability in wind direction necessitates many fields to be surrounded by barriers. This method of erosion control is consequently quite objectionable where large equipment is used.

2.2.8 Woody Vegetation Along Watercourses

Vegetation offsets the effects of topography and soil on water erosion by absorbing the impact of rainfall and reducing the velocity of runoff (P.F.R.A., 1982:58). Vegetative strips along a drain or watercourse have the following advantages:

1. they serve as effective filters of sediment and nutrients;

2. they decrease the velocity of water, helping to prevent rill and gully erosion; and

3. they prevent cultivation up to the edge of the stream bank, a practice which weakens the top of the bank and contributes to bank failure (Ontario Ministry of Natural Resources, 1982:6). The last advantage is especially pronounced if the vegetative buffer zone is woody in nature.

Buffer strips are narrow bands of vegetated land adjacent to a watercourse (Upper Thames River Conservation Authority, Fall 1981:1). If the buffer strip is higher than the adjacent areas, it will act as a barrier offering resistance and slowing the force of water which helps to settle out some of the sediment before it reaches the stream or ditch (Upper Thames River Conservation Authority, Fall 1981:1). A well-vegetated buffer strip (especially when composed of woody vegetation) will protect ditch and steam banks from slumping or eroding thus preventing the formation of gullies.

The development of woody vegetation and controlled cattle access were two soil erosion control methods used successfully to stabilize the banks along the Thorndale watercourse (Upper Thames River Conservation Authority, Spring 1983:4). This stream bank stabilization was part of a demonstration program to promote and illustrate acceptable means of controlling erosion and sedimentation along watercourses in the Thames River Basin (Upper Thames River Conservation Authority, Spring 1983:4).

Many other erosion control measures are available to the farmer but will not be discussed in detail. Some other erosion control measures are as follows:

1. waterway gradient control structures;
2. land acquisition and conversion programs;
3. limited grazing;
4. establishing "protected areas"; and
5. block tree planting.

The soil-water management techniques discussed above will be regarded as environmentally effective because of general agreements in the literature concerning their favorable characteristics, environmental impact, and applicability. As these techniques are environmentally effective, they will be considered to be technically sound in terms of reducing the physical impact of erosion.

Social and economic parameter determination will, however, require a greater degree of data originality because they are more prone to change from area to area and time to time.

2.3 SOCIAL ACCEPTABILITY OF SOIL-WATER MANAGEMENT TECHNIQUES

The Soil Conservation Committee (1980) notes that, while most of the technology to reduce soil loss is known, social and political obstacles are recognized as the major problems of erosion control methods. Because soil nutrient and organic matter losses and associated soil structure deterioration are often not highly visible processes, assessing current awareness of existing and potential soil erosion problems within the agricultural community is very important (Soil Conservation Committee, 1980).

Christensen and Norris (1983:15) note that the adoption of proper management practices by farmers has been hampered by differences in attitudes between public officials and farmers concerning what factors influence decisions. Christensen and Norris (1983:15) also note that personal values and beliefs, neighborhood and social pressures, and traditions all have an important effect on a farmer's decision to adopt specific conservation practices. Christensen and Norris (1983:17) list other factors that influence farmer attitudes:

1. personal characteristics such as age, number of years on current farm, education, and farming experience;

2. institutional characteristics such as the size of farm, type of farm, and land tenure characteristics;

3. physical characteristics of the farm such as land topography, amount of soil erosion, and practices currently used; and

4. economic characteristics such as economic earning, technical and financial assistance, perceived and real profitablity of practices.

These characteristics should be determined when evaluating social acceptance because of their importance in identifying perception differences.

Many farmers hesitate to admit that there is any relationship between their land and the erosion problem, even though they admit that erosion is a problem. Other farmers may be hesitant to recognize erosion problems thus do not install appropriate ameliorative measures (Christensen et al., 1983:15). Perceptions of risk related to income levels and farm yields, effectiveness, costs, benefits and need for soil-water management techniques will greatly influence a farmer's choice of a practice. Christensen and Norris (1983:16) state that these differing perceptions can be attributed to information about and experience with individual techniques and practices.

Different studies have produced different results regarding the farmer's attitude toward the best soil-water management technique (Christensen and Norris, 1983:16). Most of these studies utilized farmer questionnaires.

P.F.R.A. (1982:114) notes that there is an urgent need to develop effective means of transferring soil conservation technology to individual farmers and conservation groups. The P.F.R.A. (1982:115) also notes that the provision of financial and material assistance for individual farmers to implement specific approved conservation practices over a period of time is required. One way to encourage such government programs is to illustrate the economic feasibility of certain soil-water management techniques.

2.4 ECONOMIC FEASIBILITY OF SOIL-WATER MANAGEMENT TECHNIQUES

Soil deterioration is, to a large extent, a reflection of the economics of agriculture. Farmers are often forced to watch their land deteriorate because of economic pressures and limitations (Simpson-Lewis *et al.*, 1983:253). The Planning Branch of the Treasury Board Secretariat (1982:10) notes that recommendations of soil-water management techniques should be based on the general ability of crops and forages to maximize long-term farm incomes while meeting conservation needs. The M.D.M.R. and E.M. (1977:38) defines a viable farm as one that has sufficient resources to give the operator a reasonable return for his investment and labor. The M.D.M.R. and E.M. (1977:38) also states that an important criterion in determining whether a farm is viable is the management ability of the operator which is almost impossible to measure.

Operator age is a very important indicator because, for an older operator, resource production can decline for the following reasons:

1. the less efficient manner in which resources are combined; and

2. the decrease in productivity of labor (M.D.M.R. and E.M., 1977:38).

The M.D.M.R. and E.M. (1977:77) also states that the older farmer will tolerate a lower income (and save for retirement) to avoid the additional debt and uncertainty required to improve or expand his farm.

The M.D.M.R. and E.M. (1977:38) further notes that the identification of uneconomical farm units is useful because farms below the poverty level do not have the capital to use their resources most effectively. This is apparent because the areas with the greatest concentration of small farms also have the greatest poverty and erosion problems (M.D.M.R. and E.M., 1977:39). If a farm unit yields a net return of less than $3,750.00 (national poverty level), it is considered not economically viable (M.D.M.R. and E.M., 1974:38). The M.D.M.R. and E.M. (1977:39) has determined that the minimum farm size required to provide a net of $3,750.00 is between 85 hectares (210 acres) and 154 hectares (380 acres). Ideally a pure grain farm should be at least 202 hectares (500 acres), a mixed farm should be 146 hectares (360 acres), and a livestock farm should be 162 hectares (400 acres) (M.D.M.R. and E.M., 1977:39).

In the development of any management plan the primary objective usually is optimal resource usage. The objective of optimal resource usage is to maximize the difference between benefits and costs (Krueger and Mitchell, 1977:16). P.F.R.A. (1982:97) states that comparisons of revenues and costs indicate optimal production practices. One such method of determining or comparing revenues and costs is by using a benefit-cost analysis (Planning Branch of the Treasury Board Secretariat, 1982:1).

According to the P.F.R.A. (1982:49) the total cost of erosion consists of:

1. the cost of increased technological inputs;
2. increased power requirements; and
3. 15 percent loss (average) in potential yields that cannot be recovered by technological inputs.

The P.F.R.A. (1982:101) lists several costs, associated with the implementation of soil-water management techniques:

1. public costs such as research, extension services, capital projects, grants, and administration;

2. the benefits foregone that may have been realized if money was spent elsewhere;

3. short-term reductions in production; and

4. private costs of adopting conservation practices.

The P.F.R.A. (1982:101) lumps benefits into the following four large groups: decreased soil salinity; decreased erosion; increase in available plant nitrogen; and consequent increase in production.

Seecharan (1980:58) states that benefits from conservation practices can result not only in increased crop yields but also increased incomes. He (1980:58) also notes that, by reorganization of resources, a profit-maximizing farm could increase average farm net revenue by 18 percent from pre-development conditions.

Based on this fact, effective farm planning and farm management research necessitates the development of individual enterprise or on-farm analysis (Longmuir _et_ _al_., 1978:i). Such analyses usually involve one of two processes:

1. detailed documentation and receipts of records; or

2. average price and cost information together with physical input requirements.

Because both processes are very time consuming, computer programs have been developed to facilitate data processing and analysis (Longmuir et al., 1978:i).

Various computer programs have been developed to simulate cropping enterprises with given inputs. These programs provide economic indicators of specific cropping systems.

One such computerized simulation model, SOILEC (SOIL conservation EConomics), simulates the soil loss and economic outcomes over a one-year (short-term) or a 50-year (long-term) planning horizon (Elevard et al., 1983:387). The model is quite complex in that it produces a present net value figure (in terms of net income) for a specific management system. In doing so, it incorporates user-specified discounting rates, inflation, management variables, technology parameters (of the management systems), site characteristics, and other economic information (Elevard et al., 1983:388). The detailed data requirements restrict the applicability and practicality of this program but the program has proven useful to the policy-making clientele.

One model, indigenous to the University of Manitoba, is called the Budgetary Crop Production Simulator. The model was developed by the Department of Agricultural Economics and Farm Management to assist the farm manager in determining the cost/benefit ratio of alternative cropping patterns or machinery investments (Longmuir et al., 1978:1). This Budgetary Crop Production Simulation program enables farm managers and policy makers to determine the costs and benefits of alternative cropping patterns (Longmuir et al., 1978:3).

2.5 INTEGRATION OF MANAGEMENT PLAN COMPONENTS

The resources of people, land, and water are so interrelated that the manipulation of any one directly or indirectly affects another (M.D.M.R. and E.M., 1977:10). Proper planning of soil use and land management are so interrelated as to be inseparable (Runka, 1980:20). For improved soil conservation at the farm level there is a need to document socio-economic aspects of soil erosion control measures (Soil Conservation Committee, 1980:28).

A multi-disciplinary resource study investigating the physical and socio-economic base of the Whitemud Watershed Conservation District incorporated the following three phases:

1. comprehensive inventory of the resource problems;
2. concentration on specific problems and definition of alternative solutions; and
3. preparation a development plan to optimize the social and economic benefits to the watershed public (M.D.M.R. and E.M., 1974:22).

A detailed management plan will involve specific farm recommendations as each farm must apply specific soil-water management techniques differently (P.F.R.A., no date). For this reason, broad generalizations suitable for the entire T.R.w. subescarpment will be given.

Many studies have been done on soil erosion, yet there is an apparent lack of information on the appropriate application of remedial soil-water management techniques within escarpment and subescarpment regions.

Several observations may be noted as follows:

1. literature on soil erosion is extensive;

2. a need exists to analyze social acceptance and economic feasibility of specific soil-water management techniques;

3. the technology concerning ameliorative soil-water management techniques exists. The literature provides thorough information concerning the environmental effectiveness of specific soil-water management techniques, thus a literature review provides adequate data concerning environmental implications of each technique;

4. sociological and demographic data concerning soil erosion vary from area to area and need to be identified via farm surveys. For this reason field research entailing the completion of questionnaires by individual farm operators is essential to provide the necessary data;

5. economic data on soil erosion are complex. Economic feasibility is thus simplified by concentrating on an on-farm analysis. Many economic feasibility studies have been based on small units. This study evaluates economic consid-

erations for the entire subescarpment. This generalization is apparently more useful for management plans. The Budgetary Crop Simulator program developed by the University of Manitoba will adequately provide economic indicators of various farming enterprise systems; and

6. a need remains to further document the extent and degree of soil erosion problems (Soil Conservation Committee, 1980:28).

Chapter III

METHODS

3.1 RESOURCE INVENTORY

The first phase of the study involved a resource description and analysis of the study area. A subunit map, depicting areas with similar physiographic characteristics of slope and agricultural capability, was developed and is presented in Chapter IV. Three subunits were delineated. Farmers were classed, according to the location of the majority of their land, as belonging to one of the three subunits. Subunit one had 21 farmers, two had 18 farmers and three had 4 farmers. Farmers in subunit three will be categorized with those in two because:

1. subunit three is too poorly represented to be analyzed properly;
2. analysis of the remaining subunits will be facilitated, as both now have almost equal numbers; and
3. those farmers in subunit three had much of their land in subunit two.

Information concerning present and past characteristics of land use and demographic variables was obtained. Trends were noted and possible implications examined.

Geologic data pertinent to the study area were obtained from literary sources.

Panchromatic air photos (1981, scale=1:15,840) of the study area were interpreted, and evident soil erosion areas were mapped. As sheet erosion is very difficult to distinguish on panchromatic air photos at this scale, evidences of rill and gully erosion were the only physical detriments interpreted. Ground inspection was performed to illustrate present parameters of soil-water management problems.

The resource inventory, presented in Chapter IV, provides the necessary information to define and describe the major soil-water management problems within the subescarpment of the Turtle River watershed. Information regarding the environmental effectiveness of different soil-water management techniques may be found in Chapter II. Data concerning the social acceptability and economic implications of possible ameliorative techniques were obtained through questionnaires.

3.2 DATA COLLECTION

3.2.1 Sampling the Population

The population sampled was the farming sector of the subescarpment of the Turtle River watershed. Prior to contacting the specific farm operators, an introductory letter and accompanying map (Appendix A) were mailed out to all residents in the study area. Residents were then contacted in person and, if possible, an interview occurred at that time or was scheduled for some future date.

The study area is occupied by 130 farmers, 15 (12%) of which owned small holdings (50 acres or less) thus were not included in the sample population. Attempts were made to contact the 115 remaining farmers but 23 (20%) could not be contacted or located. Thirty-three (36%) of the 92 contacted farm operators could not be interviewed because they were too busy.

Forty-three questionnaires were completed. Several interviews consisted of double or triple interviews where the opinions and farming practices of 2 or 3 farmers were incorporated in one questionnaire. In summary then, 43 (37%) completed questionnaires represent 59 (51%) opinions and farm practices of a possible 115 farms.

3.2.2 Interview Questionnaire

Questionnaires are usually postal surveys which are mailed out to a very large sample size (Berdie and Anderson, 1974:18). Some of the advantages of postal questionnaires over interviews are:

1. establishing contact when people are not home;
2. larger numbers of people can be contacted;
3. respondents can take as long as they want to answer the questions;

4. less bias in that the respondent has no desire to please the interviewer; and

5. there is uniform question presentation (Berdie and Anderson, 1974:19).

Some of the advantages of interviews over questionnaires are the following:

1. reliability and validity of respondent identification are not questionable;

2. better response rate compared to postal questionnaries;

3. interviewer can describe and explain questions when necessary; and

4. interviews are more personal (Berdie and Anderson, 1974:19).

The author has chosen a variation of the two techniques to extract the benefits of both while foregoing many disadvantages.

The questionnaire (Appendix B) was read to the respondent in a stuctured interview. When a question was not understood, it was explained and clarified. Responses to this type of interview are recorded exactly as stated.

3.3 DATA PROCESSING AND ANALYSIS

3.3.1 Social Data

Social data, pages 1 through 5 of the questionnaire, were incorporated into S.A.S. programs to obtain information concerning:

1. present soil erosion control methods utilized;

2. which, if any, demographic and personal variables influence whether certain soil-water management techniques are implemented;

3. whether the farmer's perception of his neighbors' opinions influences the farmer's practices;

4. which conservation techniques the farmers would use if specific incentives were provided; and

5. awareness and participation of government assistance programs.

These data were used to determine which factors influenced farmers' practices and attitudes. The social data were examined for the whole population and for each subunit to determine if any trends or relationships were evident.

3.3.2 Economic Data

Pages 6 through 32 of the questionnaire provide the necessary data required for the Budgetary Crop Simulator program developed by the Department of Agricultural Economics, University of Manitoba. The model summarized in Figure 2 is the basis for this computer program.

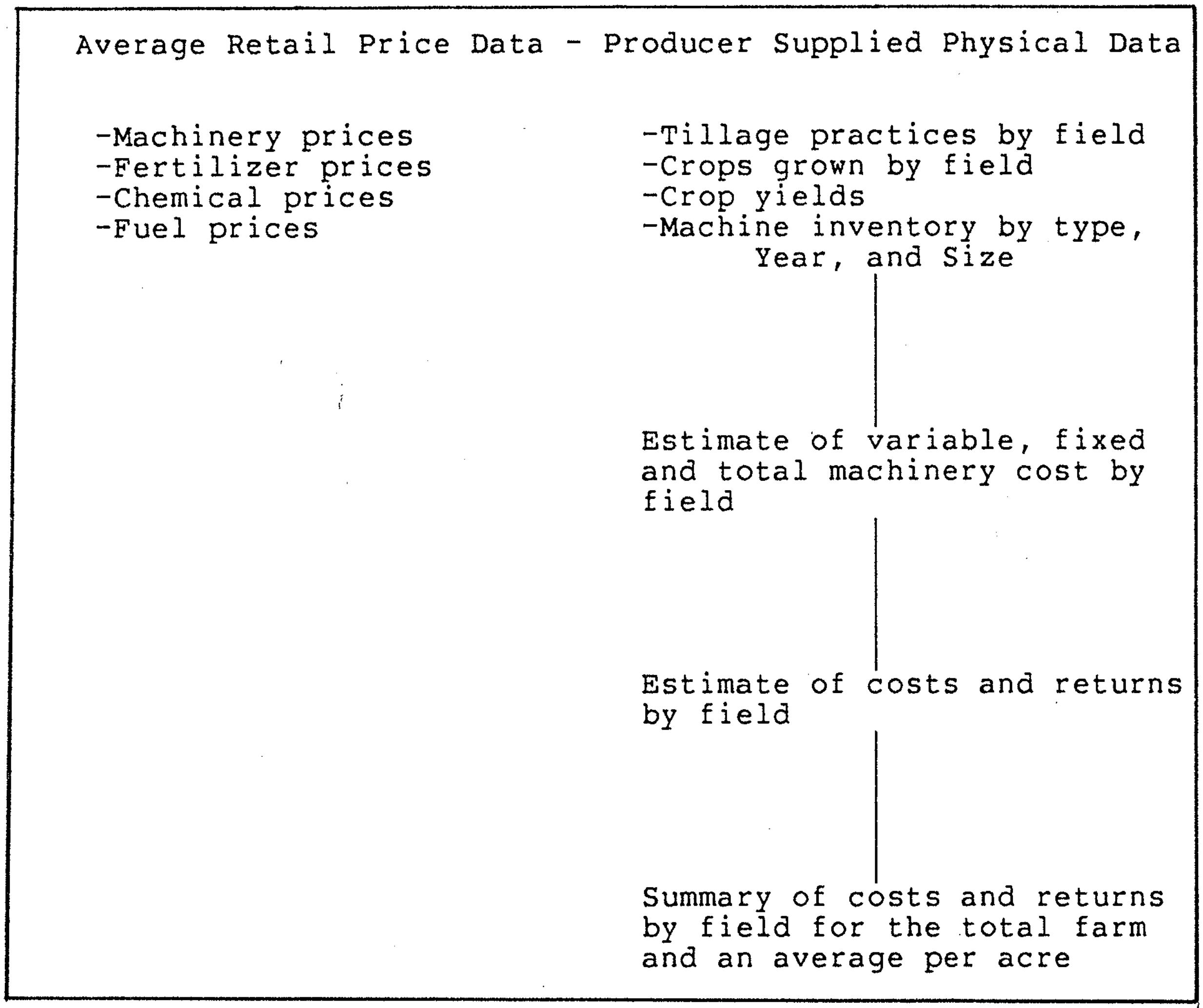


Figure 2

Illustrative description of data processing flow chart in budget simulation

Source: Longmuir et al. (1978:4)

The model is designed to compute the total costs (both fixed and variable) and the gross returns of particular farming enterprises, thereby determining associated net returns. The cost estimates are derived from the machinery inventory, the land inventory, the specific management and cultural practices, and the price data associated with a particular year of production (Longmuir et al., 1978:47).

The expected or given value of yield return for that year produces a value of gross returns. An example output of the Budgetary Crop Simulator program is given in Appendix C. As may be noted in Appendix C, a total cost/benefit summary and a total cost breakdown per acre and per field are generated. Variations in inputs simulate different farm enterprises. With each variance in input is a corresponding change in output. This model provides a tool to analyze the economic implications of various adjustments in cropping practices. Economic data were based on 1982 farming practices, yields, and prices. Data from the 43 interviews were entered, and budgetary summaries were produced.

The economic indicator subsequently used in this study was the average of net returns accruing to farm operator labor and management. This is calculated by subtracting operating costs, depreciation, and returns to investment from gross returns. Rea Josephson (Personal Communication, 1983) notes that the value given by this average represents the most appropriate indicator of the long-run economic feasibility of a specific farming enterprise.

The analysis of the economic indicators first involved the classification of farms according to dominant cultural practices used. Farming enterprises were grouped as follows:

1. Forage farms if approximately 30% of total productive agricultural land was in forage;

2. Minimum-fallow farms if approximately 80% of total productive agricultural land was in annual crop, and minimum fallow was practiced on this land. These farms usually had very little land in summerfallow. They were usually operated in conjunction with adequate fertilizer application, thus a fertilizer farm was not examined;

3. Cover-crop (other than forage) farms if approximately 30% of all annual crops were cover crops;

4. Composite farms if two or more of the above erosion control techniques contributed to a notable extent in the cultural practices of the enterprise but to a lesser degree than noted in the specific farm types;

5. Zero-tillage farms if approximately 30% of the farm was zero tilled and much of the remaining land was utilized by practicing other conservation techniques. No farms of this type were found in the study area, thus economic data pertaining to external farms (outside the study area) were used for economic comparisons. The percentage figures of 30% and 80% were used to determine farming enterprise groups because these figures represented natural (obvious) boundaries and 30% is used in the literature (P.F.R.A., 1982:79);

6. Conventional-tillage farms if no appreciable determination of dominant cultural practices was noted. Such farms often practiced varying degrees of specific erosion control methods but only to a limited extent. The analysis of these farms could then be based on representative economic indicators.

Economic data are given on a per-field basis, but farm economic indicators are based on total farm operations because fields require rotation, and farming costs and benefits depend largely on the association of soil-water management techniques with other cultural practices.

No zero-tillage farm enterprises were sampled in the study area thus budgetary data for zero-till farms outside the study area were obtained and used as comparisons. Grassed waterways, contour tillage, wooded vegetation along streams, and shelterbelts are conservation techniques that could not be analyzed by the Budgetary Crop Simulator program because they did not represent cropping practices that would substantially affect a farm enterprise's operation.

Data from the 43 interview questionnaires were entered into the computer and budgetary summaries were outputed. Average farm-budget indicators were calculated for:

1. the entire sample population;
2. subunit one; and
3. subunit two.

Comparisons of the economic indicators were performed to note general differences among the farming groups within and between the two subunits.

3.4 DEVELOPMENT OF RECOMMENDATIONS

The development of ameliorative soil-water management guidelines or recommendations for the subescarpment of the T.R.w. proceeded as follows:

1. formulation of conclusions and recommendations based on predominant public attitudes and other concerns;
2. priorization and listing of the associated conclusions and recommendations specific to each management technique;
3. listing of conclusions and recommendations with specific reference to each subunit; and
4. delineation of possible research areas, topics, and problems for future study.

A description and analysis of a resource inventory based on past and present, physical, and demographic characteristics is necessary to provide a thorough understanding of the resource problems in the study area.

A structured interview questionnaire is appropriate for determining social acceptability and economic feasibility because it combines the benefits of both an interview and a questionnaire.

Processing by S.A.S. provides a good graphical illustration of social acceptability trends. The Budgetary Crop Simulator program represents an appropriate and efficient method of providing economic indicators of farming enterprises.

Chapter IV

RESULTS OF THE RESOURCE INVENTORY

A management plan may be considered a consolidation of a series of smaller plans, each dealing with identified management objectives. Many management plans consist of three phases:

1. a resource description and analysis;
2. a description of expected goals and objectives; and
3. an analysis of these goals and objectives to produce a set of directions and guidelines or recommendations.

This chapter, constituting the resource description and analysis of the study area, consists of the following five sections:

1. the development of a subunit map;
2. an evaluation of land use and demographic characteristics;
3. a general description of geologic characteristics of the study area;
4. a mapping of past soil erosion areas; and
5. a description of present soil-water management problems.

These sections will provide the necessary components to describe the major soil-water management problems and issues in the subescarpment of the Turtle River watershed.

4.1 SUBUNIT MAP DEVELOPMENT

The study area was separated into subunits which were based on correlative relationships between slopes and agricultural capability. Profiles were developed for various cross-sections of the study area. Empirical data concerning elevations were obtained for these cross-sections.

Profiles were drawn and slopes calculated to produce Figure 3. Elevation data pertaining to profile 1 were obtained from a map developed by the Department of Public Works (1951). Elevation data pertaining to profiles 2 through 5 were obtained from a map developed by the Water Development Branch (no date). As shown in Figure 3, slopes were categorized into groupings. These specific demarcations were based on changes in general slope for each profile. This method was considered appropriate to compensate for any possible misrepresentative profiles or parts of profiles.

The changes in slope were plotted on the profile sections in the study area and are shown in Figure 4. These categorized groupings of slopes were incorporated with differences in soil capability for agriculture. Figure 5 illustrates the boundaries of the major soil capability classifications.

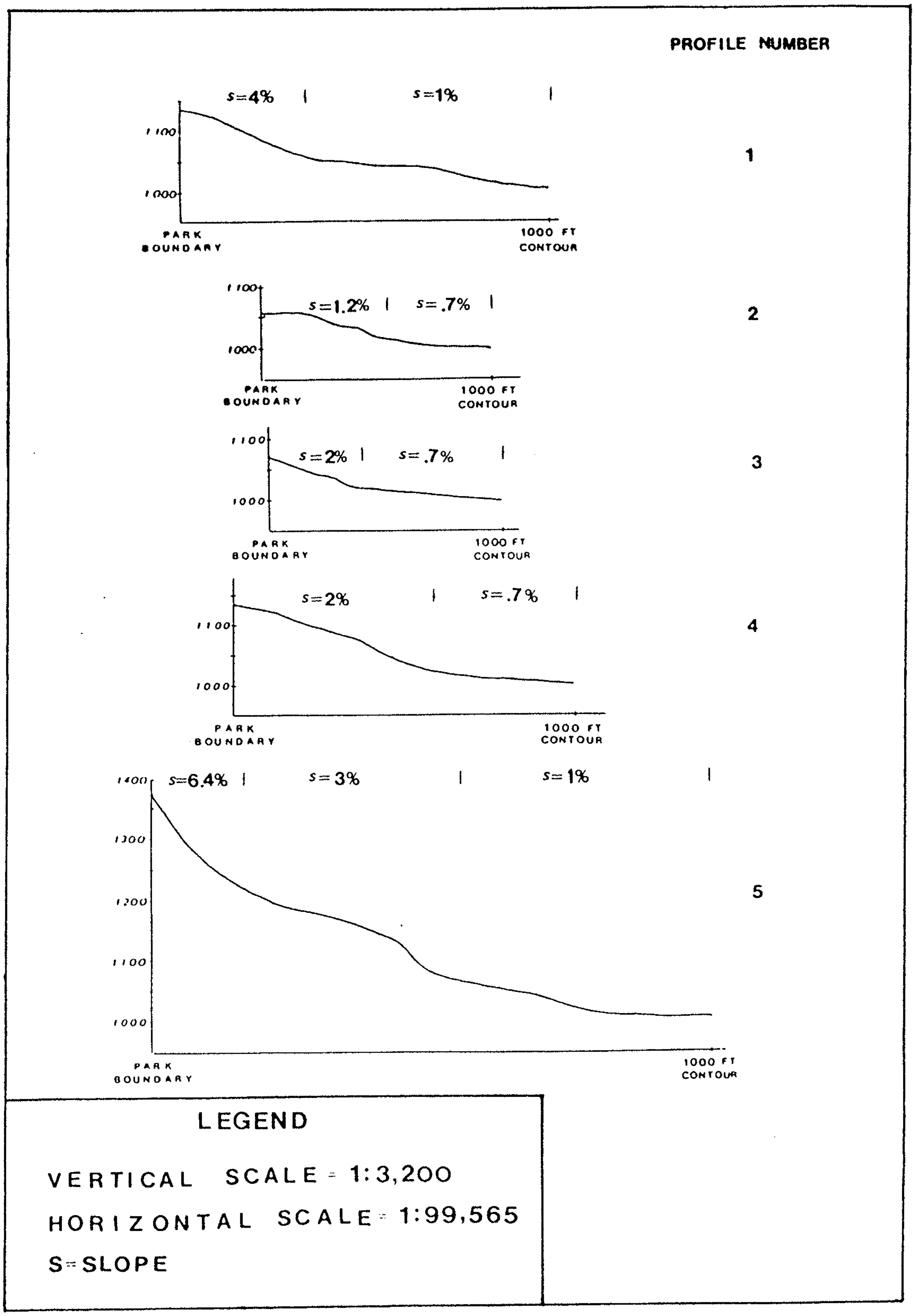


Figure 3
Profile cross-sections within the study area

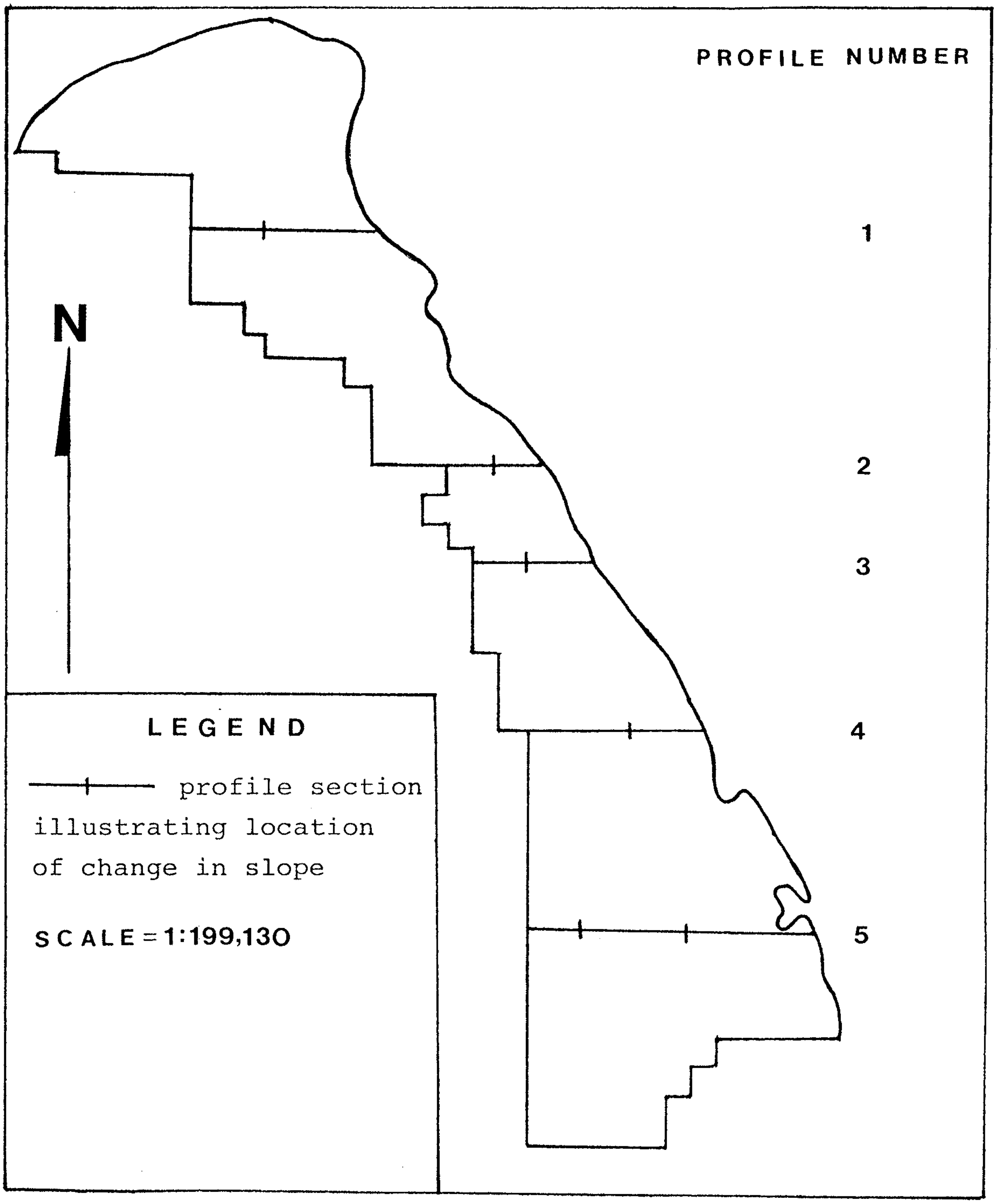


Figure 4
Location of changes in slope for various profile cross-sections within the study area

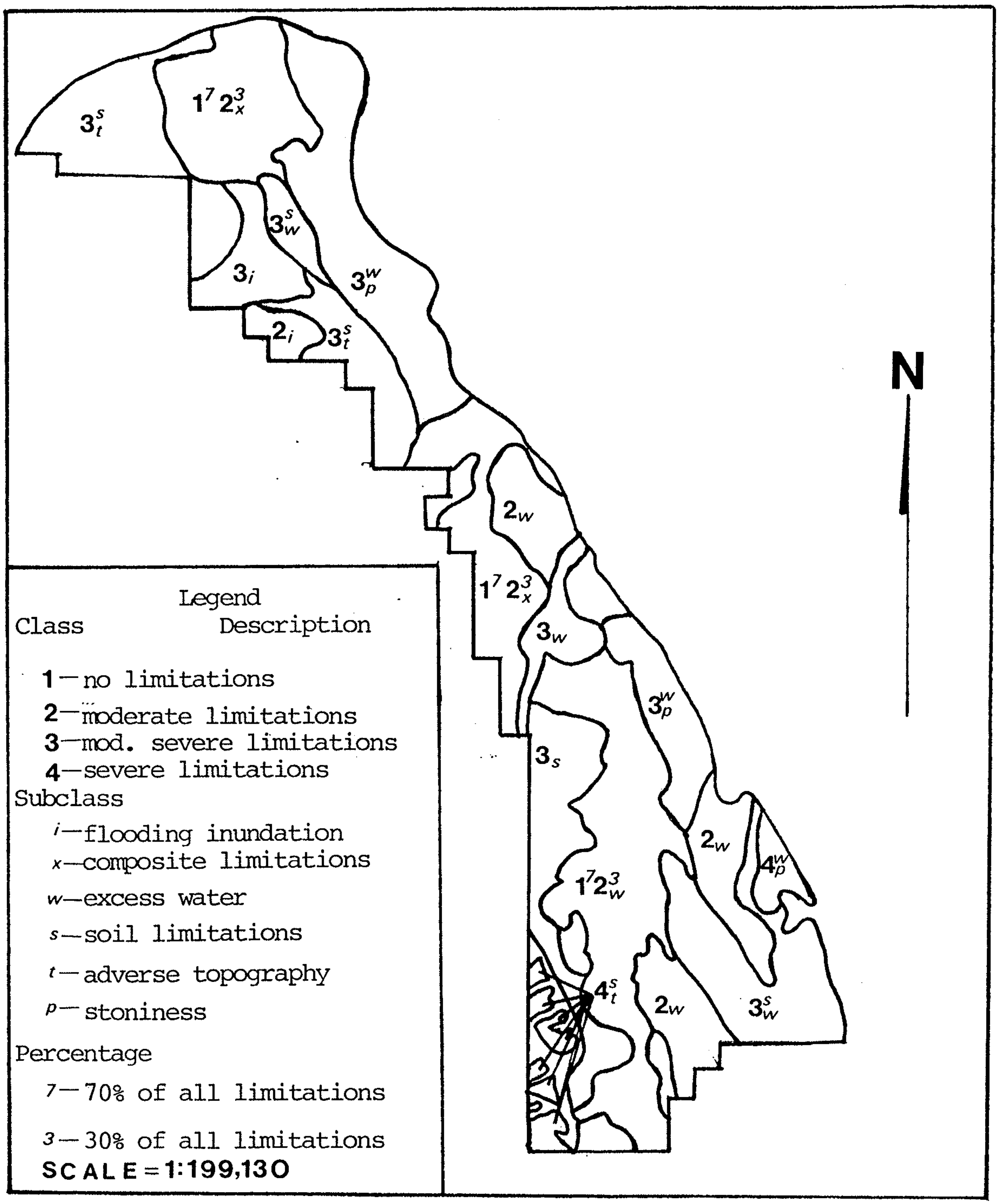


Figure 5
General boundaries in soil capability for agriculture within the study area

Source: Soil Research Institute (1967)

Figure 6 illustrates the three subunits of the study area. Subunit boundaries were determined by combining the changes in slopes of selected profiles (Figure 4) and distribution of various classes of soil capability for agriculture.

Subunit one is represented by profile slopes of 0.7% to 1% with soil capability for agriculture categorized largely as a class 3 with moderately severe limitations due to excess water and stoniness.

Subunit two has profile slopes of 1.2% to 4%. Soil capability for agriculture in subunit two varies considerably but may be generally classed as 2 thus having moderate limitations. Specific limitations would include excess water, flooding, soil limitations (low permeability, low natural fertility, low moisture-holding capacity, and salinity), and adverse topography. In general, then, subunit two has a steeper slope, more adverse topography, and is more prone to excessive moisture than subunit one.

Subunit three is represented by only one slope measurement of 6.4%. The soil's capability for agriculture may be classed predominantly as 3 with some 4 (severe limitations). Subunit three is specifically limited for agriculture by soil limitations and adverse topography.

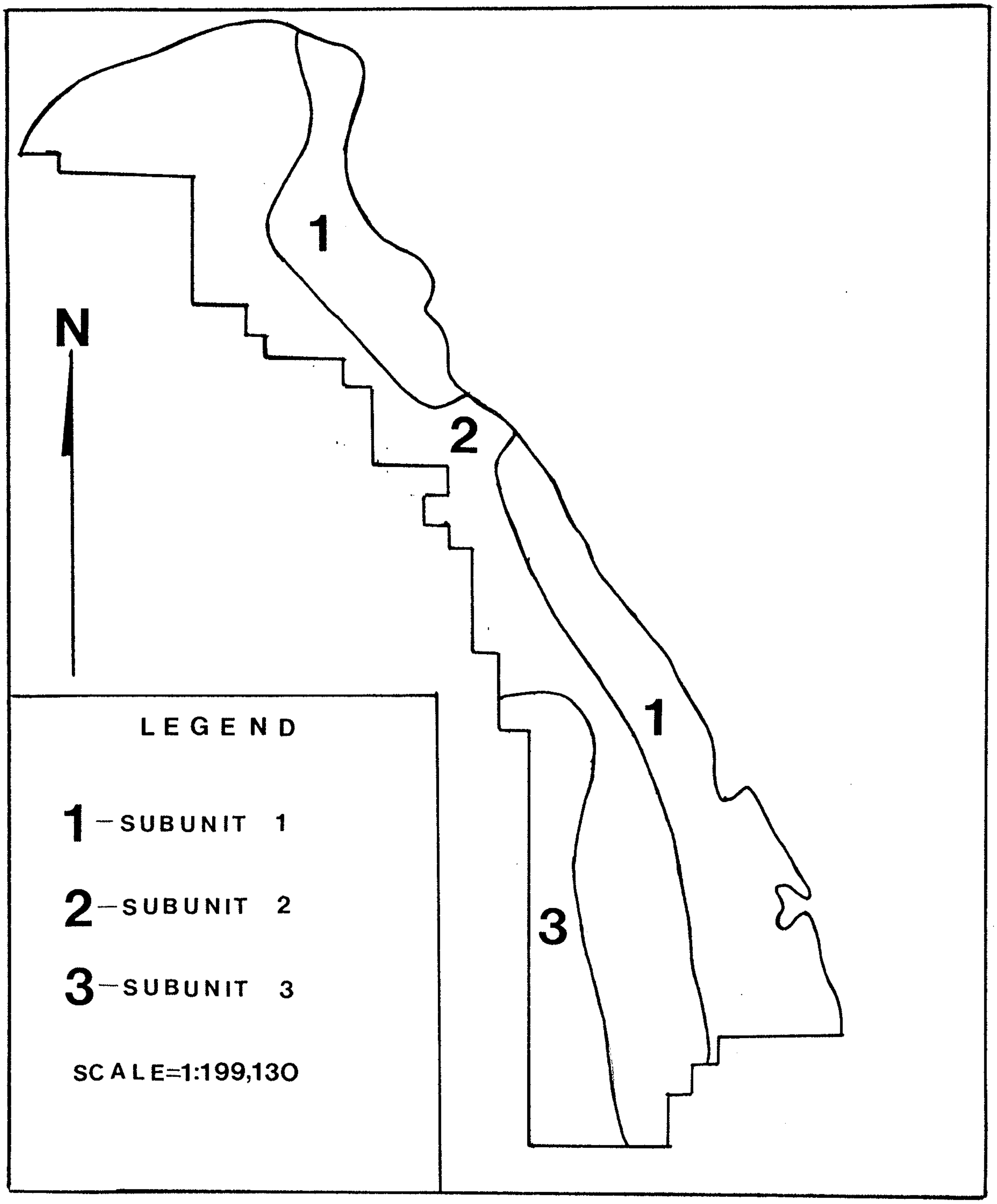


Figure 6
Location of subunits within the study area

4.2 LAND USE AND DEMOGRAPHIC VARIABLES

A census of agricultural data for the Rural Municipality of McCreary was used to evaluate land use and demographic variables because most of the farmers in the study area (74% or 32 of 43) were located in this R.M.. According to Table 1 the following trends may be noted concerning land use from 1971 to 1981:

1. the area of cropped land has increased;
2. the area of land in pasture has increased;
3. the area of land in summerfallow has been quite variable for the three census years;
4. the area in woodland has decreased; and
5. the total number of census farms has shown a steady decline.

These trends imply that the farming population is slowly declining while woodland is being removed for uses such as annual crops and pasture. The implication of these types of land use changes is that an increasing amount of land is being cleared for more intensive agriculture use. This shift in land use may be detrimental to the land if the land cleared is susceptible to erosion and/or the agricultural practices are not conservation-oriented.

One may compare these census data to land use data obtained from the study area. Table 2 illustrates the percentage of land in specific agricultural use for the R.M. of McCreary (1971, 1976, 1981), for each subunit and the entire study area.

Table 1

Use of land and total number of census farms in the R.M. of McCreary for 1971, 1976, 1981

Use of Farm Land (ha)		1971	1976	1981
Total area of farmland in hectares		43,165	45,114	42,305
Improved	Cropped	18,018	17,860	21,762
	Pasture	1,913	2,410	3,428
	Summer-fallow	5,753	7,364	4,025
	Other	956	1,328	879
Unimproved	Woodland	3,809	3,695	2,019
	Other	12,716	12,457	10,192
# of Census Farms		229	214	211

Source: Statistics Canada, 1973, 1978, 1983.

Table 2

Percentage of land in specific uses in the R.M of McCreary (1971, 1976, 1981), for each subunit and the entire study area

Use	Census Data			Study Area Data		
	1971	1976	1981	Subunit One	Subunit Two	Both Subunits
Cropped	41.7	39.6	51.4	60.5	52.4	56.1
Pasture	4.4	5.3	8.1	8.3	8.2	8.3
Fallow	13.3	16.3	9.5	11.5	9.4	10.3
Woodland	8.8	8.2	4.8	5.0	7.2	6.2
Other	31.8	30.6	26.2	14.7	22.8	19.1

Source: Statistics Canada, 1973, 1978, 1983.

It is apparent that the study area data illustrate similar trends to the agricultural census data.

Table 3 compares census data for the the R.M. of McCreary (1971, 1976, 1981) to the study area data concerning the percentage of farms in specific size categories. The purpose of this table is to determine if and where the study area sample population misrepresents the entire municipality. According to Table 3, smaller-sized holdings may be under-represented and larger-sized holdings over-represented by the sample population. This observation is evident for the individual subunits also.

One explanation may be that many smaller farmers considered themselves too small or inconsequential to be examined on an economic basis. Perhaps the study area does indeed consist of a higher percentage of larger farms and a lower percentage of smaller farmers as compared to the R.M. of McCreary as a whole. Many explanations are possible but if this observation is truly indicative of the characteristics of the sample population, thus rendering the sample misrepresentative, then it will be accepted as a limitation of the study.

Table 4 illustrates the percentage of total farmers in each age group in the R.M. of McCreary (1981), subunit 1, subunit 2, and the entire study area. The sample population appears to represent most age groups relatively well. Age groups 15-19 and 20-24 are not represented but this may be due to the small sample size (only 43).

Table 3

Percentage of farms classified by size (hectares) for the R.M. of McCreary (1971, 1976, 1981), each subunit and the entire study area

Farm Size	Census Data			Study Area Data		
	1971	1976	1981	Subunit One	Subunit Two	Both Subunits
Under 3.6	1.6	0.4	3.2	0	0	0
2.7-28	0	0.9	2.4	0	0	0
29-96	24.0	21.0	25.1	14.3	13.8	14.0
97-161	24.9	25.3	21.8	9.5	22.7	16.5
162-226	17.5	15.4	13.3	23.8	4.5	13.8
227-307	16.6	15.4	11.5	23.8	27.3	25.6
308-452	10.5	14.1	15.6	14.3	13.6	13.9
453-647	3.1	5.1	3.8	9.5	13.6	11.6
648 and Over	1.8	2.4	3.3	4.8	4.5	4.6

Source: Statistics Canada, 1973, 1978, 1983.

Table 4

Percentage of farm operators in each age group for the R.M. of McCreary (1981), each subunit, and the entire study area

Age of Farmer in years	1981 Census Data	Study Area Data		
		Subunit One	Subunit Two	Both Subunits
15-19	0	0	0	0
20-24	4.7	0	0	0
25-29	10.8	0	4.6	2.3
30-34	12.3	14.3	9.1	11.7
35-39	8.0	9.5	13.7	11.6
40-44	9.5	9.5	13.6	11.5
45-49	11.3	14.3	4.5	9.4
50-54	10.0	0	22.7	11.3
55-59	10.0	19.0	9.1	14.1
60-64	10.5	19.0	9.1	14.1
65-69	6.7	0	9.1	4.6
70 and Over	6.2	14.4	4.5	9.4

Source: Statistics Canada, 1983.

The specific subunits and the study area as a whole tend to represent the R.M. of McCreary when considering the percentage of operators in each age grouping and the percentage of land in specific agricultural land uses. As illustrated in Table 3, however, the sample population apparently under-represents the small farms and over-represents the larger farms of the R.M. of McCreary.

Upon an inter-subunit analysis, two generalizations become apparent. First, in subunit one, a larger percentage of annual crops and summerfallow are found as compared to subunit two. Second, subunit two illustrates a significantly higher percentage of woodland as compared to subunit one. These generalizations may be indicative of the agricultural limitations within the study area.

4.3 GEOLOGIC CHARACTERISTICS

A better understanding of the limitations imposed upon soil capability for agriculture will be facilitated if general geologic parameters are known.

The T.R.W.C.D. is underlain by various shales, sandstones, and evaporites of the Cretaceous and Jurassic periods. Ehrlich *et al*. (1958:21) describe the geology of the escarpment region as being composed of intermixed end moraines, eskers, glacial outwashes, and lacustrine deposits. The portion of the T.R.W.C.D. within the Riding Mountain National Park (R.M.N.P.) is characterized by a very irregular topography caused by the intermixture of these deposits with their varied physical forms. The steeper part of R.M.N.P. is deeply incised by numerous ravines which cut through the surface deposits and into the shale bedrock (Ehrlich et al., 1958:20).

The lowland region is composed of a variety of surface deposits but the greatest portion of the area consists of smooth ground moraine. Ehrlich et al. (1958:21) note that the surface of these till deposits was reworked in the shallow waters of glacial Lake Agassiz, and most of the area is presently very stony.

Moving west from the lowland region to R.M.N.P., various beach ridges are encountered. The 1000-foot (300-meter) contour represents a major transition zone along the Manitoba escarpment consisting of various beaches and bars. In general the subescarpment region (1000-foot (300-meter) contour to the R.M.N.P. boundary) consists of numerous gravel and sand beach ridges which lie across the direction of natural and artificial drainage.

A detailed geologic description of the subescarpment may facilitate the analysis of the social and economic data by providing a basis of reasoning to evaluate the results noted.

Ehrlich et al. (1958:20) note that the basic unit in most soil classification systems is the soil associate. A soil associate consists of soils that are similar in physical features and chemical composition as revealed by profile characteristics. This similarity of profile features occurs only within areas of similar vegetative cover, parent material, relief, drainage, and age. A soil associate may be defined as consisting of associated soils occurring in a landscape pattern and developed from similar parent material (Ehrlich et al., 1958:30).

Subunit one is largely composed of soil associations in which the dominant soil is a Black Meadow. Black Meadow soils are usually imperfectly drained and have an A horizon which is thick, very dark, high in organic matter, friable, and neutral to mildly alkaline in pH. Most of the soils in subunit one are developed on lacustrine deposits and include soils in the following associations:

1. Dauphin association (Dauphin clay-type soils) which are often typed as Class II and noted for being gently sloping, slightly stony, and require improvement in workability;

2. Lakeland association (clay-loam to till substrate) which is often typed as Class III and noted as being susceptible to wind and water erosion, prone to excessive salinity, and limited in fertility thus requiring various conservation techniques; and

3. Almasippi association (loamy fine sand to till substrate) which also is often typed as a Class III soil (Experimental Farms Service, 1958). Some soils were developed on thin lacustrine deposits over till. These soils are

largely classed as belonging to the McCreary association (very fine sandy-loam to clay-loam) which may be categorized as a Class III soil. Subunit one, then, is composed of relatively organic rich soils comprised largely of clay loamy and till-type substrates.

Subunit two is composed dominantly of soil associations in which most soil types are Alluvial in origin (Experimental Farms Service, 1958). These soils are considered quite useful for agricultural productivity. Soils of this type are usually classed as Class I, provided the land is gently sloping (Erhlich et al., 1958:83). As noted in a previous section, however, subunit two has a relatively significant slope thus has soils typed as Class II due to topographical limitations. Most soils in subunit two are developed on slightly to moderately calcareous deposits. Most subunit two soils may be found in the Edwards association thus are largely silt-loam to silty clay-loam in texture. Some soils, however, are found in the Edwards shale phase, consequently have a lower potential for agriculture. Although Class I and II soils (as found in subunit two) have the potential for good productivity, effective conservation techniques are essential to maintain the soil in good condition and to control weeds, diseases, and insect pests (Ehrlich et al., 1958:83).

Most soils in subunit three are composed of soil associations in which the dominant soil is a Grey Wooded (Experimental Farms Service, 1958). Grey Wooded soils are developed under deciduous and coniferous forests and have an A horizon that is very thin or absent, leached and dark grey, platy, and slightly acidic. Subunit three soils are largely developed on boulder till and consist of medium-textured till of dominantly shale origin. The most common soil association is the Clarksville association which is composed of very fine sandy-loam to clay-loam. Subunit three is somewhat broken up by sections of Unclassified type soils where eroded channels and steep inclines comprise eroded slope complexes (Experimental Farms Service, 1958). Generally then, subunit three has poor topsoil, is largely comprised of shale-type soils, has adverse topography, and is considered to be in Class III or IV for soil capability for agriculture. Major soil-water management problem areas, resulting partly from the above physiographic and geologic limitations, were observed and are illustrated in a later section. One method used to demarcate areas affected by erosion is the interpretation of panchromatic air photographs. The next section illustrates some erosion problem areas within the subescarpment region that were determined via the interpretation of panchromatic air photographs.

4.4 RESULTS OF THE MAPPING OF SOIL EROSION AREAS

The most recent coverage of the study area in panchromatic air photos was August, 1981. The photos interpreted were obtained from the Air Photo Library, Department of Natural Resources, in Winnipeg. The air photos used may be found in air photo index 62J-99. All photos were 1:15,840 in scale which was large enough to accurately delineate rill and gully erosion area boundaries by stereoscopic vision yet small enough to provide a good overview of the study area.

Areas where erosion was evident were demarcated on Figure 7. These erosion areas were then ground-truthed to determine if erosion was still present. As shown in Figure 7, some areas were cropped at the time of ground-truthing thus erosion was not evident without soil profile examinations. Other 1981 erosion areas were found in summerfallow but erosion was not readily identifiable. Other areas marked on Figure 7 in black were shown on the 1981 photos as eroded areas and also illustrated evidences of erosion in the summer of 1983.

Appropriate timing is essential when identifying erosion problem areas. The importance of timing was illustrated during the field research when a specific summerfallow field clearly demonstrated erosion problems prior to being worked with a cultivator.

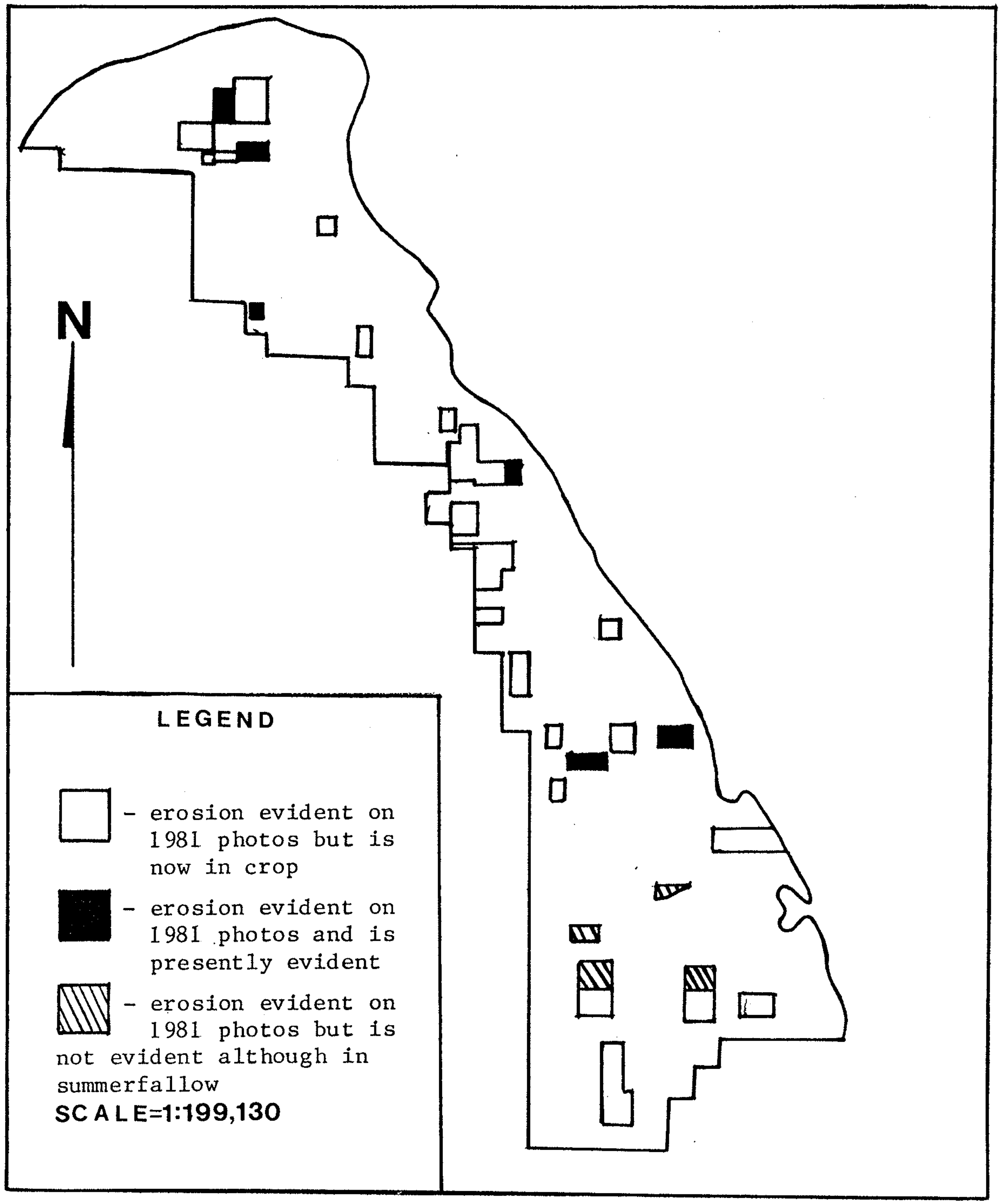


Figure 7
Location of identified areas of erosion on 1981 photos

After cultivation, this field appeared as many other summer-fallow fields illustrating no appreciable erosion problems. For this reason, ground-truthing was performed during the field research. Major soil-water management problem areas were observed and are noted in the next section.

4.5 SOIL-WATER MANAGEMENT PROBLEMS

Ground observations of the study area were performed to define the parameters of soil-water management problems. Photographic slides were taken of specific representative problem areas. Several slides were then selected and reproduced in print form to provide a pictorial illustration of these problem areas. These photographs are shown in Figures 8 through 16.

Figure 8 (SE 8-20-15W) depicts one of the major problems in the subescarpment region: adverse topography. The steep slope and rapid runoff common in subunit three resulted in the formation of the gully in Figure 8. Erosion such as this is augmented by continual compaction and disturbance of the soil by livestock.

Sediment emanating from such sources ultimately reaches watershed drains which result in their infilling. In some cases, this sediment may even reach Dauphin Lake resulting in various environmental detriments. This type of erosion can be controlled by managed grazing systems and/or a healthier vegetative cover on the area.

NOTICE/AVIS

PAGE(S) 64-68 ~~IS~~/ARE ~~EST~~/SONT colour photos

PLEASE WRITE TO THE AUTHOR FOR INFORMATION, OR CONSULT THE ARCHIVAL COPY HELD IN THE DEPARTMENT OF ARCHIVES AND SPECIAL COLLECTIONS, ELIZABETH DAFOE LIBRARY, UNIVERSITY OF MANITOBA, WINNIPEG, MANITOBA, CANADA, R3T 2N2.

VEUILLEZ ECRIRE A L'AUTEUR POUR LES RENSEIGNEMENTS OU VEUILLEZ CONSULTER L'EXEMPLAIRE DONT POSSEDE LE DEPARTEMENT DES ARCHIVES ET DES COLLECTIONS SPECIALES, BIBLIOTHEQUE ELIZABETH DAFOE, UNIVERSITE DU MANITOBA, WINNIPEG, MANITOBA, CANADA, R3T 2N2.

Figure 8

Gully erosion in subunit three

Figure 9

Erosion along edge of summerfallow field

Figure 10

Erosion of summerfallow field in subunit two

Figure 11

Erosion of summmerfallow field in subunit three

Figure 12

Salinization of soil

Figure 13

Gully erosion on boundary of subunit one

Figure 14

Overgrazing and erosion in subunit three

Figure 15

Pollution of ditch due to manure pile

Figure 16

Beaver dam under bridge in subunit three

Figure 9 (NE 29-21-15W) is representative of a prevalent problem in the T.R.W.C.D.: that being summerfallowing along the edge of a field. Evidences of this erosional problem are also found throughout the subescarpment region, particularly subunit one. In this case, the field was apparently seeded in a pedigree crop. For such fields it is recommended that a buffer zone should surround the crop to separate the crop from contaminate seed sources. This example illustrates a situation in which the farmer has attempted to devote as much field space as possible to the growing of this specific crop. As is evident in the photo, this attitude has resulted in rill and gully formation along the field's edge. Despite the gentle slope in the area, erosion has occurred resulting in loss of topsoil from the field.

Farmers have, in the past, been able to move some of the eroded material seen in the ditch back onto the field with farm machinery. Although this practice replaces some of the lost soil, much of the fertilizer and nutrients are washed down stream. This temporary remedial practice also increases a farmer's time and monetary input to constantly battle natural processes.

Rills and gullies also develop on the edge of entirely summerfallowed fields as illustrated in Figure 10 (NW 19-22-16W). This specific erosion problem was evident in the 1981 photos. The gully that has formed has washed a substantial amount of topsoil into the ditch (foreground). This erosion was caused by a combination of three factors:

1. the lack of vegetative cover or stubble and mulch;
2. the steep slope of the area; and
3. excessive moisture levels.

These factors combined with the poor adhesive nature of the soil (being a silty-loam) caused this field to be very susceptible to erosion regardless of the fact that it had been tilled perpendicular to the slope (contour-tilled).

This erosion may have been inhibited or completely eliminated if different cropping practices were utilized. Remedial cropping practices might include:

1. zero-tillage or minimum-tillage systems;
2. continuous-cropping systems; and

3. maximum use of forages.

Gully erosion as seen in Figure 10 removes valuable topsoil by excavating the field, consequently increasing sediment load downstream and creating hazardous field conditions necessary for the farmer to rectify. Appropriate cropping practices may reduce or cushion the effects of this type of erosion.

The causes of the erosion problem in Figure 11 (NE 8-20-15W) are similar to those noted in the description of Figure 10. The gully in Figure 11 has affected the entire length of the field. This field fortunately has a buffer strip along the ditch (foreground) which has caught much of the eroded topsoil. This buffer reduced the erosive power of the runoff, consequently much of the eroded sediments were deposited at the foot of the buffer zone. Other inherent benefits of such buffer zones would be the reduction of the influx of nutrients, fertilizers, and sediments downstream into drainage ditchs, streams, and lakes. The field in Figure 11 was later cultivated several times to obliterate most signs of erosion. This erosion may have been reduced if environmentally sound soil-water management techniques were incorporated.

Another associated problem with excessive summerfallowing (besides erosion) is the upwelling of salts to the surface which is known as salinization. An example of the problem of the salinization of topsoil is illustrated in Figure 12

(SE 17-22-15W). This photo illustrates a prevalent concern in the study area. The white low spot in the corner of this field is less productive than the remainder of the field. The whitish tone is saline soil that has formed from the up-welling and gathering of salts at the soil's surface. This salinization may be a result of excessive tillage and an excessively high water table which combine to bring salts to the surface through enhanced capillary action. Most agricultural crops are not highly tolerant of saline soils thus agricultural productivity and consequently economic returns are reduced.

Several techniques that might reduce such harmful effects are:

1. reduced or zero tillage;
2. cover cropping; and
3. seeding with salt tolerant forages such as Slender wheatgrass, Tall wheatgrass, and Russian wild rye.

Concerns with salinization should exist throughout the entire T.R.W.C.D. because the effects on agricultural production are often not so pronounced as in Figure 12 but rather may be a ubiquitous reduction in productivity which is not localized thus is difficult to recognize.

Figure 13 (NE 9-22-16W) illustrates some of the erosion problems associated with livestock operations. Although the slope is relatively gentle in this area, a large gully has formed on this pasture as a result of the excessive traffic by livestock.

Although not shown clearly by the photo, cattle were allowed to enter the drain to obtain drinking water. The immediate slope between the pasture and the drain was disturbed by the activity of the livestock. This has disrupted vegetative cover, where most required, resulting in erosion. Increased deterioration of vegetative cover due to cattle trampling and grazing induced further erosion, which ultimately continued to reach the present state depicted in the photo.

This eroded gully has caused:

1. a loss of productive pasture, thus increasing the stress placed on the remainder of the pasture; and

2. a displacement of soil from the pasture to the drain where it may be washed further downstream, resulting in various negative consequences. Erosion of this type may have been prevented by restricting cattle access to the Ogg drain.

Two soil-water management problems are illustrated in Figure 14 (NE 19-20-15W). First, to be noted is the condition of the pasture. Overgrazing is indicated by the poorly developed vegetation. This lack of plant vigor may ultimately permit runoff to excavate rills and gullies into the unprotected soil. Second, cattle access, although controlled, is permitted to the edge of the ditch (foreground) which is used as a source of water. This practice is slowly resulting in erosion.

Another problem associated with allowing cattle to water in drains and ditches is that of contamination. Various diseases, insects, pests, minerals, pollutants, etc. may be transported downstream by these drainage channels. Appropriate grazing systems and livestock management are required to ensure such problems do not occur or do not become more severe.

Figure 15 (SW 12-24-16W) illustrates one water-related problem that the T.R.W.C.D. should consider as a serious environmental concern. Waste material (manure) has been washed from a feed stock area into a water-filled ditch (foreground). Such pollutants may ultimately be washed downstream to enter waters such as Dauphin Lake. These pollutants may adversely affect the recreational opportunities contingent upon Dauphin Lake. Satisfactory buffer zones between waste piles, or in this case manure piles, and private or public drainage channels will inevitably prove very useful in reducing possible harmful environmental consequences.

Figure 16 (NE 7-22-16W) illustrates one of the wildlife-related problems common in the subescarpment of the T.R.W.C.D.. Beavers have constructed a dam under this bridge. The T.R.W.C.D.B. must hire a man with a backhoe to remove this obstruction to alleviate the flooding problems that have resulted upstream. Dynamiting has served as a solution in other situations. Blockage of drains by beaver dams is one wildlife-related problem associated with

R.M.N.P. which the Board must deal with. The T.R.W.C.D.B. may implement a soil-water management plan that solves most cultural-related erosion problems, but this plan must not be divorced from other influences such as wildlife.

The subescarpment region and the T.R.W.C.D. in general exhibits many soil-water management problems. These problems may be summarized as follows:

1. erosion caused by
   - excessive slope
   - excessive moisture
   - excessive summerfallowing
   - lack of buffer zones
   - inappropriate livestock and pasture management;
2. pollution; and
3. wildlife problems.

Other issues that have been noted in the subescarpment region are:

1. poor road construction;
2. flooding;
3. privately constructed access routes; and
4. an excessively high water table.

This list is by no means exhaustive but merely represents some of the major soil-water management concerns that the Board should address.

Land use in the subescarpment region and the entire T.R.W.C.D. has been shifting from woodland to more economically rewarding agricultural uses such as pasture and annual crops.

Based specifically on slope characteristics and soil capability for agriculture, the subescarpment region may be subdivided into three subunits. These subunits represent varying degrees of the land's capability for specific agricultural practices. The specific percentages of land in different uses, geologic conditions, and the severity of the various soil-water management problems vary among the three subunits.

Although there are many types of soil-water management problems in the subescarpment region of the T.R.w., this study evaluates only those problems that are associated with cultural practices. Chapter V evaluates the social acceptability and economic implications of these cultural practices.

Chapter V

RESULTS OF SOCIAL AND ECONOMIC ANALYSES

This chapter analyzes the social and economic data obtained from the 43 questionnaires. The social data were incorporated into various S.A.S. programs to determine the frequency with which soil erosion control methods are practiced. These programs indicate if any of the demographic or personal variables influenced the specific methods that were practiced. S.A.S. programs predict which conservation practices would likely be used if specific incentives were provided. The programs also illustrate the farmer awareness of and participation in government assistance programs.

The results of the economic data provide indicators as to the economic implications of various technique-dominated farm enterprises. Both social and economic analyses are presented first for the entire study area, then for the individual subunits. Various observations of comments and opinions obtained in the questionnaire are noted and discussed.

The combination of these results enables the determination of which, if any, soil-water management techniques are most likely to be accepted and incorporated by farmers of the subescarpment of the Turtle River watershed.

Social data, on pages one through five of the questionnaire, were analyzed using various S.A.S. programs. The various computer symbols used in the development of these Graphs accompany each Graph throughout the text. Category boundaries for symbols (codage, codon, codgss, and codfming) have been defined by analyzing their Cumulative Frequency Distribution (C.F.D.). Such an analysis permits the determination of boundaries with approximately 33% of the farmers classed into each category. For example, in codage groups 21-41, 42-57, and 58-75 approximately 33% of the sample population is represented by each group. This categorization facilitates analysis between age groups.

Graph 1 illustrates the frequency of farmers (within each subunit) that use each erosion control practice. Trends relating to the computer symbols codage, codon, codgss, codfming, neighbor, pressure, genuse, ed, treat, soiler, and family have been developed to explain the results noted in Graph 1. The symbols have been correlated against the various erosion control practices to produce Graphs 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, and 22 (see page 82). The results noted in these correlations may be explained by the results observed in the symbols alone. Graphs 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, and 23 (see page 82) illustrate the results of each symbol, within each subunit, which explain relationships noted in the correlations. In general, then, Graphs 2-23 illustrate and explain various relationships that may be apparent between the soil erosion methods practiced and various demographic and personal variables. Graph 24 (see page 97) illustrates which erosion practices would be used, within each subunit, if various incentives were provided.

Graphs 25 and 26 (see page 100) respectively illustrate the awareness and participation of farmers, within each subunit, concerning government assistance programs pertaining to the various erosion control practices.

A detailed analysis of the individual Graphs will provide information concerning social and personal related correlations and attitudes.

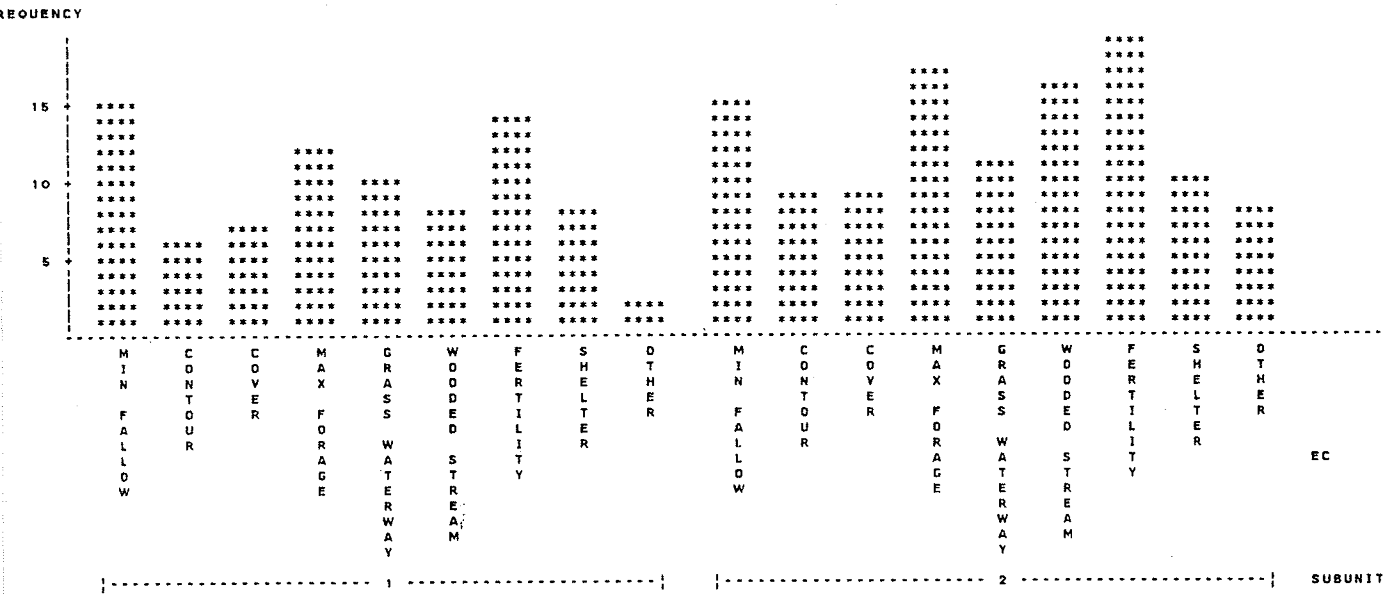
5.1 SOCIAL ANALYSIS

The general frequency of farmers that practice erosion control methods within the two subunits is illustrated in Graph 1. The frequencies represented in subunit two are relatively larger than those in subunit one. This observation is apparent for all erosion control techniques except minimum use of summerfallow. As a generalization, more farmers in subunit two practice erosion control methods as compared to one.

As may be seen in Graph 1, zero tillage is not listed. This is because no farmer in the study area practiced this soil erosion control technique. Some of the reasons given by the farmers for not implementing this technique are:

GRAPH 1

FREQUENCY WITH WHICH SOIL EROSION CONTROL METHODS ARE PRACTICED WITHIN EACH SUBUNIT



EC - derived from question Bb of the questionnaire; refers to the soil erosion control methods that are practiced in the study area.

1. twenty-seven percent think that zero tillage is too expensive to experiment with;

2. thirty percent feel that the land is too wet and heavy for zero tillage, thus would compact without tillage;

3. seventeen percent of the farmers do not believe in zero-tillage systems;

4. ten percent of the farmers use manure and forage rotation to maintain agricultural productivity, thus zero till is not required; and

5. sixteen percent of the farmers are not sure that zero tillage would work in the area.

The farmers who do not use the other soil erosion control techniques gave the following reasons:

1. thirty percent do not use minimum fallow because:
   - they are not accustomed to this practice,
   - summerfallowing is required to control weeds,
   - fallowing rests the land,
   - minimum fallowing is thought unnecessary,
   - fallowing drys the land sufficiently to allow seeding;

2. sixty-five percent do not use contour tillage because they think the slope is too low to warrant the extra labor and money;

3. sixty-three percent do not use cover crops because:
   - the market is too poor,
   - they are not accustomed to specialty crops,
   - improved varieties are required;

4. thirty-three percent do not use forages because of poor markets;

5. fifty-one percent do not use grassed waterways because the additional time and labor required in their construction has not warranted such a practice;

6. forty-four percent do not plant woody vegetation along streams because it has not been required or because natural growth has been sufficient;

7. twenty-three percent chose not to use adequate fertilizer applications because they require too high an initial capital outlay and it has not been feasible to grow additional grain when quotas have been so low;

8. fifty-eight percent chose not to use shelterbelts because natural ones are abundant and not desired;

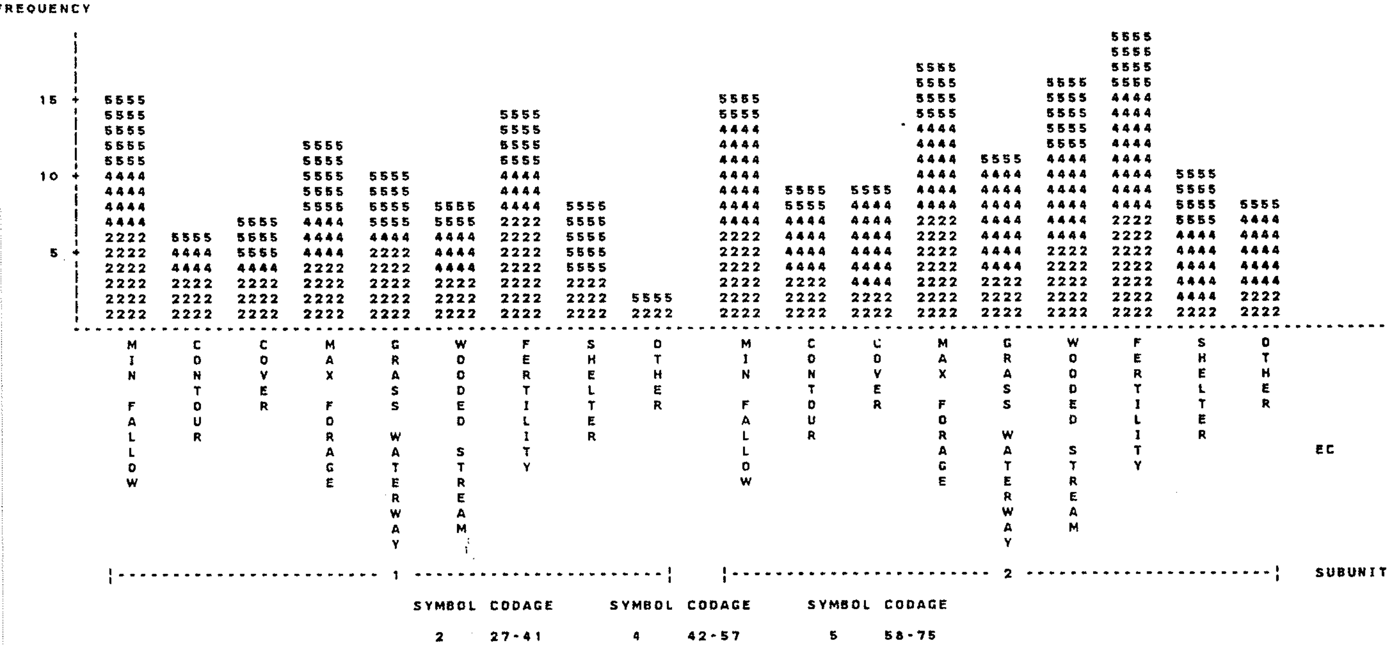
9. seventy-eight percent do not use tile drainage because it is too expensive.

In subunit two there is a larger frequency (as compared to subunit one) of farmers in the age group 42-57 practicing soil conservation techniques (Graph 2). This observation may be explained by Graph 3 which indicates there is a larger frequency of farmers in the age group 42-57 in subunit two as compared to subunit one. Older farmers (58-75) planted more shelterbelts than younger farmers. All planted shelterbelts, however, were used around the farmyard as opposed to being used as field shelterbelts.

There are relatively more farmers in subunit one who have been on their farms for 2-16 years that practice erosion control techniques than those who have been on their farms for 26-52 years (Graph 4). The opposite is noted for subunit two where farmers in codon group 26-52 (as compared to codon group 2-16) appear to represent a larger proportion of those practicing erosion control techniques (Graph 4).

GRAPH 2

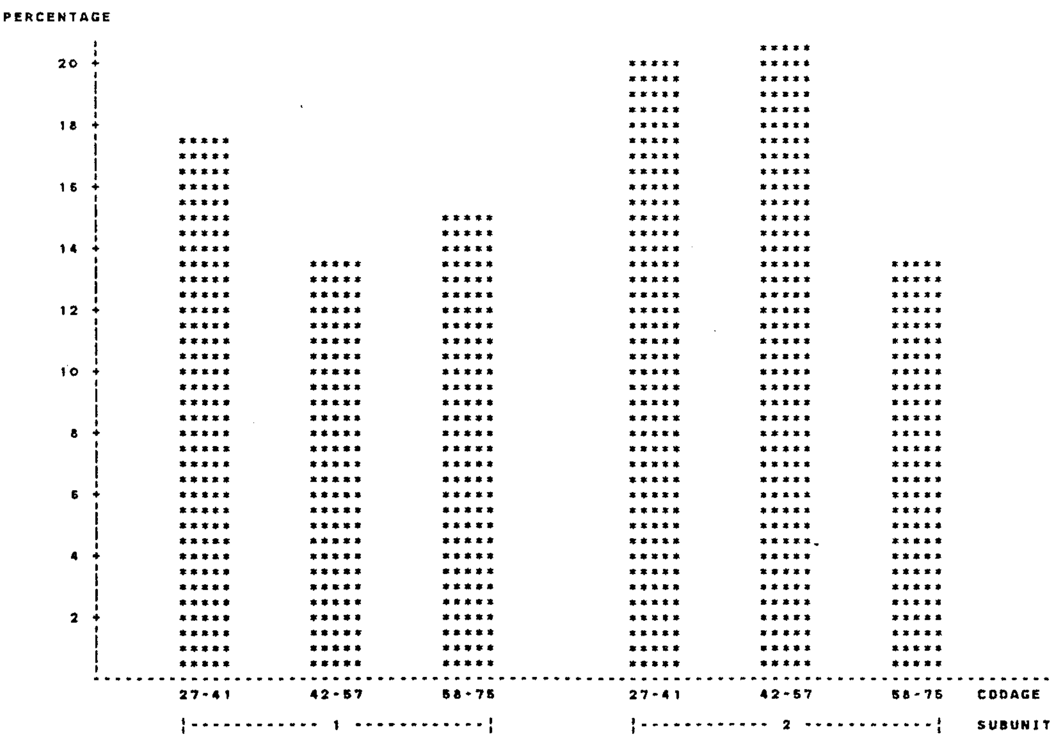
FREQUENCY OF CODAGE GROUPS FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



CODAGE - derived from question Da; refers to a specific coding or class of ages (eg. codage 2 represents those farmers who are 27-41 years old).

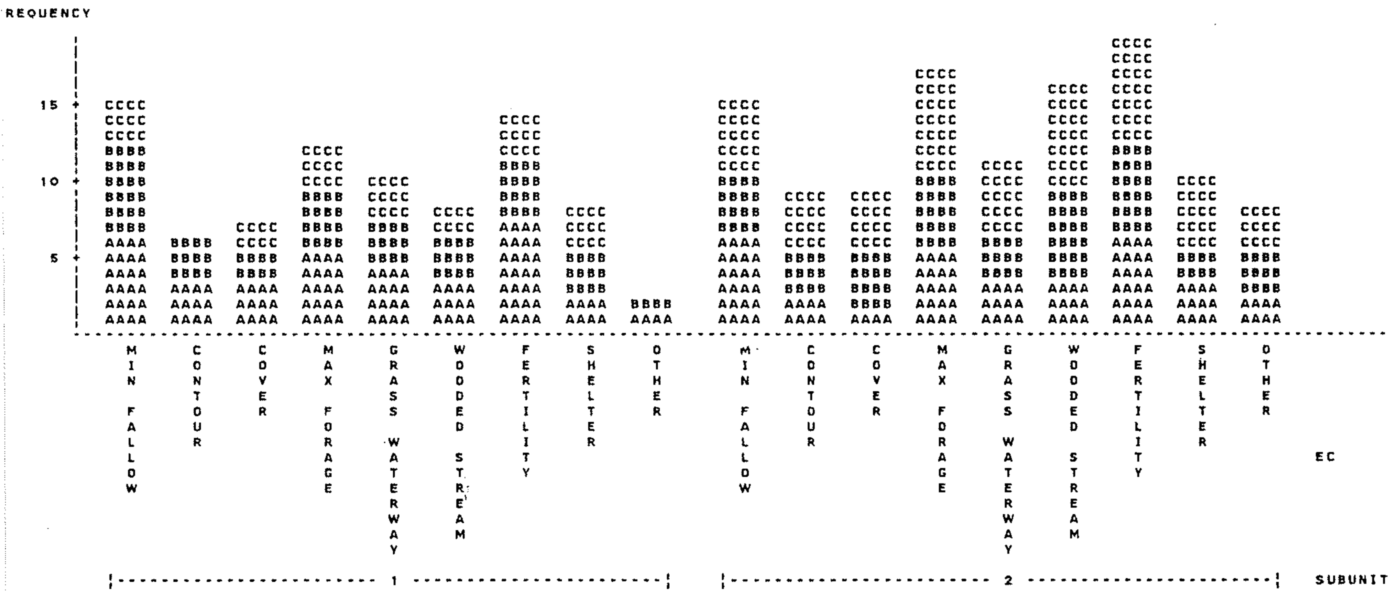
GRAPH 3

PERCENTAGE OF FARMERS BY CODAGE GROUP WITHIN EACH SUBUNIT



GRAPH 4

FREQUENCY OF CODON GROUPS FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



SYMBOL CODON SYMBOL CODON SYMBOL CODON

A 2-16 B 17-25 C 26-52

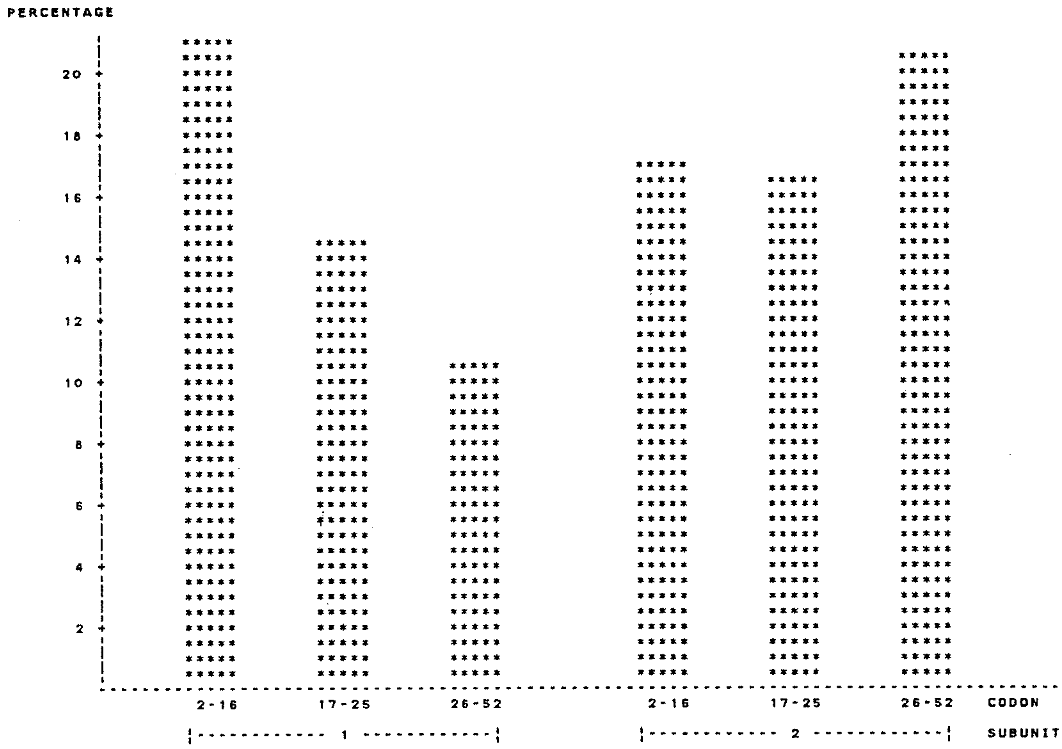
CODON - derived from question Db; refers to a specific coding or class of farmers who have been on their present farm for a specified number of years (e.g., codon A represents those farmers who have been on their present farm for 2-16 years).

Both observations may be explained in Graph 5. Subunit one contains a larger frequency of farmers in codon group 2-16 as compared to codon group 26-52, and subunit two contains a larger proportion of farmers in codon group 26-52 as compared to codon group 2-16.

In both subunits the larger proportion of farmers practicing erosion control techniques have a higher gross income (e.g., 29,000 and greater, see Graph 6). Graph 7 illustrates the reason for this observation. Both subunits have

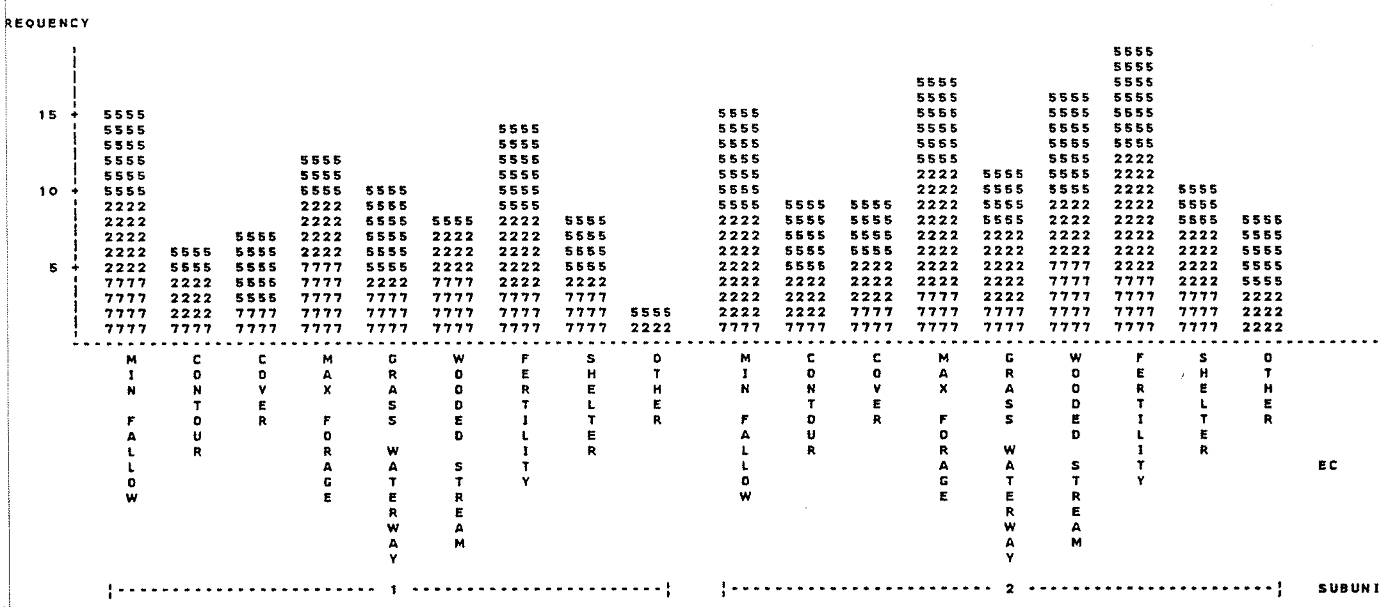
GRAPH 5

PERCENTAGE OF FARMERS BY CODON GROUP WITHIN EACH SUBUNIT



GRAPH 6

FREQUENCY OF CODGSS GROUPS FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



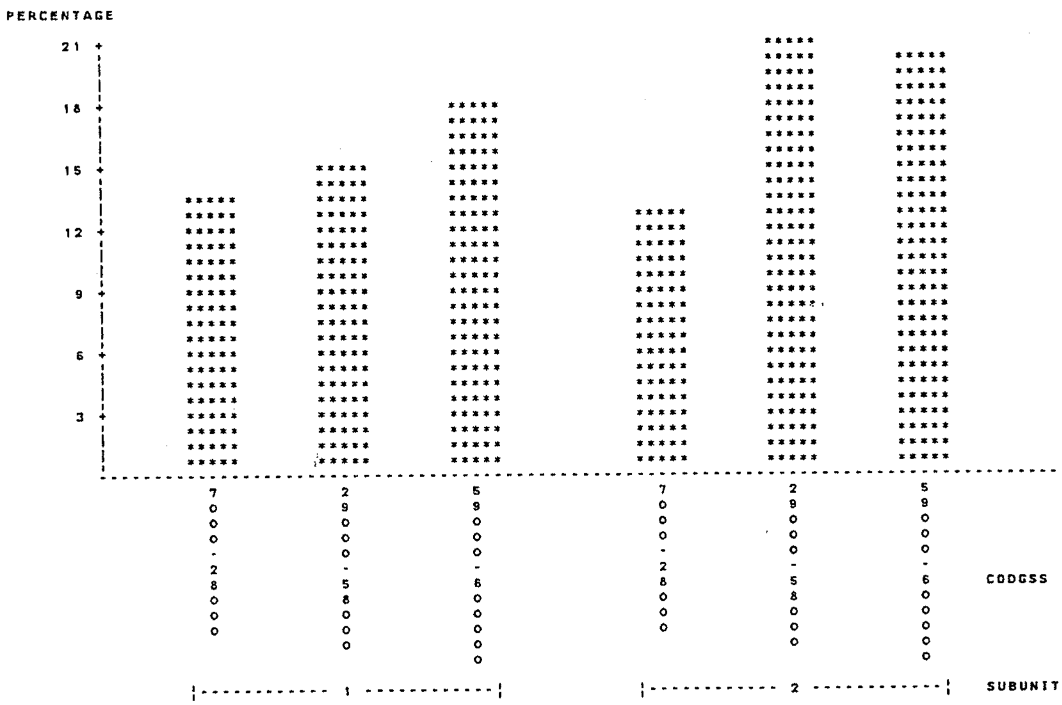
SYMBOL CODGSS SYMBOL CODGSS SYMBOL CODGSS

7 7000-28000 2 29000-58000 5 58000-600000

CODGSS - derived from question De; represents a specific coding or class of farmers who fall into a specific gross income bracket (e.g., codgss 7 represents all those farmers who had gross earnings from $7000 to $28,000 in 1982).

GRAPH 7

PERCENTAGE OF FARMERS BY CODGSS GROUP WITHIN EACH SUBUNIT



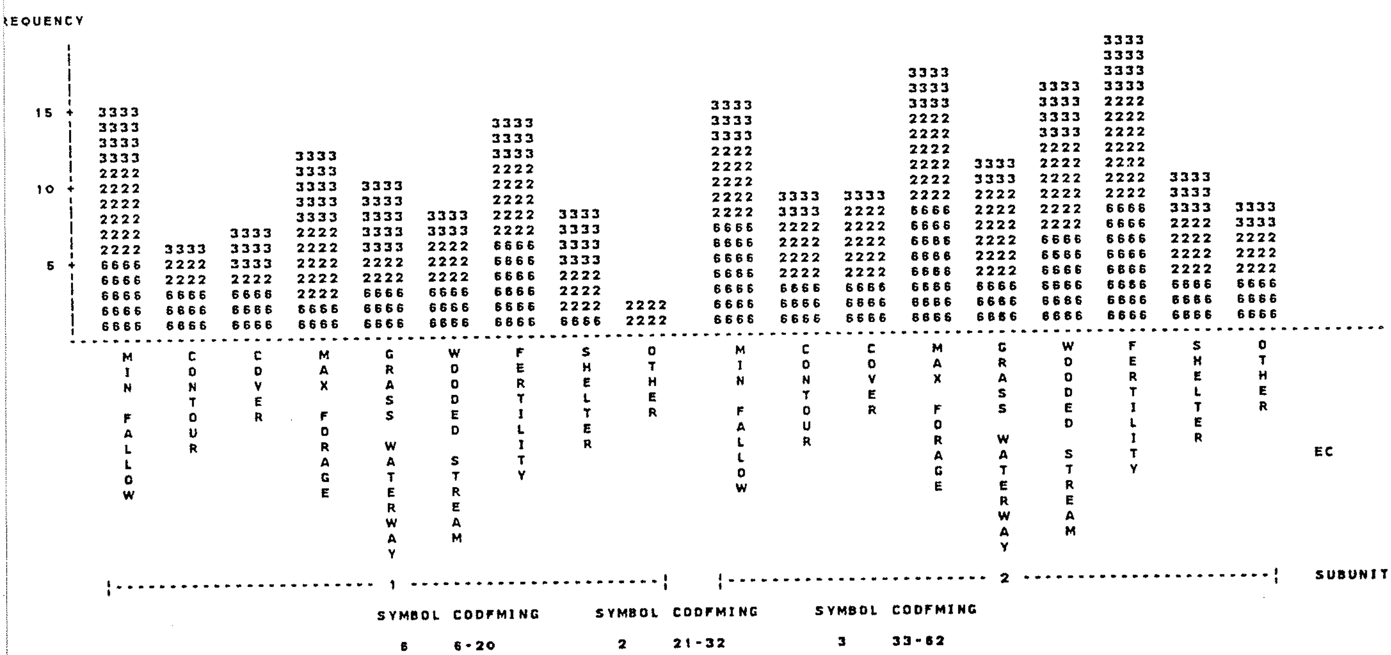
a higher proportion of farmers in these income groups. This represents one limitation of the C.F.D. analysis: in this case exactly 33% of the farmers could not be represented by each group. This misrepresentation occurs because five farmers earned a gross income of $30,000, and whatever category this figure fell into would be skewed and would exhibit a relatively higher percentage than the other two groups. Generally speaking, then, each income group appears to be represented accordingly, thus no direct relationship may be drawn between gross income and erosion control practices used.

The conclusion can be drawn from Graph 8 that the number of years that a farmer has farmed does not influence whether specific soil erosion control techniques are practiced. The relative proportion of each codfming group within each subunit is explained in Graph 9. A notable observation is seen in subunit two where the largest percentage of farmers practicing soil erosion control methods are found in codfming group 6-20.

In both subunits, most farmers who practice conservation practices say they are not influenced by what their neighbors feel about their farming practices (Graph 10). This result may be explained in Graph 11 which shows that in

GRAPH 8

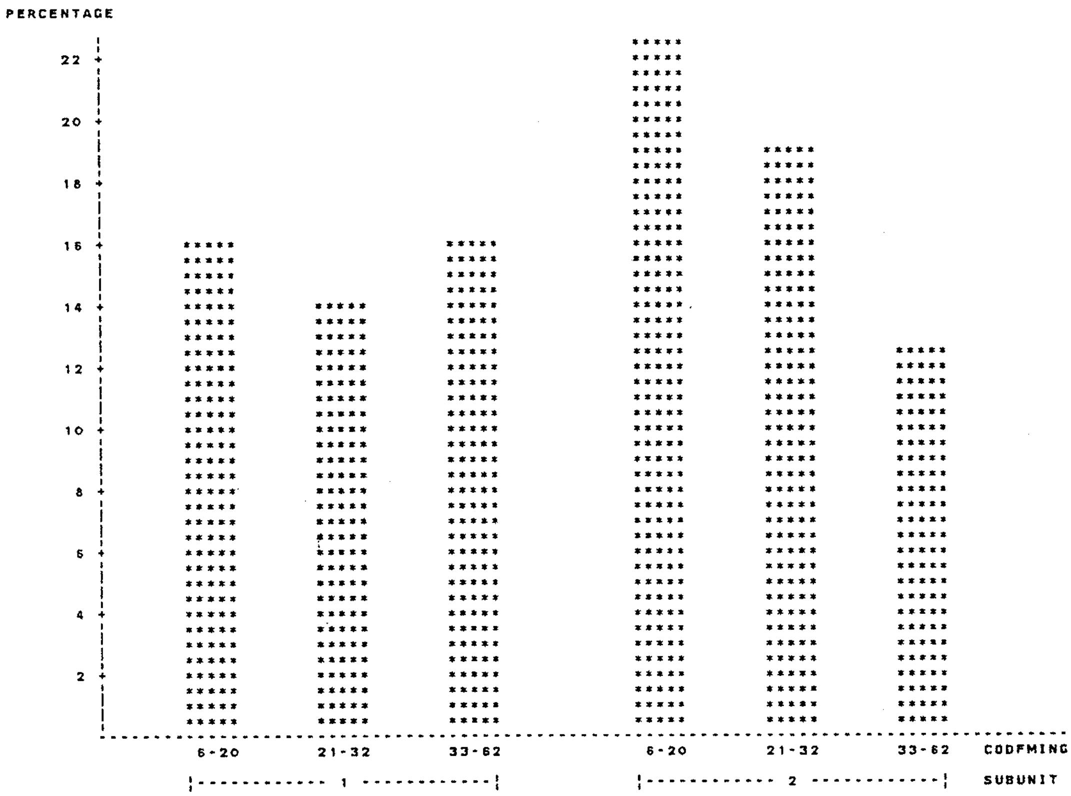
FREQUENCY OF CODFMING GROUPS FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



CODFMING - derived from question Dc; refers to a specific class of farmers who fall into a certain category concerning the total number of years they have farmed (e.g., codfming 6 represents those farmers who have farmed 6-20 years).

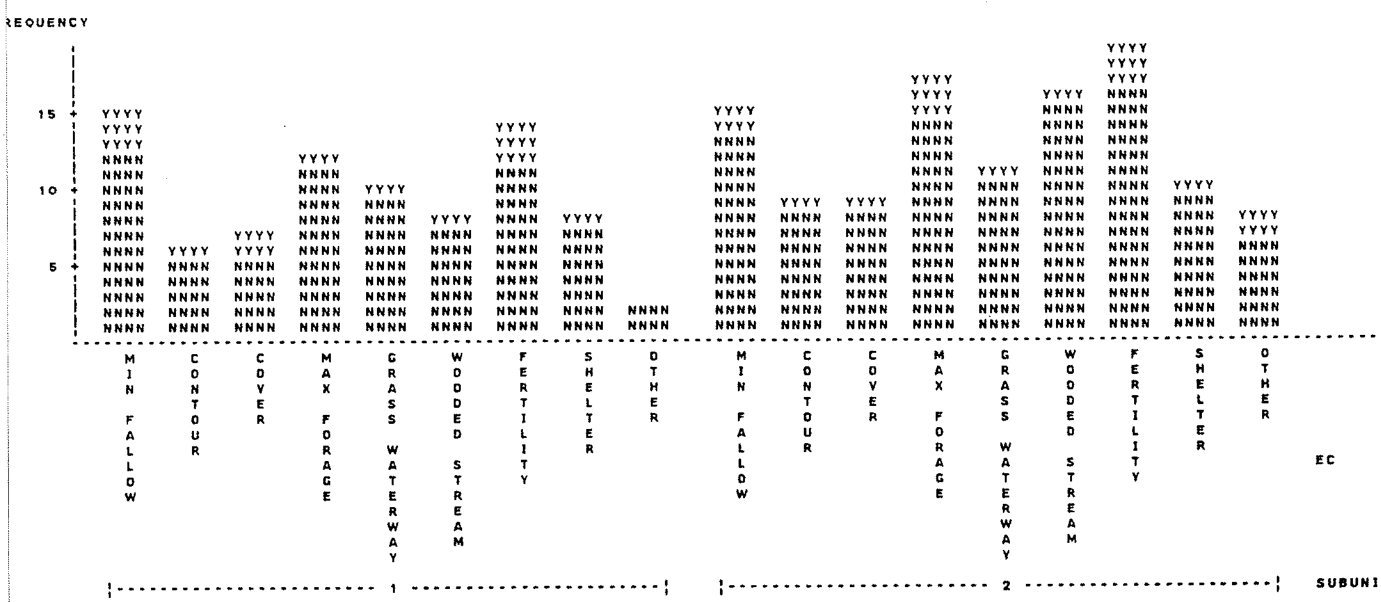
GRAPH 9

PERCENTAGE OF FARMERS BY CODFMING GROUP WITHIN EACH SUBUNIT



GRAPH 10

FREQUENCY OF RESPONSES TO NEIGHBOR QUESTION FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



SYMBOL NEIGHBOR

N NO

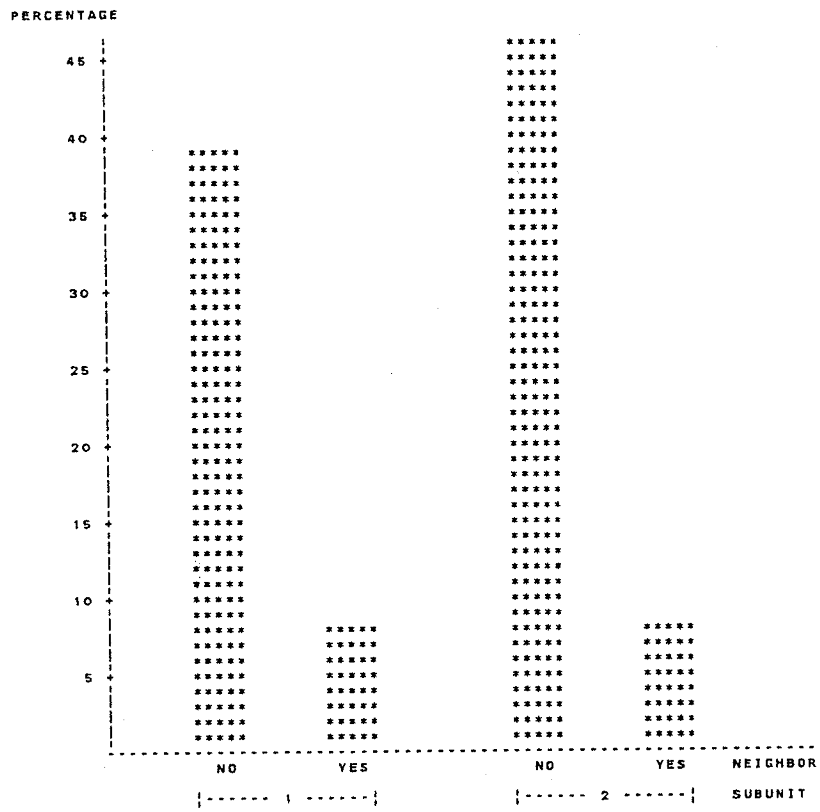
SYMBOL NEIGHBOR

Y YES

NEIGHBOR - derived from question Cg; inquires whether the farmer is influenced by what his neighbors think about his farming practices.

GRAPH 11

PERCENTAGE OF RESPONSES TO NEIGHBOR QUESTION WITHIN EACH SUBUNIT



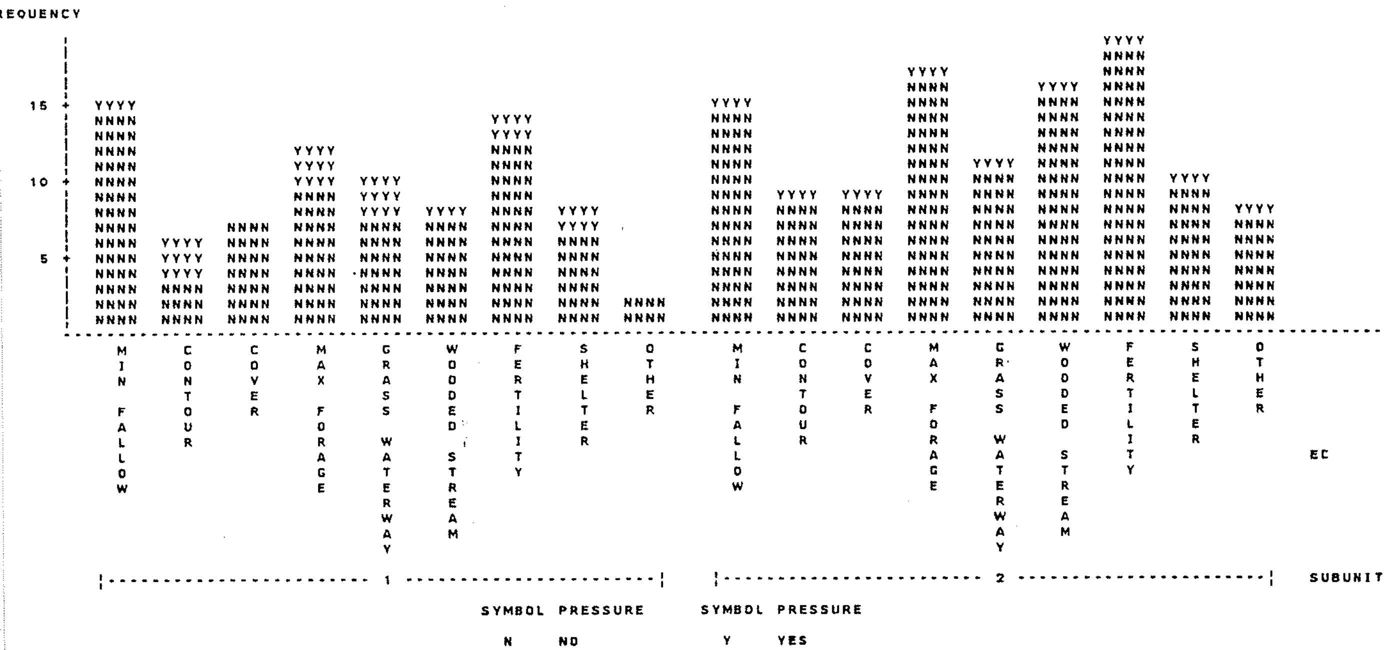
general most farmers replied no to the neighbor question.

Graph 12 illustrates that, of the farmers in both subunits practicing conservation techniques, most feel that if they started using more conservation techniques, their friends and neighbors would not look down on them. The reason for this result is illustrated in Graph 13.

Most of the farmers that practice conservation techniques feel that they would engage in more conservation techniques if everyone else in the neighborhood did likewise (Graph 14). This observation, evident for both subunits, may be explained in Graph 15 where most of the farmers answered yes to the genuse question.

GRAPH 12

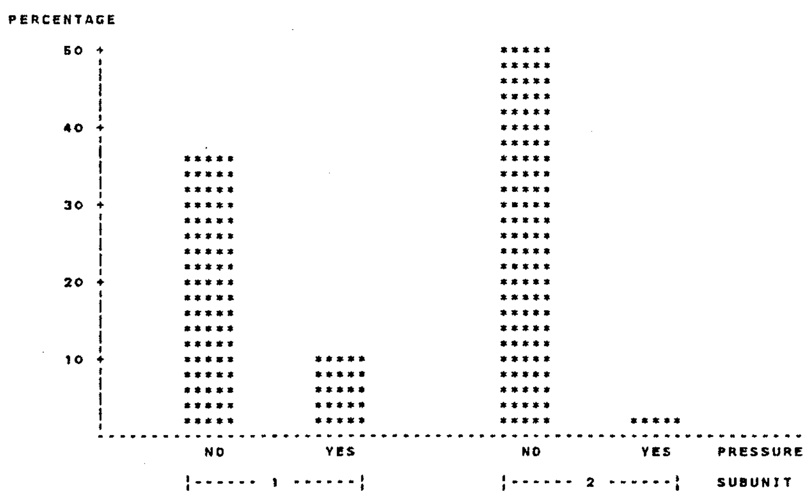
FREQUENCY OF RESPONSES TO PRESSURE QUESTION FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



PRESSURE - refers to question Ce where farmers were asked if they thought that if they started using more soil conservation practices that certain friends and neighbors might look down on them.

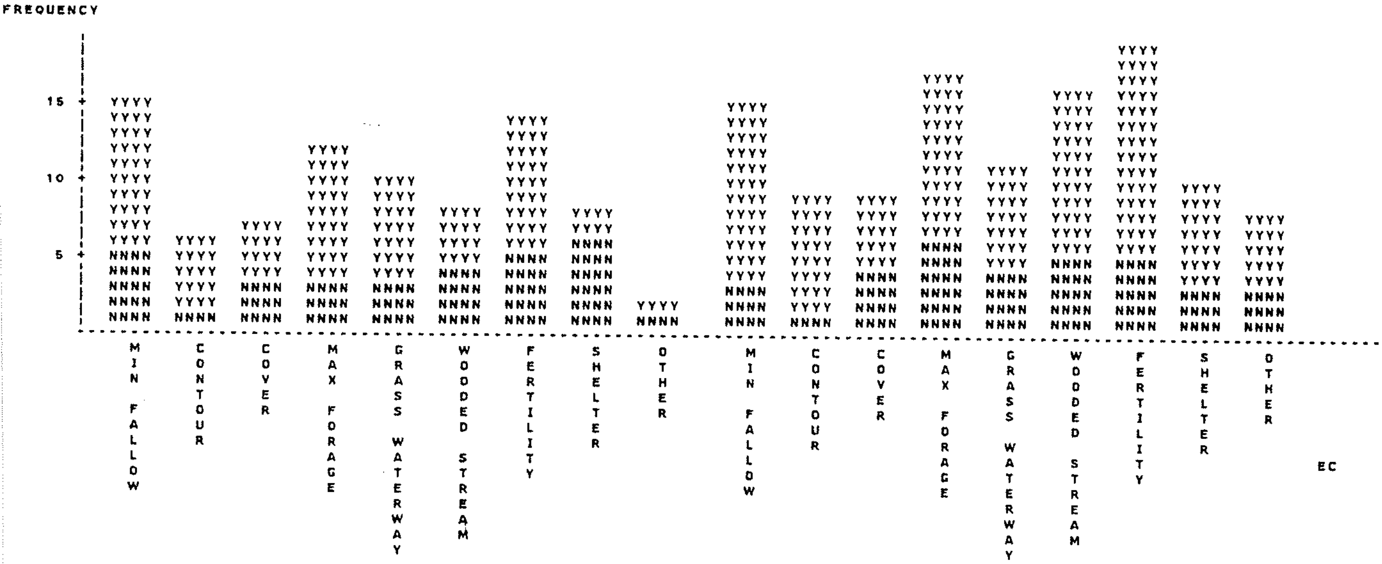
GRAPH 13

PERCENTAGE OF RESPONSES TO PRESSURE QUESTION WITHIN EACH SUBUNIT



GRAPH 14

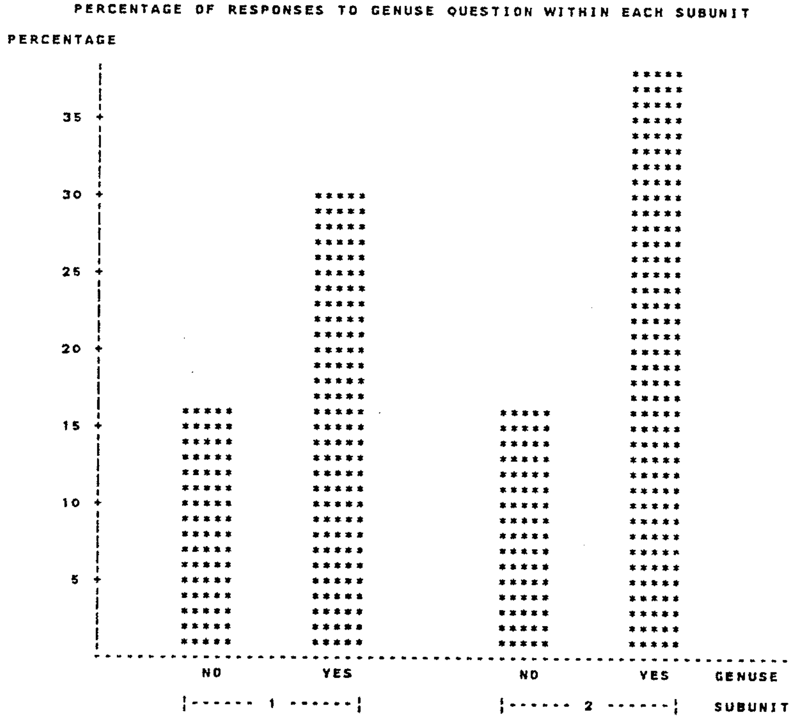
FREQUENCY OF RESPONSES TO GENUSE QUESTION FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



GENUSE - refers to question Cf which questions if the farmer would engage in more conservation practices if everyone else in the neighborhood did likewise.

GRAPH 15

PERCENTAGE OF RESPONSES TO GENUSE QUESTION WITHIN EACH SUBUNIT



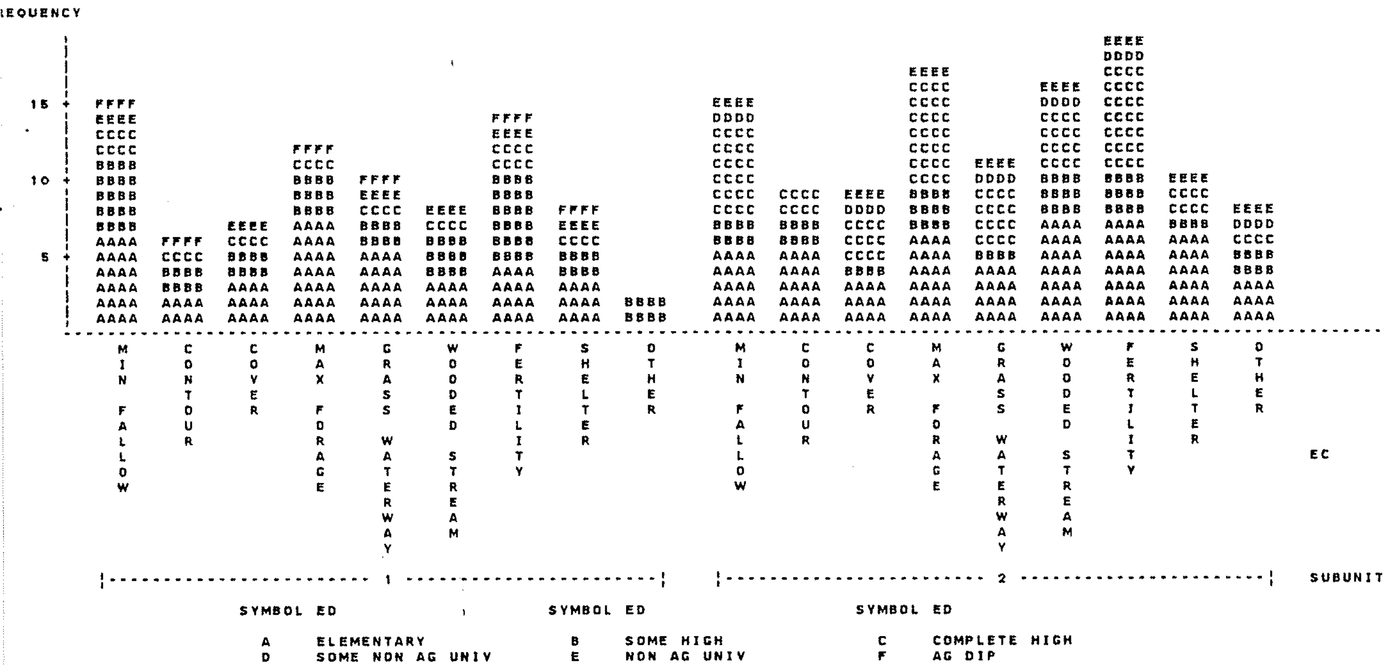
Generally, farmers of all education levels practice conservation techniques (Graph 16). This observation is shown in both subunits. The varying degree of representation for each subunit is explained in Graph 17 which illustrates that a larger percentage of farmers in subunit two (as compared to one) have completed high school. This observation is also exhibited in Graph 16. This may have some relationship to the fact that more farmers in subunit two (as compared to one) practice conservation techniques.

Most of the farmers that participate in erosion control methods feel that they will be leaving their land (soil) in as good a condition as when they started farming it (Graph 18). This result can be seen in both subunits. The reason for this result is evident upon examination of Graph 19.

Of the farmers who practice soil erosion control practices in subunit one, a larger percentage feel that they have significant soil erosion on their farm than those who do not (Graph 20). Of the farmers who practice soil erosion control practices in subunit two, most feel they had no significant soil erosion on their farm as compared to those who do not (Graph 20). This observation seems appropriate in that apparently more farmers in subunit two practice soil erosion control methods as compared to those in subunit one (Graph 21).

GRAPH 16

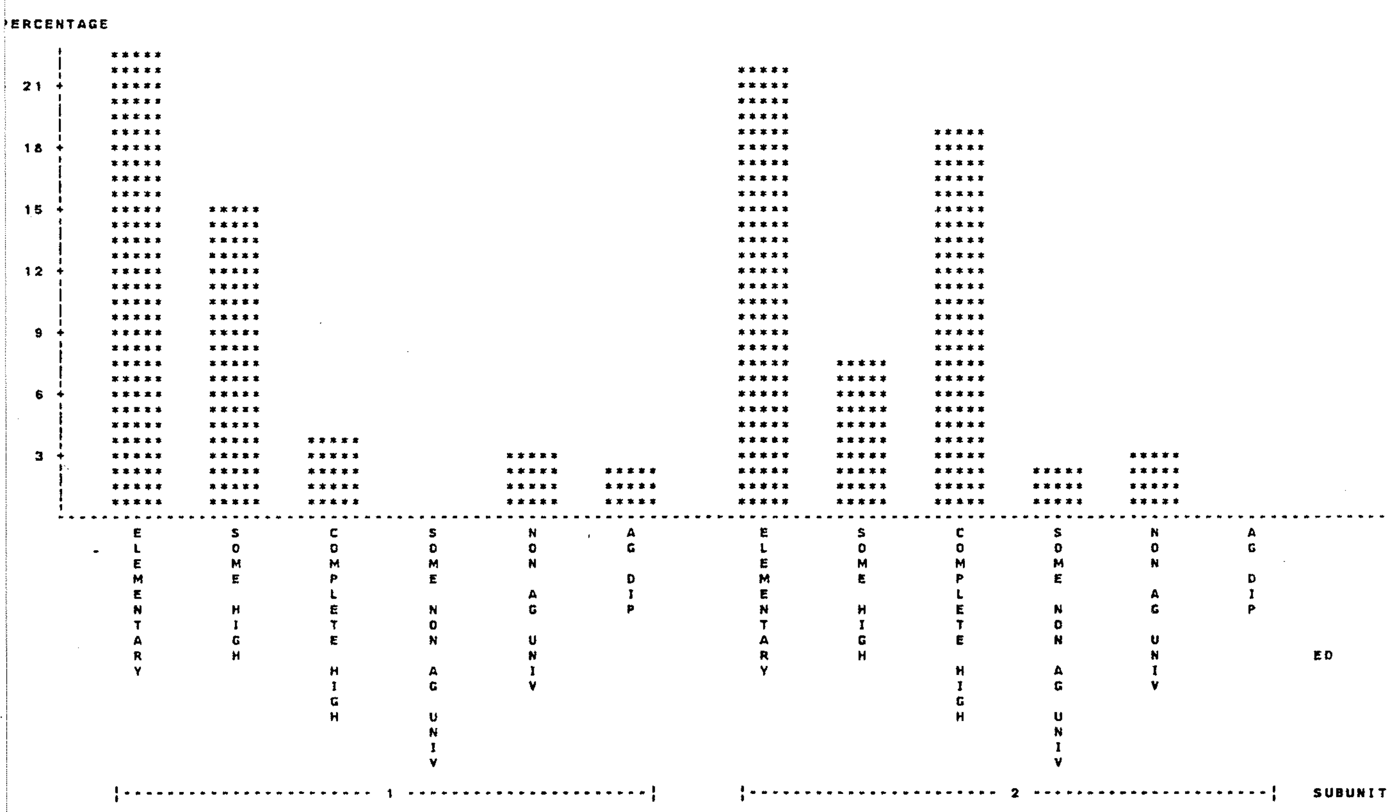
FREQUENCY OF SPECIFIC EDUCATION LEVELS FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



ED - refers to question Dd of the questionnaire which supplies information concerning education.

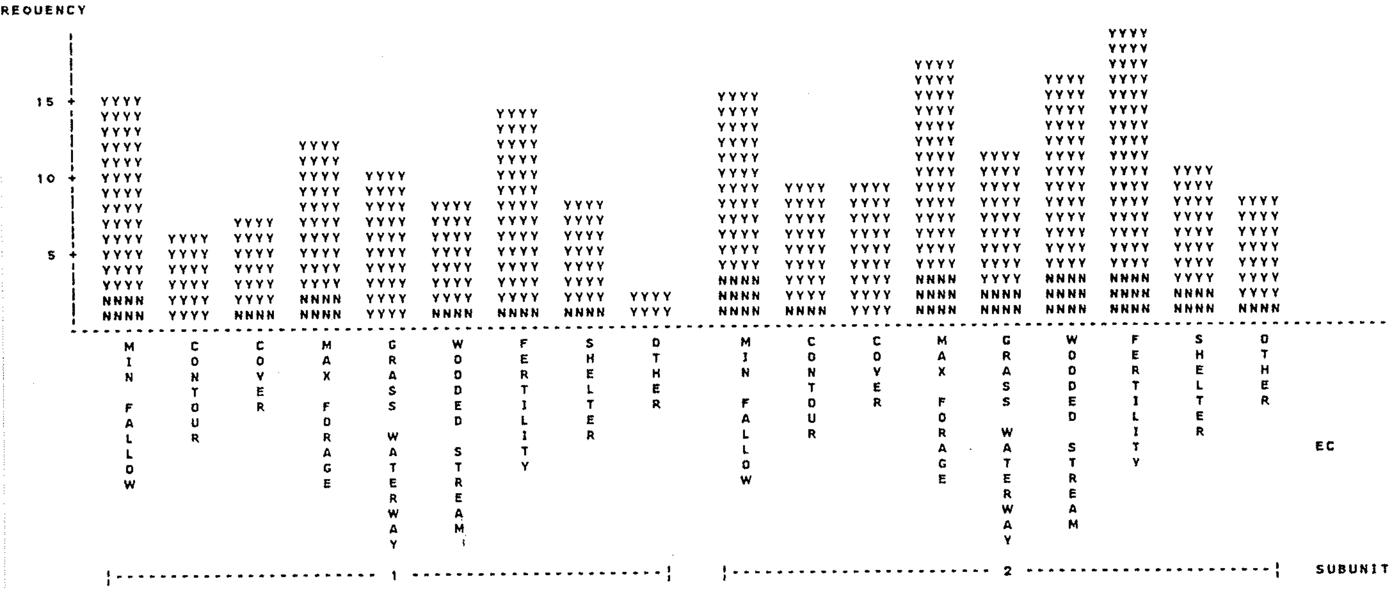
GRAPH 17

PERCENTAGE OF FARMERS WITH SPECIFIC EDUCATION LEVELS WITHIN EACH SUBUNIT



GRAPH 18

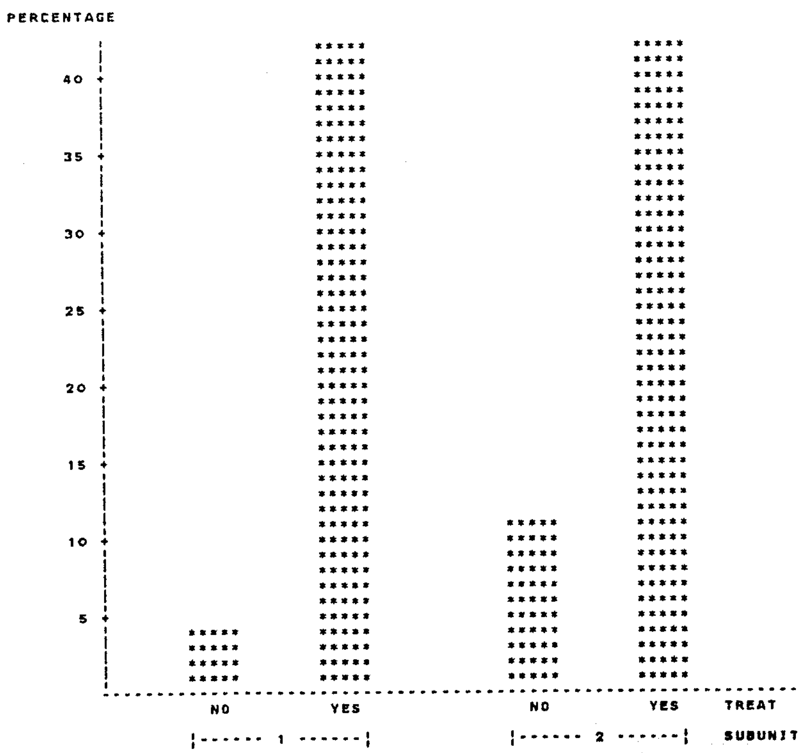
FREQUENCY OF RESPONSES TO TREAT QUESTION FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



TREAT - refers to question Ch which asks the farmer if he will be leaving the land in as good a condition as when he started farming it.

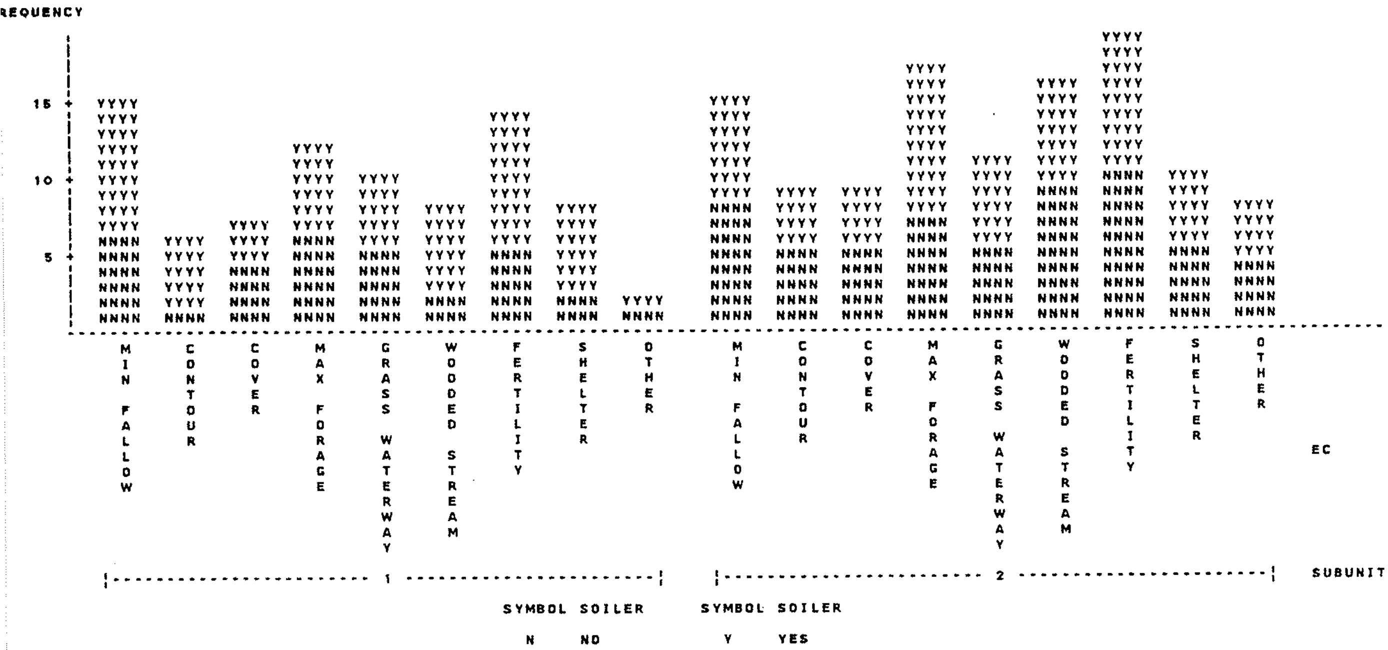
GRAPH 19

PERCENTAGE OF RESPONSES TO TREAT QUESTION WITHIN EACH SUBUNIT



GRAPH 20

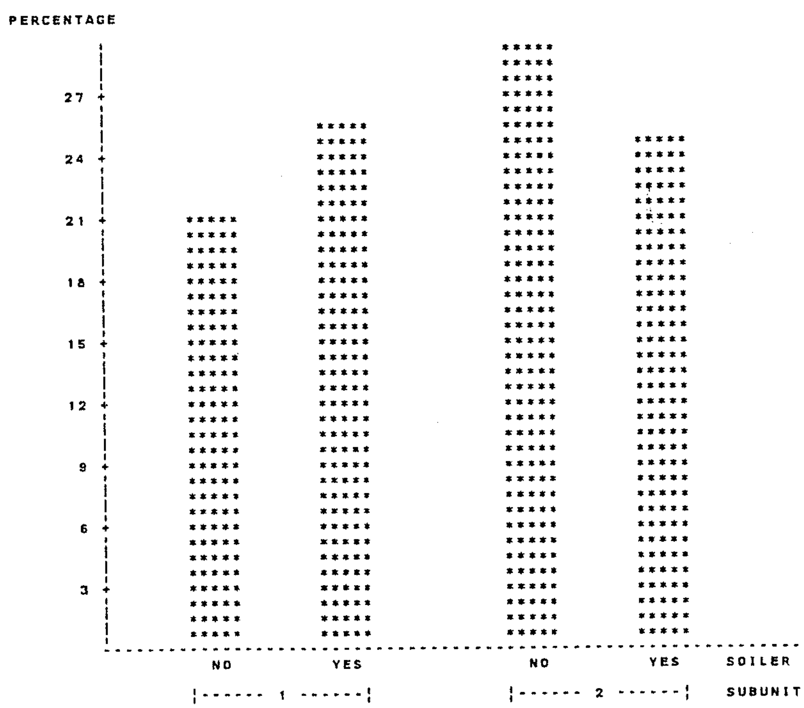
FREQUENCY OF RESPONSES TO SOILER QUESTION FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



SOILER - refers to question Ca which asks if the farmer thought he had significant soil erosion on his farm or not.

GRAPH 21

PERCENTAGE OF RESPONSES TO SOILER QUESTION WITHIN EACH SUBUNIT



In both subunits the majority of farmers who practice soil erosion control methods plan to leave their farms to a family member (Graph 22). This observation is reflected in Graph 23. One may conclude that a farmer planning to leave the farm to a family member (as opposed to those who do not) is more willing to institute conservation practices.

For all practices, except cover cropping, it is apparent that more farmers in subunit two (as compared to one) think they would use more conservation techniques if various incentives are provided (Graph 24).

The various government assistance programs or incentives that are mentioned by the farmers (corresponding percentages indicated) are as follows:

1. zero tillage - public education via demo plots, seminars, field trips, etc. (90%)
   - supply the seeder (30%)

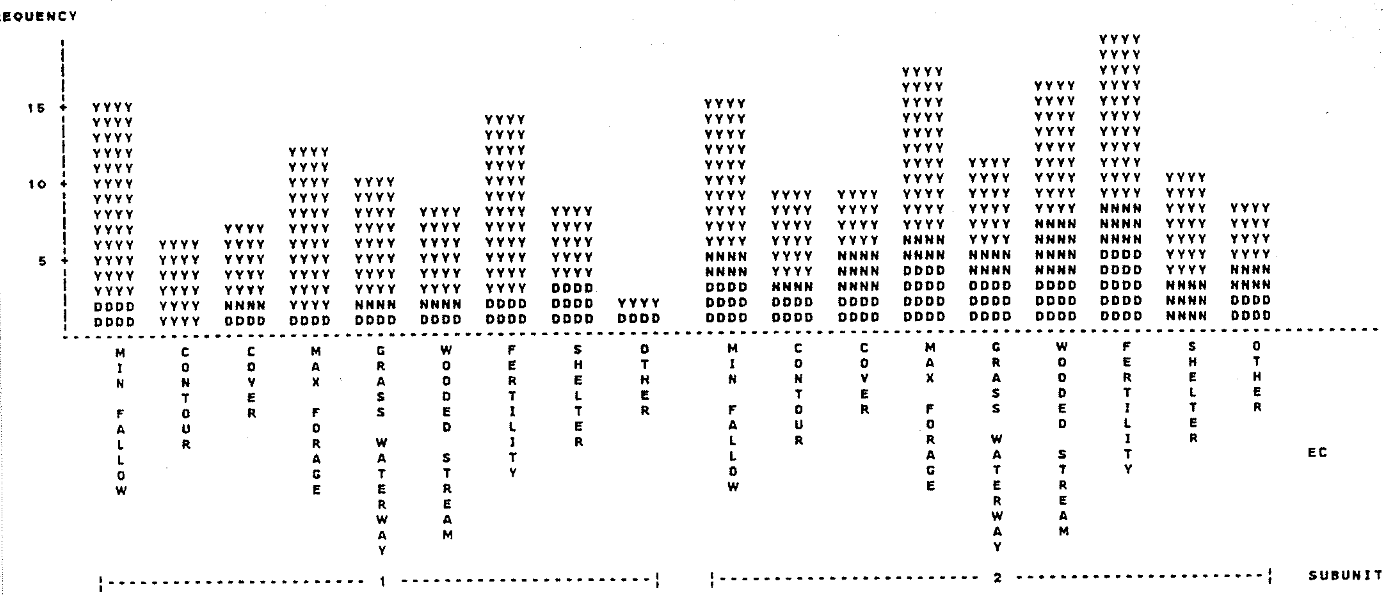
2. minimum fallow - reduce the price of fertilizer (30%)
   - education and management advice (30%)
   - illustrate economics (30%)

3. contour tillage - public education (80%)

4. forages - stabilize forage market (30%)
   - better regulatory and review mechanisms associated with the sale of T.R.W.C.D. seed (25%)

GRAPH 22

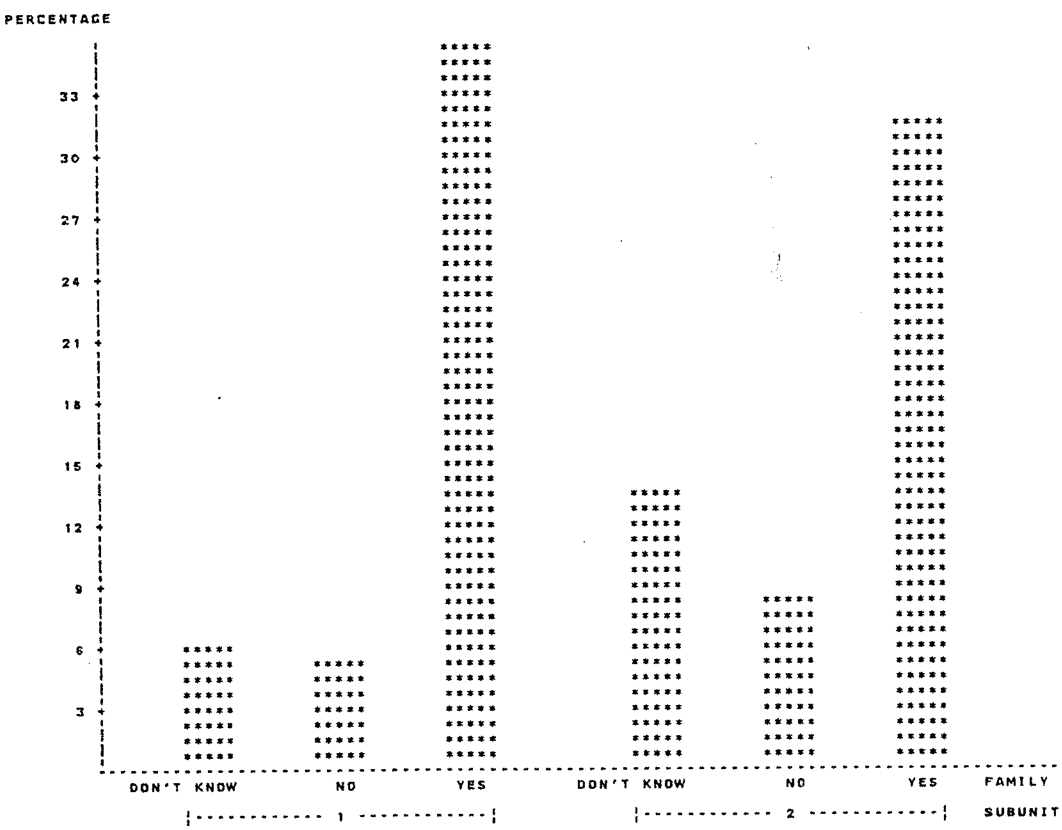
FREQUENCY OF RESPONSES TO FAMILY QUESTION FOR EACH EROSION CONTROL METHOD PRACTICED WITHIN EACH SUBUNIT



FAMILY - refers to Ci which questions if the farmer believes his farm will continue to be operated by a family member after he retires.

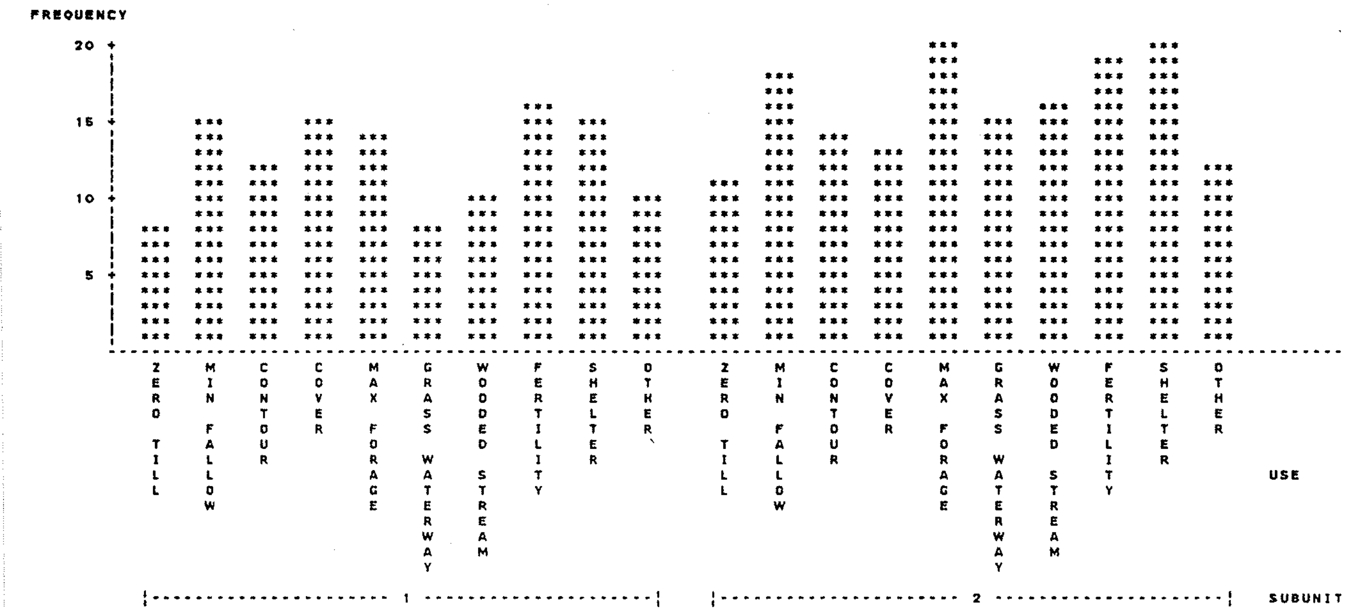
GRAPH 23

PERCENTAGE OF RESPONSES TO FAMILY QUESTION WITHIN EACH SUBUNIT



GRAPH 24

REQUENCY OF FARMERS BY SUBUNIT THAT WOULD USE THE SOIL EROSION CONTROL METHODS IF SPECIFIC INCENTIVES WERE PROVIDED



USE - refers to question Cc which provides information concerning which soil erosion control practices would be used if various government assistance and advice programs or incentives were implemented.

5. cover crops - stabilize market price (50%)
   - technical advice and test plots (30%)

6. grassed waterways - education (72%)
   - have the Board build and farmer mainitain (20%)

7. wooded vegetation along streams - natural is sufficient (44%)
   - disincentive for plowing too close to drains and creeks (25%)

- financial assistance or subsidy on acreages put into buffer zones (17%)

8. fertilizer - reduce price (39%)
   - illustrate economics (public education) (27%)
   - free soil-testing and technical advice (11%)

9. shelterbelts - natural shelterbelts are sufficient (76%)

10. other (tile) - financial assistance (37%)
    - public education (26%)
    - more research (26%)

    (burning) - disincentive (60%)

Several of the farmers (9%, generally the older ones) feel no government assistance should be offered to induce the utilization of erosion control methods.

Almost every farmer (40 of 43 or 93%) in subunit one mentioned that public education is lacking. Various farmers are concerned about market prices and quotas for several products such as fall rye and, in some cases, hay. There appears, however, to be a general consensus that if the on-farm environmental or economic benefits could be illustrated via demonstration plots, field trips, seminars and slide presentations, then more farmers would be willing to adopt or incorporate appropriate conservation practices.

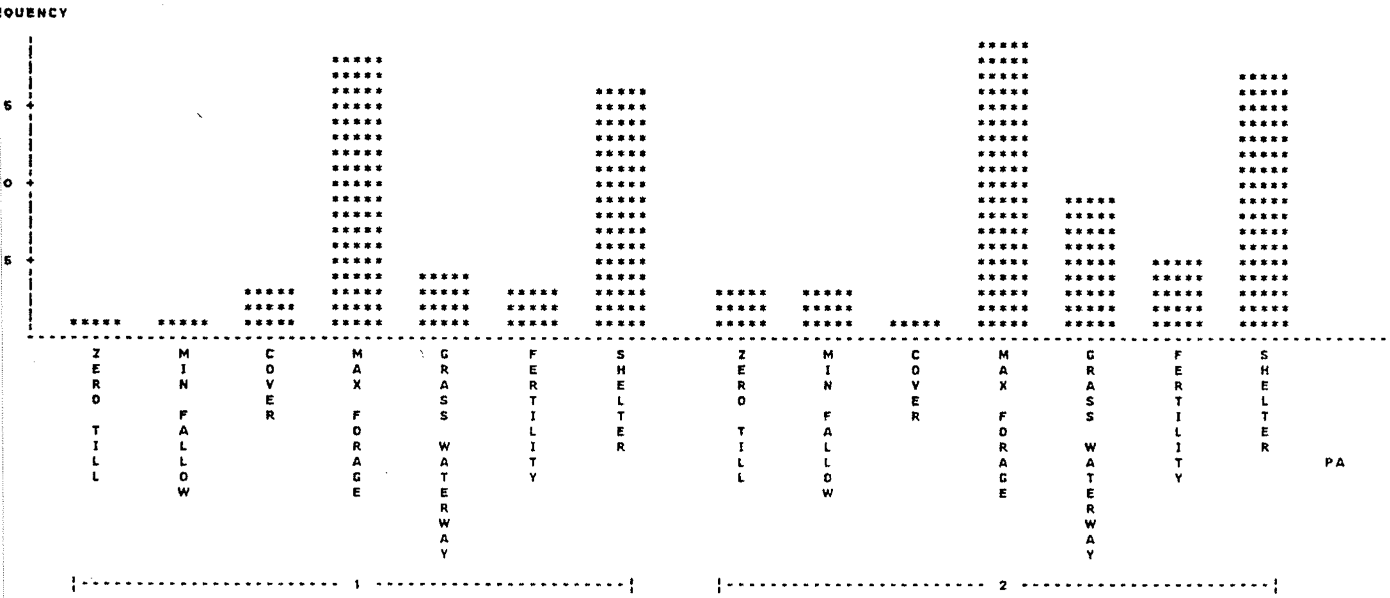
Many farmers (25 of 43 or 58%) stated they would prefer that a local resident direct or participate in such educational programs. According to these farmers, the subescarpment region has unique properties, characteristics and difficulties, consequently the region could not be readily understood by a nonlocal resident. The farmers consider a nonlocal resident to be one who has not resided in or around the area for at least one or two years.

In both subunits most farmers are aware of three government assistance programs: forage seed assistance (86% aware), shelterbelts (77% aware) and Gully Stabilization (30% aware) (Graph 25). This observation may be a result of the fact that these are the three most well-developed government assistance programs. The percentage of farmers aware of other government assistance programs ranges from 19% for adequate use of fertilizer to 8% for zero tillage, minimum use of summerfallow, and cover crops.

Most farmers in both subunits aware of government assistance programs participate in them (Graph 26). Eighty-six percent of farmers are aware of the maximum use of forage program, while 51% participate in it. For the shelterbelt program, 77% are aware and 49% participate. Although 30% of farmers are aware of the grassed waterways program, only 5% participate in it.

GRAPH 25

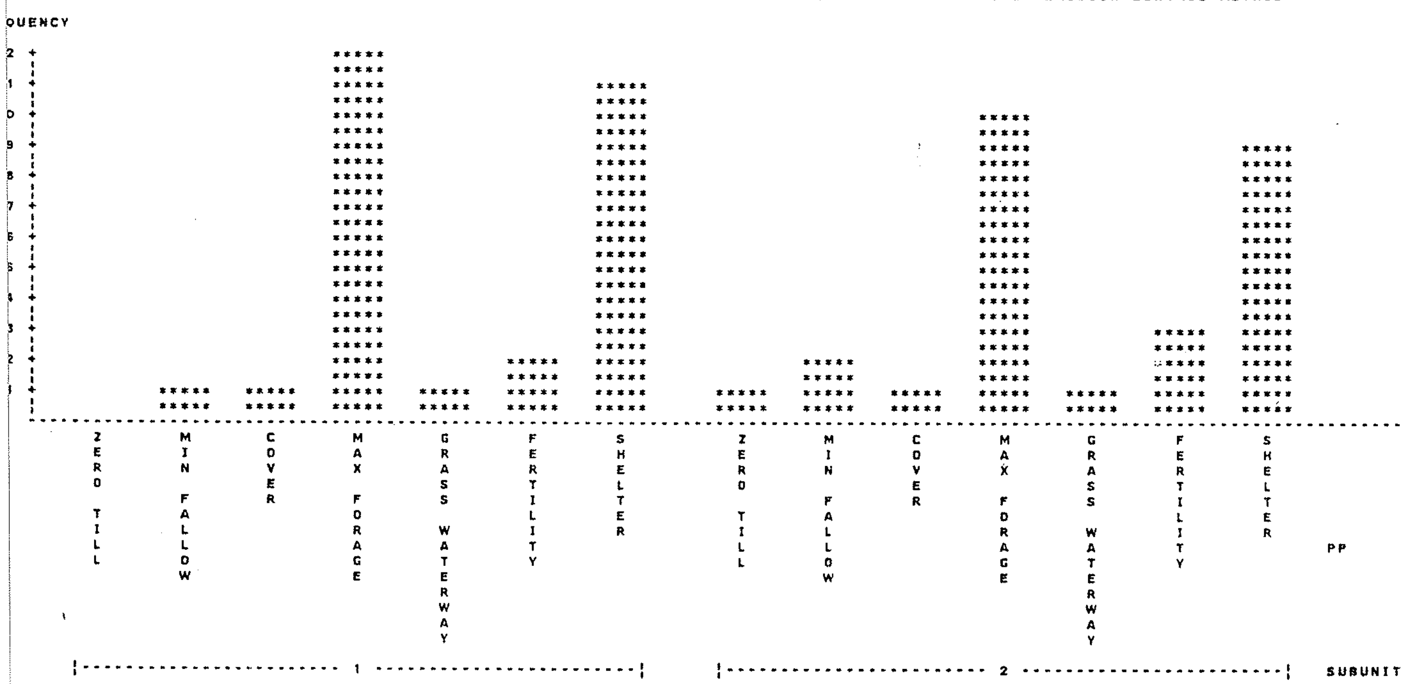
FREQUENCY OF FARMERS BY SUBUNIT THAT ARE AWARE OF GOVERNMENT ASSISTANCE PROGRAMS FOR EACH EROSION CONTROL METHOD



PA and PP - refer to question Bc which evaluates the farmers awareness and participation in any government assistance programs which exist for the various soil erosion control practices.

GRAPH 26

FREQUENCY OF FARMERS BY SUBUNIT THAT PARTICIPATE IN THE GOVERNMENT ASSISTANCE PROGRAMS FOR EACH EROSION CONTROL METHOD



Government assistance programs for the other erosion control practices are not utilized to a large extent. This may be due to the relatively low incentive that these programs offer.

More farmers in subunit two presently practice and would practice conservation techniques compared to those in subunit one. This may be related to the observations that a larger percentage of farmers in subunit two (as compared to one):

1. are 42-57 years old;
2. have high school education;
3. have relatively high economic indicators;
4. have been on their farms 26-57 years;
5. have farmed for only 6-20 years; and
6. feel they have no significant soil erosion on their farm.

The questionnaire provided a chance for farmers to describe other conservation techniques that have proven useful. They are as follows:

1. buffer zones;
2. strip farming;
3. forage rotation; and
4. when summerfallowing is necessary - leave sufficient time in the fall for the field to grow in with volunteer vegetation as this will bind the soil and prevent erosion in the winter and spring.

5.2 ECONOMIC ANALYSIS

Farms are classified according to the dominant cultural practices utilized in 1982.

As noted in chapter III, the other erosion control techniques (grassed waterways, woody vegetation along streams, shelterbelts, contour tillage, and tile drainage) could not be practically analyzed with the Budgetary Crop Simulator program. Tables 5 and 6 illustrate the economic results of the various farm classes for the farms within subunit one and subunit two, respectively. The economic indicators are simply estimates that illustrate the relative economic status of a farm in terms of the farmer's returns per acre to labor and management for a given year. These indicators are determined by the Budgetary Crop Simulator program, by subtracting total costs of production (excluding operator labor and management) from the gross returns (Longmuir *et al.*, 1978:34).

Upon analyzing the economic data for the entire sample population, several observations are noted. First, there appears to be a wide variety of possible economic indicators ($-37.79 to $126.34) which is quite normal for this type of analysis. This wide variation exists because:

a) farmers' incomes are variable due to yield and price fluctuations. They do not obtain returns to investment nor recover depreciation costs every year;

Table 5

Economic (dollars) and classification results for the farms within subunit one

Subunit One			
Farm Class	Returns per acre to Labor and Mngt	Farm Class	Returns per acre to Labor and Mngt
Conventional	-5.45 *	Min. Fallow	27.05
Cover	-30.11	Conventional	-14.30 *
Forage	21.85	Forage	29.32
Forage	-.77	Min. Fallow	16.91 *
Conventional	-17.08	Composite	8.34
Forage	-11.01	Composite	-15.92
Conventional	10.53	Composite	- 1.09 *
Min. Fallow	21.17 *	Min. Fallow	- 4.55 *
Composite	40.80	Forage	- 9.89 *
Min. Fallow	4.54	Composite	38.50
Min. Fallow	-30.53		
Subunit One Average			
3.69			
Average for Entire Study Area			
19.28			

* typical farms of this classification

Table 6

Economic (dollars) and classification results for the farms within subunit two

Subunit Two			
Farm Class	Returns per acre to Labor and Mngt	Farm Class	Returns per acre to Labor and Mngt
Conventional	-34.97	Conventional	-11.68 *
Cover	15.00 *	Conventional	-19.82 *
Forage	-13.12	Forage	1.99
Forage	-3.18 *	Min. Fallow	113.54 *
Min. Fallow	33.78 *	Composite	9.29
Forage	12.80 *	Composite	-37.79
Composite	16.20	Composite	- 2.72
Min. Fallow	60.37 *	Conventional	-12.29 *
Composite	16.50	Forage	23.43 *
Min. Fallow	28.51 *	Conventional	32.72
Composite	-11.81	Min. Fallow	126.34 *
Subunit Two Average			
34.52			
Average for Entire Study Area			
19.28			

* typical farms of this classification

b) the economic indicators are based on one years data (1982) during which relatively low crop prices were incidently experienced. For these reasons various farm operations exhibit a negative return per acre to labor and management. It should be noted, however, that the study area and sample size are large enough to give the conclusions a comfortable degree of reliability.

Second, observations within specific farming categories are noted. The large ranges within each farm grouping indicate that there are large variances in the economic returns attainable within any one farm group. Forage farms, however, appear to be the most stable enterprises in terms of returns to labor and management. Average net returns to labor and management for each subunit and for the study area as a whole were determined by the Budgetary Crop Simulator program. It should be noted however, that these averages are the result of an analysis of weighted inputs and outputs. This weighting effect is based on acreages, thus the weight is dependent upon the size of the farm.

Third, a comparison of the subunit averages demonstrates that subunit two exhibits a higher average economic return to labor and management than subunit one. This observation is apparent despite the fact that both subunits have approximately the same distribution of individual farm classifications. Specific farm enterprises that typically represent the individual farm groupings or categories are illustated by a asterisk (*) in Tables 5 and 6. These farm enterprises are considered to be the best representatives of the farm classification in question.

Various general comments may be established from Tables 5 and 6. First, when considering the entire sample population or even the individual subunits, it may be concluded that, based on the economic indicators, conventional farm enterprises exhibit lower returns to labor and management as compared to the farms that practice some type of conservation tillage.

Second, farms utilizing minimum use of summerfallow are among the farms represented by constantly high returns to labor and management (as indicated by the typical minimum-fallow farms (*) in Tables 5 and 6). It should be noted, however, that minimum-fallow farms also are represented by relatively low returns to labor and management. This wide variance in economic indicators may be due to the varying degrees of managerial skills. Perhaps high returns may be attained if appropriate management decisions are implemented and/or inversely, low returns are inevitable if poor managment decisions are utilized.

Third, maximum use of forages appears to be a relatively stable conservation practice in that the range and extremes noted are significantly reduced compared to other erosion control methods.

Fourth, composite farms and cover-cropping farms are poorly represented by typical enterprises. This fact may indicate that many phases or stages of these farm types are possible. Both categorizations, however, are typically represented by a single farm which correspondingly illustrates below-average economic returns.

The four observations noted above are evident for the entire study area, for each subunit, and for the study area and specific subunit averages.

As no zero-tillage farm was found in the study area, economic data for zero-tillage enterprises were obtained from other economic studies. Economic indicators for ten zero-tillage farms (based on 1982 data) across Manitoba were available (from the Department of Agricultural Economics, University of Manitoba). The returns to labor and management for various selected zero tillage farms across Manitoba are as follows:

1. $-37.99;
2. $-33.31;
3. $-21.65;
4. $-57.97;
5. $-1.01;
6. $-21.52;
7. $-28.63;
8. $1.42;
9. $32.63; and
10. $18.01.

The farms represented by the first seven returns had approximately 33% of the farm in zero till while the remaining three farms had all fields in zero till.

The farm enterprises which were one-third in zero tillage attained relatively low returns to labor and management. The farm enterprises that were completely devoted to zero till attained relatively high returns to labor and management. One may conclude then that farm enterprises converted entirely to zero tillage are more economical than those that are only one-third zero tillage.

When comparing the zero-tillage farms (data extracted from external sources) to the farms sampled in the study area, two observations become apparent:

1. farm enterprises one-third in zero tillage exhibit returns to labor and management below the subunit and study area averages; and

2. farm enterprises entirely in zero tillage illustrate returns to labor and management that are equivalent and, in some cases, above most conventional-tillage and many conservational-tillage farms.

5.3 CHAPTER SUMMARY

The social data were analyzed using various S.A.S. programs. More farmers in subunit two presently practice and would practice soil erosion control methods as compared to subunit one.

Zero tillage was the one soil erosion control technique not practiced in the study area. Generally, older farmers (ages 58-75) use shelterbelts. The number of years a farmer has been on his present farm, the number of years a farmer has farmed, education, and gross income are variables that do not appear to affect which conservation practices are utilized.

Most farmers (percentages are indicated in brackets) who practice soil erosion methods feel that:

1. they are not influenced by what their neighbors feel about their farming practices (86%);

2. if they started using more conservation techniques, their friends and neighbors would not look down on them (88%);

3. they would engage in more conservation techniques if everyone else in the neighborhood did likewise (67%);

4. they will be leaving their land (soil) in as a good a condition as when they started farming it (84%); and

5. the farm will likely be taken over by a family member when they retire (65%).

Most farmers (in both subunits) aware of government assistance programs participate in them.

The various conclusions arising from this chapter are discussed in Chapter VI. Recommendations arising from the conclusions are also presented in the next chapter.

Chapter VI

CONCLUSIONS AND RECOMMENDATIONS

The encroachment of agriculture into the subescarpment of the T.R.W.C.D. has created a need to analyze techniques that can reduce soil-water management problems. The soil-water management techniques evaluated were zero tillage, minimum use of summerfallow, contour tillage, cover crops, maximum use of forages, grassed waterways, woody vegetation along streams, adequate (optimal) fertilizer application, and shelterbelts. The major soil-water management problems found in the subescarpment include erosion, decreased agricultural productivity, pollution of drains, and overgrazing.

This chapter presents conclusions based on the results of the environmental, social, and economic analyses of the various remedial agricultural techniques that may ameliorate the soil-water management problems.

These techniques have been incorporated into a set of priorized management guidelines or recommendations that may be used in the development of a soil-water management plan for the subescarpment of the T.R.W.C.D.. This chapter also provides a list of recommended areas for further study.

6.1 CONCLUSIONS

6.1.1 Conclusions Regarding Public Attitudes and Other Concerns

1. Farmers in the study area are not influenced by what their neighbors feel about their farming practices. Most farmers however, are interested in the practices adopted by other farmers because new techniques that are demonstrated to be economically viable could also prove feasible on their farm.

2. Most farmers do not notice any appreciable amount of erosion on their land. If this is in fact the case, then most problems with soil erosion are resulting from a small population.

Sixty-five percent of the farmers are concerned with leaving their farm to a family member. This leads them to attempt to improve agricultural productivity and decrease erosion by utilizing conservation practices.

3. There appears to be a need for a wildlife buffer zone around R.M.N.P. to reduce erosion and act as a depredation buffer. There are problems with non-point sources of pollution (sediment, manure) and with overgrazing of pasture lands which result in erosion.

6.1.2 Technique-Specific Conclusions

Upon combining the results of the environmental effectiveness, social acceptability, and economic feasibility data, one may list the conservation techniques in order of their probability of being incorporated within the study area. Such a list represents a priorization of the cultural techniques that government agencies may focus upon when implementing projects, programs, and policies within the subescarpment of the T.R.W.C.D.. The techniques comprising this list are discussed in descending order of priorization.

1. As shown in the study area, minimum use of summerfallow, when used in conjunction with adequate fertilizer application, is effective in improving the soil's productivity while increasing economic returns.

2. Adequate fertilizer applications, when used in conjunction with minimum use of summerfallow, are used to conserve the soil while increasing yeilds. Some farmers are unable to apply the preferred amounts of fertilizer because of the high initial capital outlay and because of the unstable grain markets.

3. The forage seed assistance program of the T.R.W.C.D. is being used by 86% of the farmers sampled. Although maximum use of forages is a socially acceptable, environmentally effective and an economically reliable erosion control technique, non-livestock oriented farmers are reluctant to use it because of the unstable nature of the forage market. The unstable forage market may act as a deterent for forage production if the forage seed assistance program is abolished or phased out.

4. Grassed waterways are not being implemented in the study area because of the lack of public awareness and stringency in eligibility associated with the T.R.W.C.D. Gully Stabilization program. There is also a lack of public education concerning the on-farm benefits of grassed waterways.

5. Natural vegetation is a sufficient buffer to erosion along streams. There is a problem however, with the lack of a vegetative buffer zone along drains and creeks. Although these buffer zones take land out of production, they are environmentally beneficial to the farmer and the public in general and often maintain agricultural productivity.

6. Natural field shelterbelts are sufficient to control erosion. Man planted shelterbelts are not required because field shelterbelts trap moisture thus enhance the problem of excessively high water tables.

7. Cover cropping is an environmentally effective erosion control technique and has been used in the study area to avoid problems with spring seeding in excessively moist soils. Cover crops however, have exhibited unstable market prices, low returns (per unit input), and various operational problems (such as freezing and disease) thus have not been socially acceptable in the study area.

8. Although contour tillage contributes to soil erosion control while requiring relatively little economic input from the farmer, only 35% of the farmers sampled used this

technique because they perceived the technique to be of limited usefulness.

9. Zero tillage is shown (from outside data) to be an economically feasible and environmentally effective technique especially if the entire farm is in zero till. Despite this fact, zero till is not practiced by any farmer in the study area because they feel that the land is too heavy and wet. The literature supports the farmers of the study area as there is a consensus that zero-tillage farms are not feasible on soils characterized by a high water table.

10. Tile drainage is a conservation technique that can increase productivity by lowering the water table but is not feasible because of the high initial investment costs. Many farmers are averse to the practice of stubble burning as a conservation technique.

6.1.3 Subunit-Specific Conclusions

1. The study area was divided into three subunits. Subunit one has more annual crops and summerfallow but less woodland compared to subunit two. Subunit one is composed of poorly drained, clay-loamy soils which have an organically rich A horizon. These soils are generally quite productive for agriculture.

2. The soil in subunit two is silty loam thus can be productive but is very susceptible to erosion. Subunit two has moderate limitations based on adverse topography and exces-

sive water. More farmers in subunit two (as compared to one) have a higher education, illustrate relatively high economic returns, and are less hesitant to accept various erosion control techniques.

3. Subunit three soils are not very productive and are prone to erosion due to the poor soil type and adverse topography.

6.2 RECOMMENDATIONS

6.2.1 Recommendations Regarding Public Attitudes and Other Concerns

1. When instituting policy, the implementing agency should focus the crux of the policy into on-farm economic and environmental benefits. Projects and programs resulting from these policies may most effectively promote conservation if developed as demonstration plots.

2. A district wide soil analysis program should be promoted to evaluate the status of the land's productivity because inadequacies in soil structure, nutrient levels, and organic matter, if brought to the attention of the land owner, may spark interest in conservation techniques.

3. Development and preservation of woodlands and other wildlife habitat should be developed along the R.M.N.P. boundary (subunit one and two) to act as a buffer between the park and surrounding agricultural land. Policies should be developed to educate and enforce landowners in eliminating the release of various non-point sources of pollution

(including sediment) into public drainage channels throughout the watershed. Information concerning improved grazing systems for private owners should be developed and promoted throughout the district.

6.2.2 Technique-Specific Recommendations

1. A financial assistance program for minimum tillage should not be developed but rather attention should be focused on public education and technical assistance. A demonstration site should be developed to illustrate the economic and environmental benefits of the minimum use of summerfallow.

2. Public education concerning the economics of fertilizer application should be increased through the use of a demonstration plot. Free soil testing services should be provided as an incentive to farmers to implement or adopt various conservation techniques.

3. The T.R.W.C.D. should continue their forage seed assistance program as they have in the past. If this program is phased out, monitoring of the maximum use of forage activities should be instituted.

4. The T.R.W.C.D.B. should publicize, review, and perhaps revise its present Gully Stabilization program to expand the number of farmers that may be eligible.

5. The T.R.W.C.D., in conjunction with the Water Resources Branch and the Department of Agriculture, should insti-

tute a policy that will promote the development of buffer zones and encourage natural growth along streams. A demonstration site should be developed to illustrate the on-farm benefits of various types of buffer zones.

6. The T.R.W.C.D.B. should not provide assistance for the establishment of field shelterbelts but rather promote the preservation of existing natural shelterbelts. Although these natural shelterbelts trap snow thus increase moisture problems in the area they also reduce runoff, inhibit wind erosion, and provide diversity essential for wildlife habitat. It should be noted that the decision to establish or promote shelterbelts (natural or man planted) is a site specific decision.

7. A program should be developed that will advance the availability of technical and managerial advice regarding the incorporation of cover crops as a management technique. Such a program will be directed at enhancing the social acceptability of cover crops.

8. Various educational programs should be developed to demonstrate the environmental and economic implications of contour tillage while suggesting other conservation techniques that may be implemented concurrently.

9. Zero tillage should not be promoted until its environmental effectiveness and economic feasibility in heavy wet soils are proven in the study area.

10. The economic feasibility and environmental effectiveness of tile drainage should be determined by evaluating the operations of the present T.R.W.C.D. tile drain demo site or by evaluating the information extracted from farming records of enterprises in the subescarpment that presently use tile drain. A policy should be established to discourage non-conservation oriented practices such as stubble burning.

For effective land management, two or more conservation techniques are usually integrated into one farming system or cropping year. For this reason, it is suggested that demonstration sites incorporate an integration of conservation techniques. Such integrated sites may be distributed throughout the study area but it suggested that for efficient demonstration purposes, a conservation farm(s) be developed in the study area. This farm would illustrate the results of combined conservation strategies.

6.2.3 Subunit-Specific Recommendations

1. Educational programs should be concentrated in subunit one. Conservation techniques such as the minimum use of summerfallow will prove very beneficial in reducing stone picking costs, improving moisture holding capacity, and inhibiting erosion, while not requiring major impositions on presently existing management skills.

2. More environmentally effective and management demanding conservation techniques should be encouraged in subunit

two. Minimum use of summerfallow, maximum use of forages, adequate fertilizer application, and even tile drainage and zero tillage test plots would be most practically initiated in subunit two.

3. Farmers should maintain a continuous or annual vegetative base in subunit three because of this area's vulnerability to erosion. Properly managed grazing systems, maximum of forages and wildland development should be encouraged by the T.R.W.C.D. in subunit three.

6.3 FURTHER STUDIES

Deficiencies and inadequacies in the literature have indicated that the following studies should be done, funded or assisted by the T.R.W.C.D. or other related government departments to ensure Manitoba's productive land base is maintained:

1. evaluate the appropriateness of specific areas as demonstration sites in the Turtle River Watershed Conservation District;

2. evaluate and implement improved public extension and education services related to soil and water conservation;

3. develop a soil-water management plan for the lowland region;

4. evaluate strategies to stabilize local markets for cover crops, forages, and for cereal grains;

5. evaluate the economic feasibility and environmental effectiveness of tile drainage in the subescarpment region;

6. study the feasibility of other conservation techniques such as under cut tillage; and

7. the Manitoba Conservation Districts Association should improve communications (eg. bulletins, memos, meetings) among the conservation districts to broaden the information base regarding the effectiveness and applicability of various conservation techniques, policies, programs and institutions; and

8. as soil is a finite resource, a study should be initiated that will assess the critical economic and environmental threshold at which society will be forced to implement soil and water conservation measures.

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Appendix A

TURTLE RIVER WATERSHED CONSERVATION DISTRICT

July 4, 1983

Dear Sir:

I am conducting a study on soil erosion on the east side of Riding Mountain National Park. One phase of this study is to determine which agricultural practices reduce soil erosion and are economically and socially feasible for the farmer to encorporate.

This data will be gathered in mid July to early August by collecting valuable information and opinions from landowners within my study area (See enclosed map). These landowners will be asked to contribute their knowledge and expertise during a brief visit from myself.

Data collected from the landowners will be integrated into a report in early 1984 to assist the Turtle River Watershed Conservation District develop effective soil - water management programs, with a goal of reducing soil erosion in your district and surrounding areas.

Your cooperation will greatly be appreciated. I look forward to meeting with you soon. If you have any questions or require further information please contact me at:

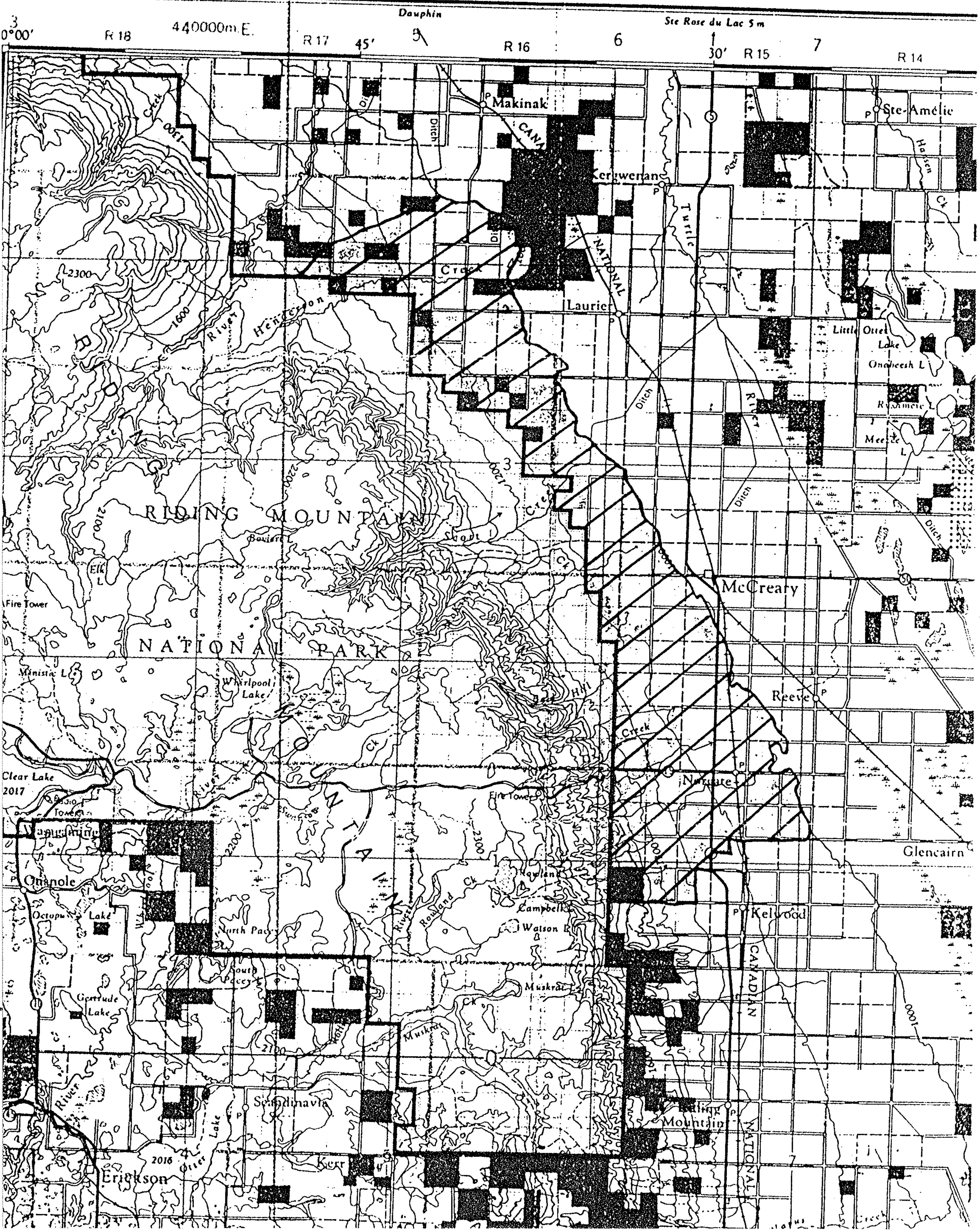
Box 253
Dauphin, Manitoba
R7N 2V1
638-7444

Gratefully yours,

Greg Bruce

Greg Bruce

1:250,000


Dauphin
Ste Rose du Lac 5 m
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Turtle
NATIONAL
Laurier
Henderson
Creek
River
Little Otter Lake
Onobeesh L
Rushmere
Meese L
Ditch
RIDING MOUNTAIN
NATIONAL PARK
McCreary
Fire Tower
Elk L
Whirlpool Lake
Ministic L
Reeve
Clear Lake
2017
Neepawa
Glencairn
Onanole
Octopus Lake
Rowland Ck
Campbell L
Watson L
North Pacy
South Pacy
Gertrude Lake
Kelwood
CANADIAN
Muskrat
Scandinavia
Riding Mountain
NATIONAL
Otter Lake
Erickson
Kerr
2016
2300
2100
2200
1600
1300
1200
1000

Appendix B

INTERVIEW QUESTIONNAIRE

SOIL EROSION RESEARCH

A. INTRODUCTION

a) Name of Farmer ____________________

b) Municipality of majority of land ____________________

c) Legal description of farmyard Qtr _____ Sec _____ Twp _____ Rge _____

d) Telephone ____________________

e) Date ____________________

B. PRESENT LAND USE AND CONSERVATION PRACTICE

a) Improved Lands:

	Acres
-Cropland in Annual crops	______
-Summerfallow	______
-Forages	______
-Farmyard & Miscellaneous	______
Unimproved Lands:	
-Woodland	______
-Native hay & pasture	______
-Other	______
TOTAL	______

b) Please state where any of the following soil erosion control methods are practiced; and reasons why or why not utilized:

Practice	Location	Reason(s)
Zero Tillage		
Minimum use of Summer-fallow		
Contour tillage		
Cover crops		

Practice	Location	Reason(s)
Maximum of forages		
Grassed Waterways		
Woody vegetation along streams		
Good Fertility		
Shelterbelts		
Other (Please specify)		

c) Are you aware of government assistance including Turtle River Watershed Conservation District in the following land use practices? Which, if any, did you participate in?

Practice	Aware Y/N	Participate Y/N
Minimum tillage		
Minimum use of Summerfallow		
Contour tillage		
Cover crops		
Maximum of forage		
Grassed waterways		

Practice	Aware Y/N	Participate Y/N
Woody vegetation along streams		
Good fertility		
Shelterbelts		
Other (Please specify)		

C. OPINIONS:

a) Do you have any significant soil erosion on your farm?
No ________ Yes ________ If yes, where ________________________________
____

b) What would be required from the government or TRWCD before making the previously stated erosion control practices worthwhile?

Practice	Financial assistance of Technical Advice from the government and/or TRWCD
Minimum tillage	
Minimum use of Summer-fallow	
Contour tillage	
Cover crops	
Maximum of forages	
Grassed waterways	

Practice	Financial Assistance etc.
Woody vegetation along streams	
Good fertility	
Shelterbelts	
Other (Please specify)	

c) Would you specifically use these practices if such assistance or advice was available?
No ________ Yes ________
Which ones and why? ____

d) What else would provide incentives to encourage farmers to use such conservation techniques?

e) Do you think that if you started using some soil conservation practices that certain friends and neighbours will "look down" on you?
Yes ________ No ________

f) Would you engage in more conservation practices if everyone else in the neighbourhood did likewise?
Yes ________ No ________ Which ones? ______________________________

g) Do you care what your neighbours think about your farming practices?
Yes ________ No ________

h) Will you be leaving the land (soil) in as good a condition as when you started farming it? ______________________________

i) Do you believe that this farm will continue to be operated by a family member after you retire?
Highly likely ________ Not likely ________ Don't know ________

D. PERSONAL

a) Age ________

b) Number of years on present farm?

c) Number of years you have farmed?

d) Education:

Elementary ________	Completed University
Some High School ________	-non-agriculture
Completed High School ________	-agriculture degree
Some University	-agriculture diploma
-Non-agriculture	
-agriculture	

e) Approximate yearly income?

E. ECONOMIC

Machinery (Crops) Inventory

Machine Type	Inventory No.	Year	Size	Owned Rented Custom	Type	Tractor Inventory No. If Applicable
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					

(Continued)

Machinery (Crops) Inventory (Continued)

Machine Type	Inventory Number	Year Manufac-tured	Year Purchased	Size	Owned Rented Custom	Type and Special Machinery Options	Tractor Inventory No. if Applicable
	25						
	26						
	27						
	28						
	29						
	30						
	31						
	32						
	33						
	34						
	35						
	36						
	37						
	38						
	39						
	40						
	41						
	42						
	43						
	44						
	45						
	46						
	47						
	48						
	49						

(Continued)

Machinery (Crops) Inventory (Continued)

Machine Type	Inventory Number	Year Manufac-tured	Year Purchased	Size	Owned Rented Custom	Type and Special Machinery Options	Tractor Inventory No. if Applicable
	50						
	51						
	52						
	53						
	54						
	55						

TRACTORS USED IN LIVESTOCK

If any tractors specified in the master machinery list were used in a livestock enterprise, indicate the number of hours the tractors were used in the livestock enterprise for the year. Use the inventory number of the tractor given in column two of the master machinery list to identify the tractor. It should be noted that these tractor hours were associated exclusively with the livestock enterprise being in addition to tractor hours associated with baling, forage and pasture maintenance operations.

Tractor Inventory Number	Hours of Annual Use
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________

Land Inventory

Crop Grown in 1982	Inventory Number	Size (acres)	Stubble or Fallow	Owned/Rented
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			
	14			
	15			
	16			
	17			

(Continued)

Land Inventory (Continued)

Crop Grown in 1982	Inventory Number	Size (acres)	Stubble or Fallow	Owned/Rented
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			
	26			
	27			
	28			
	29			
	30			
	31			
	32			
	33			
	34			

(Continued)

Land Inventory (Continued)

Crop Grown in 1982	Inventory Number	Size (acres)	Stubble or Fallow	Owned/Rented
	35			
	36			
	37			
	38			
	39			
	40			
	41			
	42			
	43			
	44			
	45			
	46			
	47			
	48			
	49			
	50			

TOTAL ACRES .... ________

CROP PRACTICES (Grain, Oilseed and Summerfallow)

	CROP:			
1.	Item — Field Inventory #			
	Total acres seeded			
	Soil type (specify light, medium, or heavy)			
	Average distance to storage (on farm) (miles)			
	Average distance from storage to market (in miles)			
	Yield in 1982 (units)			
	Quality of crop (specify grade)			
	Yield of harvested straw			
	Acres of harvested straw			
2.	Insurance			
	Hail (coverage/acre)			
	Crop (coverage option - 50%, 60%, or 70% and dollar option - low or high)			
	Value of claims in 1982			
	Number of acres claimed on			
	Indicate any other crop insurance coverage and claims on this field in 1982, if applicable			
3.	Seed			
	Seed Class: Commercial, Certified or Other			
	Cost of Seed (optional)			
	Seeding rate (optional)			
	Seed treatment (chemical used)			
	If reseeding was done in 1982, indicate previous seeding and seed types			

4. Fertilizer (Include previous fall application)

Analysis of 1st application	______	______	______
Application Rate	______	______	______
Method of application	______	______	______
Analysis of 2nd application	______	______	______
Application Rate	______	______	______
Method of Application	______	______	______
Analysis of 3rd application	______	______	______
Application Rate	______	______	______
Method of Application	______	______	______

5. Weed Control[1] (Include previous fall application)

Chemical(s) Used in First Application	______	______	______
Number of Acres[2] Treated	______	______	______
Rate of Application if other than Recommended Rate	______	______	______
Chemical(s) Used in Second Application	______	______	______
Number of Acres Treated	______	______	______
Rate of Application if other than Recommended Rate	______	______	______
Chemical(s) Used in Third Application	______	______	______

---

[1] Specify whether liquid or granular form of a chemical was used (i.e., liquid or granular Treflan).

[2] If less than the whole field was treated.

Number of Acres Treated			
Rate of Application if other than Recommended Rate			

6. Insect Control

First Chemical Used			
Number of Acres Treated			
Rate of Chemical Application			
Second Chemical Used			
Number of Acres Treated			
Rate of Chemical Application			

7. Miscellaneous

8. Fall Tillage and pre-seeding practices

- please list all operations over the fields from previous harvest to seeding; specify implement used (i.e., plow, cultivator H.D., cultivator L.D., disc, harrows, sprayer) by indicating inventory number or implement name and number of times over. If the field was summerfallowed the previous year then no fall cultivations are included.

If the field is summerfallowed, indicate all the 1982 practices as well as all last fall's post harvest operations.

9. Seeding (i.e., press drill, packers)

10. Post-seeding (i.e. weed sprayer, row crop cultivator, harrows)

11. Harvesting (cereals and oilseeds)

Indicate Swather(s) used

Indicate Combine(s) used

Indicate Truck(s) used

Indicate Other

12. Expected Drying (if applicable)

No. of bushels dried

Moisture level before drying

Moisture level after drying

Cash costs per bushel (optional)

13. Harvesting (potatoes, sugarbeets, etc.)

Indicate Windrower(s) used	________	________	________
	________	________	________
Indicate Harvester(s) used	________	________	________
	________	________	________
Indicate Truck(s) used	________	________	________
	________	________	________
Indicate Binpiler(s) used	________	________	________
	________	________	________
Indicate Other ________	________	________	________
________	________	________	________

14. Harvesting (straw)

Indicate Baler(s) used	________	________	________
(Please list the equipment used to bring the straw to storage).	________	________	________
	________	________	________

FORAGE PRACTICES

CROP:			
1. Description Field Inventory #			
Total acres seeded			
Soil type (specify light, medium, or heavy)			
Average distance to storage (on farm) (miles)			
2. Yield			
1st cut			
(i) Yield in 1982 (units)			
(ii) Round or square bales?			
(iii) Bale weight (in lbs.)			
2nd cut (if applicable)			
(i) Yield in 1982 (units)			
(ii) Round or square bales?			
(iii) Bale weight (in lbs.)			
3rd cut (if applicable)			
(i) Yield in 1982 (units)			
(ii) Round or square bales?			
(iii) Bale weight (in lbs.)			
3. Fall grazing in 1982 (if applicable)			
(i) No. of beef calves X No. of days			
(ii) No. of dairy calves X No. of days			
(iii) No. of steers or heifers X No. of days			
(iv) No. of beef cows and bulls X No. of days			
(v) No. of dairy cows and bulls X No. of days			

4. Insurance

Hail (coverage/acre) ______ ______ ______

Crop (coverage option--50%, 60% or 70% and dollar option-low or high) ______ ______ ______

Value of claims in 1982 ______ ______ ______

Number of acres claimed on ______ ______ ______

5. Seed

Commercial, Certified, or Other ______ ______ ______

Forage mix ______ ______ ______

Rotation length: Number of years of productive stand expected before breaking ______ ______ ______

Cost of seed (optional) ______ ______ ______

Seeding rate (optional) ______ ______ ______

Seed treatment (chemical used) ______ ______ ______

6. Fertilizer (include previous fall application)

Analysis of 1st application ______ ______ ______

Application Rate ______ ______ ______

Analysis of 2nd application ______ ______ ______

Application Rate ______ ______ ______

Analysis of 3rd application ______ ______ ______

Application Rate ______ ______ ______

7. Weed Control (include previous fall application)

First chemical used ______ ______ ______

Number of acres[1] treated ______ ______ ______

Rate of application ______ ______ ______

[1] If less than the whole field was treated.

Second chemical used ______ ______ ______

Number of acres treated ______ ______ ______

Rate of application ______ ______ ______

Third chemical used ______ ______ ______

Number of acres treated ______ ______ ______

Rate of application ______ ______ ______

8. Insect Control

First chemical used ______ ______ ______

Number of acres treated ______ ______ ______

Rate of application ______ ______ ______

Second chemical used ______ ______ ______

Number of acres treated ______ ______ ______

Rate of application ______ ______ ______

9. Miscellaneous

______ ______ ______ ______

______ ______ ______ ______

10. Before harvest practices

(i.e. weed sprayer, fertilizer broadcaster) ______ ______ ______

______ ______ ______

______ ______ ______

______ ______ ______

11. Harvesting

- please list all operations over the field from time of 1st cut to the last harvesting operation; specify implement used (i.e., swather [PTO or pull type], mower, rake, baler, hay wagon, bale wagon, hay stacker, stack mover, front-end loader, etc.) Indicate inventory number or implement name.

12. Breaking Practices

- please list normal operations over the field to break the forage in the last year of production (i.e., plow, tandem disc, cultivator, etc.)

SILAGE AND HAYLAGE PRACTICES

CROP: ____ ____ ____

1. Description Field Inventory # ____ ____ ____

Total acres seeded ____ ____ ____

Soil type (specify light, medium or heavy) ____ ____ ____

Average distance to storage (on farm) (miles) ____ ____ ____

2. Yield

1st cut

(i) Yield in 1982 (units) ____ ____ ____

(ii) Moisture content at harvest ____ ____ ____

2nd cut (if applicable)

(i) Yield in 1982 (units) ____ ____ ____

(ii) Moisture content at harvest ____ ____ ____

3rd cut (if applicable)

(i) Yield in 1982 (units) ____ ____ ____

(ii) Moisture content at harvest ____ ____ ____

3. Fall grazing in 1982 (if applicable)

(i) No. of beef calves X No. of days ____ ____ ____

(ii) No. of dairy calves X No. of days ____ ____ ____

(iii) No. of steers or heifers X No. of days ____ ____ ____

(iv) No. of beef cows and bulls X No. of days ____ ____ ____

(v) No. of dairy cows and bulls X No. of days ____ ____ ____

4. Insurance

Hail (coverage/acre)			
Crop (average option-50%, 60% or 70% and dollar option-low or high)			
Value of claims in 1982			
Number of acres claimed on			

5. Seed

Commercial, Certified or other			
Forage mix (haylages)			
Rotation length: Number of years of productive stand expected before breaking (haylages)			
Cost of seed (optional)			
Seeding rate (optional)			
Seed treatment (chemical used)			

6. Fertilizer (include previous fall application)

Analysis of 1st application			
Application rate			
Method of application			
Analysis of 2nd application			
Application rate			
Method of application			
Analysis of 3rd application			
Application rate			
Method of application			

7. Weed Control[1] (Include previous fall application)

Chemical(s) used in first application ________ ________ ________

Number of acres[2] treated ________ ________ ________

Rate of chemical(s) applied, if other than recommended rate ________ ________ ________

Chemical(s) used in second application ________ ________ ________

Number of acres treated ________ ________ ________

Rate of chemical(s) applied ________ ________ ________

Chemical(s) used in third application ________ ________ ________

Number of acres treated ________ ________ ________

Rate of chemical(s) applied ________ ________ ________

8. Insect Control

First chemical used ________ ________ ________

Number of acres treated ________ ________ ________

Rate of application ________ ________ ________

Second chemical used ________ ________ ________

Number of acres treated ________ ________ ________

Rate of application ________ ________ ________

9. Miscellaneous

________________ ________ ________ ________

________________ ________ ________ ________

---

[1] Specify whether liquid or granular form of a chemical was used. (i.e., liquid or granular Treflan).

[2] If less than the whole field was treated.

10. Fall Tillage and pre-seeding practices (silages)
   - please list all operations over the fields from previous harvest to seeding; specify implement used (i.e., plow, cultivator H.D., cultivator L.D., disc, harrows, sprayer, fertilizer broadcaster by indicating inventory number or implement name). If the field was summerfallowed the previous year then no fall cultivations are included.

11. Seeding (silages)
   (i.e., press drill, packers)

12. Post-seeding (silages)
   (i.e., weed sprayer, fertilizer broadcaster, row crop cultivator).

13. Summer practices (haylage)
(i.e., weed sprayer, fertilizer broadcaster)

14. Harvesting

- please list all operations over the field from time of 1st cut to the last harvesting operation; specify implement used (i.e., forage harvester, wagon, truck, front-end loader; etc.) Indicate implement inventory number or implement name.

15. Breaking Practices (haylages)

- please list normal operations over the field to break the forage in the last year of production (i.e., plow, tandem disc, cultivator, etc.)

Crops D-1

FORAGE SEED PRACTICES

CROP:			
1. Description Field Inventory #			
Total acres seeded			
Soil type (specify light, medium, or heavy)			
Average distance to storage (on farm) (miles)			
2. Yield			
Yield in 1982 (units)			
Yield of harvested straw			
Acres of harvested straw			
3. Fall grazing in 1982 (if applicable)			
(i) No. of beef calves X No. of days			
(ii) No. of dairy calves X No. of days			
(iii) No. of steers or heifers X No. of days			
(iv) No. of beef cows and bulls X No. of days			
(v) No. of dairy cows and bulls X No. of days			
4. Insurance			
Hail (coverage/acre)			
Crop (average option-50%, 60% or 70% and dollar option-low or high)			
Value of claims in 1982			
Number of acres claimed on			

5. Seed

Commercial, Registered or Other			
Forage mix			
Rotation Length: Number of years of productive stand expected before breaking			
Cost of seed (optional)			
Seeding rate (optional)			
Seed treatment (chemical used)			

6. Fertilizer (include previous fall application)

Analysis of 1st application			
Application rate			
Analysis of 2nd application			
Application rate			
Analysis of 3rd application			
Application rate			

7. Weed Control (include previous fall application)

First chemical used			
Number of acres[1] treated			
Rate of application, if other than recommended rate			
Second chemical used			
Number of acres treated			
Rate of application, if other than recommended rate			

[1] If less than the whole field was treated.

Third chemical used ______ ______ ______

Number of acres treated ______ ______ ______

Rate of application, if other than recommended rate ______ ______ ______

8. Insect Control

First chemical used ______ ______ ______

Number of acres treated ______ ______ ______

Rate of application ______ ______ ______

Second chemical used ______ ______ ______

Number of acres treated ______ ______ ______

Rate of application ______ ______ ______

9. Miscellaneous

______ ______ ______ ______

______ ______ ______ ______

10. Fall Tillage and pre-seeding practices

- please list all operations over the fields from previous harvest to seeding; specify implement used (indicate inventory number or implement name). If the field was summerfallowed the previous year then no fall cultivations are included.

______ ______ ______

______ ______ ______

______ ______ ______

______ ______ ______

______ ______ ______

______ ______ ______

______ ______ ______

11. Seeding (i.e., press drill, packers)

12. Post-seeding (i.e., weed sprayer)

13. a) Harvesting (forage seed)

Indicate Swather(s) used

Indicate Combine(s) used

Indicate Truck(s) used

b) Expected Drying (if applicable)

Number of bushels dried

Moisture level before drying

Moisture level after drying

c) Harvesting (straw)

Indicate Baler used.

(Please list the equipment used to bring the straw to storage)

14. Breaking Practices (forages)

- please list all operations over the field to break the forage in the last year of production (i.e., plow, tandem disc, cultivator, etc.)

Farm Analysis System

Department of Agricultural Economics

University of Manitoba

Year 1983
RECORD # 1

LIST OF MACHINERY INVENTORY

Inventory #	Tillage Name	Size	Year Manufactured	Year Purchased	Hours Used	New Replacement Cost	Price Paid in year Purchased	Beginning of year Book Value	End of year Book Value	Beginning of year Market Value	End of year Market Value	Depreciation	Investment	Depreciation Rate
1-O	TRACTOR(DIESEL)	90	1964	1983	170	41127	2723	2723	2315	2342	2014	409	218	0.150
2-O	TRACTOR(DIESEL)	70	1964	1978	129	31988	3872	968	387	1822	1567	581	169	0.150
3-O	TRACTOR(GAS)	45	1952	1968	20	20564	1841	0	0	192	165	0	18	0.150
4-O	TRACTOR(GAS)	28	1955	1963	28	12795	3829	0	0	188	161	0	17	0.150
5-O	CULTIVATOR L.D.	15	1975	1975	59	3707	3707	741	371	1109	954	371	103	0.100
6-O	CULTIVATOR H.D.	10	1973	1973	32	2890	2890	0	0	640	550	0	59	0.100
7-O	AUGER-MOTOR	6	1968	1975	18	1865	649	130	65	194	167	65	18	0.100
8-O	ONE WAY DISC	12	1961	1973	31	3147	515	0	0	114	98	0	11	0.100
9-O	PRESS DRILL	14	1965	1973	28	13132	3929	0	0	870	748	0	81	0.100
10-O	HARROW (DRAG)	30	1975	1975	30	3090	3090	618	309	925	795	309	86	0.100
11-O	SPRAYER	30	1971	1979	14	1918	574	344	287	314	270	57	29	0.100
12-O	SWATHER(PTO)	15	1973	1978	22	4665	2195	1097	878	1032	888	219	96	0.100
13-O	COMBINE (S.P.)	6	1959	1980	25	36600	1542	848	617	980	843	231	91	0.150
14-O	TRUCK	250	1949	1979	43	14969	162	65	41	89	76	24	8	0.150
15-O	BALER (SQUARE)	10	1964	1968	79	9800	5361	0	0	558	480	0	52	0.100
16-O	ROTOTILLER	4	1971	1979	0	7446	2228	1337	1114	1219	1048	223	113	0.100
17-O	MOWER(PTO)	7	1973	1975	20	2434	1800	360	180	539	463	180	50	0.100
18-O	RAKE-WHEEL	10	1972	1972	14	2636	2636	0	0	502	431	0	47	0.100
19-O	STOOKER	0	1973	1973	0	2308	2308	0	0	511	439	0	48	0.100
20-O	P.T.O. WAGON	2	1965	1969	18	4182	2288	0	0	277	238	0	26	0.150
					(B)	221263	48138	9231	6562	14414	12396	2669	1340	
					(E)	221263	48138							

S - Sold(Month of Sale)
P - Purchase(Month of Purchase)
O - Owned
C - Custom
R - Rented
(number) - Month of Sale or Purchase

Appendix C

Distance Field to Storage	3.0
Yield/Acre	25.0
Yield/Acre Secondary Crop	0.2
Improved Acreage	

Code #	Tillage Name	Size	# Times Over	Acres /Hour	Price	Variable Costs Fuel $/AC	Lub. $/AC	Repairs $/AC	Total Variable Cost $/AC	Fixed Costs Insur. $/AC	Invest. $/AC	Deprec. Cost	Total Fixed Cost	Total Cost
5	CULTIVATOR L.D.	15.	2.00	7.22	3707.	0.85	0.13	0.20	1.18	0.01	0.43	1.54	1.99	3.16
6	CULTIVATOR H.D.	10.	1.00	4.64	2890.	1.28	0.19	0.21	1.68	0.01	0.25	0.0	0.26	1.94
7	AUGER-MOTOR	6.	2.00	19.84	1865.	0.05	0.01	0.02	0.08	0.00	0.08	0.27	0.35	0.42
8	ONE WAY DISC	12.	1.00	4.81	3147.	1.19	0.18	0.28	1.65	0.00	0.04	0.0	0.05	1.70
9	PRESS DRILL	14.	1.00	5.43	13132.	0.75	0.11	2.01	2.87	0.01	0.34	0.00	0.35	3.22
10	HARROW (DRAG)	30.	2.00	13.99	3090.	0.32	0.05	0.07	0.44	0.01	0.36	1.29	1.66	2.10
11	SPRAYER	30.	1.00	11.05	1918.	0.16	0.02	0.09	0.28	0.00	0.12	0.24	0.36	0.64
12	SWATHER(PTO)	15.	1.00	6.93	4665.	0.94	0.14	0.14	1.22	0.01	0.40	0.91	1.33	2.55
13	COMBINE (S.P.)	6.	1.00	6.08	36600.	0.56	0.08	1.60	2.24	0.01	0.38	0.96	1.35	3.59
14	TRUCK	250.	1.00	4.17	14969.	0.86	0.13	1.02	2.00	0.00	0.03	0.10	0.14	2.14
15	BALER (SQUARE)	10.	1.00	2.73	9800.	1.24	0.19	1.82	3.24	0.01	0.22	0.0	0.22	3.46
20	P.T.O. WAGON	3.	1.00	11.08	4182.	0.32	0.05	0.07	0.45	0.00	0.11	0.0	0.11	0.56
1	TRACTOR(DIESEL)	90.			41127.			3.03	3.03	0.03	0.91	1.70	2.64	5.67
2	TRACTOR(DIESEL)	70.			31988.			1.53	1.53	0.02	0.71	2.42	3.15	4.67
4	TRACTOR(GAS)	28.			12795.			0.04	0.04	0.00	0.07	0.0	0.07	0.12
	TOTAL COST/ACRE/FIELD					9.74	1.46	12.42	23.62 ***	0.13	4.44	9.44	14.01 ***	37.64 ***

Acres	75.		Client # 1
Average Field Size	75.		
Distance Field to Storage	3.0		
Yield/Acre	35.0		
Yield/Acre Secondary Crop	0.2		
Improved Acreage			

Code #	Tillage Name	Size	# Times Over	Acres /Hour	Price	Variable Costs Fuel $/AC	Lub. $/AC	Repairs $/AC	Total Variable Cost $/AC	Fixed Costs Insur. $/AC	Invest. $/AC	Deprec. Cost	Total Fixed Cost	Total Cost
5	CULTIVATOR L.D.	15.	2.00	7.22	3707.	0.81	0.12	0.20	1.13	0.01	0.43	1.54	1.99	3.11
6	CULTIVATOR H.D.	10.	1.00	4.64	2890.	1.19	0.18	0.21	1.59	0.01	0.25	0.0	0.26	1.84
7	AUGER-MOTOR	6.	2.00	14.17	1865.	0.07	0.01	0.02	0.11	0.00	0.08	0.27	0.35	0.45
8	ONE WAY DISC	12.	1.00	4.81	3147.	1.16	0.17	0.28	1.61	0.00	0.04	0.0	0.05	1.65
9	PRESS DRILL	14.	1.00	5.43	13132.	0.75	0.11	2.01	2.87	0.01	0.34	0.00	0.35	3.22
10	HARROW (DRAG)	30.	2.00	13.99	3090.	0.32	0.05	0.07	0.44	0.01	0.36	1.29	1.66	2.10
11	SPRAYER	30.	1.00	11.05	1918.	0.16	0.02	0.09	0.28	0.00	0.12	0.24	0.36	0.64
12	SWATHER(PTO)	15.	1.00	6.93	4665.	0.94	0.14	0.14	1.22	0.01	0.40	0.91	1.33	2.55
13	COMBINE (S.P.)	6.	1.00	5.78	36600.	0.59	0.09	1.68	2.36	0.01	0.38	0.96	1.35	3.71
14	TRUCK	250.	1.00	2.98	14969.	1.20	0.18	1.43	2.81	0.00	0.03	0.10	0.14	2.94
15	BALER (SQUARE)	10.	1.00	2.73	9800.	1.24	0.19	1.82	3.24	0.01	0.22	0.0	0.22	3.46
20	P.T.O. WAGON	3.	1.00	11.08	4182.	0.32	0.05	0.07	0.45	0.00	0.11	0.0	0.11	0.56
1	TRACTOR(DIESEL)	90.			41127.			3.03	3.03	0.03	0.91	1.70	2.64	5.67
2	TRACTOR(DIESEL)	70.			31988.			1.53	1.53	0.02	0.71	2.42	3.15	4.67
4	TRACTOR(GAS)	28.			12795.			0.04	0.04	0.00	0.07	0.0	0.07	0.12
	TOTAL COST/ACRE/FIELD					9.94	1.49	12.93	24.36 ***	0.13	4.44	9.44	14.01 ***	38.38 ***

Crop Tame Hay

Field # 3

Client # 1

Acres 30.
Average Field Size 30.
Distance Field to Storage 1.0
Yield/Acre 2.0
Yield/Acre Secondary Crop 0.2
Improved Acreage

Code #	Tillage Name	Size	# Times Over	Acres /Hour	Price	Variable Costs: Fuel $/AC	Variable Costs: Lub. $/AC	Variable Costs: Repairs $/AC	Total Variable Cost $/AC	Fixed Costs: Insur. $/AC	Fixed Costs: Invest. $/AC	Fixed Costs: Deprec. Cost	Total Fixed Cost	Total Cost
15	BALER (SQUARE)	10.	2.00	2.45	9800.	1.37	0.21	2.02	3.60	0.01	0.22	0.0	0.22	3.83
17	MOWER(PTO)	7.	2.00	3.01	2434.	0.79	0.12	0.32	1.23	0.01	0.21	0.75	0.97	2.19
18	RAKE-WHEEL	10.	2.00	4.30	2636.	0.46	0.07	0.16	0.69	0.01	0.19	0.0	0.20	0.89
20	P.T.O. WAGON	3.	2.00	14.51	4182.	0.25	0.04	0.06	0.34	0.00	0.11	0.0	0.11	0.45
2	TRACTOR(DIESEL)	70.			31988.			1.79	1.79	0.02	0.71	2.42	3.15	4.94
3	TRACTOR(GAS)	45.			20564.			0.47	0.47	0.00	0.07	0.0	0.08	0.54
4	TRACTOR(GAS)	28.			12795.			0.23	0.23	0.00	0.07	0.0	0.07	0.30
1	TRACTOR(DIESEL)	90.			41127.			0.45	0.45	0.03	0.91	1.70	2.64	3.08
	TOTAL COST/ACRE/FIELD					5.75	0.86	8.04	14.65 ***	0.07	2.49	4.87	7.43 ***	22.08 ***

Crop Summerfallow

Acres 60.
Average Field Size 60.
Distance Field to Storage 0.0
Yield/Acre 0.0
Improved Acreage

Client # 1

Code #	Tillage Name	Size	# Times Over	Acres /Hour	Price	Variable Costs: Fuel $/AC	Lub. $/AC	Repairs $/AC	Total Variable Cost $/AC	Fixed Costs: Insur. $/AC	Invest. $/AC	Deprec. Cost	Total Fixed Cost	Total Cost
5	CULTIVATOR L.D.	15.	2.00	6.92	3707.	0.84	0.13	0.21	1.18	0.01	0.43	1.54	1.99	3.16
10	HARROW (DRAG)	30.	2.00	13.52	3090.	0.33	0.05	0.07	0.45	0.01	0.36	1.29	1.66	2.11
1	TRACTOR(DIESEL)	90.			41127.			1.42	1.42	0.03	0.91	1.70	2.64	4.06
	TOTAL COST/ACRE/FIELD					2.35	0.35	1.97	4.68 ***	0.05	1.70	4.53	6.28 ***	10.96 ***
	ACCUMULATED COST/ACRE/FOR ENTERPRISE					7.46	1.12	9.42	18.00	0.11	3.51	7.64	11.26	29.25

Year 1983 Crop Enterprise Summary for Record # 1 for Red Spring Wheat Field # 1

Input	Physical Record	Acres	Cost/Acre	Total	Total	Total
				Dollar Record		
Fuel & Lubrication		75.0 X	11.20	840.05 V		
Repairs		75.0 X	12.42	931.60 V		
Fertilizer	No Fertilizer Used					
Chemicals	10.5 Active Oz. 2,4-D Amine 80	75.0 X	1.05	78.75 V	78.75	
Labor	218.33 Hours @ 5.31	75.0 X	15.46	1159.34 V		
Interest on Operating Capital		75.0 X	2.52	189.23 V		
Crop Insurance Premiums		75.0 X	2.00	150.00 V		
Taxes		75.0 X	3.24	242.78 F		
Machine Insurance		75.0 X	0.17	12.57 F		
Overhead, Miscellaneous		75.0 X	4.93	369.60 F		
Total Cash Costs		75.0 X	52.99		3973.92	
Investment Land & Buildings		75.0 X	21.47	1610.10 F		
Machinery Investment		75.0 X	5.59	418.92 F		
Total Machinery Depreciation		75.0 X	11.12	834.11 F		
Total Non Cash Costs		75.0 X	38.18			2863.13
Total Cost		75.0 X	91.16			6837.04
Output (Acres X Yield = 75.0 X 25.00)		1875.00 X	4.48			8400.00
Output (Acres X Yield = 75.0 X 0.16)		12.00 X	35.85			430.20
Net Returns to Management		8830.20 _	6837.04			1993.15
Returns to All Labor and Management		8830.20 _	6837.04 +	1159.34		3152.50
Returns to Investment Labor & Management		3152.50 +	418.92 +	1610.10		5181.51
Returns to Investment Depreciation Labor and Management						6015.62

		Acres	Cost/Acre	Total	Total	Total
Fuel & Lubrication		30.0 X	6.61	198.31 V		
Repairs		30.0 X	8.04	241.18 V		
Fertilizer	No Fertilizer Used					
Chemicals	No Chemicals Used					
Labor	97.34 Hours @ 5.31	30.0 X	17.23	516.85 V		
Interest on Operating Capital		30.0 X	2.01	60.32 V		
Taxes		30.0 X	3.24	97.11 F		
Machine Insurance		30.0 X	0.17	5.03 F		
Overhead, Miscellaneous		30.0 X	4.93	147.84 F		
Total Cash Costs		30.0 X	42.22		1266.63	
Investment Land & Buildings		30.0 X	21.47	644.04 F		
Machinery Investment		30.0 X	5.59	167.57 F		
Total Machinery Depreciation		30.0 X	11.12	333.65 F		
Total Non Cash Costs		30.0 X	38.18			1145.25
Total Cost		30.0 X	80.40			2411.88
Output (Acres X Yield =	30.0 X 2.00)	60.00 X	36.00			2160.00
Output (Acres X Yield =	30.0 X 0.17)	5.04 X	23.43			118.09
Net Returns to Management		2278.09 _	2411.88			-133.80
Returns to All Labor and Management		2278.09 _	2411.88 +	516.85		383.05
Returns to Investment Labor & Management		383.05 +	167.57 +	644.04		1194.66
Returns to Investment Depreciation Labor and Management						1528.31

Year 1983 Crop Enterprise Summary for Record # 1 for Oats Field # 2

Input	Physical Record			Acres	Cost/Acre	Total	Total	Total
Fuel & Lubrication				75.0 X	11.43	857.54 V		
Repairs				75.0 X	12.93	969.59 V		
Fertilizer		No Fertilizer Used						
Chemicals	10.5 Active Oz.	2,4-D Amine 80		75.0 X	1.05	78.75 V	78.75	
Labor	227.43 Hours @		5.31	75.0 X	16.10	1207.67 V		
Interest on Operating Capital				75.0 X	2.58	193.67 V		
Crop Insurance Premiums				75.0 X	1.80	135.00 V		
Taxes				75.0 X	3.24	242.78 F		
Machine Insurance				75.0 X	0.17	12.57 F		
Overhead, Miscellaneous				75.0 X	4.93	369.60 F		
Total Cash Costs				75.0 X	54.23		4067.16	
Investment Land & Buildings				75.0 X	21.47	1610.10 F		
Machinery Investment				75.0 X	5.59	418.92 F		
Total Machinery Depreciation				75.0 X	11.12	834.11 F		
Total Non Cash Costs				75.0 X	38.18			2863.13
Total Cost				75.0 X	92.40			6930.29
Output (Acres X Yield =	75.0 X	35.00)		2625.00 X	1.32			3465.00
Output (Acres X Yield =	75.0 X	0.16)		12.00 X	35.85			430.20
Net Returns to Management				3895.20 _	6930.29			-3035.09
Returns to All Labor and Management				3895.20 _	6930.29 +	1207.67		-1827.41
Returns to Investment Labor & Management				-1827.41 +	418.92 +	1610.10		201.60
Returns to Investment Depreciation Labor and Management								1035.72

	Red Spring Wheat	Oats	Tame Hay	Summerfallow	Total	Farm Average
I. Acreage By Crop(acres)	75.	75.	30.	60.	240.	1.
II. Cost of Production						
1. Fuel & Lubrication	840.05	857.54	198.31	162.25	2058.14	8.58
2. Repairs	931.60	969.59	241.18	118.48	2260.85	9.42
3. Fertilizer	0.0	0.0	0.0	0.0	0.0	0.0
4. Chemicals	78.75	78.75	0.0	0.0	157.50	0.66
5. Seed Treatment Costs	0.0	0.0	0.0	0.0	0.0	0.0
6. Seed & Cleaning Cost	0.0	0.0	0.0	0.0	0.0	0.0
7. Twine Costs	0.0	0.0	0.0	0.0	0.0	0.0
8. Labor	1159.34	1207.67	516.85	167.01	3050.88	12.71
9. Custom Charges	0.0	0.0	0.0	0.0	0.0	0.0
10. Interest Oper. Cap.	189.23	193.67	60.32	47.38	490.61	2.04
11. Crop Insurance Prem.	150.00	135.00	0.0	0.0	285.00	1.19
12. Drying Costs	0.0	0.0	0.0	0.0	0.0	0.0
13. Equipment Rentals	0.0	0.0	0.0	0.0	0.0	0.0
14. Rent	0.0	0.0	0.0	0.0	0.0	0.0
15. Taxes	242.78	242.78	97.11	194.22	776.88	3.24
16. Machinery Insurance	12.57	12.57	5.03	10.05	40.22	0.17
17. Overhead, Misc.	369.60	369.60	147.84	295.68	1182.72	4.93
18. Total Cash Costs	3973.92	4067.16	1266.63	995.08	10302.78	42.93
19. Investment Land&Bldg	1610.10	1610.10	644.04	1288.08	5152.32	21.47
20. Investment in Mach.	418.92	418.92	167.57	335.13	1340.53	5.59
21. Machinery Depr.	834.11	834.11	333.65	667.29	2669.16	11.12
22. Total Non Cash Costs	2863.13	2863.13	1145.25	2290.50	9162.01	38.18
23. Total Cost	6837.04	6930.29	2411.88	3285.58	19464.79	81.10
III. Gross Returns						
24. Average Yield/Acre	25.00	35.00	2.00	0.0	N/A	N/A
Breakeven Yield/Acre	11.83	41.08	1.17	0.0	N/A	N/A
25. Average Price	4.48	1.32	36.00	0.0	N/A	N/A
Breakeven Price	2.12	1.55	21.11	0.0	N/A	N/A
26. Crop Insur. Revenue	0.0	0.0	0.0	0.0	0.0	0.0
27. Straw ($/Acre)	430.20	430.20	0.0	0.0	860.40	3.58
28. Grazing ($/Acre)	0.0	0.0	118.09	0.0	118.09	0.49
Total Gross Returns	8830.20	3895.20	2278.09	0.0	15003.48	62.51
IV. Net Returns to Mgmt.	1993.15	-3035.09	-133.80	-3285.58	-4461.31	-18.59
V. Returns to Labor & Mgmt.	3152.50	-1827.41	383.05	-3118.57	-1410.43	-5.88
VI. Returns to Investment Labor & Mgmt.	5181.51	201.60	1194.66	-1495.35	5082.42	21.18
VII. Returns to Investment Depr. Labor & Mgmt. or NET CASH RETURNS (See Note)	6015.62	1035.72	1528.31	-828.06	7751.58	32.30

Note: NET CASH RETURNS is defined as the amount of money left to pay for labor (family and hired), service long term debts, replace machinery as they depreciate and for management and profit.

Year 1983 Crop Enterprise Summary for Record # 1 for Summerfallow Field # 4

Input	Physical Record		Acres	Cost/Acre	Dollar Record Total	Total	Total
Fuel & Lubrication			60.0 X	2.70	162.25 V		
Repairs			60.0 X	1.97	118.48 V		
Fertilizer	No Fertilizer Used						
Chemicals	No Chemicals Used						
Labor	31.45 Hours @	5.31	60.0 X	2.78	167.01 V		
Interest on Operating Capital			60.0 X	0.79	47.38 V		
Taxes			60.0 X	3.24	194.22 F		
Machine Insurance			60.0 X	0.17	10.05 F		
Overhead, Miscellaneous			60.0 X	4.93	295.68 F		
Total Cash Costs			60.0 X	16.58		995.08	
Investment Land & Buildings			60.0 X	21.47	1288.08 F		
Machinery Investment			60.0 X	5.59	335.13 F		
Total Machinery Depreciation			60.0 X	11.12	667.29 F		
Total Non Cash Costs			60.0 X	38.18			2290.50
Total Cost			60.0 X	54.76			3285.58
Output (Acres X Yield =	60.0 X	0.0)	0.0 X	0.0			0.0
Net Returns to Management			0.0 _	3285.58			-3285.58
Returns to All Labor and Management			0.0 _	3285.58 +	167.01		-3118.57
Returns to Investment Labor & Management			-3118.57 +	335.13 +	1288.08		-1495.35
Returns to Investment Depreciation Labor and Management							-828.06

Cost and Return Per Acre Per Crop For Record Number 1 In 1983

	Red Spring Wheat	Oats	Tame Hay	Summerfallow	Farm Average
I. Acreage By Crop(acres)	75.	75.	30.	60.	1.
II. Cost of Production					
1. Fuel & Lubrication	11.20	11.43	6.61	2.70	8.58
2. Repairs	12.42	12.93	8.04	1.97	9.42
3. Fertilizer	0.0	0.0	0.0	0.0	0.0
4. Chemicals	1.05	1.05	0.0	0.0	0.66
5. Seed Treatment Costs	0.0	0.0	0.0	0.0	0.0
6. Seed & Cleaning Cost	0.0	0.0	0.0	0.0	0.0
7. Twine Costs	0.0	0.0	0.0	0.0	0.0
8. Labor	15.46	16.10	17.23	2.78	12.71
9. Custom Charges	0.0	0.0	0.0	0.0	0.0
10. Interest Oper. Cap.	2.52	2.58	2.01	0.79	2.04
11. Crop Insurance Prem.	2.00	1.80	0.0	0.0	1.19
12. Drying Costs	0.0	0.0	0.0	0.0	0.0
13. Equipment Rentals	0.0	0.0	0.0	0.0	0.0
14. Rent	0.0	0.0	0.0	0.0	0.0
15. Taxes	3.24	3.24	3.24	3.24	3.24
16. Machinery Insurance	0.17	0.17	0.17	0.17	0.17
17. Overhead, Misc.	4.93	4.93	4.93	4.93	4.93
18. Total Cash Costs	52.99	54.23	42.22	16.58	42.93
19. Investment Land&Bldg	21.47	21.47	21.47	21.47	21.47
20. Investment in Mach.	5.59	5.59	5.59	5.59	5.59
21. Machinery Depr.	11.12	11.12	11.12	11.12	11.12
22. Total Non Cash Costs	38.18	38.18	38.18	38.18	38.18
23. Total Cost	91.16	92.40	80.40	54.76	81.10
III. Gross Returns					
24. Average Yield/Acre	25.00	35.00	2.00	0.0	N/A
Breakeven Yield/Acre	11.83	41.08	1.17	0.0	N/A
25. Average Price	4.48	1.32	36.00	0.0	N/A
Breakeven Price	2.12	1.55	21.11	0.0	N/A
26. Crop Insur. Revenue	0.0	0.0	0.0	0.0	0.0
27. Straw ($/Acre)	5.74	5.74	0.0	0.0	3.58
28. Grazing ($/Acre)	0.0	0.0	3.94	0.0	0.49
Total Gross Returns	117.74	51.94	75.94	0.0	62.51
IV. Net Returns to Mgmt.	26.58	-40.47	-4.46	-54.76	-18.59
V. Returns to Labor & Mgmt.	42.03	-24.37	12.77	-51.98	-5.88
VI. Returns to Investment Labor & Mgmt.	69.09	2.69	39.82	-24.92	21.18
VII. Returns to Investment Depr. Labor & Mgmt. or NET CASH RETURNS (See Note)	80.21	13.81	50.94	-13.80	32.30

Actual 3.129 % Returns on Capital

University of Manitoba

	Red Spring Wheat	Oats	Tame Hay	Summerfallow	Farm Average
I. Number of Clients With the Crop	1.00	1.00	1.00	1.00	1.00
II. Cost of Production					
1. Fuel & Lubrication	11.20	11.43	6.61	2.70	8.58
2. Repairs	12.42	12.93	8.04	1.97	9.42
3. Fertilizer	0.0	0.0	0.0	0.0	0.0
4. Chemicals	1.05	1.05	0.0	0.0	0.66
5. Seed Treatment Costs	0.0	0.0	0.0	0.0	0.0
6. Seed & Cleaning Cost	0.0	0.0	0.0	0.0	0.0
7. Twine Costs	0.0	0.0	0.0	0.0	0.0
8. Labor	15.46	16.10	17.23	2.78	12.71
9. Custom Charges	0.0	0.0	0.0	0.0	0.0
10. Interest Oper. Cap.	2.52	2.58	2.01	0.79	2.04
11. Crop Insurance Prem.	2.00	1.80	0.0	0.0	1.19
12. Drying Costs	0.0	0.0	0.0	0.0	0.0
13. Equipment Rentals	0.0	0.0	0.0	0.0	0.0
14. Rent	0.0	0.0	0.0	0.0	0.0
15. Taxes	3.24	3.24	3.24	3.24	3.24
16. Machinery Insurance	0.17	0.17	0.17	0.17	0.17
17. Overhead, Misc.	4.93	4.93	4.93	4.93	4.93
18. Total Cash Costs	52.99	54.23	42.22	16.58	42.93
19. Investment Land&Bldg	21.47	21.47	21.47	21.47	21.47
20. Investment in Mach.	5.59	5.59	5.59	5.59	5.59
21. Machinery Depr.	11.12	11.12	11.12	11.12	11.12
22. Total Non Cash Costs	38.18	38.18	38.18	38.18	38.18
23. Total Cost	91.16	92.40	80.40	54.76	81.10
III. Gross Returns					
24. Average Yield/Acre	25.00	35.00	2.00	0.0	N/A
Breakeven Yield/Acre	11.83	41.08	1.17	0.0	N/A
25. Average Price	4.48	1.32	36.00	0.0	N/A
Breakeven Price	2.12	1.55	21.11	0.0	N/A
26. Crop Insur. Revenue	0.0	0.0	0.0	0.0	0.0
27. Straw ($/Acre)	5.74	5.74	0.0	0.0	3.58
28. Grazing ($/Acre)	0.0	0.0	3.94	0.0	0.49
Total Gross Returns	117.74	51.94	75.94	0.0	62.51
IV. Net Returns to Mgmt.	26.58	-40.47	-4.46	-54.76	-18.59
V. Returns to Labor & Mgmt.	42.03	-24.37	12.77	-51.98	-5.88
VI. Returns to Investment Labor & Mgmt.	69.09	2.69	39.82	-24.92	21.18
VII. Returns to Investment Depr. Labor & Mgmt. or NET CASH RETURNS (See Note)	80.21	13.81	50.94	-13.80	32.30

Note: NET CASH RETURNS is defined as the amount of money left to pay for labor (family and hired), service long term debts, replace machinery as they depreciate and for management and profit.