AN ENVIRONMENTAL ASSESSMENT OF AGRICULTURAL PRACTISES AND POLICIES: IMPLICATIONS FOR WATERFOWL HABITAT MANAGEMENT

By

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Abstract

The land consumptive practises which characterize much of western Canadian agriculture have become a source of concern for the managers of other resources existing in the region. The current relationship between agricultural and waterfowl interests is a manifestation of these concerns.

A major objective of this study is to provide farmers and waterfowl interests with a basis for reconciliation. The hypothesis of the study is that farmers and waterfowl managers are essentially environmental managers, and thus have many interests in common.

The research consisted of three main phases. Initially a survey was conducted to identify farming practises and the farmers' attitudes towards land management. The survey findings were analyzed by comparing them with the published results of scientific evaluation. The results of the analysis were utilized to formulate recommendations.

The study's findings demonstrate the extent to which regional customs and traditions influence land management decisions. Government policies, legislation, and institutional factors are also singled out as having a significant impact on the manner in which a farmer manages his land, and ultimately the surrounding environment.

The study concludes with recommendations, which if implemented, would provide benefits to farmers, waterfowl interests, and society at large. The jurisdictions considered to be best equipped to respond to each recommendation are also identified.

Acknowledgements

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CHAPTER ONE

INTRODUCTION

1.1 Study background

The arrival of the Europeans and the introduction of agriculture have produced profound changes in the ecology of the agricultural zone of the Canadian Prairie Provinces. Some native plant and annual species have benefited from a symbiotic relationship with the introduced species; many other once dominant native animal and plant communities, however, have been greatly reduced in numbers and largely displaced by domestic introduced species. The manmade ecological changes are superimposed on changes that are taking place continuously without the intervention of man (Bird 1961).

The extent to which man's activities have altered the prairie landscape is documented by Hedlin (1978), who notes that the development of agriculture in western Canada has been responsible for the removal of native vegetation from nearly 90 million acres. Other researchers suggest that this pattern of development is likely to continue. Lodge (1969) states:

> Increased production costs and higher investment charges resulting from the increase in land costs are making farmers increasingly sensitive to the economic loss involved in uncropped acreage. Land within the settled area, formerly under trees, bush, or sloughs, is being cleared, broken, drained, and cropped because of economic necessity.

Predictably, the land consumptive practises which characterize much of western Canadian agriculture have become a source of concern for the managers of other resources found in the region. The current relationship between agricultural and waterfowl interests is illustrative of these concerns.

1.2 Focus of the study

As well as producing 98 out of every 100 bushels of wheat produced in Canada, the agricultural region of the Prairie Provinces is the source of five out of every eight ducks shot in North America (Lodge 1969). If the trends established by the agricultural sector continue to be followed, however, the region's future as a waterfowl producer is in jeopardy. The waterfowl resource depends on an adequate supply of breeding habitat; an advancing civilization represented by agriculture is reducing the area of habitat (Kiel et al. 1972).

Although the impact of agricultural development on the waterfowl resource has been successfully documented, the ensuing criticisms directed at the agricultural sector have had few beneficial results. Most farmers receive no direct economic benefits from the waterfowl sustained on their land and thus are unwilling to modify their practises solely for the benefit of waterfowl. Continued criticism of the agricultural sector, emphasizing its negative impacts on waterfowl, only contributes to the development of a waterfowl manager - farmer relationship which is uncooperative, and at times borders on antagonistic.

In part this relationship stems from the tendency of the respective resource managers to take a narrowly defined, specialist's approach to the management of a specific resource. This tactic only serves to emphasize differences, and in the long term benefits no one.

Recent research findings indicate that the negative impacts of certain agricultural practises extend well beyond the waterfowl resource, posing a threat to the future of the agricultural base itself. (In some circumstances these practises may inadvertently be promoted by government policies.) These findings suggest that waterfowl managers and agriculturalists may have a common interest in resolving certain management conflicts.

The underlying premise of this study is that there is a need to analyze the relationship between agriculture and waterfowl within the broader framework of environmental management. Ultimately it is the environment, specifically the soil and water, on which the welfare of both interests depends. By using the environmental framework as the "common denominator" for analysis, the mutual interests of both parties are more likely to be identified, and eventually used as a basis for the development of a more cooperative management approach. This study attempts to fulfill this need.

1.3 Research objectives

The objectives of this study are:

1) To identify and assess the impact of current farming practises on the environment, and to determine the implications of these on the management of the waterfowl resource.

2) To identify and assess the impact of legislation and government agricultural policies on the environment and to determine the implications of these on the management of the waterfowl resource.

3) To identify and assess the impacts which new developments in agricultural technology and government policy may have on the environment and to determine the implications of these impacts on the management of the waterfowl resource.

4) To assess the extent to which farmers may be willing to modify current agricultural practises in order to aid in maintaining, or enhancing the quality of, waterfowl habitat.

5) To determine areas of common management interest to farmers and waterfowl managers.

6) To outline management alternatives and procedures which are beneficial to agricultural interest and waterfowl interest alike.

1.4 Methodology

The methodology employed in this study consisted primarily of personal interviews based on a standardized questionaire (Appendix I), conducted amongst sample populations of farmers in two study areas. The purpose of the questionaire was to identify the land management practises employed by farmers and the attitudes associated with the use of these practises. The interview schedule was also designed to determine the extent to which farmers' practises are influenced by government policies, and the willingness of farmers to modify current practises, or adopt alternative practises which are environmentally less disruptive and more accommodating to waterfowl.

Due to the length of the questionaire and the nature of the information required, it was necessary that the questionaire be adminstered personally. Warwick and Lininger (1975) note that the higher subject participation rate is a major advantage of personal interviews. Oppenheim (1966) suggests that when the questionaire is lengthy, and the study design calls for more than one open-ended question, interviews should be used to obtain the information required. The high costs (time and travel), and the danger that the interviewer will bias the responses, are considered to be the main problems associated with interviewing procedures (Warwick and Lininger 1975; Oppenheim 1966).

The individuals approached for an interview comprised a stratified random sample of farmers resident in each of the wards of the municipalities chosen as study areas. The sample was drawn from the most recent (1977) municipal list of electors.

To simplify data analysis, the samples chosen from each study area were equal in size. Initially the sample consisted of 32 individuals from each municipality. These represented approximately 22 percent and 27 percent of the farmers resident in the Rural Municipality of Strathcona and Rural Municipality of Odanah, respectively. Two members of each sample group refused to be interviewed thereby reducing representation to 20.4 percent and 25.4 precent respectively.

The interviews were conducted during the final two weeks of March, and first three weeks of April, 1977. Farmers received no prior notification of the impending interview. Individuals who were not at home, or busy with other tasks when the interviewer called, were contacted at another time. All respondents were informed that the information they provided was to be used by the interviewer in completing a study necessary to fulfill the requirements for a Master's degree. They were also assured that personal identities would not be revealed in the study. The average duration of the interviews was two hours.

To assist in the evaluation of the data obtained through the questionaire, and in the formulation of recommendations, an extensive literature review was undertaken. The literature review was augmented with information collected through personal correspondence and interviews with elected representatives, agricultural researchers, government officials, implement distributors, and other individuals directly or indirectly involved in agricultural activities or waterfowl management. Extensive use was also made of information obtained from government publications and municipal assessment reports.

1.5 Description of the Study Areas

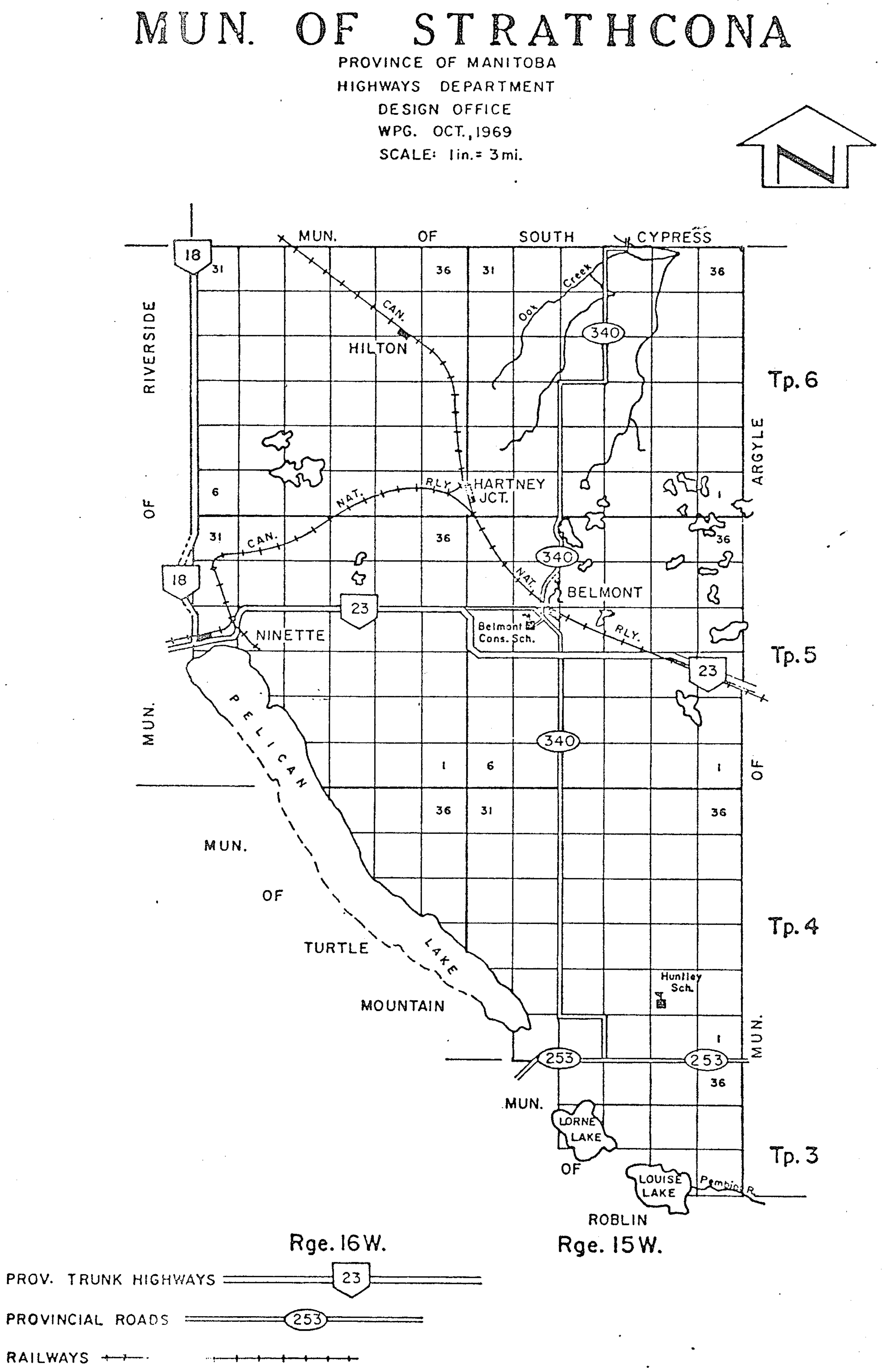
The areas chosen for the study were the Rural Municipalities of Strathcona and Odanah (Maps 1.1, 1.2 and 1.3). The R.M. of Odanah includes townships 13 and 14 and ranges 17 and

18. The R.M. of Strathcona consists of township 6 range 15 and 16, township 5 range 15 and 16, township 4 part of range 15 and 16, and township 3 part of range 15.

These municipalities were chosen because both are located in a similar climatic and soil zone, and both have traditionally harboured waterfowl habitat. Their geographic separation and the slightly different types of farming operations stressed in each area, facilitate comparison between regions and farming operations.

Both municipalities are situated within the Aspen Parklands of Manitoba, an area lying between the grassland of the Great Plains and the northern coniferous forest. The Aspen Parkland is situated on soils of the Black Soil Zone, encroaching somewhat on Degrading Black Earth and Dark Brown Zones adjacent to it (Bird 1961).

Ellis and Shafer (1943) describe Strathcona's topography as a knob and basin type. The soils are generally shallow in depth and offer poor resistance to erosion. The dominant soil association found within the Municipality is Hilton clay-loam, a shallow profile glacial till. The soils of the Heaslip complex, a mixture of till and water deposits, are of secondary importance. Hills are invariably stony and droughty due to excessive runoff from the steeper slopes. Moisture in the area is rarely (and then only briefly) excessive. Careful conservation of moisture is a regional necessity.

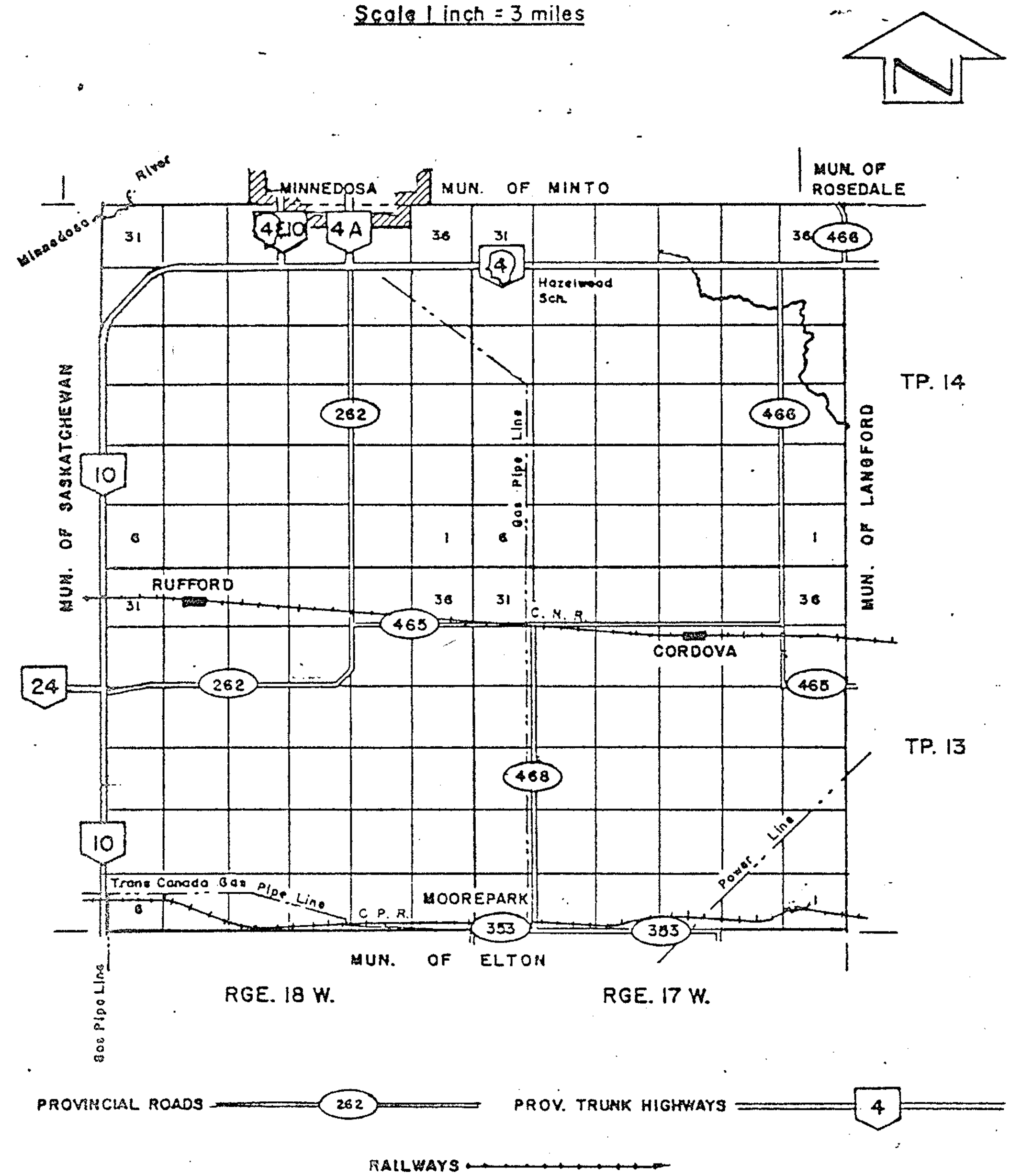

MUN. OF STRATHCONA
PROVINCE OF MANITOBA
HIGHWAYS DEPARTMENT
DESIGN OFFICE
WPG. OCT., 1969
SCALE: 1 in. = 3 mi.
N
MUN. OF SOUTH CYPRESS
MUN. OF RIVERSIDE
MUN. OF ARGYLE
MUN. OF TURTLE MOUNTAIN
MUN. OF ROBLIN
HILTON
HARTNEY JCT.
BELMONT
Belmont Cons. Sch.
NINETTE
CAN. NAT. RLY.
Oak Creek
PELICAN LAKE
Huntley Sch.
LORNE LAKE
LOUISE LAKE
Pembina R.
18
23
340
253
Tp. 6
Tp. 5
Tp. 4
Tp. 3
Rge. 16 W.
Rge. 15 W.
PROV. TRUNK HIGHWAYS 23
PROVINCIAL ROADS 253
RAILWAYS

Map 1.2

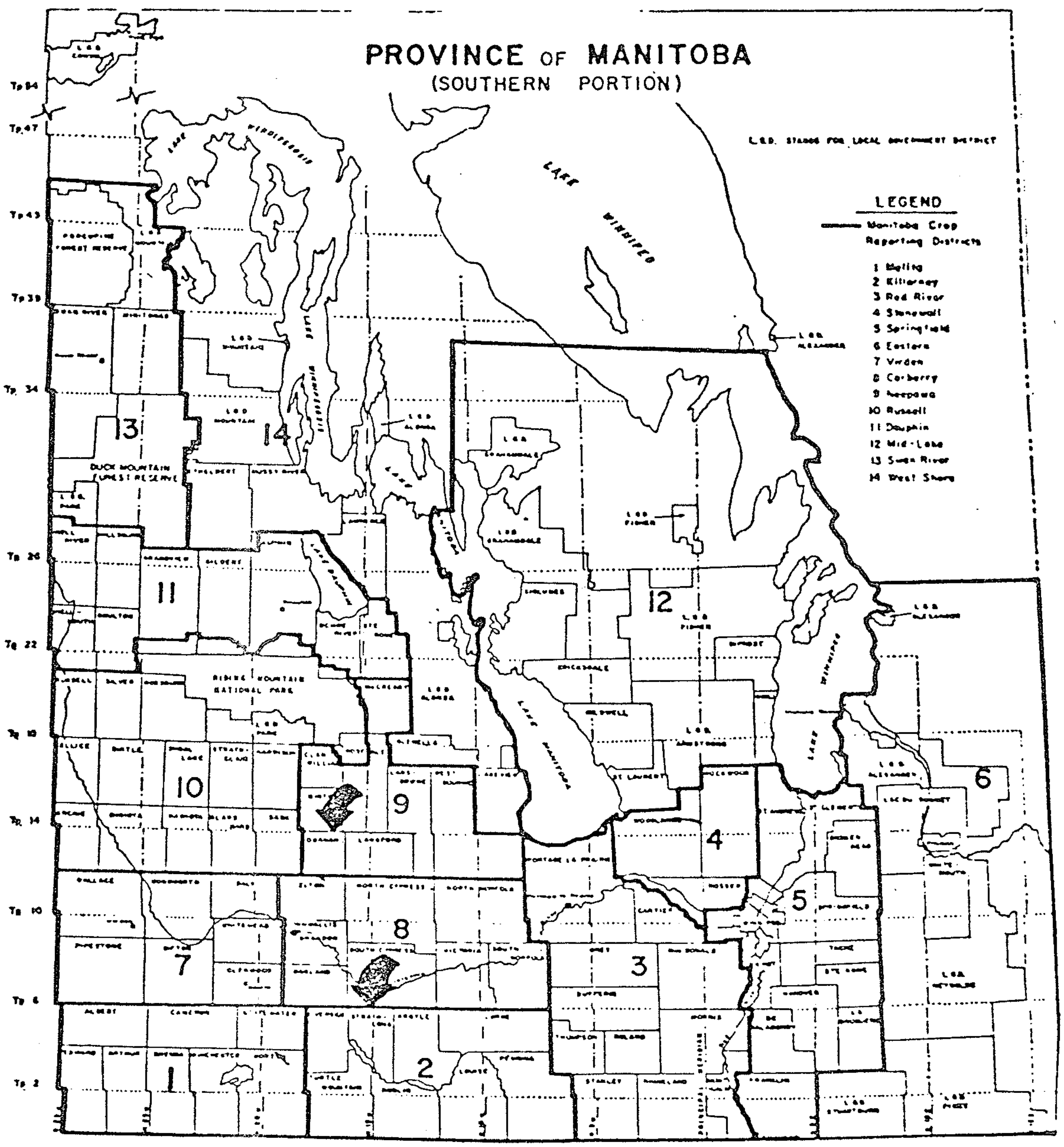
Nº 65

MUN. OF ODANAH

PROVINCE OF MANITOBA
HIGHWAYS DEPARTMENT
DESIGN OFFICE
WINNIPEG, NOVEMBER 1968



Map 1.3 Relative location of Odanah and Strathcona in Manitoba.[1]



[1]Source: Manitoba Department of Agriculture 1976 Yearbook

The Canada Land Inventory (1966) identifies approximately 60 percent of the soils in Strathcona's territory as having an agricultural capability of Class 3,[1] with the major limitation being adverse topography. The remaining soils in the Municipality have an agricultural capability of Classes 4, 5, or 6.

The Canada Land Inventory (1970) indicates that approximately 50 percent of Strathcona's area has a waterfowl producing capability of Class 3[2] with topographical limitations, 20 percent is considered to have a Class 4 capability with limitations, and the remaining area has Class 5 and 6 capabilities.

The Newdale Association consisting of loam to clay-loam soils is virtually the only soil complex found within the R.M. of Odanah. The Newdale Till Plain in its virgin state was an area of tall grass prairie interspersed with oak groves. Topographically the Newdale Association within Odanah is considered to be in the smooth phase, having notable relief in the form of low knolls and slight depressions. The soils

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[1]For a descriptive legend of soil classes see Appendix II.

[2]For a descriptive legend of waterfowl producing classes see Appendix II.

are of a moderate productivity which may be limited by susceptability to wind and water erosion, limited fertility, and soil drought; a large percentage are also imperfectly to poorly drained (Ehrlich 1957).

The Canada Land Inventory (1966) has identified two major agricultural capability classes in the Odanah area. Approximately 70 percent of the land consists of Class 2 soils having a topographical limitation, with the remainder of the area comprising Class 6 soils.

Approximately 35 percent of Odanah's territory has Class 1 waterfowl producing capabilities, 25 percent has Class 2 capabilities with limitations, 35 percent has Class 3 capabilities with limitations, and the remainder consists of Class 5 waterfowl habitat (Canada Land Inventory 1973).

1.6 Limitations of the Study

This study has a number of limitations, several of which are mentioned in the text. Generally the study's findings are based on responses to the survey questionaire which was administered to sample populations of two rural municipalities whose territories comprise only a small percentage of the total area in which agricultural and waterfowl interests must interact. Given the diversity of soil, climatic, social, and economic micro-conditions encountered within this vast region, the findings of this study should not be considered to be equally relevant at all locations within the region.

Furthermore, although the study includes discussions of the economic implications of the various management alternatives introduced, intensive benefit-cost analyses would require additional studies.

CHAPTER TWO

UNCULTIVATED LANDS, MANAGEMENT AND DEVELOPMENT

2.1 Introduction

The vast majority of the uncultivated acreage within the agricultural zone of the Canadian Prairie Provinces consists of those lands classified as unimproved; that is, native pastures, wetlands, woodlands, and idle lands adjacent to roads, railways, and other service corridors. In addition, a small percentage of the land classified as improved is not cultivated on a regular basis. This area consists primarily of tame pastures and farmsteads.[1]

The Manitoba situation is illustrative of the land use pattern which has been developing throughout the Prairies. In 1971 the total area of land in farms within the Province amounted to 19,008,000 acres. Of this total, 67 percent was considered to be improved. By 1976 an additional 600,000 acres of unimproved land had been broken and transferred into the improved land inventory. Most of this acreage became annually tilled cropland rather than improved pasture or farmstead land. This acreage represents a 9.6 percent reduction in the total area of

[1]According to the 1976 Yearbook of Manitoba Agriculture, this land represents approximately 5 percent of the total land area within Manitoba's agricultural zone.

unimproved land located within the agricultural zone (Manitoba Department of Agriculture (M.D.A.) 1976a).

Although untilled upland represents a declining percentage of the land area in the agricultural zone, its value in the sustenance of waterfowl and other forms of wildlife is attested to by a number of researchers. Higgins (1975) found that nesting densities and hatching success rates of shore and game birds were highest on idle or lightly used tracts of non-tilled upland. The results of a study by Duebbert and Lokemoen (1976) indicates the desirability of undisturbed grass-legume fields as duck nesting sites. Findings by Page and Cassel (1971) and Oetting and Cassel (1972) suggest that undisturbed railway and road rights-of-way are valuable nesting areas.

Despite these findings, other researchers report that unimproved and uncultivated lands within the agricultural zone are being subjected to development and management practices[2] which are reducing their value as habitat both in a quantitative and qualitative sense. Since waterfowl and their habitat represent only a small segment of the environment, it is suggested that the impact of certain of these practices may

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[2]The term "development practice" as used here refers to the long term and more permanent methods used to change the character of the land; e.g. drainage and removal of bush. Those techniques which are referred to as "management practices" are those which have a shorter term, less permanent impact on the land; included are practices such as grazing and burning.

also be detrimental to other components of the environment.

The survey undertaken in conjunction with this study enabled the researcher to compile an inventory of the land development and management practices associated with uncultivated land in two waterfowl-producing areas of agro-Manitoba. Since the survey was adminstered in two geographically separated municipalities, an inter-regional comparison of results is possible. The implications of the findings are discussed with extensive reference to the literature and to the advice of experts from various land or environmental management disciplines.

2.2 Presentation and Discussion of Results

The farmers who were contacted in the R.M. of Odanah and the R.M. of Strathcona managed 21,645 and 31,610 acres respectively. Table 2.1 provides a summarized description of the types of farming operations and land use patterns found within these study areas.[3] As the table indicates, grain and mixed cattle and grain farming are the main forms of agricultural enterprise conducted in both areas. In Strathcona,

[3]The reader is cautioned that the figures used in this study are based upon the estimates given by the farmers. Farmers are able to obtain fairly accurate estimates of their cultivated acreage from the measuring devices attached to their grain seeding equipment. Where uncultivated acreage is concerned, however, their access to mechanically derived estimates is much more limited. Furthermore, seasonal and annual fluctuations in wetland acreage, as well as farmers' personal perceptions, are likely to influence their estimates regarding total wetland, bushland, or unimproved pasture acreage. Given these factors, the problem of double counting often arises and thus affects the accuracy of the information provided.

Table 2.1 Land use on sample farms within the study areas

Municipality	(Annually) cultivated acreage	Uncultivated acreage Pasture & Hay Improved	Unimproved	Waste	Total	Total acreage
Odanah	14,629	555	1511	5096	7,162	21,645
Strathcona	20,034	942	4879	6507	12,328	31,610

Municipality	Farm Type	Number of Units	Average acreage	Average untilled	Average untilled excluding tame hay
Odanah	Mixed	17	668	256 (38%)	211 (31.6%)
	Grain only	13	791	204 (25.8%)	204 (25.8%)
Strathcona	Mixed	22	917	358 (39%)	315 (34.4%)
	Grain only	8	1,429	461 (32.3%)	461 (32.3%)

however, mixed farming clearly dominates, both in terms of the absolute number of farming units, and the total acreage which they occupy.

The results of the data analysis suggests that there is a relationship between the type of farm operation (whether mixed or specializing only in grain production) and the percentage of unimproved land remaining on the farm. In both municipalities, the average mixed farm is smaller than the average grain farm--the difference in acreage being much more pronounced in the R.M. of Strathcona. Since mixed farmers usually utilize some of their acreage for the production of tame forage, it is expected that these operations have a larger percentage of uncultivated acreage. When the improved pasture and hayland components are excluded from the calculations, however, the results indicate that the mixed operations also have a larger percentage of unimproved acreage. These findings support the oft-stated hypothesis that the trend toward larger and more specialized farms is giving rise to a less diverse local ecosystem; one which is less suitable for the production of waterfowl and other wildlife.

2.21 Land Development

The land development practices which have been most responsible for the removal of diversity from the landscape of agro-Manitoba are wetland drainage and landclearing (Hedlin

1978). The results of the study survey show that during the last ten years, some farmers in both municipal study areas engaged in one or both of these practices to increase their cultivated acreage (see Tables 2.2 and 2.3).

2.211 Wetland Drainage

Table 2.2 summarizes the drainage data obtained from the survey. As demonstrated, 100 percent of the farmers who responded to the survey have some wetland acreage. Forty-three percent of the Strathcona respondents and 66 percent of the Odanah respondents reported having undertaken some drainage in the last ten years.[4] In Odanah, drainage was responsible for 14.8 percent decline in wetland acreage. In Strathcona, the impact of drainage was less pronounced; farmers' estimates suggest that they drained approximately 3.0 percent of the wetlands existing at the beginning of the ten year period.

The regional difference between the drainage rates may be attributed to several factors. Firstly, the wetland acreage of the Odanah sample population is proportionately more than double that of the Strathcona sample. This may influence Odanah farmers to drain more frequently than their Strathcona counterparts. Secondly, many of the sloughs or potholes located in Strathcona tend to be larger and more permanent, and

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[4] Some farmers expressed an awareness of the illegal nature of some drainage activities. Others emphasized that they did not drain, they only filled in potholes. These factors may have affected the accuracy of their responses and should be kept in mind by the reader.

Table 2.2 Land drainage in the study areas (1968 - 1978)

Municipality	Sample size	Farms with wetlands	# of farmers who drained	Est. 1968 wetland acreage	Est. 1978 wetland acreage	Acres drained	% wetland reduction
Odanah	30	30	20 (66%)	3,281.5	2,795.0	486.5	14.8
Strathcona	30	30	13 (43%)	2,281	2,213.0	68	3.0

Table 2.3 Land clearing in the study areas (1968 - 1978)

Municipality	Sample size	Farms with bushland	#of farmers who cleared	Est. 1968 bush acreage	Est. 1978 bush acreage	Acres cleared	% bushland reduction
Odanah	30	22	10	2578	2315	263	10.2
Strathcona	30	28	13	5536	4294	1052	19.0

thus are more difficult to drain. Finally, a larger number of Strathcona farmers are cattle producers. Many of these individuals use their wetlands for grazing purposes. Consequently, they are less likely to perceive wetlands as being worthless, both from an economic and a psychological perspective, and therefore may be less inclined to drain them.

2.2111 Drainage and Access to Equipment

The accessability which farmers have to drainage equipment provides an index of the level of current, and perhaps future, drainage activities. In the R.M. of Odanah, 33 percent (10) members of the sample population own a landleveler or scraper; 90 percent (9) of these individuals admitted using this equipment for ditching and filling potholes. An additional 20 percent (6) of the Odanah respondents indicated that they rent or borrow equipment for similar purposes. In Strathcona, a smaller inventory of equipment is indicative of that municipality's farmers' lower propensity to drain. Only 6.6 percent (2) of the farmers surveyed own drainage equipment; another 6 percent (2) rent equipment for drainage purposes. A source of concern to those individuals wishing to discourage additional wetland drainage is provided by the fact that 6.6 percent (2) Strathcona farmers reported their intention to purchase drainage equipment. Since those farmers who rent equipment often rent it from their neighbours, it is probable that increased accessibility will also result in increased drainage activity within a given neighbourhood.

2.2112 Drainage and the Future

The results of the survey indicate that given the present legal and economic framework, drainage activities will continue to play a significant role in shaping the landscape of the future. Thirty percent of both sample populations stated that they plan to undertake additional wetland drainage. The majority of these individuals were from the group which reported having done some draining in the past ten years.

If attitudes affect behavior, then the prediction of continuing wetland drainage has additional support. In response to the question:

> If you could improve some characteristic of the land in this area, what would you do?

56 percent (17) of the Odanah farmers and 23 percent (7) of the Strathcona farmers suggested that additional slough drainage or consolidation would be desirable. Notably, however, 20 percent (6) Strathcona farmers expressed their opposition to further pothole drainage. These individuals felt that additional drainage may reduce the humidity of the air and the amount of moisture available to their crops, as well as aggravating downstream flood problems and destroying wildlife habitat.

2.2113 Purpose of Drainage

Farmers from the study areas reported undertaking wetland drainage to achieve two main purposes. Firstly, they drain to improve the cultural pattern. This is substantiated by the fact that frequently, only small acreages are drained (see Table 2.4). A number of individuals indicated that their main objective is to consolidate, rather than to decrease, their total wetland area. Others insisted that they drain solely "nuisance potholes", that is, those which hold water only on a temporary[5] basis or during wet years. These, they emphasized, "are no good for ducks anyway".

Secondly, farmers drain to increase their cultivatable acreage. As Table 2.5 indicates, the majority of the farmers in both study areas appear to regard the improved cultural pattern, as the main benefit to be derived from wetland drainage.

2.2114 Drainage and Waterfowl

The impact of agricultural drainage of wetlands on the quality and availability of waterfowl habitat has been discussed in a number of reports (Pospahala et al. 1974; Stewart and Kantrud 1973; Kiel et al. 1972; Millar 1969). In summary, these reports suggest that the drainage of wetlands destroys nesting habitat and crowds breeding birds into smaller areas where their nests are easily ravaged by predators. Since

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[5]Further inquiry established that their definition of "temporary" is rather broad, spanning the spectrum from ephemeral, to seasonal, as defined by Stewart and Kantrud (1973). Stewart and Kantrud found that wetlands included in the ephemeral to seasonal range provide some of the best waterfowl nesting areas.

Table 2.5 Purpose of drainage

Municipality	Sample size	# of farmers who drained	A. To improve cultural pattern	B. To increase cultivatable acreage	A and B
Pdanah	30	20 (66%)	10	4	6
Strathcona	30	13 (43%)	8	2	3

Table 2.4 Acreage drained

Municipality	# of farmers who drained	-5 acres	5 to 10 acres	10 to 20 acres	20 to 40 acres	40+ acres
Odanah	20	7	2	4	2	5
Strathcona	13	8	4	-	1	-

waterfowl are a common property resource, individual farmers have no direct economic incentive to encourage production on their property. As the results from the study areas show, many of them attempt to gain some economic benefits, by choosing to drain and cultivate their wetlands. Goldstein (1971) called the problem of allocating wetlands between the agricultural and wildlife sectors "the classical...resource distribution problem: one scarce resource with two alternative uses." Goldstein's analysis may have been somewhat superficial; wetlands may have more than two alternative uses.

2.2115 Drainage and the Environment

Groundwater hydrologists and other researchers note that the long-range economic and environmental consequences of drainage have not been adequately studied. Found et al. (1974) state that until recently, little emphasis has been given to the broader environmental impacts of agricultural land drainage. Jenkins (pers. comm.) suggested that some of the environmental impacts of continuing drainage in Manitoba have not yet been determined. These may extend well beyond the borders of the individual farm or municipality. Other impacts, however, have been apparent for some time. Many of these relate to the effects which drainage activities have on the physical hydrology of the area.

2.2116 Drainage and Streamflows

The most significant influence of drainage on an area's hydrology is on the timing of streamflow, particularly the magnitudes and durations of high and low flows (Found et al. 1974; Baker 1973). Bird (1961) described the sloughs and marshes of the Prairie Parkland as "perched wetlands"[6]. Perched wetlands are important regulators of spring runoff and storm flows; their drainage results in the loss of temporary headwater storage and an increase in the magnitude of peak flows (Thomas 1956). The storage capacity of these wetlands can be tremendous. Drainage on 560 quarters in the Souris Basin of North Dakota eliminated 12,600 acre feet of natural storage (Jenkins pers. comm.)

Many of the farmers within the study areas regarded the impacts of their drainage activities as insignificant; especially since some of them claimed to drain only those potholes which hold water on a seasonal basis or during the wet years. These are precisely the times when the headwater storage is most necessary. Munro (1967) reported that in southwestern Saskatchewan, the number of water areas fluctuated from 1,335,000 in 1955 to only 49,000 in 1961. As this example illustrates, draining all potholes which hold water only during wet years would decrease headwater storage tremendously. In Manitoba, widespread drainage in upland regions such as those

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[6]Wetlands which are separated from the regional watertable by an unsaturated zone.

in which the study areas are located, has increased the peak runoff and contributed to flooding in downstream areas. This problem was officially recognized as early as 1947, when it became the subject of a Royal Commissional Report (Lyons 1947). As recently as 1970, drainage in the upland areas of the Whitemud River Watershed (an area which includes most of the R.M. of Odanah) was named as one of the factors contributing to the flooding of cummunities and farms in the lower reaches of the Whitemud and Big Grass Rivers. Property damage as a result of this flood was in excess of one-half million dollars (M.R.E.M.[7] 1974). In an attempt to prevent additional flood damage from occurring in the future, a large capacity by-pass drain is now being constructed around Gladstone, a community which has been subjected to frequent flooding (Johnson pers. com.).

The lands of the R.M. of Strathcona drain into two river basins. Most of the municipality drains into the Souris River Basin; the remainder lies within the Pembina Basin. The Pembina River Basin has been the subject of studies which recommended the construction of flood control structures costing millions of dollars (International Pembina River Engineering Board 1964). The lowlands adjacent to the Pembina River experienced extensive flooding in 1974. During the spring of 1976, the river carried

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[7]Manitoba Department of Mines Resources and Environmental Management.

high volumes of runoff water (M.R.E.M. 1977). In the same year, flooding was extensive in the Souris River Basin, with discharges generally double those previously recorded (M.R.E.M. 1977).

As the foregoing discussion implies, the benefits derived from implementing drainage works and reducing headwater storage in one part of a river basin may result in higher costs being incurred in another part of that basin. Although individual farmers (who drain) and municipalities may not pay for flood damages and associated costs directly, the taxation system ensures that all members of society pay these costs indirectly. In recognition of these facts, the Manitoba Water Commission (1977) suggested that in some cases, it may be economically and environmentally preferable to implement headwater storage, rather than to expand the capacity of drainage systems. In many parts of agro-Manitoba, the study areas included, natural headwater storage already exists. Lissey (1971) studied groundwater flow patterns in Manitoba and concluded that retaining potholes as retention basins would likely slow runoff and reduce potential flood problems. In view of these recommendations, and the suggestions of the Manitoba Water Commission (1977), it is questionable whether the drainage of potholes should continue.

2.2117 <u>Water Chemistry and Pollution Filtration</u>

The chemical balance of downstream water bodies can be affected by agricultural drainage activities. Drain construction, cultivation in proximity to drainage channels, and the more rapid runoff facilitated by drains, increase the water's sediment loads. Since fertilizers and other nutrients often adhere to sediment particles, these are readily introduced into the aquatic system (Found et al. 1974). Sediments are also the principal carriers of chemical pollutants (Agricultural Research Service (A.R.S.) 1975). As well as reducing its suitability for human and animal consumption, the addition of sediment and chemicals to water can have a detrimental impact on fish and other aquatic life.

The evidence from recent studies suggests that one of the most significant roles of wetlands may be their ability to remove pollutants from the water flowing into them (Found et al. 1974; Neiring 1973). Ice-covered marshes, characterized by very little water movement and low dissolved oxygen concentrations, benefit the aquatic environment by removing nitrogen through denitrification (Sparling 1966). Most marshes release nutrients, trapped the previous summer, at the time of spring runoff when temperatures are comparatively low. This pattern of storage and release is beneficial, because it minimizes the addition of nutrients during the warm summer months, when algae growth is prone to be greatest. The results of studies using artificial catchment ponds also suggest that by detaining runoff water, wetlands reduce the peak concentration of agricultural chemicals discharged to receiving waters (A.R.S. 1975).

Surface water quality readings taken from the lakes and streams into which the water from the respective study areas drains, indicate that some water pollution problems already exist. In the Whitemud River (Odanah), dissolved phosphates show a slight increase during the runoff period. These are attributed to contamination of water by agricultural runoff (M.R.E.M. 1974).

Pelican Lake and the series of smaller water bodies bordering on, or in the vicinity of Strathcona, have serious algal bloom problems. During some years, toxic algae have been prevalent; under low flow conditions, dissolved oxygen has been zero (International Pembina Engineering Board 1964). At one time, these lakes were noted for their excellent fishing (Ellis 1943).

It must be noted that these pollution problems exist despite the fact that many farmers in both study areas appear to use only small quantities of fertilizer. In Strathcona, 43 percent of the farmers interviewed indicated that some of their cropland is never fertilized, and the remainder receives fertilizer only on an irregular basis. In Odanah, 33 percent of the farmers interviewed responded in a like manner. When asked about future fertilizer application plans, however, 43 percent of the respondents in both municipalities replied that they planned to intensify present application rates. A review of Manitoba fertilizer sales trends (M.D.A. 1977a) indicates that farmers throughout the province are behaving in a similar manner. If continuous cropping becomes more prevalent these trends are not likely to be reversed. As such, it can be surmized that over time, the volume of nutrients available for leaching into the Province's waterways is likely to rise. Since many of the streams within the study areas have low flow volumes during most of the year, their ability to absorb concentrated additions of nutrients (such as during heavy rain storms) without seriously reducing water quality, is correspondingly low. Under such circumstances, wetlands acting as nutrient filters, or to stem peak flows, would be very beneficial.

2.2118 Drainage and the Watertable

As elsewhere in the Prairie Parkland, most of the drains constructed in the study areas are designed to remove surface water from surface depressions, locally referred to as sloughs or potholes. Due to the low porosity of the clay and clay loam soils and glacial tills found in these areas, the surface water in the depressions was thought to represent a perched watertable--separated from the regional watertable by an unsaturated zone (Bird 1961; Eisenlohr 1972). The evidence provided by recent pothole hydrology studies challenges this view.

According to Meyboom (1963), groundwater outcrops may occur as local recharge or discharge areas. A hydrological study in the hummocky moraine of central Saskatchewan led Meyboom (1963) to conclude that many recharge areas are covered with thousands of little discharge areas. The findings of a similar study by the same author (1967) suggested that, while small temporary sloughs are local discharge areas during most of the summer and fall, they may be replenishing groundwater during the spring and early summer. Since these are the very kinds of sloughs which farmers in the study areas are tempted to drain, their actions may be contributing to the destruction of an aquifer recharge source.

The results of other studies support Meyboom's conclusions. Lissey (1968) studied groundwater flow systems in the Oak River Basin of Manitoba, an area with topographic features and soil conditions similar to those found in Strathcona and Odanah. He found that sloughs in the Oak River Basin serve as focal points for the recharge and discharge of groundwater. He concluded that his findings are applicable throughout most of the Canadian Prairies.

Lissey (1971) concluded that almost all groundwater recharge in the Prairies is derived from snowmelt water which collects in depressions (sloughs or potholes) because the snow melts before the ground thaws sufficiently to absorb meltwater. (According to Found et al. (1974), this type of ground water recharge is generally associated with areas of seasonal excess moisture, such as parts of the western plains.)[8] Artificial drainage on a depression's flanks will decrease water accumulation in recharge areas and subsequently lower the watertable (Found et al. 1974). Lissey (1971) recommended that potholes be retained as recharge areas for town and farm water supplies.

An intensive study of prairie pothole hydrology was undertaken in the Coteau du Missouri region of North Dakota. The researchers, Sloan (1970; 1972), and Eisenlohr and others (1972), concluded that the watertable is a shallow curved surface which links pothole water surfaces. Although the watertable follows the regional topography, it does not reflect small local topographical variations. Perched ponds, while they do exist, are primarily ephemeral bodies of snowmelt water which disappear as soon as the frozen soil beneath them thaws.

If continued drainage in the study area is in fact destroying aquifer recharge sites, several things may occur. Firstly, the decline in the watertable may force those individuals or communities who rely on groundwater as a source for domestic supplies to incur the cost of deepening wells or to seek alternative supplies. Since recharge areas may be located

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[8]M.D.A. (1978a) states that seasonal excess moisture is a major limitation to crop production in a region which encompasses the study areas.

at some distance from the site where the aquifier is actually tapped (Newton, pers. comm.), such expenditures would not necessarily be restricted to the site of the drainage activities. Secondly, if as Sloan (1970; 1972) and Eisenlohr and others (1972) suggest, the water table is a shallow curved surface which does not reflect small local topographical variations, it is possible that by lowering the watertable, the depth to the capillary zone could also be increased sufficiently to cause moisture stress in the crops growing on the many knolls found in both study areas. Although scientific data is lacking, conversations with farmers in the study areas indicate that climatically induced fluctuations in the watertable may already be having a similar impact. Several farmers suggested that they chose not to drain for the reason described above. They have found that in wet years they get good crops on the knolls and poor crops in the low-lying areas. In dry years, however, this relationship is reversed.

2.2119 Drainage Planning

Ultimately, any project which is undertaken can only achieve the desired objectives, while minimizing economic costs and undesirable environmental impacts, if it is adequately planned; land drainage is no exception. Agriculture Canada (1971) advises that prior to undertaking slough drainage, two factors must be considered. Firstly, it is suggested that when recharge sloughs (which are much more common than discharge sloughs) are drained, provision should be made for ponding the runoff water during the winter and early spring to provide an opportunity for groundwater recharge. Secondly, the soil characteristics of the flooded land should be ascertained.

The evidence compiled in the literature indicates that in some circumstances, slough drainage for the purposes of gaining additional cropland may not be economically justifiable. Basically there are three types of sloughs: recharge, discharge, and those which serve both functions simultaneously (Lissey 1968). When discharge sloughs are associated with long intermediate and regional flow systems, the water which enters them contains dissolved solids. If the rate of inflow exceeds the rate of outflow, the water can only be taken up by evapotranspiration (Lissey 1968; Sloan 1972). This leaves the slough bottom soils so saline as to be incapable of producing domestic crops. When this land is reclaimed, the costs are twofold; the farmers incurs irrecoverable reclamation costs, and land which might otherwise be providing waterfowl habitat is rendered totally unproductive.

Although the survey was not designed to determine how much saline acreage farmers in the study areas have drained, the results of the survey show that 100 percent of the Odanah respondents and 93 percent of the Strathcona respondents have some saline acreage.[9] Many of these individuals reported that

[9] A more thorough discussion of soil salinity is found in the following chapter.

their saline land is located adjacent to the edges of sloughs found on their property. Considered together, these findings suggest that some of the lands which farmers within the study areas either have drained, or plan to drain, may also be too saline for crop production.

In Manitoba, the Department of Agriculture through its Technical Services Branch provides assistance to farmers wishing to undertake land drainage. This service is offered to ensure that the on-farm drainage which is undertaken is adequately planned (Korven and Heinrichs 1975). Prior to obtaining this assistance, a farmer must obtain the approval of the local Agricultural Representative. If slough drainage is involved, the approval of a soil specialist is also required. The approval of the soil specialist provides assurance that the slough bottom soil is suitable for cultivation. An examination of Manitoba Department of Agriculture files, however, reveals that only a small percentage of all farmers who undertake drain construction utilize the Department of Agriculture's services. During the ten year period 1968 to 1977, none of the farmers surveyed (in either of the Rural Municipalities studied) applied for technical assistance to plan their drainage works.

Unfortunately, it is questionable whether the technical services provided, even when employed by the farmers, are effectively discouraging the construction of drainage systems which are undersirable from either an economic or an environmental perspective. A review of the assistance provided indicates that it is elementary, consisting mainly of an engineering survey and the staking of the route for the required rainage channel.

The results of a study by Elliot (1978) suggest that the officially required process of approving drain construction may not always be followed by provincial personnel. Elliot scrutinized slough drainage applications filed with the Technical Services Branch between 1963 and 1976 and found that in many cases, these applications lacked the signature of a soils specialist. It could not be determined whether the absence of a signature was due to an oversight, or the failure of a soils specialist to investigate the slough area. Friesen (pers. comm.) expressed the opinion that many individuals involved in the provision of technical services act as though they are obligated to consent to any drainage requests made by the farmers. No assurance can be given that these individuals consider either environmental or economic factors when they decide to approve applications for drainage services (Friesen pers. comm.). Since officially sanctioned drainage by a single farmer in a given region often induces his neighbours to undertake similar projects (Friesen pers. comm.), it seems likely that the technical advice provided by the Department of Agriculture is doing little more than increasing the rate at which this Province's wetlands are being drained.

2.212 Land Clearing

The introduction of the bulldozer and mechanized farm equipment in the post-war period rapidly increased the ease and thus the incidence of land clearing in the Prairie Provinces (Bird 1961). Frequently, clearing is a forerunner to drainage (Pospahala et al. 1974). If the cultural pattern of newly cleared land is severely interrupted by the presence of pot-holes or sloughs, a farmer is provided with an incentive to drain or fill these waterbodies and thereby to increase the efficiency with which he can work his field.

A summary of the findings regarding bushland in the study areas appears in Table 2.3. As the figures indicate, the majority of the farmers interviewed have some bushland remaining on their farms. In the last ten years, however, the extent of this area has decreased substantially. A regional comparison of farms on the basis of size, shows that the larger-scale farmers have had a greater tendency to clear land than the smaller operators. In Odanah, 33 percent of the sample population indicated that they had cleared some bushland in the past ten years. This resulted in a 263 acre or 10.2 percent reduction in bush area. In Strathcona, clearing activities were much more extensive. Forty-three percent of the Strathcona respondents undertook landclearing operations during the ten year interval. They succeeded in reducing the area of bushland and other native cover by 1,052 acres or 19 percent. The more extensive clearing undertaken in Strathcona can be attributed to the fact that a much larger proportion of the land held by Strathcona farmers is unimproved.

2.2121 Clearing and Wildlife

The impacts of landclearing on wildlife have been well documented. In addition to destroying cover and browsing areas for mammals such as deer, the removal of native vegetation ruins waterfowl nesting areas. The removal of trees and vegetation from the edges of potholes or sloughs eliminates a snow trap and thereby destroys a spring runoff source for these water bodies (Kiel et al. 1972). A North Dakota pothole study showed that snowmelt water, while representing only 31 percent of the total water supplied to the pothole, was probably the most vital component of the water supply in that it became available in the spring, when plants were starting to grow and waterfowl were nesting (Shjeflo 1968).

2.2122 Erosion

The negative effects of indiscriminately removing the vegetative canopy are not restricted to wildlife, however. Often bare soil is seriously eroded. Eroded sediments contribute to air pollution and are by far the greatest single pollutant of surface waters (A.R.S. 1975). From the perspective of agricultural interests, erosion is undesirable, in that it removes valuable topsoil and thereby decreases the land's productivity.

A direct result of clearing more land in the Prairie Provinces has been a marked increase in wind and water erosion (Bird 1961). Conditions in both of the municipalities chosen as study areas support Bird's allegation.

In the R.M. of Odanah, erosion damage is only slight; that which exists being the result of uncontrolled water run-off, evinced by some gullying (M.R.E.M. 1974). In the R.M. of Strathcona, however, erosion presents a much more serious problem. Virtually all the soils found in this municipality are shallow and very susceptible to erosion by water, and to a lesser degree, by wind (Ellis 1943).

Jenkins (1968) studied the Hilton soils, the dominant soils found in Strathcona. He reported that all the Class 3 (for agriculture) cultivated land (which represents 70 percent of all land in the area) suffered from water erosion to the extent that ordinary tillage implements reached through the remaining 'A' horizon. Approximately 25 to 75 percent of the original A horizon or surface soil had been lost from most of the area. The remaining (Class 4 for agriculture) land was affected by both wind and water action, but due to the exposed position, wind was considered to be the most serious eroding agent. It had removed all of the A horizon and part of the

B horizon. Occasional blowouts were also observed. Since cultivation practices have not changed substantially since Jenkins' study was completed, it can be assumed that current soil conditions in Strathcona are not significantly better.

The manner in which farmers responded to the survey (Table 2.6) indicates that most individuals recognize that their land is beset by wind and/or water erosion. The majority of the farmers who acknowledged the existence of an erosion problem also indicated that they employ management techniques aimed at reducing their land's susceptibility to erosive action. In Strathcona at least, these control measures appear to be inadequate. At times the "management techniques" are little more than cosmetic. Water runways and shallow drains, for example, continue to be cultivated until gullies impede machinery operation or sedimentation renders them ineffective. Then, a scraper or land leveller is used to refill the gully or remove the sediment deposits.

Although the ideal situation of maintaining all but flat non-erodible soils seeded to a vigorous growth of grasses and native trees is not always practical, in certain areas permanent grassland and woodland are the only means of soil conservation available (Meyer and Monmering 1971). Vegetation effectively reduces slope steepness by forcing the flow of water to meander as it moves downslope. Since a large portion of the soil annually eroded from the land is scoured from the banks and beds of natural channels which are dry much of the year,

Table 2.6 Incidence of erosion on sample farms within the study areas

Municipality	Sample size	Wind erosion	Water erosion	Wind & water erosion	Attempt to control erosion
Odanah	30	10	19	8	13
Strathcona	30	5	24	4	19

these areas should also be maintained in a dense vegetative cover (Posey 1973).

2.2123 Water Conservation and Flood Control

The maintenance of a vegetative canopy also aids in water conservation and flood control. Burgy and Papazafirion (1971) state that watershed researchers have come to the virtually unanimous conclusion that a reduction in vegetative density results in increased water yields. Various plant species may intercept rainfall in proportions varying from 3 to over 90 percent (Burgy and Papazafirion 1971; Clark 1940). Growing vegetation also reduces the soil's susceptibility to sealing by rainfall impact and increases its porosity, thereby enhancing percolation and hence *in situ* interception processes (Hilton 1971). When trees, brush, or other native cover are removed, the benefits of vegetative protection may be lost for at least a part (and that often a critical part) of the year. This is particularly true of hilly cultivated cropland, where the absence of vegetation in the spring increases the volume and velocity of runoff and results in frequent flooding of low-lying areas (Bird 1961).

2.2124 Farmers' Attitudes

The advice given in the two preceding sections is not new. After studying the soils in the Strathcona area, Ellis (1943) recommended that complete tree removal be avoided. Native vegetation barriers should be saved to form field boundaries, and steep slopes and ravines should remain under forest or grass cover to reduce runoff, and to conserve moisture. Ellis (1943) suggested that moisture conservation was especially important to prevent droughtiness on knolls. Unfortunately Ellis's recommendations have often been ignored. Given present circumstances, it appears that this is not likely to change. Forty percent of the farmers interviewed in each of the study areas declared that they intend to clear additional acreage. As Table 2.7 shows, these individuals are already farming more land than the average farmer in the respective municipal sample. Since most of the better land is already under cultivation, it is probable that additional clearing will result in increased rates of erosion and other undesirable environmental impacts.

More positively, however, it must be noted that some farmers recognize that continuing the indiscriminate clearing of land is counterproductive. Twenty-three percent (7) Odanah farmers and 30 percent (9) Strathcona farmers suggested that a program designed to retard further land clearing activities, and to encourage tree planting and the maintenance of more permanent grassland, would be a worthwhile and appropriate method of improving land management in their area.

2.2125 <u>Legislative Controls</u>

Although the Land Rehabilitation Act (R.S.M. 1970, L.50) empowers municipalities to regulate and control farming practices that may threaten the economic stability of their area, neither of the municipalities discussed in this study have chosen to avail themselves of this right. While the political

Table 2.7 Clearing activities related to farm size.

Municipality	Average farm size of farmers who cleared	Average farm size of nonclearers	Average farm size of those planning to clear	Average farm size of those with no plans to clear
Odanah	856.0	654.3	746.6	704.7
Strathcona	1441.5	738.8	1173.0	956.7

tenability, and effectiveness, of controlling land development practices using legal (and punitive) measures is questionable, it is apparent that some measures aimed at preserving the remaining native cover are necessary and would be beneficial. In the short run, such efforts will reduce the amount of new land which farmers will be able to bring under cultivation. In the long run, however, the economic and environmental benefits of decreased erosion and less frequent flooding would be substantial at all levels--the individual farm, the municipality, and the region.

2.2126 Road and Rail Right-of-Way Development

In many parts of southwestern Manitoba (which includes the study areas), the only lands not allocated to the agricultural sector are the road allowances which border every section. These were established by the pre-settlement surveys to be utilized as corridors along which most municipal roadways were constructed. Ownership of the road allowances rests with the municipalities in which they are located.

Other rights-of-way (R.O.W.'s) were established by the railways. Over the years, some of the lines were found to be underutilized, and by 1977 almost 140 miles of track had been deactivated (Hall Commission 1977). During 1977, the Hall Commission recommended that in Manitoba an additional 632.9 miles of track be abandoned. Upon deactivation, it is probable that public agencies will be given the opportunity to take possession of these railway properties.[10]

While utilized as transportation corridors, the use of right-of-way lands for alternative purposes is obviously restricted. Within the study areas, however, many of the corridors bordering the sections were never developed or fell into disuse and gradually reverted to their natural state. These corridors (like the rail R.O.W.'s) are 99 feet in width, covering approximately 12 acres per running mile. As Table 2.8 suggests, their area within the study zones will become even greater when several rail lines are abandoned. The author observed that some uninproved earth roads are also in the early stages of abandonment.

If current trends continue unchecked, it is probable that many of the unused R.O.W.'s will eventually be developed for agricultural purposes. Although some municipalities have passed by-laws prohibiting the cultivation of road allowances (Miliken pers. comm.), others--Odanah and Strathcona included, have not developed any policies regarding the use of these lands.

The author's observations suggest that farmers in both municipal study areas frequently encroach on publicly owned road allowances. The results of the survey showed that in

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[10]For a discussion of the disposition of abandoned railway beds, see Appendix III.

Table 2.8 Rights-of-way which are undeveloped, abandoned or in the early stages of abandonment.

Municipality	Est. miles of undeveloped road R.O.W.'s	Est. miles of unimproved earth roads	Est. miles of abandoned R.R.R.O.W.'s	Est. miles of R.R.R.O.W.'s to be abandoned	Total miles	Total acres
Odanah	47	1	-	24	72	864
Strathcona	143	42	6	16	207	2484

Strathcona, 60 percent (6) of the farmers whose land is crossed by, or adjacent to, a R.O.W. cultivate this area. In Odanah, where fewer unused R.O.W.'s exist, only one of the farmers surveyed indicated that he cultivated any R.O.W. land. Several individuals, however, suggested that they will improve their cultural pattern by cultivating across a railway bed after its abandonment.

To some extent the actions of the farmers who chose to cultivate unused R.O.W.'s is understandable. The absence of a firm policy, combined with the apparent disinterest which the public officials responsible show in managing or maintaining these lands, does not help to dissuade further encroachment.

Over time, the urge to develop R.O.W.'s is likely to become even more pervasive. As the most accessible unimproved lands on private holdings are developed, farmers will be tempted to expand their operations by cultivating the apparently "unclaimed" public lands. In addition, the process of farm consolidation encourages farmers who own two or more coterminous sections to break the abandoned R.O.W. which divides their holdings and impedes their cultural pattern.

A number of alternatives regarding the future (nonagricultural) use of unused transportation corridors requires investigation. In many parts of the prairies, wind erosion constitutes a serious soil management problem. Although wind breaks can help to mitigate wind action, farmers are sometimes reluctant to plant wind breaks on their own property because they take some cropland out of production or interfere with the operation of equipment. Municipal officials also discourage tree planting along travelled corridors because of the snow drifting problem which may ensue. The R.O.W.'s could hold a solution to the concerns of the farmers and the municipal officials. A program designed to establish or maintain wind breaking vegetation along unused R.O.W.'s would avoid disrupting traffic and, in the long run, would contribute to soil protection and add a measure of diversity to an increasingly unvariegated landscape.

Due to their linear nature, R.O.W.'s do not represent the ideal form of wildlife habitat. In areas where undisturbed cover is becoming scarce, however, the importance of maintaining these areas of natural vegetation should not be underestimated. Several farmers in the study areas indicated that they frequently observe deer utilizing the R.O.W.'s as travel corridors. Studies by Page and Cassel (1971) and Oetting and Cassel (1972) showed that some waterfowl species nest adjacent to roads and rail lines despite the fact that these R.O.W.'s were still in active use. These findings suggest that abandoned R.O.W.'s may offer some potential as sites at which waterfowl habitat could be developed.

In some cases, protecting R.O.W.'s from agricultural development may not represent the optimum alternative. Within the study areas for example, virtually all farmers have some wetlands or other acreage which might better be left undeveloped.

In such circumstances, the viability of exchanging the private wasteland for arable R.O.W. acreage should be examined.

In southwestern Manitoba, the ratio of public land to private land is very low (M.D.A. 1976b). Efforts to increase the area available for use as wildlife sanctuaries and other purposes necessitate the expenditure of government funds. In addition, individuals who have traditionally farmed the land which the government proposes to purchase occasionally oppose sales which would restrict private use (Brandon Sun Nov. 17 1977).

In some areas, the road allowances are the last vestige of public ownership and represent the only lands to which public authorities have direct management access. The soon to be abandoned railway beds provide an opportunity to expand the area of public land at minimal cost. If anything more than a nominal public interest (based solely on ownership) in these lands is to be retained, however, public officials must show an active interest in their management. By so doing, the credibility of officials who frequently criticize the management of private lands, while neglecting public lands, may also increase.

To be effective, management plans should be developed and implemented before farmers have had the opportunity to encroach upon these areas. In the R.M. of Pipestone, for example, a project to reclaim road allowances (which had been cultivated over an extended period), met with only limited success, because farmers claiming the equivalent of squatter's rights, refused to cooperate (Miliken pers. comm.). In the future, reclamation projects might be more successful if implemented immediately after the ownership of land is transferred. Since the new owner cannot claim to have a traditional right to farm R.O.W. land, he has fewer grounds on which to oppose reclamation efforts.

2.22 Land Management

2.221 Burning

Although the practise is a subject of controversy, many farmers in the Prairie Provinces continue to use fire as a land management tool. The findings pertaining to the use of this practise within the study areas are summarized in Table 2.9.[11]

The uncultivated lands which farmers reported burning can be categorized according to the purpose for which they are used. In general, these include native grasslands, rights-of-way such as fencelines, ditches, and the shoulders of public roadways, and small wetlands. The reasons which farmers gave for burning over these areas are similar to those outlined by Cowan (1977). The recurring reasons are presented in company with the land category to which they apply:

[11]Stubble burning data is included in the table only for the purposes of comparison. The subject will be discussed in detail in a subsequent chapter.

Table 2.9 Use of fire as a mangement tool on uncultivated farmlands.

Municipality	Sample	Use fire as a management tool	Burn native vegetation only	Burn stubble only	Burn native vegetation and stubble	Spring burner	Fall burner	Spring and fall burner
Odanah	30	28 (93%)	7	2	19	1	19	8
Strathcona	30	16 (53%)	3	1	12	-	12	4

A. Native grassland.

1. To improve native pasture and increase hay yields;

2. To remove old growth from native hayland to facilitate moving; and

3. To control the growth of scrub and weeds.

B. Rights-of-way.

1. To tidy up fencelines and destroy weeds which may interfere with the operation of electric fences;

2. To reduce weed growth and the snow holding capacity of ditches and road shoulders and thereby decrease snow drifting problems on roadways;

3. Accidentally, as a result of fire spreading from stubble fields; and

4. Unsure, enjoy burning and the tidy appearance of burned sites.

C. Small wetlands.

1. To destroy the weeds, willows, thistles, and cattails which grow around the edges of potholes;

2. To reduce the sloughs' snow holding capacity, thereby allowing for rapid drying and earlier cultivation in the spring; and

3. Accidentally, due to fire spreading from stubble fields.

2.2211 Fire, Habitat Manipulation, and Wildlife

Fires have always played an important role in the shaping of the prairie landscape (Bird 1961). Bragg and Hulbert (1976) concluded that fire is an essential factor in establishing and maintaining natural prairie. In the absence of fire, the invasion of lowlands by woody growth is rapid. Upland soils with a high clay content (such as those found in Odanah and

Strathcona) resist invasion more effectively. Bragg and Hulbert (1976) suggested that controlled burning is a good management technique for preventing woody plants from invading the prairie. They are supported by other studies which also suggest that fire used for manipulating habitat can be an effective wildlife management tool (Manitoba Clean Environment Commission 1977; Fritzell 1975; Cushwa and Martin 1969; Hadley and Kieckhefer 1963; Beckwith 1954).

It is important to note that all of the studies cited agree that in contemporary times, only controlled burning is a beneficial management practice. The data in Table 2.9 indicates that farmers who burn stubble have a greater propensity to burn native vegetation growing on idle lands in the vicinity of their farms. This relationship suggests that in the study areas, much of the burning of peripheral vegetation is due to farmers impulsively setting fires, or fires accidentally spreading from stubble acreage. From the perspective of the wildlife manager, such fires do not represent controlled burning management techniques. In waterfowl nesting regions, uncontrolled fires may destroy habitat and nests. The destruction of habitat forces nesting birds to congregate in confined areas and indirectly increases the probability of nest predation (Cowan 1977; Fritzell 1975).

Although the prairie fires which took place in the preagricultural era were controlled mainly by natural factors, their random occurrence ensured that not all nesting cover was burned every year. Today, however, the natural cover necessary for the sustinence of waterfowl and other wildlife is greatly reduced in area and often exists only in small discontinuous plots. Since some farmers in the study area burn in the spring and fall of each year (Table 2.9), it is probably that in regions where burning is a common practice, a large percentage of the total habitat suitable for nesting is destroyed every year.

2.2212 Water and Soil Management

The impacts of uncontrolled burning are not restricted to wildlife. These must be considered when burning is contemplated.

McMurphy and Anderson (1965), Hanks and Anderson (1957), Robacker and Miller (1955) and Pickford (1932) found that fire reduced the stands of perrennial grasses and removed protective mulches. These take from four to six years to attain their preburn volume (Dix 1960; Ehrenreich 1959). The absence of mulch may result in decreased infiltration and increased runoff, impacts which are undesirable where water must be managed for flood control and as a drought prevention measure (Kucera and Dahlmen 1967; Weaver and Rowland 1952). Hanks and Anderson (1957) found that decreased infiltration rates resulted from burning regardless of the time of burning, and the effect continued all season. Dix (1960) and Robacker (1955) concluded that erosion was more severe on burned sections of experimental plots. Launchbaugh (1964) and Ehrenreich (1959) suggest that continued burning may harm the soil and vegetation.

2.2213 Weed Control

One of thereasons given for burning rights-of-way and sloughs was weed control. In an area where agricultural crops are the main source of income, weed control understandably represents an important management concern. In Manitoba, The Noxious Weeds Act (R.S.M. 1970, N110) makes all owners or occupiers of land responsible for taking such actions as might be necessary to prevent the ripening or scattering of weeds or weed seeds. The Department of Highways and the Rural Municipalities are responsible for the control of weeds along the roads and road allowances under their jurisdiction.

Leskiw (1978) discussed methods of maintaining a disturbed priarie and suggested that early spring burning is a low cost maintenance measure which should be carried out every two to four years. Harburn (pers. comm.) of Winnipeg's Living Prairie Museum has also found that early spring burning in alternate years is an effective means of controlling introduced annual weed species and increasing the vigour of native species. When survey findings are compared with these recommendations, it becomes apparent that the majority of the farmers (who burn in the fall) are not effectively controlling annual weeds. Fall burning may give the appearance of controlling weeds because it removes the weed stocks. The seeds (which may already have been shed), however, survive to reinfest the burned area in the following year. By burning early in the spring, the introduced weed shoots are destroyed and the native vegetation which begins to grow later in the season is not damaged (Leskiw 1978).

The growth of perennial species, such as the native grasses which may be growing in ditches or fencelines, is not effectively retarded by burning. Many native species regenerate mainly through rhizome spread and their growth may be stimulated rather than suppressed by fire.

If, as Leskiw and Harburn recommend, effective weed control can be achieved in native cover by burning only every two to four years, then the annual or biannual burning which some farmers practise cannot be justified purely on the basis of weed control requirements. A two, three, or four year system of rotational burning would minimize the harmful effects of fire on waterfowl habitat, while still enabling the farmers to achieve their weed control objectives on uncultivated land.

Burning more frequently than recommended may result in increased weed populations. Weeds are plants which are adapted to disturbed situations (Leskiw 1978). Leskiw also states that native grass species form a closed community sod which resists the establishment of noxious annual weeds. McMurphy and Anderson (1965) were led to believe that annual late spring burning reduces the numbers of introduced species, but by removing the layer of protective mulch, fire may aid other introduced species to become established more rapidly. Continued burning over an extended period of time could harm both soil and vegetation (Ehrenreich 1959). This is particularly true of accidental fires which usually occur when the soil surface is dry (Lauchbaugh 1964). Since much of the burning in the study areas is done under dry conditions (in the fall), the outcome may be damage to native vegetation and the creation of conditions favourable to the establishment of noxious annual weed species.

In some circumstances, wetland weed problems may be created (at least in part) by the farmers' own activities. Succumbing to the temptation to cultivate ephemeral wetlands not only destroys the native growth within them, it also spreads weed seeds found on cultivating equipment into these areas. During years of high precipitation, mechanical control of the weeds which have become established in the low-lying areas may become impossible, thus forcing the farmer to resort to other control methods.

2.2214 Right-of-Way Management

The Manitoba Clean Environment Commission (1977) acknowledges that in some parts of the Province, vegetation near roadways must be controlled to prevent the creation of a snow drifting problem. The Commission concluded that the full use of herbicides and mowing should make burning unnecessary. Oetting (1971) found that the reduction of mowing to only twenty feet of the inslope of North Dakota State Highways was sufficient to prevent snow drifting and road blockage. Leskiw (1978) suggests that the seeding of carefully selected native grass species would reduce highway maintenance costs greatly. Certain short grass species, even when left uncut or unburned, capture only minimal quantities of snow.

Black and Siddoway (1975) have found that tall wheat grass barriers may be used to trap snow. Other research findings indicate that standing stubble, cut at variable heights, has an enhanced snow-holding capacity. In areas where snow drifting interferes with road traffic, the viability of using these management techniques to capture snow before it drifts onto the roadway warrants investigation.

If alternative (to fire) right-of-way management practices are adopted, however, care must be taken to ensure that these will not prove just as disruptive to wildlife as the uncontrolled use of fire. Currently, for example, the Department of Highways and the rural municipalities initiate right-of-way maintenance activities such as spraying and mowing during the month of June. During this period, many waterfowl broods have not yet hatched and thus are highly susceptible to damage or destruction. In sensitive areas, maintenance schedules should be planned to avoid such conflicts.

2.2215 <u>Legal Aspects of Burning</u>

The Fires Prevention Act (R.S.M. 1970, F80) is the legislative mechanism which provides control in Manitoba. Outside the Wooded District (as defined by the Act), however, fire control is haphazard (Manitoba Clean Environment Commission 1977). Any landowner can set fire to his land without notifying municipal authorities, so long as he surrounds the fire site with a 20 foot wide fireguard. The Manitoba Clean Environment Commission concluded that in windy conditions, this fireguard does not provide sufficient protection. The fact that farmers in the study area admitted to setting accidental fires supports the Clean Environment Commission's findings. It may also be evidence that some farmers frequently burn without taking the required precautions.

The lighting of fires which endanger other private or public property is prohibited under Section I of the Fires Prevention Act. Although this restriction theoretically makes farmers who burn public rights-of-way or adjacent private property liable for a fine of $100 to $300, the law is only enforced if the private landowner or the municipality chooses to press charges. Private individuals, however, are usually reluctant to take legal action against their neighbours. Control by municipal officials is no more effective. These individuals (often farmers) are members of the local community and therefore are loath to curb the actions of their electors. Municipal officials in both study areas also admitted that some burning of public rights-of-way is considered beneficial, in that it reduces the need to undertake maintenance financed by the public purse.

In addition to the fire control provisions included in The Fires Prevention Act, The Municipal Act (S.M. 1970, M225) authorizes (but does not oblige) municipalities to pass by-laws governing the types of fires permitted within their boundaries. To date, however, neither of the municipalities which constitute the study areas, nor any other municipality in Manitoba, has chosen to exercise this right.

2.2216 Burning and Regional Attitudes

Despite the fact that their soil and climatic conditions are comparable, 93 percent (28) of the Odanah farmers use burning as a management tool whilst only 53 percent (16) of their Strathcona counterparts employ this practice. Furthermore, the survey findings indicate that in both municipalities those individuals who burn stubble are also more inclined to burn other vegetation. These findings suggest that the extent to which fire is employed as a management tool may often be determined by personal attitudes or regional traditions rather than by the practical benefits which burning may have to offer.

2.222 Grassland Management

2.2221 Introduction

A major portion of the (annually) uncultivated acreage within the agricultural zone of the Canadian Prairies consists of land utilized for the production of native, and to a much lesser extent, tame forage species. Over the years, rising demands for wheat and other cultivated crop products have resulted in the conversion of large acreages of native range to cropland (Wight 1976). Cyclically depressed cattle prices, and the high capital costs of acquiring forage harvesting equipment (in addition to the line of equipment necessary for cereal crop production), have also contributed to this pattern of development. Since non-cattle producers derive direct economic benefits from their unimproved land only if they rent it to another cattle producer, it can be hypothesized that these individuals will be motivated to convert this acreage into grain-producing cropland. If this trend continues, it can be expected to produce repercussions which will be felt throughout the environment. Highly erodible land, best suited for forage production, will be left without a permanent cover of protective vegetation for much of the year. The waterfowl habitat provided by grasslands will also be lost. Since equipment operation is much less frequent on grassland (especially unimproved grassland), farmers can afford to be much more tolerant of the wetlands or bluffs found in these areas. When the land is cultivated, such landforms interfere with equipment operation and the farmer is motivated to remove them. The resulting impact on waterfowl production could be quite significant. Higgins (1977) found that untilled upland (a category which includes various forms of grassland) attracted proportionately more nesting ducks than did annually tilled cropland. The hatching success rate was also higher in the former land category.

The scenario respecting the changing land use pattern constructed above is supported by the evidence obtained from the study areas. As summarized by Table 2.1 and discussed in Section 2.2, mixed cattle and grain farmers in both municipal study areas tend to have smaller acreages, and maintain a larger percentage of untilled and unimproved land. In the R.M. of Odanah, approximately 21 percent of the uncultivated acreage comprises land utilized for grazing or hay production purposes. Indicative of the relatively greater importance of cattle production in Strathcona, 42 percent of the uncultivated land farmed by the sample population is utilized for grazing or forage production. Further, it is interesting to note that the farmers in the sample populations do not appear to regard hay as a cash crop. In both municipalities tame hay, which has a high yield potential, is produced only by livestock farmers. Total production for both sample populations amounts to approximately 1,100 acres (see Table 2.10).

2.2222 Native Grasses

Sprague (1974) emphasized that in a time when the demands of recreational hunters are increasing, rangeland should be managed as wildlife habitat. Campbell (1952) stated that the basic principles of good farming apply to range pastures as much as to any other crop.

Table 2.10 Tame hay production on sample farms in the study area.

Municipality	Sample size	Livestock producers	Tame hay producers	Estimated total tame hay acreage
Odanah	30	17	17	314
Strathcona	30	21	16	800

Milonski (1958) and Higgins (1977) found that grazing, mowing, haying, and burning practices associated with grassland management interfered with waterfowl by significantly reducing nesting success. Sprague (1974) stated that good grassland management is good wildlife management for many animals. His suggestion represents the basic theme for the following discussion.

2.2223 Burning

As is outlined in Section 2.221, farmers in Odanah and Strathcona indicated that they utilize fire as a grassland management tool. The reasons given for burning included weed control, yield improvements, and removal of litter to facilitate mowing.

Research opinion on the advisability of using fire as a grassland management tool appears to be divided. Penford (1964) reported that denudation increased forage production and had no significant effect on plant composition. Hadley and Kieckhefer (1963), Kucera and Ehrenreich (1962), and Peet et al. (1975) studied the relationship between spring burning and native forage yields and arrived at similar conclusions. The higher production was attributed to the higher soil temperatures present where drift and litter had been removed by burning (Ehrenreich 1959; Peet et al. 1975).

After investigating the impact of spring fire and clipping on a Kansas Bluestem prairie, Hulbert (1969) reported that only when litter is abundant do burning or clipping contribute to increased growth. Gay and Dwyer (1965) reported burning increases yields only when accompanied by nitrogen fertilization.

Kucera and Dahlmen (1967) studied tall grass prairie in Missouri and concluded that during dry years, the benefits of litter removal may be offset by greater water loss and more critical moisture conditions. Clark et al. (1943) found that burning not only increased water loss, it decreased yields. Clark et al. (1943) also advised against burning because it destroys the cover of cured vegetation which is usually present in moderately grazed pastures. This growth is valuable in the early part of the grazing season as a significant supplement to the young growth which is too watery to constitute a satisfactory feed for cattle when eaten alone.

Dix (1960), studying North Dakota grasslands, and Hanks and Anderson (1957) also agreed that burning decreases forage yields. In the Flint Hills Range of Kansas, it was found that burning may aggravate range damage caused by overgrazing (McMurphy and Anderson 1965).

As the foregoing discussion suggests, definitive conclusions regarding the propriety of utilizing fire as a grassland management tool has not been reached. Although several of the researchers report that increased yields may result when abundant old growth is removed by spring fires, Leskiw (1978) and Harburn (pers. comm.) suggest that burning every two to four years is adequate for litter removal. Since most grassland areas in the municipalities being studied are grazed or mowed on an annual basis, litter buildup is not sufficient to justify the annual or biannual burning to which they are sometimes subjected. Where grazing is possible, the effects are similar to clipping, and burning such areas is not necessary (Harburn pers. comm.).

One of the problems encountered by farmers in the study areas arises from the fact that during years when the water levels are high, the lowland (slough) areas become inaccessible to hay harvesting equipment. Often these areas are unfenced and surrounded by cropland, so cattle cannot be grazed there. In order to remove the litter which the unharvested grass constitutes (and which will hinder the operation of some types of hay cutting equipment in the following haying season), these lowland areas are burned. Since most farmers interviewed burn in the autumn, it can be assumed that most grassland burning of this nature will also be undertaken during that season. If, during the subsequent winter the snowfall is heavy, it is probable that in the following spring and summer, water levels will also be high, thus rendering the slough hay unharvestable. The potential waterfowl habitat destroyed by fire during the previous fall will, however, be lost. In order to avoid the development of this situation, it seems reasonable that burning to remove litter should be delayed until the spring, when some information regarding water levels in wetland areas is available. In some circumstances, the use of temporary fences (electric) to contain cattle for a period sufficient in length to enable them to decrease the volume of dead growth might also be feasible as a means of saving potential habitat.

Although the Manitoba Department of Agriculture has not developed official recommendations regarding the use of fire as a grassland management tool, departmental personnel generally discourage the practice (Campbell pers. comm.; Partridge pers. comm.). They regard the benefits of fire to be mainly psychological--the appearance of fresh green growth on a black background gives the farmer a sense of accomplishment. The findings from the study areas lend some support to this thesis. The findings show that in Odanah, 100 percent of the livestock producers use fire as a management tool. Despite the fact that a larger percentage of Strathcona farmers produce cattle, and from the perspective of forage yields likely have a greater need to burn only 38 percent of the Strathcona livestock producers reported engaging in burning of any kind. This implies that the economic benefits (increased yields) derived from grassland burning are minimal. Given the damaging impact which uncontrolled fires have on other aspects of the environment, it is questionable that their continued use for grassland management purposes is justifiable.

2.2224 Grazing

Milonski (1958) and Higgins (1977) cite heavy grazing as one of the major factors which restricts waterfowl hatching success in untilled upland areas. Higgins suggests that a delay of summerfallow operations until after June 1st would improve duck nesting success on cultivated land. As a result, it seems reasonable to assume that delayed grazing would improve nesting success in grassland areas. The literature regarding grassland management implies that delayed grazing of native species would also benefit farmers by improving yields.

Native grassland provides the major form of pasture in both study areas. Ninety-three percent of the Odanah livestock producers and 100 percent of their Strathcona counterparts have some native pasture. In contrast, only 44 percent and 62 percent of these producers respectively, indicated that they have tame pasture acreage.

A summary of the approximate dates on which spring grazing is initiated is provided in Table 2.11. As the table shows, the majority of the farmers in both municipalities begin grazing native pasture by mid-May. According to the results of scientific evaluation, grazing at this early date amounts to mismanagement.

Heavy grazing in the early part of the growing season can be as responsible for overgrazing as overstocking throughout the year (Campbell 1952). While native pastures are resilient

Table 2.11 Dates at which sample farmers initiate spring grazing on native pastures.

Grazing dates	Odanah	Strathcona
May 1 - 10	3	5
May 11 - 20	8	12
May 21 - 31	1	1
June 1 - 10	3	2
June 11 -	-	1
Totals	15	21

in terms of their ability to withstand and recover from adverse climatic influences, this resiliency can only be maintained if they are not overstocked. Overgrazing depletes stands and reduces yields; higher yielding grasses lose their dominance to lower yielding varieties. Once overgrazed and mismanaged, it is difficult to restore native pastures even with the addition of sophisticated technological inputs (Kilcher 1977).

The native grasses of the Northern Plains grow slowly during the first four to six weeks after growth commences. During this period, the native sward is not capable of sustaining heavy grazing (Kilcher 1977). According to the Manitoba Department of Agriculture (1978b), resting native species during the critical first month of growth--May 20th to June 17th--allows the more productive species to build up food reserves to compete with the less palatable woody species. Findings by Temanson (1975) support this claim.

Due to the sensitivity of native species to early spring grazing, researchers and agricultural extension workers recommend that on native grassland and bushland pastures, grazing be delayed until at least mid-June (Campbell 1952; Beacom et al. 1971; Looman 1976; Kilcher 1977). Campbell (pers. comm.) feels that July 1st is the optimal date on which to begin grazing native species. At the end of the grazing season, 40 to 50 percent of the season's total production should remain (Campbell 1952;

Lyster May, 1977; Campbell pers. comm.). Carryover holds snow, reduces erosion, and ensures continuity of production.

As the findings of this study indicate, many farmers are reluctant to institute deferred grazing programs. These findings are corroborated by M.D.A. (1978b) and Kilcher (1977) who found that farmers commonly consider deferred grazing and the retention of the recommended carryover to be wasteful.

Several studies suggest that in practice, the protection of native grasses in the spring increases overall yields. Campbell (1952) found that plots protected until mid-June produced 65 percent more forage than those clipped from late April through September. A further yield increase resulted from protection until July. Noble (1975) reported that ranchers in South Dakota find that resting a pasture for a whole grazing season is the best improvement practice. It allows for improved seed production, and establishment of seedlings.

A recent study by Lodge and Wiens (1973), focusing on the Brown and Dark Brown Soil Zones of Alberta and Saskatchewan, was undertaken to determine the economic feasibility of delaying the grazing of native pasture until early or mid-June. The researchers found that by delaying grazing until June 5th, the length of the normal grazing season was reduced by 13 percent while the carrying capacity of the pasture increased 23 percent. (Delaying grazing an additional 15 days increased capacity by

25 percent). Since the higher carrying capacity was used in a reduced time period, the forage available was adequate for a 41 percent larger cattle enterprise. As these results show, during 1973 delayed grazing in the Brown and Dark Brown Soil Zones was justified even though only economic criteria were considered. The possible environmental costs or benefits of grazing earlier or later than recommended were not included in the calculations.

The study concluded that the economic viability of delayed grazing is a function of the cost of feeding alternative forage during the delayed grazing period. While several alternative forage sources have been suggested (Lodge and Wiens 1973), research findings show that a relatively few acres of tame cool season grasses will withstand heavy use while the native pasture is protected (Partridge pers. comm.; Kilcher 1977; Looman 1976; Beacom et al. 1971; Campbell 1952). High inputs are thus limited to a few acres while the major gain accrues from a much larger area of native cover. In addition, the use of tame pasture makes it possible to extend the grazing season in the fall, when introduced species continue to grow after native species have already become dormant (Kilcher 1977).

Despite the benefits which may be derived from complimenting native pasture with some tame pasture, only 44 percent (7) and 62 percent (13) of the Odanah and Strathcona livestock producers respectively, reported having tame pasture acreage.

Since most of these individuals do not use the tame pasture to delay grazing on native grassland (Table 2.11), however, the benefits which they obtain from having tame pasture are likely well below those optimally attainable.

2.2225 Rotational Grazing

Rotational grazing is a pasture management technique which has proven to be an effective means of preventing overgrazing and maximizing the forage yield and the efficiency with which it is used (Clark and Tisdale 1943; Kilcher 1977; Wilson and Winch 1977; Campbell pers. comm.; M.D.A. 1978b). Optimally, the system should be based on four fields, allowing for one week of pasturing and three weeks for recovery (Wilson and Winch 1977). In regions where the protection of waterfowl habitat is a major concern, the rotational grazing cycles could be organized so grazing in sensitive nesting areas is delayed until the final week of the four week rotation. This should help to improve the probability of nesting success.

As is the case with delayed grazing, however, most farmers in the study areas appear to be reluctant to adopt rotational grazing. In Odanah, only 6.7 percent (1) of the livestock producers having native pasture employ rotational grazing. In Strathcona, 9.5 percent (2) of the livestock producers interviewed indicated they use this management technique.

The infrequency with which rotational grazing is employed can be attributed to several factors. Firstly, it is a practice which requires relatively intensive management--cattle must be moved from pasture to pasture. Secondly, (as is the case with delayed grazing), farmers tend to associate the rotation of cattle off pastures which have some grass remaining with waste (Campbell pers. comm.). Finally, rotational grazing requires cross fencing, the cost of which farmers are often reluctant to incur (M.D.A. 1978b).

Although the foregoing discussion of rotational grazing is concerned with its use on private lands within the study areas, it also applies to the management of the Crown owned pasture leases found at various locations throughout agro-Manitoba. Most Crown land leases have fences only on their perimeters, thus rotational grazing on these lands has been instituted only on a very limited basis (Nielson pers. comm.; Campbell pers. comm.).

2.2226 Fertilization

Fertilization has received serious consideration as a range management tool only within the past few years (Wight 1976). Within the study areas, this management practise does not appear to have been widely adopted. In Odanah, only 41 percent of the livestock producers indicated that they fertilize their pasture and/or hayland. In Strathcona, 48 percent of the livestock producers responded in a similar manner.[12] A number of the respondents who reported applying fertilizer, however, indicated that they did so only on a very irregular basis.

The findings of other studies suggest that farmers who do not fertilize their grasslands are obtaining less than optimum returns from their land (M.R.E.M. 1974). The major limiting factor to grassland production appears to be nitrogen availability. When nitrogen is applied, water use efficiency and forage quality and yields improve significantly (Kilcher 1977; Wilson and Winch 1977; Black and Wight 1972; Rogler and Lorenz 1957). The palatability of fertilized range is also enhanced by nitrogen fertilization. When given a choice, all classes of livestock, including wildlife, always grazed or overgrazed fertilized areas and ignored non-fertilized areas (Wight 1976). The latter finding may be significant from two perspectives. To the farmer, it indicates that if efficient use is to be made of all rangeland and overgrazing is to be prevented, entire pasture units must be fertilized. Alternatively, to the wildlife manager it suggests that the judicious use of fertilizer may be an effective means of confining cattle "traffic"

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[12]Unfortunately, the survey failed to distinguish between tame grassland and native grassland fertilization. The fertilizer data discussed (including manure application) refers to grassland fertilization in general. In spite of its shortcomings, the data provides some indication of the intensity with which grasslands in the study areas are being managed.

to areas in which it is least likely to conflict with the needs of wildlife.

2.223 Tame Forages

As noted in Sections 2.1 and 2.2221, the tame forage acreage represents a relatively minor portion of the total land area in agro-Manitoba. In the study areas, tame grassland, the bulk of which is used for hay production, comprises 2.6 percent and 3.2 percent of the land farmed by survey respondents in Odanah and Strathcona respectively. This is an area of approximately 1,500 acres.[13]

The most common forage varieties grown for hay and pasture throughout Manitoba are alfalfa--a legume, and brome grass (Gross and Storgaard 1975). The latter variety is also the most important forage grass in the central and northern parts of the Prairie Provinces. It is often seeded in a mixture with alfalfa (Looman 1976).

Introduced forage species have several major advantages over native grasses. Firstly, they produce much higher yields (Looman 1976; Friesen 1974); secondly, they withstand grazing earlier in the spring and later in the fall than do native grasses (Looman 1976; Kilcher 1977; Partridge pers. comm.; Lodge

[13]In addition, some farmers produce clover and alfalfa hay on summerfallowed acreage. This will be discussed in greater detail in the following chapter.

and Wiens 1973). Like the native grasses, however, domestic forages will only produce large, high-quality yields if they are properly managed. Many of the management practices which apply to introduced species are similar to those applicable to native grasslands. These practices and their use in the study areas are discussed below.

2.2231 Burning

According to the responses given by the farmers who were interviewed, burning is not a practice commonly associated with the management of domestic forage species. These findings are corroborated in the literature. In Manitoba, the use of fire as a domestic forage management tool is recommended only in alfalfa seed production where it may be effective for disease and insect control, or as a physiological shocking measure (Campbell pers. comm.).

2.2232 Grazing

Although domestic pastures can be used for spring grazing as early as the middle of May, overgrazing, particularly during the spring, leads to deterioration (Looman 1976). In overgrazed fields, sown species are replaced by weeds or native species (Looman 1976). The balance between over- and undergrazing a pasture can best be achieved by employing a rotational grazing system (Wilson and Winch 1977). As suggested in Section 2.2225, few farmers in the study area have chosen to adopt this management practice.

2.2233 Fertilization

The majority of the farmers in the study areas possessing tame grassland have swards consisting of a legume or a grass-legume (alfalfa-brome) mixture. Legumes grown with grasses in forage swards produce high yields without benefit of the nitrogen inputs required by pure grass stands. Bailey (1976), studying forage nutrition and soil fertility at Brandon, Manitoba, concluded that the soil in alfalfa fields should be tested and nutrients such as potassium, phosphorous, and sulphur should be applied according to need. If this is not done, alfalfa stands are likely to suffer from winterskill, and will gradually be depleted.

The management techniques practised by study area farmers contrast sharply with Bailey's recommendations; they tend to favour the grass in the grass-legume sward. In Odanah, approximately 55 percent of the farmers who reported having some tame grassland indicated they do not fertilize it. In Strathcona, 52 percent of the farmers responded in a similar manner. Since only 20 percent (3) of these individuals indicated that they undertake any form of soil testing, it is probable that their alfalfa or alfalfa-brome stands are not receiving the nutrients necessary to insure optimum production.

Tame grasslands, consisting of less than 20 percent alfalfa, should have nitrogen applied on them at least two and preferably three times per year (M.D.A. 1978b). Given the survey results cited above, it is justifiable to conclude that the productivity of non-legume stands is also below what might optimally be achievable.

2.2234 <u>Forage Harvesting</u>

The time at which forages are harvested may be a critical factor in determining their feed value. Some of the greatest harvesting losses are the losses in feed value which are caused by late harvesting (Friesen 1974). In Manitoba, forage growers can aim for a two cut system (Bailey 1976; Wilson and Winch 1977); brome grass should be cut at the earlier head stage (Wilson and Winch 1977). Although the date on which these growth stages are achieved depends on the conditions experienced during the growing season, in the spring these stages are usually reached between June 15th and June 21st (Bailey 1976; Friesen, 1974).

A review of the survey data indicates that 60 percent of the Odanah farmers and 62 percent of the Strathcona farmers (who produce their own hay) begin harvesting operations after the 1st of July. At this time, it is probable that fibre content is above, and protein content is below, the optimum level. Since moisture supplies are usually low in July and August, a delay of the first harvest results in slow growth and a low yielding second harvest (Bailey 1976).

Second crops are harvested by only 26 percent (4) of the Odanah forage producers and 38 percent (8) of their Strathcona counterparts. The majority of these individuals cut their second crop during the final week of August or the first week of September. The delayed second harvest is undesirable for two reasons. Firstly, it may cause a labour conflict with grain harvesting needs; secondly, insufficient regrowth in the fall may reduce the spring vigour of the crop in the ensuing year (Wilson and Winch 1977; Bailey 1976).

2.2235 Grassland Renovation

In order to ensure that domestic pasture and hayland are maintained in a highly productive state, they must be reseeded using a legume or a grass-legume mixture. The frequency with which renovation is necessitated is a function of climate and various management factors. Rohweder et al. (1977) suggest that when grass-legume stands are not adequately fertilized (as was shown to be the case in the study areas), the legume will be displaced by grass and weeds in three or four years. In contrast, the results of the survey show that most producers prefer to extend the period between renovations beyond the three or four years implicitly recommended by Rohweder et al. (1977). Forty percent (8 of 21) of all farmers who indicated that they have hayland consisting of introduced species reported renovating it every five or six years. Another 40 percent indicated that they wait eight years or longer before reseeding. Only 5 percent (1) of the respondents reported that they reseed more frequently than once every five years.

The relative infrequency with which many farmers in the study areas renovate their grassland may be attributed to several factors. Firstly, it may be due to the fact that these individuals are unaware of the benefits offered by improved grassland management. A second (and more plausible) explanation arises from the fact that the conventional techniques currently used to renovate grasslands within the study areas have relatively high costs associated with them. The disc harrow or field cultivator used to cultivate grassland requires that 40 to 100 percent of the sod be disturbed prior to sowing clover or alfalfa (Smith et al. 1977). Conventional grassland renovation not only requires the farmer to incur the time and fuel costs of renovation, the destruction of the old sod also results in the loss of a complete season of production and an increased susceptibility of the soil to erosion.

The recent development and marketing of a machine designed to renovate (cultivate and seed) grasslands in a single pass should revolutionize traditional grassland management practices. This machine tills a narrow furrow into sod and allows legumes or clovers to be sown without destroying existing grasses (Bucher et al. 1975). The competitive edge of the existing growth is reduced by either clipping or grazing the newly renovated area. Despite the advantages offered by the grassland seeder, the farmers surveyed have yet to use this type of equipment. Almost 70 percent of the farmers having some improved grassland claimed they were unaware that such equipment is available.

2.2236 Tame Forages--General Discussion

As the foregoing discussion suggests, many farmers who have grasslands consisting of introduced species are not optimizing their returns from these lands. The findings of this study are supported by M.R.E.M. (1974) which suggests that forage yields could be doubled and probably tripled if the management technology which is available was applied. The results of a study undertaken at the Brandon Manitoba Agricultural Research Station led Bailey(1976) to conclude that alfalfa can be one of a farmer's most profitable crops; if good returns are not realized, poor management is likely the culprit.

To the waterfowl biologist, an account of forage management techniques may initially appear to have little relevance to waterfowl habitat management. When placed in a broader environmental and economic setting, however, the relationship between habitat and forage management becomes apparent.

Table 2.1 demonstrates that within the study areas, mixed farms tend to be smaller and have a greater percentage of unimproved land--land which is important to the sustainance of waterfowl. M.R.E.M. (1974) states that a mixed farm may be as much as 28 percent smaller than a farm dedicated to grain production, and continue to be economically viable.

One means of fostering mixed farming may be to encourage farmers to expand tame forage acreage and improve its management. Excessive forage production is undesirable--large surpluses of hay and cattle create marketing problems and the nature and timing of tame forage grazing and harvesting operations may also disrupt waterfowl nesting activities. In those circumstances when introduced species can be utilized to complement (as suggested in Section 2.2224) rather than supplant unimproved grassland, however, increasing their production (of tame forages) would prove beneficial to farmers and waterfowl interests alike. A larger and more reliable supply of forage, produced on a farm of constant acreage, should increase the economic vitality of smaller mixed operations. Hammond (1964) pointed out that the future of waterfowl is principally in the hands of the small farmer. This suggests that using economic measures to improve the competitiveness, and thus the survival opportunities of small farmers, should indirectly prove beneficial to waterfowl interests.

CHAPTER THREE

MANAGEMENT OF CULTIVATED LANDS

3.1 Introduction

As indicated in the introduction to Chapter Two (see Section 2.1), the agricultural region of Manitoba, like that of its Prairie Province counterparts, consists principally of lands classified as "improved". Most of this area--approximately 13 million acres (M.D.A. 1977a) is dedicated to the production of crops which currently require the land to be cultivated on an annual basis. Although the majority of the prime farmlands are already under cultivation, additional acreage is broken every year (M.D.A. 1977a).

Since many of the lands being developed for agricultural purposes also provide some of the best waterfowl habitat available, waterfowl biologists have viewed this pattern of development with concern. Due to the nature of many cultural practices, land which is cultivated affords little of the habitat required by nesting waterfowl. Although waterfowl managers have long been outspoken opponents of certain cultural practices, the overriding economic importance of the agricultural sector has often meant that the needs of wildlife have been ignored.

Given the economics of Canadian agriculture, slim profit margins and rapidly rising capital costs, as well as a growing demand for food supplies, it would be illusory to suggest that a large percentage of the acreage presently under cultivation will be restored to waterfowl production. Certain changes in cultural practices, making them more accommodating to waterfowl may, however, be feasible; from the perspective of the agricultural sector they may be imperative. In recent years agricultural scientists have voiced opinions which are very critical of some agricultural practices (Rennie 1977; Bowren 1976; Ferguson and Gorby 1964). Frequently, these practices are not only economically inefficient, they are also contributing to the destruction of the very resources upon which agricultural interests depend for their survival. Hedlin (1978) points to the drought and dust storms of the 1930's as examples of what transpires when environmentally unacceptable practices are followed.

In the remainder of this chapter, the practices associated with the management of cultivated lands within the study areas are considered. The implications of the findings are related to the environment in general, and where appropriate, to waterfowl specifically. As in Chapter Two, the survey data provides the basis for discussion.

3.2 Presentation and Discussion of Results

For a summarized description of the land use pattern found on the sample farms of the study areas, the reader is referred to Table 2.1. As the data presented by the table indicates, approximately 67 percent and 63 percent of the land held by Odanah and Strathcona farmers respectively is cultivated.[1] In both cases, the proportion of cultivated area has increased in the past ten years (Section 2.21).

Since cereal grains constitute the major crops grown in both study areas, the management practises discussed are primarily those associated with cereal grain production.

3.3 Summerfallow

Subsequent to its introduction into western Canada during the early 1890's (Molberg et al. 1967), the practice of summerfallowing came to be regarded as integral to the production of cereal grains. Although many of the farmers within the study areas have reduced their summerfallowed acreage, the majority--100 percent (30) in Odanah and 86 percent (26) in Strathcona continue to engage in the practise. The proportion of their cultivated acreage summerfallowed in a given year varies from 15 to 50 percent per farm in Odanah and 0 to 50 percent in Strathcona. On average, approximately 30 percent and 25 percent of the cultivated acreage in Odanah and Strathcona respectively is fallowed every crop year.

The subjects of the survey often gave several reasons for summerfallowing their croplands. The recurring ones are summarized in Table 3.1. The frequency with which each response

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[1]In agro-Manitoba generally, 67 percent of the land is cultivated (M.D.A. 1977a).

Table 3.1 Reasons farmers in the study areas gave for engaging in the practise of summerfallow.

Reasons for fallowing[1]	Frequency of responses: Odanah	Strathcona	Totals
Weed control	17	15	32
Moisture conservation	9	13	22
Reduced fertilizer costs	7	7	14
Give land a rest	3	8	11
Dislike fertilizing	6	4	10
Unsure	5	3	8
Produce forage	4	2	6
Customary	2	4	6
Dislike sprays	3	2	5
Spread workload	4	1	5
Avoid grain carryover	2	1	3

[1]Although it may appear that some of the "reasons" given above are in fact restatements of each other, and thus should not be listed separately, in reality apparently similar reasons were found to have distinct meanings. For example, while some farmers may not like to use fertilizer mainly because of its cost, others stated quite clearly that they are reluctant to apply fertilizer to their fields every year because they are concerned that it may be dangerous to the environment.

was cited is also recorded. The main reasons for fallowing cropland--increased nutrient availability and decreased fertilizer requirements, weed control, and moisture conservation--are not unlike those traditionally used to justify the employment of this management practice (Bowren 1976; Rennie 1977; Spratt 1975; Lindwall 1976; Hedlin 1978; Haas et al. 1974). They are discussed in the following sections.

3.31 Moisture Conservation

When the practice of summerfallowing was introduced, its main purpose was to conserve water for the following crop (Rennie 1977). Recent studies suggest that fallow soil traps and stores water in a very inefficient manner (Hedlin 1978; Haas et al. 1974). Several American researchers found that only 16 percent of the available moisture is stored by fallow soil (Store et al. 1973; Massie et al. 1966). In the Parklands area, summerfallow has been shown to store an average of only 13 percent of the precipitation received during a 22 month fallow period (Bowren 1976).

Despite the obvious inefficiency, soil scientists have concluded that in regions where moisture availability is a serious limiting factor to crop production, the practice of summerfallowing is necessary. A small amount of moisture results in tremendous yield increases. This is particularly true in the Brown and Dark Brown Chernozemic soils of Saskatchewan and Alberta (Hedlin 1978; Johnson 1977).

In some climatic and soil zones, however, good yields can be sustained without including summerfallow in the crop rotation. After completing an extensive study of summerfallow practices in the western United States, Haas et al. (1974) concluded that summerfallowing should be undertaken only in regions receiving less than 16 inches precipitation annually. The findings agree with Spratt et al. (1975). Other researchers have indicated that within the Black Soil Zone, fallowing for moisture conservation cannot be justified (Hedlin 1978; Johnson 1977). Since both study areas are located in the Black Soil Zone, and receive in excess of 16 inches precipitation annually (Spratt et al. 1975; Shaykewich 1971), it can be assumed that farmers (in the area) who maintain fallow acreage for moisture conservation purposes, are engaged in a practice of questionable value. If precipitation during the period between crops is sufficient, the soil profile may be recharged to capacity and fallowing may actually contribute to a net moisture loss (Haas et al. 1974).

3.32 Soil Nutrition and Weed Control

The increased availability of soil nutrients and improved weed control are two other factors cited as benefits of fallowing cropland. Fallowing stimulates the conversion of nitrogen to the nitrate form commonly used by plants (Haas et al. 1974). The results of studies undertaken in the Black Soil Zone of Manitoba show that fallow acreage provides an additional 45 pounds of nitrogen to the crop (Hedlin 1978). When wheat and barley yields from stubble and fallow cropland which had received no nitrogen addition were compared, it was found that the yields from stubble acreage were 45 percent below those obtained on fallow acreage.

Although farmers within the study area most frequently cited "weed control" as a reason for fallowing cropland, research findings regarding the desirability or effectiveness of using this practice for weed control purposes are inconclusive. Hedlin (1978) states that summerfallow "...has never been particularly effective in this respect and with the advent of selective herbicides is seldom, if ever, necessary for this purpose." Donaghy (pers. comm.) acknowledges that non-residual herbicides effectively control broadleaf weed species. The dessicant type herbicides necessary for the control of perennial weeds, however, are too costly to justify their use over large areas (Donaghy pers. comm.; Bowren 1976).

Molberg et al. (1967), Haas et al. (1974), and Spratt et al. (1975) agree that summerfallowing provides some weed control benefits. Holm (1964) and Lindwall (September 1976) suggest that weed control is the main benefit derived from fallowing cropland. Lindwall (September 1976) also notes that the gap between the cost of one tillage operation and an application of herbicides is narrowing. If this trend continues, the number of tillage operations undertaken on fallow land may eventually be reduced.

3.33 Summerfallow--the Costs

The benefits derived from fallowing should not be regarded as "free goods". Some soil and plant scientists have questioned summerfallowing on a number of accounts (Bowren 1976). In a concluding statement to their study of summerfallow practises, Haas et al. (1974) stated "...fallow can not be considered a soil conserving practise. In fact fallow is as soil depleting as most other cropping systems, or even more so." According to Hedlin (1978), the practise of fallowing almost a third of the prairie cropland each year has compounded the soil management problems created by the destruction of native vegetation.

The costs of summerfallow--economic and ecological--are largely the result of the frequent tillage operations currently associated with the practise (Rennie 1977). Table 3.2 shows the estimated frequency with which farmers in the study areas cultivate their acreage. As a comparison of the data demonstrates, these frequencies vary widely, even within areas having fairly uniform soil and climatic conditions. It is probable that the costs vary accordingly.

3.331 Soil Organic Matter

The repeated cultivation of fallow land helps to control moisture-consuming weeds, and aerates the soil. In the short run, enhanced soil aeration is beneficial to the farmer in that it accelerates the process by which nitrogen, present

Table 3.2 Frequency with which farmers in the study areas till summerfallow between the last harvest and the end of the fallow year.

Frequency of tillage	Number of responses Odanah	Strathcona
At least 10 times	2	2
At least 9 times	1	-
At least 8 times	1	2
At least 7 times	4	4
At least 6 times	12	7
At least 5 times	5	8
At least 4 times	4	-
At least 3 times	1	3
Totals	30	26

in the organic material in the soil, is converted to the nitrate nitrogen commonly used by plants (Hedlin 1978). Rennie (1977) attributes the ability (during the last 70 years) of western Canadian farmers to produce billions of bushels of cereal grains without applying significant quantities of fertilizer to the land, to the high organic content, (hence the nitrogen content), of the prairie soils. Over the years, however, the process of fallowing has taken its toll. Studies on the Black Chernozems of Manitoba have shown that the 45 pounds per acre of additional nitrogen which summerfallowed soil provides for the crop becomes available only after approximately 1,000 pounds per acre of organic matter are mineralized (Hedlin 1978).

The continued reliance on summerfallow as a means of generating nitrogen requirements has in fact amounted to little more than soil mining. Since being brought under cultivation, the prairie soils' organic content has been reduced by approximately fifty percent (Rennie 1977; Bowren 1976). Concomitantly, the soils' ability to mineralize nitrogen has decreased (Ferguson and Gorby 1971) to a level which today is forcing a growing number of farmers to apply nitrogen to fallowed land (Rennie 1977).

3.332 Erosion

In addition to reducing the natural fertility of the soil, summerfallowing may seriously increase the soil's susceptibility to the hazards of wind and water erosion. Frequent cultivation reduces organic matter and gradually destroys the surface cover provided by the crop residues remaining on the land (Molberg et al. 1967; Anderson 1976; Bowren 1976; Woodruff et al. 1972).

Within the study areas, varying degrees of erosion are apparent. In the R.M. of Odanah erosion is not severe; the Whitemud River Watershed Study (M.R.E.M. 1974), however, implicates summerfallowing as one of the management practices responsible for erosion damage within the Odanah area. Ehrlich (1957) arrived at a similar conclusion. The erosion problems encountered in the R.M. of Strathcona are much more severe. The extent of the damage is discussed in Section 2.2122. Although a comparable study of Strathcona is not available, Jenkins (1968) studied land management practices in several neighbouring municipalities having similar soils. He concluded that practices such as excessive cultivation were responsible for the gradual expansion of the eroded and saline acreage within the region. Jenkins (1968) noted that the soils' natural fertility and tilth were also on the decline.

If erosion damage is to be minimized, it is essential that as much trash as possible be retained on the soil's surface (Holm 1964; Bowren 1976; Partridge and Hodgkinson 1977). The trash affects water erosion control by bearing the brunt of rainfall impact; it also helps prevent soil clods from being broken down. When clods are broken down, soil pores are closed, less water is absorbed, and more runs off, thereby increasing erosion (Holm 1964).

A trashy surface assists in wind erosion control by reducing wind speeds near the soils' surface (Holm 1964).

The amount of residue considered necessary to protect soil from the forces of erosion is a function of soil characteristics, as well as topography and climatic factors. Research results suggest that clay-loams and silty clay-loams (the main soils found in the study areas) require from 750 to 2,000 lbs/acre (Holm 1964; Johnson 1977; Woodruff et al. 1972; Lindwall 1976). The quantity of residue present after harvest depends on such factors as the crop variety and soil fertility (Partridge and Hodgkinson 1977). Post-harvest tillage reduces residues at a rate dependent on the tillage machinery employed (Woodruff et al. 1972).

In order to demonstrate the impact of tillage operations on crop residue levels in the study areas, a scenario regarding the management of wheat residues has been created. Given current summerfallowing practices, the scenario represents an optimum situation. The analysis (Appendix IV) is based on the assumption that farmers use either heavy-duty cultivators or rod weeders for tillage on fallow acreage. These tillage implements are considered to be the best suited for maximum trash retention (Woodruff et al. 1972; Holm 1964; Johnson 1977). Residues are reduced only 10 to 15 percent with each treatment. In contrast, equipment such as the chisel plow and discer--also in common use in the study areas--may reduce trash cover from 20 to 50 percent every tillage operation.

The results of the analysis show that any farmer striving to maintain a volume of residue adequate to minimize erosion damage should not till his fallow acreage more than three times with a heavy-duty cultivator. If a rod weeder is employed, tillage should be limited to four or five operations, depending on the municipality under consideration. When these figures are compared with the tillage frequencies cited by the survey respondents (Table 3.2), it becomes apparent that most farmers are tilling more frequently than is desirable (even if it is assumed that they always use trash conserving cultivating equipment). In Odanah, 66 percent (20) of the farmers who summerfallow cropland cultivate it six or more times. The corresponding figure for Strathcona is 57.6 percent (15).

3.333 Soil Salinity

Summerfallowing is one of the cultural practices which soil scientists have come to regard as a factor contributing to the proliferation of saline affected soils within the grain growing region of western Canada and the northern United States (Johnsgard 1967; Greenlee et al. 1968; Doering and Sandoval 1976; Halvorson et al. 1974; Haas et al. 1974; Rennie 1977).

Although all soils contain water soluble salts, those which contain sufficient salts to harm plants are referred to as saline (Johnsgard 1967). On the prairies, saline soils often develop in concentric rings around sloughs and along drain channels (Luken 1962). The phenomena referred to in

Table 3.3 Saline acreage on sample farms

Municipality	Sample size	Farmer's reporting salinity	Farms on which salinity increasing	Farms on which salinity decreasing	Estimated saline acres
Odanah	30	30	14	1	360
Strathcona	30	28	14	3	915

the literature as "saline seeps" usually occur where there is a change in the slope, but not necessarily at a low point in the topography. Seeps develop near hill tops, on hillsides, at the bases of hills, and on lowlands. They occur in both glacial till and non-glaciated soils (Halvorson et al. 1974).

The findings regarding saline acreage on the sample farms in the study areas are summarized in Table 3.3. As the table demonstrates, virtually all respondents indicated that they have some saline land. The (farmers') estimates of saline acreage ranged from a few small patches of less than an acre to large blocks totalling 200 acres on a single farm. Farmers in the Strathcona sample estimated their total saline area at approximately 915 acres. Their Odanah counterparts provided an estimate of 360 acres.

Unfortunately, the questionnaire was not designed to distinguish between cultivated and uncultivated saline land. The saline acreage estimates given represent 1.6 percent of the total land area of Odanah farms surveyed and 2.9 percent of the land farmed by the Strathcona sample. Since the saline soils on their cultivated land are likely to be more problematic, however, it is plausible that the estimates which farmers gave refer mainly to cultivated (saline) acreage.

The sites at which the saline soils in the study areas are located are similar to those described in the literature. The areas adjacent to sloughs and low points were most frequently singled out as having soils affected by salt. Very few of the farmers sampled appear to have encountered the phenomenon of saline seeps developing on hillsides.

Although the area of saline soils on the sample farms is relatively small, the survey results suggest that under current management practices the problem of salinity will become increasingly serious. Forty-eight percent of the respondents (14 in Strathcona and 14 in Odanah) who currently have saline acreage reported that this area is gradually expanding. In contrast, only 6.8 percent (1 in Odanah and 3 in Strathcona) reported a decline in salinity.

The experience of other jurisdictions illustrates the rapidity with which the problems of soil salinity can be compounded. A Montana study undertaken in an area of clay-loam soils showed that saline seeps are increasing at a rate of 10 percent annually (Halvorson and Black 1974). Crosson (1971) estimated that approximately 10 percent of the cultivated acreage in Saskatchewan consists of saline soils. Rennie (1977) estimates that this area is expanding by approximately one percent annually.

As noted previously, the prevailing agricultural system, which includes fallow in the rotation, is considered to be one of the major factors responsible for increasing soil salinity. Frequent cultivation to facilitate weed control decreases transpiration during the fallow year. In a three-year rotation (33 percent fallow annually), for example, plants are transpiring water only 4 to 6 months out of three years. The absence of growing vegetation to use the available moisutre allows the water to percolate beyond the root zone, where it dissolves, and carries, salts. Ultimately the water replenishes, and raises the groundwater table (Luken 1962; Halvorson and Black 1974; Johnsgard 1967).

Excess water percolating through the soil profile may affect both local and regional groundwater tables (Greenlee et al. 1968; Doering and Sandoval 1976). Permeable deposits such as sand or gravel, located between layers of soils having a much lower hydraulic conductivity, have been known to carry salt charged waters as much as fourteen miles from the groundwater recharge site (Rennie 1977).

Salinity problems become apparent under several circumstances. Saline groundwater often contaminates surface soils when it moves through permeable layers which are truncated in shallow soils on hillsides (Doering and Sandoval 1976). If the volume of water percolating past the root zone is sufficient to raise the groundwater table, then the capillary fringe of the watertable will also rise. In fine textured soils, capillary action can take place five to six feet above the watertable. As the water, moved upward by capillary action, evaporates, the salts it carried are concentrated in the root zone (Johnsgard 1967).

If this pattern of development is to be avoided it is important to create conditions which are favourable to maintaining a downward movement of moisture within the soil profile.

In areas which are prone to saline seep development, continuous cropping has proven to be an effective control measure (Halvorson and Black 1974; Doering and Sandoval 1976; Luken 1962). On land which is continuous cropped, (particularily with grass), moisture is transpired throughout the growing season and the probability that precipitation will percolate beyond the root zone is greatly reduced. Additionally, the growing vegetation may utilize moisture from the capillary fringe, thus drawing down the watertable. If, during the succeeding period precipitation is sufficient to cause water to percolate beyond the root zone, the lower watertable, and therefore the ground's enhanced water storage capacity, provide greater assurance that the subsequent replenishment of the ground watertable will not be sufficient to cause saline groundwater to rise into the root zone. Finally, the presence of growing vegetation improves the permeability of the soil and thus reduces runoff. Under some topographical conditions the additional water retained _in situ_ may eventually leach surface salts below the root zone.

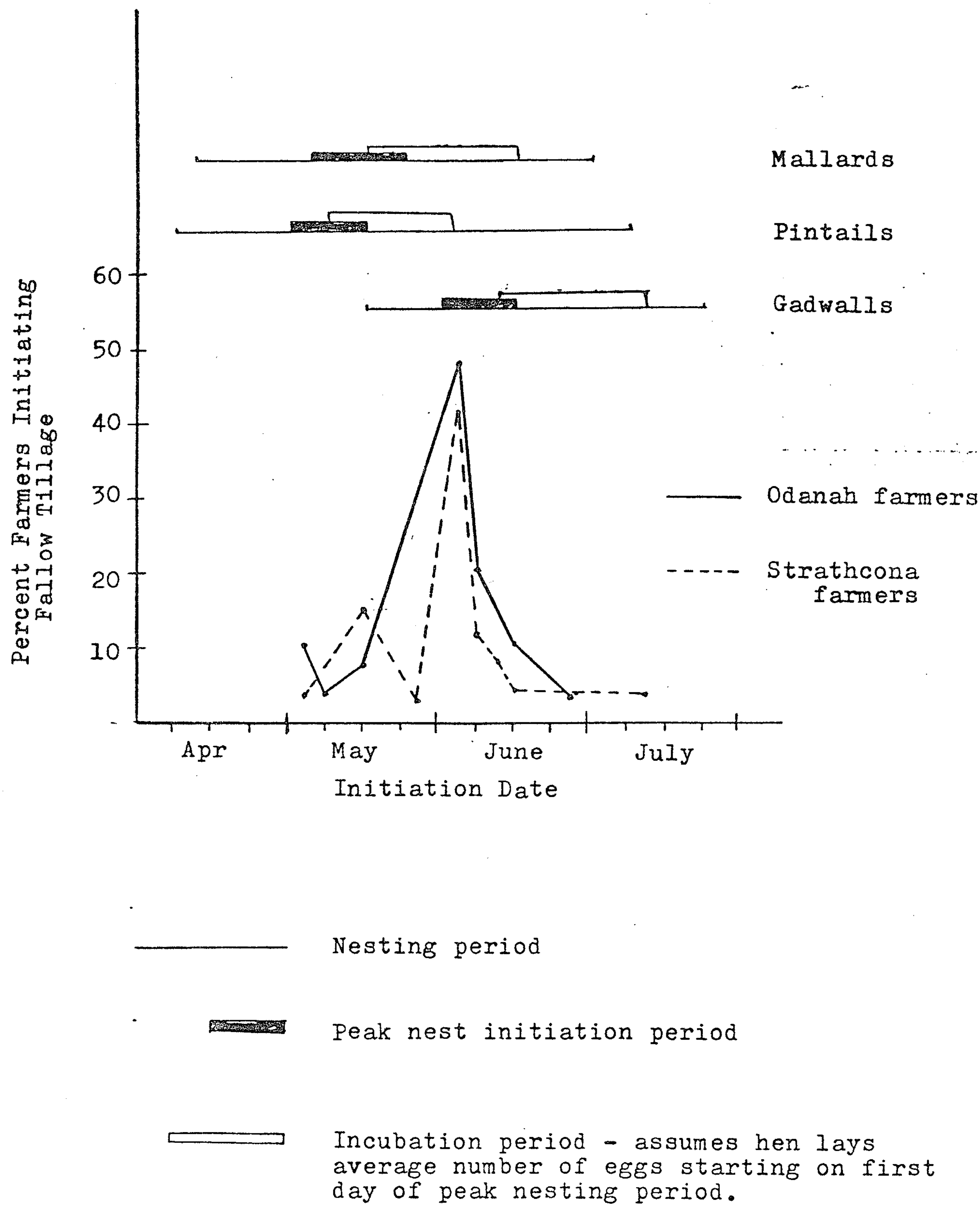
In regions where sloughs are a common feature on the landscape, salinization is primarily the result of temporarily high watertables, which contribute to the capillary movement of water toward the surface (Luken 1962). Due to the low permeability of the subsoil, the water level of sloughs tends to be dependent on precipitation (Luken 1962; Shjeflo 1968). Although fluctuations in the height of the watertables neighbouring sloughs are related to climatic factors, Luken (1962) concluded that farming practises such as summerfallowing accentuate this movement. Fallowing favours the runoff of surface waters and their subsequent accumulation in low areas (Luken 1962; Johnsgard 1967). Further, fallow tillage destroys the grasses and other vegetation which under undisturbed conditions transpire water from areas adjacent to the slough.

3.334 Waterfowl

As well as being a practise of questionable value to agricultural interests, summerfallowing has been shown to have an adverse impact on waterfowl habitat, and nesting activities. Higgins (1977) found that summerfallowed fields contained the lowest nest densities of any annually tilled cropland. Fallow tillage reduces the stubble cover and thereby detracts from the land's value as nesting habitat for some waterfowl species. Nelson and Duebbert (1974), Milonski (1958), and Higgins (1977) concluded that nest destruction is the main factor responsible for the reduced nesting success experienced on annually tilled croplands.

In Figure 3.1 the nesting chronologies of several upland nesting waterfowl species (Bellrose 1976) are compared with the times at which the sample farmers initiate spring tillage on fields programmed for summerfallow. Although nest initiation dates vary according to weather conditions (Sowls 1955), it is apparent (from Figure 3.1) that any nest initiated after the first week in May has very high probability of being destroyed

Figure 3.1 Comparison of upland duck nest initiation dates with fallow tillage initiation dates.



by farming activities. Late nesting species are particularly vulnerable.

In some circumstances, standing stubble or a heavy trash cover remaining from the previous crop acts as a lure. Ground nesting birds which are nesting for the first time, or are renesting after having their nest located on cropland cultivated earlier in the season destroyed, are attracted to this habitat. If fallow cultivation commences before the eggs hatch, the clutch will likely be destroyed. Although most farmers within the study areas reported that they try to avoid, or move, any nests they see, Milonski (1958), Cowan (1976), and Higgins (1977) indicate that these become easy prey for predators.

Unlike on fields which are sown to crops, tillage on fallow acreage continues intermittently throughout the summer. Consequently, any birds which choose to renest on fallow acreage may have their nests destroyed a second, or even third time. Furthermore, continued cultivation of fallowed acreage destroys the cover which exists on these fields, reduces the predators' search area, and thereby increases predatory pressures on waterfowl nests located in peripheral cover.

Finally, the frequency with which farmers in the study areas undertake fallow tillage suggests that this practice may promote encroachment on habitat such as potholes and adjacent peripheral cover. On continuously cropped land, the extent of encroachment by standard agricultural implements is likely to be determined by the moisture conditions prevailing during seeding time. On fallow acreage, however, every tillage operation provides the farmer with another opportunity to cultivate sites where moisture conditions earlier in the season acted as a deterrent. As a result, the extent of encroachment may well be determined by water levels encountered during the driest part of the crop season. This hypothesis is given some credibility by the fact that several farmers within the study areas casually mentioned that they consider the opportunity to burn, clear and drain, to be among the benefits of fallowing cropland.

3.34 Modifications and Alternatives

3.341 Reduced Tillage

As the preceding discussion suggests, many of the ecologically undesirable aspects of summerfallowing--depletion of soil organic matter, increased soil erosion, increased salinity, and waterfowl nest and habitat destriction--can be attributed directly to the timing and frequency with which tillage operations are undertaken on fallow acreage.

Over the years, soil scientists have investigated ways of reducing the negative impacts of fallowing. Many of their studies have concentrated on improving trash conservation by reducing cultivation.

Power and Massee (1958) found that in Montana, four tillage operations were sufficient to control weeds in summerfallow. Molberg et al. (1967) studied summerfallow tillage requirements at seven locations in western Canada. They concluded that on clay-loam soils in the Brandon area, four summerfallow tillage operations were sufficient to achieve good weed control. At locations where fields were cultivated one or two additional times, there was no beneficial response in soil moisture conservation or crop yields. Nevertheless, farmers in the Brandon region tended to till five times, or once more than was necessary (Molberg et al. 1967).

Many of the farmers who were surveyed indicated that they like to undertake one or two post-harvest tillage operations on the fields they plan to fallow the following crop year. In addition to controlling fall weed growth (Anderson 1971), fall tillage of fields scheduled for fallowing partially prepares a seedbed. If conditions in the spring warrant it, the farmer can easily change his summerfallowing plans and sow a crop on these fields. Unfortunately, fall tillage also reduces the stubble cover (Johnson 1977) and thereby detracts from the fallowed land's value as potential waterfowl nesting habitat for the following spring.

Considered purely from the perspective of maximizing summerfallow benefits, research data suggest that post-harvest tillage of acreage scheduled for fallowing is usually not necessary and sometimes may prove detrimental. Haas et al. (1974)

determined that fall tillage may be beneficial in years of relatively high precipitation and weed growth, but disturbing the stubble in the fall, even with mulching equipment, may reduce its effectiveness in retaining snow cover. Greb, Smika and Black (1967) found that straw loosened by sub-tillage was less efficient in retaining blowing snow than anchored, undisturbed straw and stubble. These researchers also found that fall tillage for weed control purposes resulted in greater moisture storage early in the fallow season; by the end of the fallow period there was no significant difference in moisture availability. Lindwall (1976) suggests that farmers either control fall weed growth with the herbicide 2-4-D, or ignore it. Lindwall believes fall germinating weeds use very little moisture, and help to hold snow.

Rennie (1977) and Anderson (1971) concur that tillage after the cereal harvest reduces snow holding efficiency. Anderson (1971) also found that summerfallowed fields tilled after harvest were the only fields on which the volumes of residue remaining at the end of the fallow period were below the minimum levels necessary for wind erosion control.

3.342 Delayed Tillage and Chemical Fallow

In recent years, soil scientists have been investigating the feasibility of delaying tillage operations in the spring, or replacing some fallow tillage with herbicide treatments.

Molberg and Hay (1967) compared the effectiveness of residual and contact herbicides with cultivation, for weed control on summerfallow. Although the chemical (Paraquat) fallow provided effective weed control and preserved 91 percent of the surface residue (versus 24 percent for cultivated fallow), the costs of chemical treatment were unacceptably high.

Other researchers have studied summerfallowing methods which rely on a combination of chemical and cultural treatments to achieve broadleaf weed control. Anderson (1969) found that on a clay-loam soil, a late fall application of 2-4-D ester controlled winter annuals without exposing the soil to the forces of erosion. Anderson (1971) reported the results of a five season summerfallow study undertaken on a clay loam soil at Swift Current, Saskatchewan. The study indicated that summerfallow weed control using only herbicides was too costly, but a combination of a herbicide and tillage treatments equalled total tillage summerfallow (in terms of benefits obtained) in all respects.

Bowren (1976) reported the results of a ten year study undertaken on silty clay-loam soil in the Parkland region of Saskatchewan. This study showed that the application of a phenoxy type herbicide early in the fallow season controlled broadleaf weeds and allowed tillage on summerfallow to be delayed until June 15th or later. There was no advantage to initiate fallow tillage after harvest in the fall. When summerfallow tillage was undertaken in the fall or prior to May

15th, two to four more tillage operations were required than if tillage were delayed until June 15th or later. Bowren (1976) estimates that three to five tillage operations can be saved if broadleaf weeds are controlled with one herbicide application early, and one application late, in the fallow season. Grassy type weeds such as quack grass can be controlled by one or two timely tillage operations.

For those farmers who are reluctant to substitute herbicide treatments for cultivation, delayed spring tillage should not be ruled out as a viable means of conserving trash on fallowed land. Anderson (1971) showed that delaying tillage until early June did not reduce the benefits of maintaining fallow cropland. Haas et al. (1974) suggest that spring cultivation can be delayed until June 1st.

3.343 Alternative Fallow Crops

In some regions and under certain soil conditions, the practice of maintaining a fallow rotation should be completely abandoned. Hedlin and Rigaux (1976) indicate that in Manitoba, the deletion of fallow as a land use practice is a reasonable objective. They point out that in 1976, Manitoba farmers could have produced 37 percent more grain if fallow land had been seeded.

One of the more pervasive arguments favouring the adoption of continuous cropping arises from the fact that salinity problems are more easily controlled, or reduced, on land which is not subjected to a fallow rotation. After studying saline seep development on clay-loam soils in Montana, Halvorson and Black (1974) concluded that more intensive cropping would greatly reduce water losses to deep percolation and thus would aid in reducing saline seep development. Their findings are in agreement with those of Rennie (1977), Johnsgard (1967), Greenlee et al. (1968), Lyster (February 1977), and Doering and Sandoval (1976).

Where the level of salinity is relatively low, it may be possible to continuously crop the land with salt tolerant species such as barley (Lyster, October 1977). Agronomic control of salinity can also be achieved by sowing native grasses or introduced forage species such as alfalfa in affected areas. Native grasses generally support some actively growing vegetation throughout most of the growing season. As a result, saline seeps are generally absent on rangeland (Halvorson and Black 1974). Spratt et al. (1972) found that a continuous cereal-alfalfa rotation decreased salinity by 68 percent over a nine year period. The root systems of forage crops can extract water from great depths and therefore are effective in lowering the watertable and its saline capillary fringe (Luken 1962; Johnsgard 1967).

Further, a vegetative canopy has a balancing influence on an area's water regime (Section 2.2123). Rennie (1977) points to the fact that on the average, only 30 percent of the annual snowfall is retained on fallow land whilst 60 percent is captured by stubble. Holm (1964) and Black (1973) found that water storage increases and runoff decreases as surface residue levels increase. These findings suggest that in regions where the expanse of saline acreage is a function of local watertable fluctuations (which in turn are related to changes in slough water levels) (Luken 1962), improving water management by preserving the stubble on cropland adjacent to sloughs would effectively stabilize the land area threatened by problems arising from the concentration of salts in the root zone.

Although the primary objective of this study was not to provide an intensive review of salinity problems occurring in the study areas, such survey results as are available support the findings of other researchers. While only 6.8 percent of the farmers surveyed who have saline land (one in Odanah and three in Strathcona) reported a decline in saline acreage, two of these farmers have discontinued employing fallow in rotation, one maintains a partial fallow by sowing clover, and one has decreased both the percentage of cropland fallowed annually and the frequency with which he cultivates fallow acreage.

3.344 Economic Factors

Due to the uncertainties posed by market and climatic conditions, farming enterprises are annually confronted with substantial economic risks. As a result, farmers are understandably reluctant to adopt management practices which may further threaten their income. The reasons which farmers gave for fallowing cropland (Table 3.1)--reduced fertilizer costs, "don't like to fertilize", "don't like to spray"--are evidence that these individuals are attempting to minimize the inputs used in producing a crop which may provide only marginal returns. Several individuals explained that they do not practise continuous cropping because in years when they are unable to sell their grain, their cash flow is reduced and fertilizer becomes unaffordable.

Similarly, an analysis of the survey results demonstrates that very few of the farmers sampled have chosen to reduce fallow tillage by substituting herbicide treatments. In Odanah, 10 percent (3) of the respondents reported that they regularly use herbicides as a substitute for cultivation. Only 4 percent (1 of 25 fallowers) of the Strathcona farmers indicated that they occasionally apply herbicides to fallow. They restrict application to patches of perennial weeds. Farmers from both study areas attributed their apparent reluctance to substitute herbicide treatments for tillage operations primarily to the high cost of chemical treatments.[2]

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[2]Among the other, less frequently cited reasons were: a lack of information regarding the employment of reduced-tillage chemical-fallow systems, and concerns regarding the environmental impact of more intensive chemical use. These factors are discussed in a subsequent section.

The results of a study by Mackenzie (1968) suggest that under some market conditions, the maintenance of fallow is economically justifiable. Mackenzie studied the economics of wheat-cultivated-fallow rotations in the prairie provinces. The net returns per cultivated acre for wheat-fallow rotations ranging in length from two to ten years were compared. He found that in general, the expansion of stubble cropping will result in higher production costs per cultivated acre. Longer rotations require more machinery and greater cash outlays for fertilizer, seed, and operating costs. The length of the rotation chosen is largely a function of wheat prices. As the price of wheat relative to input prices rises, a longer rotation period becomes viable. Mackenzie concluded that within the Black, and Grey Wooded Soil Zones, a three or four year rotation was realistic. Where (fertilized) stubble yields were at least 75 percent of the fallow yields, rotations of four years and longer were found to be suitable. The latter situation is most likely to be encountered on the soils of the Newdale Association (e.g. Odanah).

It is stressed that Mackenzie's analysis considered only the costs and benefits of fallow, as they relate to the relatively short term interests of the individual farmer. Certain of the costs of fallow--increased erosion and a decreased water retaining capacity (which may contribute to more frequent downstream flooding)--are insidious in nature, and for the individual farm, are difficult to quantify. As is often the case when

Benefit-Cost techniques are used for process evaluation, costs which can not be readily translated into monetary terms are ignored (Schumacher 1974) by Mackenzie's study. Furthermore, Mackenzie did not anticipate the rapidly rising land prices which have characterized the 1970's. Under these circumstances, intensive land use (continuous cropping) increases in economic attractiveness (Rossenbury et al. 1968).

In addition, the results of the survey suggest that Mackenzie's findings (of ten years ago) may not be applicable in the current economic climate. While most farmers continue to fallow some land, there are indications that the practice is being used more judiciously. Forty-five percent (25) of those farmers who maintain fallow acreage reported that the percentage of their cropland fallowed annually has declined over the years. A few individuals annually fallow only 10 to 15 percent of their cultivated acreage. This is analagous to a 7 to 10 year rotation. Although only 8.3 percent (5) of the sample population has completely abandoned the practice of maintaining cultivated fallow, another 7.4 percent (4) of the respondents indicated that in the near future, they also plan to adopt a continuous cropping system.

Recent experimental results provide further evidence that minimum tillage fallows, and partial fallows, may offer all the benefits of a cultivated fallow, but at lesser environmental and financial costs. Spratt et al. (1975) compared the returns from six three-year crop rotations employed on clay-loam and silt-loam soils in the Brandon region. Their study was conducted over a six year period. The results are summarized in Table 3.4. As the data show, there is no increase in economic returns when fallow is used in rotation. Despite the occasional failure, sweet clover hay substituted for fallow proved to be more profitable than summerfallowing. When oat hay and clover were included in the rotation, the crop was harvested prior to July 15th and partial fallow commenced immediately. Although weeds decreased yields of sweet clover due to the unavailability of satisfactory herbicides, in intertilled crops and oat hay, weeds were controlled as effectively as with fallow.

Anderson (1977) and Bowren (1976) reported on summerfallow experiments involving combinations of chemical and tillage weed control. Their studies were undertaken on clay-loams and silty clay-loams in the Brown and Black Soil Zones respectively. These researchers agree that the current cost of the dessicant herbicides used to control some grassy perennial weeds and volunteer grain renders their use of large acreages economically unviable. In contrast to the farmers, however, both researchers concluded that the use of phenoxy type herbicides to control broadleaf weeds, coupled with several tillage operations aimed at controlling perennial weeds, was less costly than the use of tillage alone.

In addition to the improved trash conservation, the main on-farm benefit of reducing tillage, and/or substituting

Table 3.4 Relative net returns from six crop rotations on the basis of dollars per acre per year (all three years considered) (average of six years results).

	Clay-loam soil $/acre	Sandy-loam soil $/acre
Two years of wheat and one year as:		
Fallow	18.00	4.04
Clover Hay	22.05	7.99
Potatoes	70.01	40.87
Corn	18.00	6.98
Oat Hay	19.93	6.98
Flax	16.99	4.98

Source: Spratt et al. 1975.

herbicide treatments for cultivation is afforded by a substantial reduction in fuel consumption by tractors. Since the energy savings of minimum tillage are to some extent offset by the energy required to manufacture specialized herbicides and application equipment, however, it is unclear whether adopting reduced tillage fallows would result in a socially beneficial reduction in overall energy consumption (Heichel and Frink 1975).

3.345 Influence of Tradition on Fallow Management

Apart from economic factors, traditional values play a key role in determining the kind of management practices which a farmer employs, and the degree to which he may be willing to adopt alternative management techniques. With regard to maintaining summerfallow, the data in Table 3.1 show that "...give land a rest", "customary", and "...unsure", were frequently cited as reasons for engaging in this practice. While these responses clearly suggest a powerful traditional influence, it is probably (given the discussion in Section 3.31) that some of the more substantive responses (e.g. moisture conservation) also spring from traditional perception rather than scientific demonstration.

As was noted in a preceding section of this study, very few of the farmers sampled have adopted reduced or minimum tillage fallowing techniques. Although several farmers in each municipality indicated that they have reduced the frequency with which they cultivate fallow acreage, a like number revealed that they have increased their operations. Ironically, the farmers in the latter category behaved as they did because their newly acquired, larger equipment enabled them to complete each operation more rapidly. As a result, more time was made available for additional operations.[3] One farmer informed this researcher that during some years, he has cultivated his fallow land over 15 times!

Further discussions revealed that many farm operators continue to subscribe to the adage that frequent cultivation assures good yields. Even those individuals who expressed an awareness of the environmental costs attributed to excess tillage, freely admitted that they consider fallowing to be an effective practice only if the land is cultivated until it is "black"--that is, until all surface residues have been buried. This opinion is not an isolated one. Black (1973) also noted that farmers' concerns of possible grain yield reductions have limited the acceptance of residue conserving practices in the Northern Great Plains.

The farm community's traditional tendency to measure progress and results as an increase in yields (Tweedy 1974) may represent a further impediment to those individuals wishing to institute changes in management practices. While high yielding

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[3]In a sense this pattern of development represents an antithesis. Larger equipment should allow for more timely and effective, hence fewer tillage operations.

crops are on public display and boost a farmer's status in his community, cultivation systems having lower costs and providing similar or higher profits (even if yields are somewhat reduced) may appear less successful, and instil in the farmer the fear that he will become a subject of derision by his peers. The continuing influence of the yield maximizing psychology is envinced by the responses which farmers gave to the question:

> Would you be willing to accept lower crop yields, if it were demonstrated to you, that be reducing your tillage operations you would also incur sufficiently lower equipment and fuel costs to compensate for a loss in yield?

Over 23 percent (7) of the Odanah respondents and 40 percent (12) of the Strathcona respondents indicated they would find this tradeoff unacceptable. These individuals do not represent any obvious age or farm-size category.

The influence of tradition extends even to the crop varieties which farmers choose to produce. An analysis of the survey data shows that legumes (alfalfa) are grown in rotation by 43.3 percent (13) of the Strathcona farmers and 16 percent (5) of their Odanah counterparts. With a single exception in each municipality, however, only those farmers who raise cattle employ a legume in rotation. These individuals tend to sow alfalfa only in quantities sufficient to provide winter feed for their cattle. (Since more cattle is produced in Strathcona, this explains the apparent regional preference for this cropping system.) As is the case with hay produced on permanent grassland

(Section 2.2221), the findings suggest that farmers have not yet come to recognize the cash crop value of alfalfa.

3.346 Implications for Waterfowl Management

While summerfallowing as currently practised by the majority of the farmers within the study areas is, in a number of ways, a manifestation of the conflicts which have arisen between the agricultural sector and the needs of waterfowl, it is apparent that opportunities to resolve this conflict in a mutually beneficial manner do exist.

Based on a cursory analysis, it appears that the optimum method of improving nesting success on annually tilled land would be to delete cultivated fallow from the crop rotation employed. Higgins (1977) found that on four types of annually tilled cropland--summerfallow, mulched stubble, standing stubble, and growing grain--nesting success was highest on the growing grain fields. It is important to recognize, however, that conversion to continuous cropping would increase overall grain production (Hedlin and Rigaux, 1976). Given the current marketing system,[4] increased production, if not accompanied by a simultaneous increase in demand, would likely deflate grain prices and thus reduce already slim profit margins.

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[4]The possible influence on landuse by the grain marketing system is discussed in Chapter Four.

Traditionally, this pattern of development has forced many small operators to discontinue farming, and thereby has contributed to farm consolidation, a process which some researchers have decried as dangerous to the environment in general (Perelman and Shea 1972). Others have come to recognize that increased production is contrary to the interests of the waterfowl manager specifically (Hammond 1964).

Alternatively, the benefits of reduced and delayed fallow tillage (for example) accruing to the farmer have already been well documented. While most farmers currently do not initiate spring fallow tillage until the first week of June, an examination of Figure 3.1 reveals that an additional delay (of approximately 10 to 15 days) facilitated by herbicidal weed control, should markedly improve nesting success.

The feasibility of expanding the area under partial fallow also deserves further investigation. As previously noted, a legume sown in rotation not only provides the farmer with an income producing forage crop; in areas where salinity is a problem, it may also serve as a means of rehabilitating the soil. Concomitantly, Duebbert and Lokemoen (1976) report that legume fields are attractive as waterfowl nesting sites. Although these researchers found that the optimum (legume) habitat is provided by established (5 to 10 year old) stands, in regions where habitat is in short supply, even young stands in rotation may prove attractive. If harvesting and the subsequent cultivation of these plots is delayed until early or mid-July (see

Section 3.344), the period during which nesting activities and farming activities overlap is minimized.

3.4 Seedbed Preparation

3.41 Introduction

The heading "seedbed preparation", as used in this study, is a loosely defined term which denotes a series of separate and/or simultaneous operations generally associated with the production of cereal grains and specialty crops such as oil seeds. Within the study areas, the operations which can be included under this heading are: stubble burning, cultivation, soil testing, herbicide and fertilizer application, and seeding.

3.42 Stubble Burning

The practice of removing straw and stubble from the land by burning has been condemned by agricultural scientists and conservationists alike (Bowren and Dryden 1971; Ferguson 1967; Wallace 1959). Nevertheless, it is a practice which continues to find favour with some farmers in the study areas. The results of the survey indicate that 43.3 percent (13) and 70 percent (21) of the Strathcona and Odanah respondents respectively reported that they sometimes use this management technique. In order of the frequency with which they were mentioned, the reasons which farmers gave for burning stubble included:

(1) To facilitate cultivation;

(2) To improve crop yields;

(3) To reduce fertilizer costs;

(4) To improve weed control; and

(5) Due to a dislike of heavy residue cover.

These reasons, as well as the broader environmental implications of burning over cultivated land, are discussed below.

3.421 Burning and Cultivation

A review of the literature concerned with crop residue management indicates that the practise of burning residue to facilitate cultivation has very little scientific support. Black (1973) found that as residue levels increased, soil bulk density decreased, and fertility and tilth (workability) improved. Partridge and Hodgkinson (1977) noted that organic matter helps to bind soil together to form a desirable soil structure or particle arrangement. In clay soils, where tilth and internal drainage are constant problems, it is essential that straw be incorporated into the soil (Wallace 1959).

Johnson (1977) acknowledges that mechanical problems occur in seedbed preparation when residues exceed 3,000 lbs. per acre. Given that wheat residues[5] are produced in quantities ranging from 75 to 100 lbs. per acre per bushel of grain

[5]Wheat is used as the example because it is the main cereal crop produced in Manitoba and its residue yields are similar to or higher than those of other cereal grains grown in the Province (Partridge and Hodgkinson 1977).

harvested (Holm 1964), a 3,000 lbs. per acre residue cover implies a minimum wheat yield of 30 bushels per acre. As demonstrated in Appendix IV, a 30 bushel per acre yield is substantially larger than the average yields attained within the crop districts encompassing the study areas; it is also larger than the average yield obtained at any Manitoba location (Partridge and Hodgkinson 1977).

3.422 Yields and Fertilizer Requirements

The effects of various quantities of crop residue on subsequent crop yields and fertilizer requirements has been the subject of numerous studies. The fact that inorganic nitrogen is immobilized by micro-organisms during the decomposition of carbonaceous materials such as wheat straw (Ferguson and Gorby 1964; Waddington and Bowren 1978) has prompted some farmers to suggest that stubble causes a nitrogen deficiency in the succeeding crop; hence, the practice of burning is justifiable on the basis that it reduces fertilizer needs and improves crop yields. With regard to the study areas, however, additional research findings fail to support this assertion.

Anderson and Russell (1964) studied the impact of various quantities of straw on wheat fields in the Lethbridge area. They concluded that straw in excess of 4,000 lbs. per acre occasionally depressed nitrate production and plant height, and extended the growing season. Waddington and Bowren (1978) found that on silty clay loam at Melfort, Saskatchewan, additions of 7,584 lbs. per acre of rapeseed and wheat straws reduced subsequent barley grain and straw production. The yield reduction cited in the latter study, was attributed to a nitrogen deficiency caused by microbial activity on the crop residues. As indicated in Section 3.3421, however, straw production within the study areas is likely to be well below the volumes quoted in either of the studies referred to above.

Although Dawley et al. (1964) reported that at several prairie locations heavy combine trash reduced the yield of the following grain crop, in four of five locations trash management treatments (various forms of cultivation) other than burning produced a yield which was not significantly different from the yield obtained from burned plots. A ten year study undertaken in the Black Soil Zone at Melfort, Saskatchewan, demonstrated that burned areas did not significantly outyield plots on which other trash handling techniques were utilized. When the same area was burned every year for five years, a yield reduction of 25 percent was measured (Melfort Research Hilights 1965).

Ferguson (1967) studied the effect of repeated straw applications on yields and soil properties on sandy loam at Brandon, Manitoba. After eight years of continuous cropping and applying straw in volumes of 0, 3993, and 7983 lbs. per acre, the ninth and tenth crops showed a residual benefit from the heaviest rate of straw, and yielded more than a second crop after fallow. Approximately 36 lbs. per acre of applied nitrogen was sufficient to maintain yields regardless of the amount of straw added. Available potassium increased due to the applications of straw. Black (1973) obtained similar results in Montana.

An eight-year study at two sites in the Black Soil Zone (Brandon and Melfort) produced further evidence that stubble burning is not a desirable practise. Of nine treatments monitored, fall burning and cultivation produced the lowest yields.

An explanation for the apparent lack of correlation between straw cover, nitrogen availability and crop yields is offered by Ferguson and Gorby (1964). Upon completing experiments on clay-loam soils in southern Manitoba, these researchers concluded that the saprophytic organisms present in decomposing crop residues are unlikely to interfere with nitrogen utilization by cereal crops. Cereal crops grown on soils where climatic conditions are similar to those of southern Manitoba are well adapted to the low soil temperatures prevailing during the spring and thus are readily able to compete for the available nitrate with the saprophitic organisms (which are relatively inactive when temperatures are cool). By mid-summer when temperatures are high and decomposition is rapid, crops have satisfied most of their nitrogen needs. M.D.A. (January 5, 1977) supports this explanation.

M.D.A. also suggests that burning reduces the capacity of soils to support plant growth. Fire not only reduces the number and activity of soil micro-organisms, if sufficiently hot, it may also volatilize the available nitrogen and potassium.

In addition nitrogen, phosphorous, and potassium become more susceptable to leaching after fire. Partridge and Hodgkinson (1977) have estimated the value of plant nutrients lost when straw is removed from the land. These values are shown in Table 3.5. Since in the long run the soils' ability to mineralize nitrogen is a function of their organic content, continued destruction of organic matter by burning will ultimately force farmers to increase the rate at which they apply synthetic nitrogen fertilizer.

3.423 Weed Control

While burning may destroy some weeds, total weed infestation in crops planted on land on which the stubble has been burned is not reduced (M.D.A. January 5, 1977; Faculty of Agriculture 1977). The infestation of wild oats represents one of the most serious weed control problems encountered in the Parklands region (Friesen 1975). Fire is ineffective in controlling this problem in that most seeds have fallen to the ground prior to the initiation of the burning season, and thereby escape damage. In some circumstances, burning may improve wild oat germination by more thoroughly drying the seeds (Wallace 1959).

The only conditions under which burning may provide improved weed control is when trash represents more than 25 percent of the soil cover (Johnson 1977). Excessive trash inhibits satisfactory incorporation of soil applied (pre-emergent)

Table 3.5 Value of major nutrients (N,P,K,S) in 1 ton of cereal straw.[1]

Crop	Straw removal[2] from land	Straw burning[3] on land
Wheat	4.10	2.59
Barley	5.36	2.42
Oats	7.99	2.85

[1]Based on N=18¢/lb. P=33¢/lb. K=9¢/lb. S=10¢/lb.

[2]Loss of N,P,K & S

[3]Loss of N & S only

Source: Partridge and Hodgkinson (1977)

wild-oat herbicides and thereby reduces their effectiveness. Given the negative impacts of burning, however, Johnson (1977) does not recommend that this management technique be employed. Furthermore, increasing the use of granular herbicides over liquid varieties, offers a means of reducing the conflict between trash conservation and weed control objectives. Although granular herbicides must also be incorporated, they require less intensive tillage and are effective even under trashy conditions (Donaghy pers. comm.; Sailoff pers. comm.; M.D.A. 1978c).

3,424 Water and Soil Management

The effects of burning on the soil and the hydrological cycle have already been well documented (Section 2.2212 and Section 3,421). The removal of organic material from the land's surface increases its susceptability to erosion. The moisture holding capacity of soil from which the stubble has been removed is also markedly reduced (Staple et al. 1960; Smika and Whitfield 1966; Anderson and Russell 1964; Unger et al. 1971). In areas which are generally plagued by moisture deficiencies, any amount of water lost can be very important.

One of the principal reasons for moisture loss on croplands, which have been burned over, is the greater depth to which unprotected soils are likely to freeze. Soils which are frozen have a much lower infiltration rate (Gray 1970). Fields which are devoid of surface trash have a reduced snow holding capability. Since snow has an insulative effect which increases with depth (Willis et al. 1960), maintaining surface trash in order to promote snow capture, effectively reduces the depth to which the frost is able to penetrate into the ground. Reduced frost penetration promotes earlier thawing, and thus improved infiltration of snow meltwater during the spring.

Empirical evidence of the existance of this relationship is provided by Staple and Lehane (1952). Their studies in southern Saskatchewan showed that the amounts of moisture retained from snow were appreciable in all years, while there was little retention in bare fallow approximately 50 percent of time. They concluded that one reason for this difference was the fact that soil temperatures at the one foot depth reached 32° F. in stubble a few days earlier than in fallow. Similarly, Willis et al. (1961) concluded that snow not only acts as an effective insulator, it also retards the moisture losses which occur from soil which is bare during the water.

In addition to indirectly promoting groundfrost penetration, burning also produces hydrophobic substances which speed runoff from the soil (M.D.A. January 5, 1977). The blackened surface also promotes the development of "dirty" snow, which has a lower albedo (Trewartha 1968), hence melts rapidly, and thereby increases peak water levels in receiving water bodies.

3.425 Impacts on Waterfowl

The impacts of burning native cover on waterfowl nesting habitat are discussed in Section 2.2211. In many respects the consequences of burning stubble are similar.

Cowan (1977) and Fritzell (1975) note that the time at which burning is undertaken determines the nature of its impact on waterfowl. When burning is undertaken both during the fall and spring, the destructive impact is likely to be more pronounced than if burning activities are confined to a single season.

The results of the survey (Table 3.6) indicate that most of the sample farmers choose to burn in the fall. Fewer individuals burn during both seasons.

Fall burning is particularly detrimental to species which depend on the past year's growth for nesting cover. Fritzell (1975) found that early spring burning of stubble destroyed the nests of early nesting species such as pintails. Late nesting species such as the blue-wing teal are less likely to have their nests destroyed by fire.

Cowan (1977) indicates that under the current agricultural system, stubble burning may not be a deterrent to waterfowl production. Generally, nests located in unburned stubble are destroyed by tillage operations. Unfortunately, however, stubble fires are frequently unconfined and tend to spread to the peripheral cover which would ordinarily be available for nesting activity. Further, the burning of stubble increases nest concentration and thereby leaves them more vulnerable to predation.

3.426 Farmer Attitudes

As noted in Section 2.2216, the extent to which burning is employed as a management tool may often be related to personal attitudes and regional traditions rather than to scientifically demonstrated need. This contention is supported by the data in Table 3.6. The figures show that despite similar climatic and soil conditions, Odanah farmers are much more inclined to burn stubble, than are their Strathcona counterparts. More significantly, from the perspective of the wildlife manager, those farmers who burn stubble appear also to have a greater propensity to burn other vegetation on or bordering their farm. These findings, when considered in light of the fact that some farmers in both study areas appear to be capable of managing crop residues without resorting to burning, (and the research results documented in the literature) suggest that much of the burning which is undertaken can be justified only on the basis that it satisfies certain individuals' pyromanic tendencies.

3.43 Tillage

Tillage has traditionally been considered to be a necessary step in most crop production systems. Tolton et al. (1963) suggest that the main benefits of tillage are weed control, soil aeration, trash management, and improvement of the soil's texture so as to facilitate uniform seed placement. They recommend that stubble cropland be tilled twice during the fall and once or twice (depending on the timing of seeding and the seeding implement used) during the spring.

Table 3.6 Use of fire as a stubble management tool

Municipality	Sample size	Farmers who burn stubble	Fall burners	Spring burners	Spring & fall burners	Farmers who burn only stubble	Farmers who burn stubble and other vegetation
Odanah	30	21 (70%)	14	-	7	2	19
Strathcona	30	13 (43.3%)	9	-	4	1	12

Results of studies undertaken more recently suggest that cultivating as frequently as recommended by Tolten et al. may not be economically advantageous. Zero-tillage crop production is based on the premise that the cultivation associated with conventional crop production systems is unnecessary.[6]

Experiments undertaken to determine the impact of various cultural treatments on yields of wheat produced under conventional (non-zero-tillage) cropping systems suggest that under some conditions fall tillage may not be required. Dawley et al. (1964) report that wheat yields at Indian Head, Saskatchewan (Black Soil Zone) were greatest with no fall tillage. After seven year study on clay-loam soils at Brandon, Manitoba and Melfort, Saskatchewan, Bowren and Dryden (1971) also concluded that fall tillage did not contribute to any significant yield increases. Fall tillage was considered to be beneficial primarily when annual and perennial weeds became excessive (Dawley et al. 1964; Bowren and Dryden 1971; Stobbe 1977). In Manitoba 90 percent of the cultivated cropland has serious weed problems (Faculty of Agriculture 1977).

Bowren and Dryden (1971) suggest that discing may also be necessary when crop residues exceed 2,000 pounds per acre.

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[6]Since on the Canadian Prairies zero-tillage cropping is not yet widely accepted as a crop production technique, it will be discussed in the chapter considering future developments in agricultural technology.

When a double disc drill was used for seeding, residues in quantities exceeding this figure were found to interfere with good seed placement.

The responses to the survey questionaire indicate that approximately 70 percent of the sample population undertake 2 tillage operations (on stubble) during the fall and one or two operations during the spring. The primary implements employed are discers and cultivators.

The responses to inquiries of the farmers' opinions regarding the feasibility of reducing tillage without impairing productivity are summarized in Table 3.7. Although not all farmers who expressed uncertainty or opposition to reduced tillage elaborated on the reasons prompting their response, interpretation of those reasons which were volunteered suggest that for many the affinity for tillage is strongly rooted in tradition. Of the 37 individuals who expressed uncertainty or opposition, 16 (43%) indicated that frequent tillage is good for the land and synonomous with higher yields, while 12 (40%) reported that the primary benefit of tillage is weed control. Six (16%) members of this group indicated that they would like to increase the frequency with which they cultivate.

While it is difficult to draw any definite conclusions from the data, the importance of traditional values suggests that tillage may frequently exceed the requirements of effective weed control. Consequently, it is likely that the negative environmental repercussions of cultivation also exceed the levels which must be endured for the sake of economic crop production.

Table 3.7 Farmers' opinions regarding feasability of reducing (conventional) tillage.

Municipality	Sample size	Tillage can be reduced	Tillage can't be reduced	Uncertain
Strathcona	30	13 (43.3%)	14 (46.6%)	3 (10%)
Odanah	30	10 (33.3%)	13 (43.3%)	7 (23.3%)

3.44 Herbicide Use

In Manitoba the use of herbicides for the control of broadleaf and grass weeds has increased steadily. During the years 1973 to 1977 inclusive, the consumption of the broadleaf herbicides 2-4-D and MCPA (the main varieties used) increased by approximately 13 percent (M.D.A. 1973; 1975; 1977a). The area to which these chemicals were applied, however, remained fairly stable, fluctuating between 4.5 and 5 million acres annually since 1966. Today this area amounts to approximately 65 percent of the land dedicated to the production of cereal grains and oil seeds (M.D.A. 1977a).

The most dramatic increase in herbicide use has been in the area of wild oat control. Friesen (1975) describes the wild oat infestation as the most serious weed control problem encountered in the Parklands region. From 1973 to 1977 the area treated expanded from 939,000 acres to 3,430,000 acres, or approximately 40 percent annually. During 1977 approximately 50 percent of the cereal grain cropland was treated with wild oats herbicides (M.D.A. 1977a).

The data obtained from the survey questionaire indicates that 100 percent of the farmers in both sample groups use some herbicides for crop protection (Table 3.9). Most farmers continue to use primarily spring applied liquid herbicides, a reflection of the fact that granular products are relatively new on the market. A similar use pattern can be observed throughout the Province (Donaghy pers. comm.).

From both a purely economic stance and an environmental perspective, the use of herbicides has positive and negative aspects.

When increasing the use of herbicides enables a farmer to increase his net productivity without expanding the acreage under cultivation, the herbicide in fact becomes a land conserving technology. In regions where the maintenance of undeveloped land for wildlife habitat and recreational purposes is a major concern, any reduction in the pressure to expand farm output by increasing cultivation can be considered as beneficial.

A reduced need to cultivate and the consequent increase in the amount of surface trash conserved for erosion prevention, may be among the main benefits of herbicide use. The degree to which tillage may be reduced depends on the weed problem encountered and the type of herbicide employed for control purposes.

On cereal cropland, grassy weeds such as wild oats and green foxtail can be controlled with either pre- or post-emergent herbicides. Most varieties currently on the market are pre-emergent and must be incorporated into the soil to be effective. They are available in both liquid and granular form and can be applied during the fall or the spring (M.D.A. 1978c).

One of the major drawbacks of liquid soil-incorporated herbicides is their lack of effectiveness on trashy surfaces

(M.D.A. 1978c). As a result farmers who use liquid varieties are encouraged to cultivate or burn until most surface trash is destroyed. Although granular herbicides also require incorporation, their effectiveness is not as likely to be impaired by trash, and only two tillage operations (at right angles) are sufficient to ensure adequate weed control (M.D.A. 1978c).

Provincially, trends indicate that farmers are favouring fall applied granular (pre-emergent) herbicides (Donaghy pers. comm.). Their use spreads the farmer's workload more evenly over the year, eliminates the need to delay spring planting to control wild oats by tillage, and thus moves planting dates ahead by as much as three or four weeks (Donaghy pers. comm.). Earlier seeding benefits the soil by reducing the period during which it is bare and susceptible to erosion. It also benefits waterfowl and other groundnesting species by providing additional cover earlier in the season. Since a special applicator is required to apply granular herbicides, however, the cost of this equipment (in addition to post-emergent spraying equipment) may discourage some farmers from adopting this management technique.

Most of the broadleaf weed problems occurring on Manitoba croplands can be controlled by spraying the post-emergent herbicides MCPA and/or 2-4-D (M.D.A. 1978c). A seven-year study conducted on clay-loam soils at Brandon, Manitoba, and Melfort, Saskatchewan, indicated that in regions where wild oats and green foxtail are not a problem, these chemicals can be used to displace fall tillage operations (Bowren and Dryden 1971).

Although the data Table 3.8) demonstrates that all members of the sample population employ some form of chemical weed control, a comparison of these findings with tillage trends (Table 3.9) indicates that there has not been a concurrent reduction in the frequency of tillage. While the majority of the farmers who reported increasing their tillage stated that they were attempting to control worsening wild-oat infestations without resorting to chemicals, this does not explain why other farmers who are apparently using all forms of chemical herbicides, have not reduced their tillage. Although the data from the study areas provides no definitive reasons for the behaviour of the latter group, several possible explanations can be offered.

Firstly, the increasingly monocultural character of many farms may be aggravating weed problems and thereby negating the benefits of non-tillage weed control. Secondly, the traditional tendency to associate frequent tillage and "black soil" with good farming practise, as well as the larger equipment being made available to facilitate more rapid completion of a single operation, may be inducing farmers to cultivate regardless of weed control needs. The findings discussed in Sections 3.345 and 3.431 lend support to this hypothesis.

Finally the farmers' failure to take full advantage of the opportunity to reduce tillage by controlling weeds with herbicides may be due to a lack of information regarding the

Table 3.8 Use of herbicides by farmers in the study areas.

Municipality	Sample size	Herbicide users	Liquid only	Granular only	Liquid & granular	Pre-emergent only	Post-emergent only	Pre- & Post emergent	Fall & Spring application	Fall application only	Spring application only
Odanah	30	30	17	0	13	4	11	15	9	0	21
Strathcona	30	30	21	2	7	5	11	14	6	2	22

Table 3.9 Trends in the tillage of stubble during the last 5 years (1973-1977)

Municipality	Sample size	No change in tillage frequency	Increased tillage	Decreased tillage
Odanah	30	22	6	2
Strathcona	30	23	7	-

full benefits, or most effective means of employing herbicide treatments. The findings of Badack (1977) support this allegation. The findings of this study (Section 3.452) pertaining to the farmers' use of other synthetic inputs (fertilizers), also suggests that farmers are not adequately informed, to use chemicals such as herbicides and fertilizers to maximum advantage.

Despite the benefits which they offer, the use of chemicals pest control measures is a source of conflicts interest. These arise mainly because the application of some chemicals has proven to be damaging to the environment.

The focus of much public attention have been the pesticides which persist in the environment and through their accumulation in the food chain present a threat to many forms of life. These dangers are presented primarily by organochlorine insecticides. In general, insecticides are much more toxic to humans and animal life than herbicides (A.R.S. 1975; Sheets 1976). The rarity with which they are mentioned in the relevant literature suggests that their use (relative to herbicides) in the production of cereal crops on the Canadian Prairies is insignificant.

A comprehensive discussion of the environmental impacts of herbicides is beyond the scope of this study. Several points, however, deserve brief consideration.

Most of the herbicides registered for use in Manitoba are non-persistent; degrading or volatilizing within one crop year (M.D.A. 1978c; A.R.S. 1975). If care is not excerised in the application of the herbicides themselves, or in the management of the soil on which treatment takes place, however, the transport of herbicides into areas where they may endanger desirable species of vegetation is facilitated (Tomkins and Grant 1977). Tomkins and Grant observed that species diversity was markedly decreased on vegetation plots treated with the herbicide Diuron.[7]

Sediments and water, either singularly or as a combination are the main modes by which herbicides are transported (A.R.S. 1975). While herbicides may be leached several inches into the ground and transported laterally for short distances by water moving in the soil, they can be moved greater distances in surface runoff during rain storms (A.R.S. 1975; Sheets 1976). A.R.S. (1975) suggests that agronomic practices which control the volume and peak rate of runoff are among the best measures available to control the transport of herbicides in surface waters. The techniques and conditions recommended for achieving this objective include maintenance of a dense vegetative canopy, abundant mulch or litter, high soil organic matter content, good soil structure and good subsurface drainage (A.R.S. 1975; Sheets 1976).

Although in Manitoba the problems associated with the transportation of herbicides off croplands and into sensitive stands of other vegetation may not yet be pronounced, the expansion in the use of chemicals generally, and grass killers

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[7]Diuron is in the same chemical class (Ureas) as Lorax, a herbicide recommended for use in Manitoba (A.R.S. 1975; M.D.A. 1978c).

specifically could contribute to the development of future problems. Among the vegetation stands most susceptable to inadvertant herbicide damage are the native plots which intersperse the croplands in the Parkland region. Given the importance of these areas to the sustaining of wildlife, it is desirable that in the future the impacts of various agricultural herbicides on the native vegetation be carefully studied and the use of chemicals monitored to ensure that a serious threat does not materialize.

3.45 Fertilization

3.451 Current Trends

As is the case with herbicides, the use of synthetic fertilizer (relative to the area under cultivation) is expanding rapidly in this Province. The sales figures for the period spanning from 1973 to 1977 inclusive (Table 3.10), reflect the higher rates of consumption.

The findings regarding the use of fertilizer by the farmers in the sample population are summarized in Table 3.11. Although the majority of the respondents apply fertilizer to at least some of their cropland, a few individuals in both municipalities reported that they never use synthetic fertilizer. With one exception, all members of the latter group are livestock producers and choose to apply manure on their cropland.

A substantial number of farmers indicated that they plan to begin fertilizing, or increase the amount of fertilizer

Table 3.10 Fertilizer sales in Manitoba during the years 1973 to 1977 inclusive

Year ending June 30	Materials and mixtures (tons)	Percentage increase over previous year
1973	305,989	41
1974	359,620	17
1975	379,911	5
1976	407,148	7
1977	519,109	27

Source: Manitoba Agriculture 1977 Yearbook.

Table 3.11 Consumption of synthetic fertilizer by farmers in the study areas.

Municipality	Sample size	Individuals who use synthetic fertilizer	Individuals who apply fertilizer to all cultivated crops	Individuals who apply fertilizer to some cultivated crops	Individuals who plan to increase fertilizer use
Odanah	30	25 (83%)	20	5	13
Strathcona	30	26 (86.6%)	17	9	13

they apply in the future. Those individuals who are not yet applying the provincially recommended quantities of fertilizer and who have no plans to increase fertilizer consumption cited costs, grain carryovers, and concerns that fertilizer may ultimately be damaging to the environment, as the primary factors influencing their decision.

3.452 Soil Testing

If the benefits from the use of fertilizer are to be maximized, the appropriate quantity and mixture of nutrients must be applied to the cropland. The best means of ensuring this is done is by soil testing (Agriculture Canada 1975).

Soil tests provide an inventory of the soil nutrients that are available for crop production. They help to eliminate uncertainty in determining crop fertilizer requirements and enable the farmer to avoid unnecessary use of fertilizer. In addition the soils' alkalinity and salinity can be assessed by soil tests (Agriculture Canada 1975).

All farmers who were interviewed were questioned as to how they determine the mixture and quantity of fertilizer they apply. Their responses indicate that most individuals are haphazard in their approach. "I guess", "I just know", "The neighbour has his soil tested and I use his recommendations", were common responses. One individual mentioned that his fertilizer application equipment is difficult to calibrate; hence, he has applied the same quantity of fertilizer ever since he obtained the machine. Relatively few farmers (Table 3.12) reported having their soil tested on a regular basis.

These findings suggest that many of the respondents are not using their fertilizer inputs with maximum efficiency. Synthetic fertilizers are most efficient on land which is naturally highly productive (Geno 1976). In their failure to have their soil tested, farmers are less likely to be aware of the marginal qualities (saline or alkaline) of the land to which they apply fertilizer. In some circumstances, the appropriate soil test may indicate that a farmer would be better off to reduce the land area he cultivates and fertilizes, while increasing the intensity with which he manages his prime land.

The tendency of farmers within the study area to practise land-extensive rather than -intensive management (as exhibited by the low testing rate) suggests that returns on chemical inputs may be sub-optimal, and thus offers one explanation as to why some farmers are reluctant to incur the additional costs of increasing their fertilizer consumption. Further, the unsophisticated manner in which farmers deal with inputs as costly and complex as chemical fertilizers, is likely an indicator of how they manage inputs such as herbicides. The need for increasing the information and education available to farmers, regarding the use of these inputs, becomes apparent.

Table 3.12 Soil testing by farmers in the study areas.

Municipality	Farmers who apply chemical fertilizer	Farmers who soil test on a regular basis	Farmers who reported testing soil on an irregular basis
Odanah	25	5 (20%)	6 (24%)
Strathcona	25	4 (16%)	4 (16%)

3.453 Environmental Considerations

From the perspective of environmental management, the use of fertilizers has positive as well as negative implications. Among the major benefits of (increased) fertilizer use, is the concomitant promotion of land intensive management. Fertilizers (like herbicides) enable the farmer to produce larger crops on fewer acres. Continuous cropping becomes more viable (Hedlin 1978), while practices such as summerfallowing are rendered obsolete. The impetus to expand production by invading undeveloped lands is also reduced.

The negative impact of increased fertilizer use on the environment may be felt directly or indirectly. Indirect impacts may develop primarily as a result of economic factors. If a farmer wishes to utilize fertilizer as a production input, he requires financial resources. Those farmers who find themselves in the position of not being able to afford fertilizer may experience difficulty competing with individuals who are better off. Past experience indicates that the members of the former group are eventually absorbed by the latter group. The result is the consolidation of farms, larger operating units, and a gradual reduction in the diversity of the rural environment.

The direct environmental problems arising from increased fertilizer use (especially nitrogen and phosphates) are primarily those associated with water pollution (Crosson 1975; A.R.S. 1975). Some aspects of this problem are discussed in Section 2.2117.

The pollution hazard created by the addition of nutrients to the soil depends on the time of application, and the form of nutrient applied. Nitrogen in ammonium form for example, adsorbs on clay particles and is not subject to leaching (Frere 1976). Field experiments indicate that nitrate nitrogen is more effectively used by crops and less likely to be leached if it is applied during the spring, as close to seeding time as possible (Ridley 1977; Frere 1976). Farmers and fertilizer dealers, however, often experience difficulty handling fertilizer requirements during the relatively short seeding period (Ridley 1977).

Under current conditions, the threat of fertilizers contributing to the development of a pollution problem in water bodies located within the study areas may not be serious. Although speculation on future fertilizer use is fraught with uncertainties, it is probable that the costs of fertilizer relative to other farm inputs will determine that farmers continue to increase its use (Frere 1976). Should this be the case, it is possible that a pollution problem could develop. The movement of water (hence flushing action) in the permanent wetlands located within the study areas is minimal. Increasing the availability of nutrients would promote succession and eventually could detract from the quality of these sites as wildlife habitat.

A review of the literature indicates that thus far the question of water pollution in wetland areas similar to those in the study areas has received scant attention. In the future more monitoring may become necessary.

CHAPTER FOUR

LEGISLATION AND INSTITUTIONS

4.1 Introduction

While factors such as traditions, education, and economic parameters are influential in determining the manner in which land is managed, these are not alone in eliciting specific forms of conduct from the farmer. In organized society legislation and institutions or programs established thereby, play an important role in governing the behaviour of the individual. Legislators and persons in similar positions of power use clearly defined, or subtly implied, punitive and remunerative measures to discourage some activities while promoting others.

Within the agricultural zone of the Province of Manitoba, land use is regulated by 19 provincial statutes under the administrative jurisdiction of 4 provincial departments, and a minimum of 18 federal statutes, statutory institutions, and federal-provincial agreements administered by various federal and provincial bodies (Ward 1977). Although there are exceptions to the rule, with regard to their impact on land management, the legislative powers discussed in this study tend to fall into one of two categories. Federal legislative powers are used primarily to create institutions - marketing and funding agencies - which may have a secondary or indirect impact on land use. In contrast, the provincial legislation tends to be aimed primarily at specific resource or land use problems and thus has a more direct impact on land management.

An analysis of this legislative and institutional framework within which farmers and other land managers operate, helps to account for the fact that many of the practices discussed in the preceding chapters continue to be employed by members of the study area sample group. Given the plethora of legislation and the limited scope of this study, however, only those statutes and institutions of the Crown which have the most significant impact on agricultural land use are discussed.

4.2 Legislation

The role of legislation in the achievement of certain land management objectives has been the subject of past studies. Elliot (1978) documented the administrative and legal provisions associated with artificial land drainage and the preservation of the Province's wetlands. Elliot (1978) noted that many of the key statutory provisions regarding drainage were "obscure and inconsistent". "Present drainage laws," he concluded, "cannot be counted on to contest the continued drainage of wetlands."

A review of provincial legislation as it relates to land management in general (soil and water), indicates that with a few notable exceptions policy has developed in an atmosphere which has tended to be reactionary rather than anticipatory. Prior to 1939 the Province was concerned primarily with promoting the rapid development of the agricultural sector. During the 1930's, however, it became apparent that some public policies designed to encourage responsible land management were necessary. The government responded by passing The Land Rehabilitation Act

(R.S.M. 1970, L50). This legislation, still in force, endows municipalities with extensive powers to regulate land use practices on the public and private lands within their boundaries. Included are the rights to:

> (a) ...develop within that area systems of farm practice, tree culture, water supply, land utilization, and land settlement, that will afford greater economic security;
>
> (b) exempt any lands from all or any part of the municipal and school rates and taxes and from assessment;
>
> (c) exchange lands of the municipality for other lands of the municipality...;
>
> (R.S.M. 1970, L50, S.3)

When council has the approval of 60 percent of the voting ratepayers, The Land Rehabilitation Act also empowers it to regulate tillage practises which may cause rapid soil deterioration by wind erosion.

> The by-law may contain provisions reguiring adoption of the practise of strip farming, the growing of cover crops, the providing of trash cover or the spreading of straw or other refuse on the cultivated lands, prohibiting the burning of stubble, prohibiting the cutting or requiring the planting of trees, requiring, prohibiting, or governing, tillage operations, and regulating or prohibiting the growing of crops in specified areas.
>
> (R.S.M. 1970, L50, S.9(3))

The rather explicit regulatory and planning powers granted to municipal governments by The Land Rehabilitation Act are supplemented by the more general provisions of The Municipal Act (S.M. 1970, c.100). This statute vests in the municipality the power to control some categories of drainage; its zoning provisions also permit municipal councils to control certain forms of land use.

To complement the land management powers bestowed on local governments by the legislation discussed above, two provincial statutes - The Planning Act (S.M. 1975, c.29) and The Conservation Districts Act (S.M. 1976, c.38) provide for the initiation of land management on a regional scale. Among the provisions of The Planning Act are those which empower the Lieutenant Governor-in-Council to designate an area of land to be a special planning area to provide for:

> (a) the protection and conservation of the environment and of the natural resources such as lakes, rivers shorelands, forests, agricultural lands and recreational lands...;
>
> (b) the creation and preservation of wilderness areas and wild animal and wild bird sanctuaries.
>
> (S.M. 1975, c.29, s.12)

The Watershed Conservation Districts Act (R.S.M. 1970, w.40) which was succeeded by The Conservation Districts Act (S.M. 1976, c.38) likely represents one of the most progressive pieces of legislation ever passed by the Manitoba legislature. As was the case with The Land Rehabilitation Act, however, this Act was passed only after ill-conceived drainage schemes and inappropriate agricultural practises were forcing some farmers to remove lands from agricultural production, while others struggled to protect themselves from frequent threats of flooding (Newton pers. comm.). The Watershed Conservation Districts Act provided for the formation of management districts which were to be comprised of all lands drained by a particular river and its tributaries. Natural physical boundaries, rather than geometric political boundaries were the key components of the new concepts in management implicit in the Act.

The legislation was premissive; districts could only be organized if the councils of the municipalities wholly or partly within them, requested that such action be taken. Once established, the district management board, consisting of locally appointed officials was to have jurisdiction over all of the area within the watershed. Essentially this board abrogated municipal powers to control the use and development of land that in any way related to the conservation of water resources within the district.

In terms of the mechanisms it provides for establishing and administering conservation districts, The Conservation Districts Act of 1976 is a duplicate of The Watershed Conservation Districts Act. In one respect the enactment of the former legislation represented a retreat from the planning ideals inferred by its predecessor; the need for having district boundaries which conform with those of a particular watershed was de-emphasized. In contrast with The Watershed Act, however, which was directed at the management of water — leaving the management of other resources subject to the provisions of The Resource Conservation Districts Act of 1970 (S.M. 1970, c.54), the Conservation Districts Act acknowledges the interdependence of all components of the natural resource sector and provides a mechanism for a comprehensive approach to their management (M.R.E.M. 1977). The purposes of the Act are:

(a) to provide for the conservation, control and prudent use of resources through the establishment of conservation districts; and

(b) to protect the correlative rights of owners.
(S.M. 1976 c.38, s.2)

For the purpose of carrying out the provisions of the Act the Lieutenant Governor-in-Council may also designate certain areas within the district as protected areas. In essence, this provision allows the provincial cabinet to protect certain areas from activities such as clearing and drainage (Jenkins pers. comm.).

In spite of the logic on which it is based and its altruistic intent, the review of farming practises within the study areas suggests that the legislative approach to improving land management has met with only limited success; the reasons for this are complex; no single explanation is adequate.

In part, the lack of success can be attributed to the fact that the laws regarding land management enacted by the provincial legislature tend to be permissive. While municipalities and conservation district boards are given the right to enact by-laws designed to discourage improper land use practises, they are under no obligation to do so. Neither the R.M. of Odanah nor the R.M. of Strathcona for example, have chosen to exercise their rights under The Land Rehabilitation Act (Johnson pers. comm.; Fosty pers. comm.). even though abusive techniques such as stubble burning and the cultivation of erosion-prone soils are practised in both localities. Municipal councillors are elected from amongst the local populace and as a result are reluctant to take positions which may be unpopular with a large number of their constituents. As one councillor stated:

> Just because I was elected to council doesn't mean I'm going to tell another man what to do on his land ...you can't enforce too many laws...people get bitter.

If, as is frequently the case, the councillors themselves are farmers (and engage in undesirable land use practises) then the probability that restrictive by-laws will be passed becomes even more remote.

The reluctance of local officials to take actions which in any way impinge on private property rights is also demonstrated by the manner in which municipalities have responded to The Watershed Conservation Districts Act and its successor. The Whitemud Watershed Conservation District,[1] the first district organized under this Act was not established until 1972, 13 years after the Act became law. The failure of the municipalities to take the initiative, a requirement intrinsic to the formation of any conservation district, is the single most important factor to which this lengthy reaction period can be attributed (Newton pers. comm.). Since that time, other conservation districts have been formed and additional municipalities have expressed an interest in the conservation district concept (Elliot

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[1]The Whitemud watershed includes most of the R.M. of Odanah; Strathcona is not affiliated with any conservation district.

1978). Inquiry into the operation of the existing districts, however, reveals that the problems associated with local control have not been overcome.

Management of individual districts is the responsibility of a board consisting of local individuals appointed by member municipalities and one individual appointed by the provincial cabinet (S.M. 1976, c.38, s.8). The municipal appointees tend to be farmers and as in the case of municipal councils, these individuals avoid initiating actions which may impinge upon their neighbours' land use practises. Rather than acting on their responsibilities as stewards of all resources, the board members address themselves mainly to matters related to agricultural production and drainage (Jenkins pers. comm.).

The data presented in Table 4.1 provide an indication of The Whitemud Watershed District Board's priorities; they tend to support Jenkins' contention. Further, it is important to note that those funds which were allocated to soil conservation and land management projects were used mainly to pay for the cost of reforesting and regrassing erosion-prone marginal lands (Watershed Conservation Districts of Manitoba Annual Reports 1975 and 1976)--remedial programs, which, had public officials and private individuals of the past adopted a more prudent approach to land management, might well have been avoidable.

4.21 Discussion

While identifying the problems stemming from the

Table 4.1 Whitemud Watershed Works Program expenditures during 1975 and 1976.

	1975	- % of total	1976	- % of total
Land drainage works	450,825.94[1]	50.7	624,717.52[1]	74
ARDA projects	313,076.90[2]	35.2	76,497.71[2]	9.0
Soil conservation and land management	124,919.69	14	142,996.41	16.9
Total works expenditures	$888,822.53		$844,211.64	

[1]Funds used mainly for the maintenance of the existing system.

[2]New construction and major reconstruction.

Source: Watershed Conservation Districts of Manitoba Annual Reports 1975 and 1976.

parochial attitudes of local administrators is not difficult, a ready solution is elusive. The abandonment of local control in favour of a more centralized form of decision making, albeit tempting, would likely prove to be equally unsatisfactory. The recent hearings into the activities of Manitoba Hydro (Winnipeg Tribune December 6, 1978) bear witness to the fallibility of decisions made by large centralized bureaucratic structures.

Politically such a move would also be untenable. Given the cautiousness with which municipalities have received the watershed and conservation district management concepts (which call for a more centralized form of local control), it is unlikely that they would acquiesce to a government which would decrease their powers while transferring additional powers into the hands of alien urban bureaucrats.

To some extent the problems of local administrators are related to a lack of awareness and poor communications. Some farmers in both study areas already have a strong environmental ethos and are willing to cooperate with organizations whose objective it is to promote improved environmental management. Others, however, readily admit that they do not understand the objectives of, or the need for, bodies such as the Conservation District Boards. This is evinced by statements describing the Board as nothing more than "another government agency which forces me to pay taxes so I'll keep the water on my land". The insistence that flooding and similar disasters are "Acts of God" provide further evidence that some individuals remain unaware of the extent to which the activities of man influence the severity and frequency with which such events occur. The ill-informed opposition displayed by such individuals makes administration and enforcement at any level extremely difficult - especially when those decisions which are made are subject to reversal at the ballot box. Although results are likely to be slow in forthcoming, in a democratic society a continuous and persistent program of education, is one of the more desirable means available to defuse such resistance.

Finally, a review of the land use legislation in effect in Manitoba indicates that it is mainly punitive, offering no incentives for the voluntary adoption of improved land management practises. As the Whitemud Watershed budget (Table 4.1) demonstrates, only those farmers who show the least regard for the ultimate environmental consequences of their actions (and thereby reap some short-term economic benefits) become the beneficiaries of government funded remedial projects; the conscientious managers must be satisfied primarily with benefits which are often long-term and difficult to specifically indentify. This situation is complicated by a number of institutional factors. As noted in the succeeding sections of this chapter, institutions frequently have policies indirectly promoting land use practises which completely contradict the objectives espoused in the statutes enacted specifically to promote ecologically sound land management.

4.3 Institutional Impacts

4.31 The Canadian Wheat Board - Grain Delivery Quotas

The Canadian Wheat Board has become an integral part of the prairie grain economy (Federal Task Force Report 1969). One of the main tools at the disposal of the Wheat Board to help it carry out a program of orderly marketing for western grain is the Delivery Quota Allotment System, (Bowden Committee 1970). The system was created and instituted during 1940, when large wheat surpluses were creating serious storage and transportation difficulties (Ellis 1971). Its primary objective is to limit production of grain to the qualities and quantities required to fulfill market demand (Bowden Committee 1970). The crops which are delivered on the producer's quota allotment include wheat, barley, oats, rye, rapeseed, and flaxseed.

At the system's inception, quotas were applied only to seeded acreage and calculated separately for each grain. Today additional factors are included in the quota calculation (see Appendix V). The formula upon which the producer's quota acreage is based includes the following land categories:

1) Land seeded to the six quota grains;

2) Land in summerfallow;

3) Land seeded to miscellaneous crops. This includes all crops other than the six quota grains and perennial forage;

4) Land seeded to perennial forage up to a maximum of one-third of the combined total of land in grains and oil seeds, summerfallow, and miscellaneous crops. This includes alfalfa, perennial grasses, and clovers. (Sweet clover, a biennial, is considered to be a miscellaneous crop.)

After the seeded acreage, summerfallow, and perennial forage acreage has been combined to form the total acreage eligible for quota allotment, quota acres are assigned to each of the crops produced. The manner in which these acres are distributed is left to the discretion of the farmer. Since summerfallowed acreage does not produce a crop, and since perennial forage and miscellaneous crops are not marketed by the Wheat Board, the quota eligible land utilized for those purposes can be assigned to any of the six Wheat Board crops. For crops such as wheat, at least twice as many quota acres are as a rule assigned as are actually seeded, whereas for oats for example, much of which is consumed on farms as cattle feed, the planted acreage usually exceeds the assigned acreage (Canadian Wheat Board Seeded and Quota Acreage Statistics 1975; 1976; 1977; Stacey pers. comm.). This method of assigning quota acreage provides those farmers whose yields are well in excess of the annual quota allotment released, with a greater opportunity to sell their grain stocks.

Additionally, land which will be newly broken during the specified crop year can be reported in the permit book application (Appendix V). In the subsequent crop year, this land is classified as "cultivated" and becomes eligible for inclusion in the calculation of assignable acreage (Stacey pers. comm.).

This procedure only establishes a delivery base for grains to be marketed during the current crop year. If a farmer wishes to market grain carried over from past years, quota acres must be assigned for the delivery of that grain even though it will not be seeded during the current year.

Despite the fact that the delivery quota system was established on the principle that "it would be flexible enough to enable producers to adapt to changes in market conditions, good farming practises and/or public policies" (Bowden Committee 1970) analysis suggests that this principle has not always been successfully followed. Several features of the current quota promote farming or land management practises which are technically unnecessary, environmentally disruptive, and socially undesirable.

One of the main points on which the quota system can be criticized is in its failure to relate delivery opportunities to farming practises and productivity (Parker pers. comm.). During years in which production substantially exceeds market demands, the system inadvertantly favours some cropping systems over others. Although the Wheat Board was established primarily to prevent excess production, Ellis (1971) concludes that the problem of surplus grains is recurring, and has not been solved by the Board's formation. The carryover trends for wheat (the main cereal crop produced in the prairie provinces), established in the course of the last ten years, appear to support this conclusion.

During the late 1960's carryovers increased steadily, peaking during the 1970-71 crop year (Canadian Wheat Board Annual Report 1976-77). These surpluses were reduced only because the federal government intervened and paid farmers to remove land from production (Stacy pers. comm.). Thereafter on-farm stocks declined steadily, from 542,700,000 bushels during 1970-71 to

58,000,000 bushels by 1976-77. During 1977-78 this decline was reversed. Reserves were expected to increase to approximately five times the level of the preceding year (Canadian Wheat Board Annual Report 1976-77).

A review of the quotas released during the years spanning the decline in wheat stocks indicates that for Hard Red Spring (the main variety produced), they were open during the 72-73 crop year, 30 bushels per acre during 73-74, open during 74-75, and 40 bushels per acre during 1975-76. The record harvests of 1976 resulted in the highest carryover since the 1971-72 crop year. The quota released during 1976-77 amounts to only nine bushels per acre (Canadian Wheat Board Annual Report 1976-77).

Based on the assumption that most farmers assigned twice as many acres as they seeded, it is reasonable to believe that most producers marketed approximately 18 bushels per acre of wheat during the 1976-77 crop year. In Manitoba that amounted to only 66 percent of average production (M.D.A. 1976a).

As this scenario suggests, the present quota system discriminates against high yielding crop varieties and the more productive farmer. In its most blatant form, this bias is evinced by the provision permitting farmers to deliver grain on summerfallowed acreage. Rennie (1978) cites the quota system's tacit endorsement of summerfallowing as one of the main reasons prairie farmers have not achieved a level of productivity commensurate with the capability of their soils, and the technology to which they have access.

Given that delivery opportunities and the size of a quota allotment are largely a function of cultivated acreage (as opposed to productivity per acre), farmers who wish to adopt more intensive management practises (such as continuous cropping) are given very few incentives to do so. During years in which grain demands are low, and quota releases correspondingly low, the farmer who maximizes production per acre, rather than acres of production, may well be at an economic disadvantage. Regardless of the fact that his costs per cultivated acre are higher than those of the land extensive manager, his sales per acre will be the same. While he can store his surplus stocks until market conditions improve, a reduced cash flow may hinder his ability to acquire the inputs necessary to plant a new crop.

Although it is not conclusive, the evidence from the study areas indicates that some farmers are responding in the manner suggested. This conclusion is based on the assumption that fertilizer use is an index of productivity. The questionnaire results show that 85 percent (51) of the farmers who were interviewed apply some synthetic fertilizer to their cropland. When asked if they planned to increase the rate at which they are currently fertilizing, 20 percent (10) reported that they are already producing carryovers and thus have no desire to increase their production. High input prices relative to grain prices were also cited as reasons for refraining from more intensive fertilization.

In addition to providing an incentive for the persistant use of practises such as summerfallow, the current structure of the quota system promotes the expansion of cultivated area. The stipulation that land must be broken before it can be assigned a quota, encourages farmers to consider their uncultivated or natural pasture land as a reserve which can be drawn upon to expand their quota base.

The use of this tactic to expand quota acreage is particularily attractive in regions where highly productive land is interspersed with land having a low cropping capability. In years (such as 76-77) when quota releases are severely restricted, the farmer who cultivates marginal land in addition to his prime cropland is able to deliver greater volumes of grain than the individual who chooses to retain this land in its natural state. Unfortunately, expanding the cultivated area by invading lands of marginal agricultural value may ultimately result in environmental degradation and social costs. Frequently lands considered marginal for agriculture, consist of wetlands, bushlands, and other sensitive areas which from a social, aesthetic, and functional perspective are most productive when retained in their natural state.

Data from the study areas indicates that the supply of arable land in both municipalities has been exhausted. According to the Canada Land Inventory (1966) 30 percent of the Odanah land area consists of Class 6 agricultural land. Soils in this category are described as unresponsive to improvement practises.

The balance of the land area consists of Class 2 soils on which agricultural use may be limited by adverse topography. The farmers who responded to the survey estimated that 70 percent of their land is dedicated to the production of cereal or tame forage crops. The land area of Odanah with respect to soil classes and topography is relatively homogeneous (Canada Land Inventory 1966). This suggests that some farmers are already cultivating land which has no domestic crop producing capabilities. Similarily, the erosion problems which beset Strathcona croplands (Section 2.2122) are evidence that some land currently under cultivation should have been retained under permanent cover.

In some prairie reginns, the practise of breaking land primarily to increase quota acreage has become a problem (Parker pers. comm.). The responses to the survey questionnaire also imply that certain farmers within the study may be engaging in this practise. Twenty percent (6) of the Odanah respondents and ten percent (3) of their Strathcona counterparts indicated that if the Wheat Board would permit them to include wasteland in their assignable acreage formula, they would reduce the total area which they are presently cultivating.

If the formula currently used to calculate assignable acreage remains unaltered, cultivating marginal land to increase assignable acreage is likely to become an increasingly attractive proposition. As summerfallowed acreage declines crop production will increase. Hedlin and Rigaux (1976) estimate that the total elimination of summerfallow in Manitoba would increase production by 37 percent. Unless the fallow acreage which becomes available for cropping is all seeded to miscellaneous crops or non-perennial forage crops, the additional production will result in the creation of large surpluses, smaller quota releases, and reduced delivery opportunities.

4.311 Proposed Modifications

The Grain Quota Allotment System in its present form contains provisions which act as incentives for farmers to engage in undesirable land management practises. Minor modifications to the assignable acreage calculation formula could transform the system into a valuable land management tool. Several proposals for modifications were originally outlined in a study undertaken by Large et al. (1978). These researchers emphasized that prior to implementing any changes, the full economic implications must be considered. Failure to do so could result in economic upheavals and the creation of yet more serious environmental problems.

The proposals to modify the Quota Allotment System tend to focus on altering the current status of summerfallow, perennial forage, and uncultivated and natural pasture acreage as it relates to the calculation of assignable acreage. From an environmental perspective a desirable objective would be to remove from the assignable acreage formula any provisions which encourage farmers to invade marginal lands or continue the practise of including cultivated summerfallow in their crop rotation.

Large et al. (1978) indicate that discontinuing the practise of permitting farmers to deliver grain on fallow acreage, while leaving all other variables unchanged, would prove very disruptive to the grain marketing and transportation system. They found that in the R.M. of Harrison (Manitoba) the complete deletion of fallow acreage from the assignable acreage formula would decrease farmers' quota allotment by approximately 33 percent. The impact of a similar action in the study areas would be a reduction of quota allotments by 30 percent and 25 percent in Odanah and Strathcona respectively. If the exclusion of fallow from the assignable acreage calculation moved all farmers to adopt continuous cropping, the result would be a concurrent production increase of as much as 43 percent in Odanah and 33 percent in Strathcona. Unless this productivity consisted entirely of forage or miscellaneous crops, the short-term impact on the grain storage, transportation, and marketing network would be crippling.

Similarly, any motivation to invade marginal land purely for the purpose of increasing assignable acreage, could be eliminated by permitting farmers to include all their marginal land in the assignable acreage calculation. Taken in isolation, however, this decision would increase quota acres in regions like the study areas by over 30 percent. The concomitant increase in delivery opportunities would force a review of the Canadian Wheat Board's quota-allotment strategy.

In order that the economic complications which may arise from a modification of the Quota Allotment System be minimized, a coordinated plan designed to implement changes over a transition period of five to ten years would be desirable. Rennie

(1978) suggests that in Manitoba, reducing summerfallow from 25 to 10 percent, is a reasonable objective. By reducing the maximum cultivated fallow acreage on which farmers are permitted to deliver grain to 10 percent of their cultivated acreage, farmers would have an incentive to achieve this goal. In Strathcona and Odanah this implies a reduction in fallow acreage of 15 and 20 percent respectively. The delivery quota allotment would be reduced accordingly.

As noted previously, a sudden decline in summerfallow acreage could cause considerable dislocation. A phase-down period of five to ten years in duration, however, would call for the reduction of fallow acreage by an average of only two or three percent annually. Furthermore, during the five-year period spanning from 1971 to 1976 improved acreage in this Province increased by approximately one percent annually: most of it is utilized for the production of cultivated crops (M.D.A. 1976a). Since the proposals to alter the quota calculation formula are designed to discourage additional clearing, some of the fallow acreage becoming available for continuous cropping would likely displace part of the additional acreage which was formerly made available by clearing. Consequently, it is probable that the net economic impact of reducing summerfallow by two to three percent annually, would be smaller than expected.

In order to offset the loss of delivery opportunities resulting from a reduction in fallow acreage, farmers would have an incentive to seed sweet clover or some other miscellaneous (non-Board) crop. In some parts of the Province, early ripening strains of corn, for example, have tremendous potential as a non-Board crop which can be included in the crop rotation and thereby utilized to regain quota lost to the reduction in fallow. In other regions, field peas and mustard or sunflower seeds provide similar opportunities.

Since perennial forage currently constitutes far less than the one-third of cultivated acreage proportion eligible for quota assignment (Appendix V), expanding forage production is another means by which farmers could regain assignable quota acreage. In the Parkland area, where good moisture conditions and high grain yields can be expected, well managed forage crops have proven to be as remunerative as annual grain crops (Faculty of Agriculture 1977). Presently, farmers within the study areas apparently have an aversion to producing forage as a cash crop (Section 2.2221). The incentive to do so offered by the quota system, an institution with which they are well acquainted and have come to accept, may, however, be sufficient to overcome their resistance.

Finally, altering the assignable acreage calculation formula by permitting the inclusion of natural pasture or uncultivated land in quantities equal to a pre-determined percentage of cultivated acreage, would provide farmers with an additional means of recouping their quota allotment. Setting a limit on the percentage of quota acreage which uncultivated land could represent, would ensure that no single individual obtained a disproportionate share of the benefits of this act. Although individuals who have little or no marginal land might consider the inclusion of uncultivated acreage in the quota allotment to be unjust, considered from the perspective of the entire agricultural community, the main economic impact of this modification would likely be a reduction in the competitive edge which farmers who possess little marginal land, have over those individuals who are less fortunate. On the other hand, setting a realistic limit to quota-entitled noncultivated land (possibly 20-30 acres per quarter section, averaged over the entire individual farm), would at one and the same time not stimulate the development of a land market based on the quota and thus the piecemeal absorption of smaller farms by larger ones.

4.32 Crop Insurance

4.321 Introduction

As is already the case with the Canadian Wheat Board, crop insurance is rapidly becoming an integral part of the Prairie agricultural scene. During 1976, 72.9 percent of Manitoba's eligible farmers were covered by crop insurance. This number is expected to continue to increase (Manitoba Crop Insurance Corporation (M.C.I.C.) 1977). A similar trend has been established in the neighbouring Province of Saskatchewan (Saskatchewan Crop Insurance Board 1977).

Rennie (1978) implicated crop insurance as one of the institutions deterring the implementation of improved land management and production practises. His criticisms were directed at the Saskatchewan plan's policy of charging lower insurance premiums for coverage of crops produced on summerfallow than on stubble. This policy provides an incentive for farmers to continue employing summerfallow as part of the cropping rotation. Although the Manitoba Crop Insurance Corporation has no similar policy, analysis suggests that the Manitoba plan's potential as a mechanism for encouraging environmentally appropriate land management, specifically as it relates to the preservation of wetlands and other uncultivated acreage, remains untapped.

4.322 Wetland Conservation

As noted in a prior section of this study, much of the undeveloped land located within the agricultural zone of Manitoba consists of wetlands which provide habitat for large numbers of waterfowl and other wildlife species. If the wildlife populations which these lands sustain are to be maintained, wetland conservation programs are essential. Since most of the wetlands located within the agricultural zone are on privately owned farms, winning the cooperation of the farmers is critical to the success of any conservation program.

Unfortunately, cooperation has sometimes proven difficult to obtain. Farmers with croplands in the neighbourhood of wetlands have had their crops damaged by the feeding activities of waterfowl and other bird species attracted to these (wetland) areas. These individuals tend to view wetland conservation programs as a source of additional depredation problems.

4.323 Waterfowl Depredation

The main waterfowl species responsible for crop depredation are Mallards. Damage first became severe in the 1940's when the practise of swathing grain became prevalent. The majority of the damage is sustained by barley and wheat. Loss of grain is severest during wet autumns that delay the harvest, and tends to be chronic near large wetlands (Sugden 1976).

The results of the survey undertaken in conjunction with this study indicate that approximately 17 percent (5) Strathcona respondents reported having crops damaged by waterfowl. Indicative of the greater wetland acreage in the Odanah area, 40 percent (12) of the farmers from that municipality reported experiencing waterfowl-related crop damage. Four members of the latter group, however, indicated that the damage caused by waterfowl tended to be minor and infrequent.

4.324 Blackbird Depredation

Although very little literature on the subject exists, there is some evidence that the redwinged blackbird (*Agelaius phoeniceus arctolegus*) is also contributing to the depredation problems encountered by farmers. Bird (1961) suggests that this is the most abundant bird of the Parkland. Given the persecution which hawks, owls, and other birds of prey have suffered at the hands of man (Bird 1961) it is probable that the high populations can be attributed at least partially to reduced predatory control.

The redwinged blackbird prefers to nest in vegetation over water; locations at which temporary water promotes the growth of rank vegetation are favoured nesting sites. When the nesting season terminates, flocks form and range out into the fields where they destroy grain by picking the kernels from the heads, or crushing them in the milk stage. Oats, corn and sunflowers are the principal crops on which they feed;(localized) destruction is severe enough to warrant the initiation of control measures (Bird 1961).

Results from the study areas suggest that in some cases the number of depredation incidents attributable to blackbirds may be approaching those related to waterfowl (Table 4.2). Twenty percent (6) of the Odanah farmers sampled indicated that their crops had been damaged by blackbirds; two of these individuals also reported waterfowl damage. In Strathcona, 16 percent (5) of the sample population reported blackbird damage; only one of these respondents also reported waterfowl damage.

Farmers whose crops had been damaged by the blackbirds appeared to be more concerned with the problem than those individuals reporting waterfowl damage. The individuals in the former category emphasized that unlike waterfowl depredation, which tends to become a problem mainly when wet weather delays the harvest, blackbirds are a menace virtually every year, and for a much greater portion of the crop season.

Table 4.2 Crop depredation by waterfowl and blackbirds.

Municipality	Sample size	A Waterfowl depredation	B Blackbird depredation	A and B
Odanah	30	12 (40%)	6 (20%)	2
Strathcona	30	5 (17%)	5 (16%)	1

4.325 Farmer's Attitudes

The argument that farmers whose crops are damaged by depredation are more likely to be hostile to wetland conservation projects is supported by the survey results. When asked a question designed to elicit their opinion of programs encouraging waterfowl production, the manner in which they responded indicated that the farmers interpreted this to be synonomous with wetland conservation. While 38 percent (8 of 21) of the farmers whose crops had been damaged by waterfowl or blackbirds were opposed to encouraging waterfowl production, only five percent (2 of 39) of those who had suffered no depredation gave a similar response.

Much of the opposition to wetland conservation programs voiced by farmers fearing greater depredation losses would likely be silenced if an adequate compensation program was made available. Although various provincial governments, in concert with the federal government, have attempted to reduce the share of the burden which the farmer has been forced to bear, these programs have proven to be woefully inadequate. During 1976 for example, an estimated $10 million worth of crops were destroyed by waterfowl; public agencies, however, spent only $1 million on damage prevention and compensation (Sugden 1976).

4.326 Present Compensation Programs

Manitoba has had a waterfowl damage compensation program since 1972. The program is administered by the Department of Mines, Resources, and Environmental Management. The Manitoba Crop Insurance Corporation provides the necessary actuarial services (Wood pers. comm.). The money in the compensation fund consists of a provincial contribution which is equalled by a federal contribution. The provincial share is raised from the sale of wildlife certificates to hunters (Wood pers. comm.).

Under the current system, the compensation which a farmer is likely to obtain is a function of the level of crop damage sustained, and the amount of money available in the compensation fund. Before becoming eligible for compensation, farmers are required to pay a $25 inspection fee. If damage is less than five percent of the crop's estimated value, no indemnity is paid. The limited funds available for 1978 dictated that the maximum indemnity paid to farmers was $25 per acre (Wood pers. comm.). Considering today's production costs, this amounts to little more than an insult to the farmers. It also helps to explain why only a small proportion of farmers submit damage claims (Sugden 1976).

Despite the low claim rate, and the low indemnities paid, during 1978 the Manitoba compensation fund was exhausted with $85,000 in claims remaining to be paid (Winnipeg Tribune October 17, 1978).

Where damage by blackbirds is concerned, absolutely no compensation is yet available. Before damage by these birds can be insured, actuarial science requires that at least five years of damage costs statistics must be made available; these are required to calculate insurance premiums (Wood pers. comm.). If farmers are seriously concerned with obtaining blackbird damage compensation, a damage reporting and record-keeping program should be initiated either by the farmers themselves, or the Manitoba Department of Agriculture (Wood pers. comm.).

4.327 Conclusions

The wetlands which are located within the agricultural regions of the prairies are a valuable resource, beneficial to all of society. As a result it is just that the cost to the farmer of maintaining these areas should be minimized. Under present circumstances, this goal has clearly not been achieved.

The government of Manitoba, through the formulation of the Manitoba Crop Insurance Corporation has acknowledged that farmers require a means of protecting themselves against the vagaries of natural phenomena such as hail, drought, frost, excessive moisture, excessive rainfall, flood, wind, and insect pests (M.C.I.C. 1977). Since wildlife is also part of the natural environment and since the extent of crop damage caused by wildlife (i.e. waterfowl) is frequently a function of the aforementioned climatic factors, it seems logical that insurance coverage should be extended to provide protection against depredation losses. This coverage could be provided in one of two ways. Firstly, it could be included under a general all-perils plan; secondly, and perhaps more efficiently, farmers in high risk areas could be provided with optional depredation coverage. A similar plan for providing hail insurance is already available (M.C.I.C. 1977).

4.33 Taxation

4.331 Introduction

The operator of a farm unit is subject to the influence of a tax structure created by three levels of government; federal, provincial, and municipal. Although the tax policies of all three governments may ultimately affect the manner in which land is managed, the most pervasive impacts are likely those stemming from the municipal system of assessing and collecting property taxes. If the tax structure is to be utilized as a means of encouraging environmentally desirable land use practises, it is probable that this objective will be best accomplished through alterations in the local taxation system. Bird (1974) noted the potential of using the property tax system to effect specific land management goals when he stated, "almost any kind of land tax affords opportunities for favouring certain kinds of agricultural activity while penalizing others".

4.332 Municipal Assessment and Taxation

Although the use of property taxation as a revenue raising mechanism has been criticized for its tendency to bear down most on people who are property rich and income poor (Groves 1974), in Canada it is the main source of the revenues required to support the services provided by local governments.

In Manitoba virtually all property in the rural areas is assessed by the Municipal Assessment Branch of the Department of

Municipal Affairs (Richards pers. comm.). The value at which a particular piece of property is assessed is a function of its productivity and its market value. The amount of property taxes which a landowner pays are determined by the mill rate set by the respective municipal council.

The average rates at which various land categories within the study areas are assessed, are shown in Table 4.3. The mill rates applied to the assessed values are also shown.

Although the property assessment and taxation system has never been considered to be a means of achieving positive land management goals (Richards pers. comm.), analysis suggests that with proper modifications the system could become a mechanism to achieve this end. As it is currently employed, however, the assessment and taxation process, like the grain quota system, is representative of an institution whose basic policies contradict the ideals expressed in the land management legislation passed by this Province. These contradictions stem largely from the fact that under the present taxation system, all land regardless of economic value, is assessed (albeit at varying rates) and taxed. This provides those farmers who wish to recover their tax dollars with an excuse to break lands having little or no agricultural value. Alternatively, those farmers who would retain their marginal land in its natural state have few incentives to do so.

In part, these contradictions arise from the assessment system's failure to adjust to the structural and economic changes

Table 4.3 Assessment value, mill rate, and tax revenue generated by specific classes of land in the study areas.

Land Class[1]	Estimated[2] assessment rate ($ per acre)	Mill rate[3]	Estimated tax revenue ($ per acre)
Cultivated (arable)	35	122	4.27
Arable pasture	12	122	1.47
Arable bush	10	122	1.22
Native pasture	7	122	0.85
Hay slough	4	122	0.49
Waste - slough - bush	3	122	0.36
Open water	1	122	0.12

[1]According to Provincial Land Assessment Division - Handbook to Municipal Assessment Rolls, pp. 87-91.

[2]As provided by District Assessment Offices, Souris (Strathcona and Minnedosa (Odanah).

[3]Average mill rate for Odanah (123) and Strathcona (121) according to Department of Municipal Affairs, Winnipeg.

which the agricultural industry has undergone. Farm units are no longer all relatively similar mixed operations as they were when the system was inaugurated (Manitoba Farm Bureau 1977). The combined impact of technological and economic factors has determined that most farmers are now highly specialized, emphasizing the production of either cattle or cultivated crops; the production of the former gradually becoming concentrated in feedlot operations.

The failure of the assessment system to adjust to these changes manifests itself in the terminology used to describe land for assessment purposes. "Waste-slough-hay" and "non-arable native pasture" for example, are terms implying economic value commonly used to describe uncultivated marginal land (Department of Municipal Affairs, Land Assessment Division). At a time when the majority of farmers raised some cattle, these terms were relevant; virtually all land (with the possible exception of that which was permanently under water) had some economic value as cattle browse and as a result could be legitimately assessed and taxed at rates reflecting this value. To the modern farmer who specializes in the production of cultivated crops, however, any land which is unbroken has no (direct) economic value; if it interferes with the operation of his equipment it may even be considered to be a liability. To continue taxing such land tempts the farmer who has no alternative means of recovering his tax dollars, to cultivate it. The fact that specialized grain farmers in the study areas tend to maintain a smaller percentage of untilled land than their cattle-producing counterparts, lends support to this thesis (Table 4.4).

4.3321 Property Tax Concessions

In order to provide farmers who own land of marginal agricultural value with an incentive to maintain this area in its natural state, it is proposed that municipal taxing of this land be discontinued. The Land Rehabilitation Act (R.S.M. 1970, L50) empowers municipalities to grant such relief.

Responses to the survey questionaire (Table 4.5) indicate that most members of the sample population would favour this arrangement. Similar findings were reported by Dixon (1966). The Manitoba Farm Bureau (1977) has also voiced its support for such a program.

While it could be argued that marginal agricultural land is already assessed and taxed at rates which are so low (Table 4.3) as to render an incentive program based on tax concessions ineffective, the responses to the survey questionnaire suggest that many farmers are motivated by very small economic incentives. The majority of the farmers in the study areas undertook wetland drainage, for example, primarily to improve their cultural pattern (Table 4.6). Dixon (1966) reported that the members of his sample group had similar motivations. The additional acreage the subjects of this study brought under cultivation usually amounted to only a tiny percentage of their total cropped area (Table 4.7).

Table 4.4 Land use on sample farms within the study areas

Municipality	Farm Type	Number of Units	Average acreage	Average untilled	Average untilled excluding tame hay
Odanah	Mixed	17	668	256 (38%)	211 (31.6%)
	Grain only	13	791	204 (25.8%)	204 (25.8%)
Strathcona	Mixed	22	917	358 (39%)	315 (34.4%)
	Grain only	8	1429	461 (32.3%)	461 (32.3%)

Table 4.5 Farmers' attitudes toward a hypothetical program offering tax concessions in return for protection of unoccupied land from agricultural development.

Municipality	Sample size	Favour	Opposed	Undecided
Odanah	30	17(56.6%)	11(36.6%)	2(6.6%)
Strathcona	30	19(63.3%)	7(23.3%)	4(13.3%)

Table 4.6 Purpose of drainage

Municipality	Sample size	# of farmers who drained	A. To improve cultural pattern	B. To increase cultivatable acreage	A and B
Odanah	30	20(66%)	10	4	6
Strathcona	30	13(43%)	8	2	3

Table 4.7 Acreage drained

Municipality	# of farmers who drained	-5 acres	5 to 10 acres	10 to 20 acres	20 to 40 acres	40+ acres
Odanah	20	7	2	4	2	5
Strathcona	13	8	4	-	1	-

Although the savings in tillage costs (time and fuel) derived from a more convenient cultural pattern were not asessed, it is probable that these are minor. When the costs of drainage in terms of capital, arable land lost to ditches, and the possible tillage hazards created by ditches are considered, the tillage savings become even less significant. In such circumstances even a small (and as will be discussed, very visible) tax concession would likely induce some farmers to refrain from breaking non-arable acreage.

4.3322 Property Tax Notices

In order to increase the probability that a landowner would respond to tax concessions offered in return for maintaining land in its natural state, minor revisions should also be made in the manner in which property tax information is presented in the taxation notices forwarded to landowners. Currently, the bill which a landowner receives from a municipality lists the property taxes which are payable as a "lump" sum, making no distinction between the taxes paid on arable cropland and wasteland. (Municipal Assessment Branch pers. comm.). Although the survey undertaken in association with this study did not include a question designed to test farmers' understanding of municipal taxation policies, Dixon (1966) found that many farmers are unaware of the varying rates at which their property is assessed and taxed. Dixon reported that with respect to wetland taxation, 42.5 percent of the farmers he contacted stated they were not taxed on this land, 25.5 percent thought they were taxed on wetlands, and 35 percent were unsure as to whether or not they paid taxes on wetlands.

Under the present billing system, farmers who are unfamiliar with tax assessment practises may unconsciously be averaging their "lump" sum tax over all their acreage and thus are likely to conclude that the tax rate they pay on non-arable land is well above the actual figures. Consequently such individuals have a greater incentive to attempt cropping non-arable land primarily to recover the (perceived) tax outlays. By presenting taxation notices which list the taxes due on arable and non-arable land discretely, the uncertainties giving rise to misinterpretation would be eliminated. In the event that taxing of uncultivated nonarable land is discontinued, the farmers who persist in cultivating this land will be visibly reminded of the price they pay to do so, every time they receive a tax notice. Concomitantly, discrete billing could also be utilized to remind the farmer who chooses to retain marginal land in its natural state, of the benefits he derives from his decision (Sawatzky pers. comm.).

4.3323 <u>Assessment of Arable Land</u>

If the property taxation system is to be utilized as a land management tool, a review of the criteria used to assess potentially arable acreage would also be desirable. Currently all land in this category is assessed at a higher rate than undeveloped land having no domestic crop producing capabilities.

This encourages farmers to break the remaining arable areas and exploit their crop producing potential; (Bird 1974) it also increases the land's assessment and thereby expands the municipal tax base.

At a time when most municipalities had large contiguous plots of undeveloped arable land within their boundaries, a tax policy which encouraged development was economically and politically expedient. An examination of aerial photographs[2] of lands located within the study areas, however, indicates that many of the arable plots which have not yet been broken are fragmented and irregular in shape, frequently interspersed with wetlands or other non-arable acreage. In some cases it is apparent that the main reasons they have not been brought under cultivation is because their irregular shape would inconvenience tillage operations.

By continuing to tax these plots at an arable rate, the landowner is provided with the incentive to eventually bring these areas under cultivation. Indirectly this can also increase the threat of encroachment on the adjacent non-arable acreage. The farmer, once cultivating the irregular plots of arable land, will be tempted to rationalize his cultural pattern by incorporating some portion of the non-arable acreage.

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[2]Aerial photographs of Odanah and Strathcona can be viewed at the Minnedosa and Souris assessment offices respectively.

In order that this threat of incursion on to marginal land be reduced, it is suggested that all potentially arable plots of less than a specified size, or representing less than a fixed percentage of a contiguous undeveloped area, be assessed and taxed at the same rate as the adjacent non-arable acreage. This would remove any incentive to cultivate fragmented plots of potentially arable acreage, which might arise from the desire to recoup the higher tax costs.

4.3324 Municipal Perspective

Over the long term, a property tax policy which provides landowners with an incentive to drain, clear, and/or cultivate marginal agricultural land is not in the best interests of the taxing authority. Indiscriminately denuding land of all trees and other natural vegetation for example, may lead to increased erosion over a much broader area and an overall reduction of the land's productivity. Although in the short run the additional cultivated acreage may help to generate greater tax revenues, in the long run the gradual decline of the land's productive capacity translates into a lower assessment value and a reduced tax base.

Since local leaders (municipal councillors) are elected for three-year terms, political expediency demands that most municipal planning reflects short-term goals. Many municipalities in Manitoba are already experiencing fiscal difficulties

(Winnipeg Tribune October 8, 1978). As a result a proposal to grant tax concessions on certain land categories within their constituencies, would likely be considered by municipal officials to be an immediate threat to the municipality's tax base and thus its ability to provide services.

Although in some municipalities discontinuing the taxation of non-arable land would result in a significant reduction in taxable acreage (in Odanah for example 30 percent of the land is non-arable), because of the low rates at which land in this category is assessed, the loss in tax revenue assumed by the municipality would proportionally be well below the reduction in taxed acreage. In order to offset this revenue loss, two alternative revenue raising approaches should be considered.

Firstly, the tax burden formerly assumed by uncultivated, non-arable land could be placed totally on cultivated acreage. This could be achieved either by assessing productive land at a somewhat higher rate, or by increasing the municipal mill rate. The net effect of a higher assessment or tax rate would be a tax decrease for farmers having a high proportion of uncultivated non-arable land and a tax increase for those individuals with a large percentage of their land under cultivation.

Secondly, a case can be made for increasing provincial-municipal payments by an amount which is sufficient to enable the municipalities to recover the revenues lost when lands providing social benefits are exempted from taxation. In the short-term, this financing scheme would place additional demands on the provincial treasury. Since the senior level of government frequently bears the cost of remedial programs required to restore municipal lands suffering from mismanagement, however, a property tax policy designed to effect improved land management, would in the long-term reduce the need for remedial expenditures. One administrative avenue by which the provincial contribution to municipal revenues could be increased is already in place.

4.3325 Provincial-Municipal Tax Sharing

The Provincial-Municipal Tax Sharing Act (S.M. 1976, c.70) specifies that municipalities are entitled to 2.2 percent of the provincial share of federal income tax collected in Manitoba, and one percent of the corporate taxes collected in the Province. The manner in which these funds are distributed is determined by the provincial cabinet. By increasing the municipal share of these taxes, any revenue reduction which municipalities would suffer as a result of discontinuing the taxing of wasteland, could be recovered.

An increased provincial contribution to municipal revenues would also help to alleviate certain other inequities intrinsic to raising revenues by taxing farm property. These are acknowledged in Guidelines for the Seventies (Manitoba Government 1973):

> Since farm incomes are generally low, particularily in relation to farm assessments, the farm property tax is highly regressive. In addition to bearing the burden of property tax on farms, farmers face a rate of tax that is proportionately much higher than other forms of production even though farm residences are not taxed and property taxes are deductable for income tax purposes.

The inequities are evinced by the disproportionate share of farm property taxes used to finance education costs. In 1975 for example, the farm population, which represents approximately ten percent of the Province's total population, paid 27 percent of the property portion of education costs (Manitoba Farm Bureau 1977). Unlike other businesses, which can pass these costs on to their customers, the farmers must accept the prices set by national or international markets. Their taxes must be paid in cash, regardless of their income or ability to pay.

In order to rectify this situation, it has been suggested that only services to property be charged to property, and services to people (eg. education) be paid for in some other manner (Manitoba Farm Bureau 1977) - preferably by income tax. As well as being more equitable in a welfare sense, a reduced property tax burden would also lessen the economic pressure to clear and cultivate every available acre.

Unfortunately, the policies of the present government suggest that the factors discussed herein have not been given full consideration. During 1978 the Province reduced its aid to municipalities, thereby shifting the costs of municipal government from income tax onto property tax (Winnipeg Tribune March 20 and October 3, 1978).

4.3326 Federal Taxation

The federal government's income taxation system is an example of another institution which implicitly provides some landowners with an incentive to encroach on non-arable land. Under the provisions of the Income Tax Act (S.C. c. 63, 3rd Session, 28th Parliament) a farmer is permitted to deduct from his income any amount paid by him for clearing land, leveling land, or laying tile drainage for the purpose of carrying on the farm business. Although this policy may be appropriately applied to regions in which the government wishes to encourage the development of arable acreage, its indiscriminate application complicates the task of maintaining areas of native land; the preservation of which is now considered to be both desirable and necessary.

The survey undertaken in conjunction with this study was not designed to determine whether income tax considerations influence the farmers' decision-making process, with regard to land management. As a result, the effectiveness of modifying the Income Tax Act in a manner which displays a sensitivity to environmental concerns, is open to speculation.

4.34 Conclusions

As the foregoing presentation reveals, the legislative and institutional framework within which land managers must operate, is beset with internal inconsistencies. If land management within this Province is to develop beyond the incrementalist stage in which it is presently stalled, these inconsistencies must be rectified. The proposals for institutional changes presented in this chapter, (while they should not be regarded as a panacea) offer a means of achieving this goal.

Considered independently the potential effectiveness of the proposed modifications in nurturing the development of a land management approach which is sensitive to environmental needs may appear very limited. If each modification motivates only a few individuals to respond in a positive manner, however, the cumulative benefits could be substantial. Further, the modifications tend to be complimentary (eg. a tax concession and a simultaneous increase in quota acreage), hence the incentive to respond if they are jointly implemented becomes more attractive.

Finally, these proposals for achieving environmentally appropriate land management are advantageous because they can be administered by existing bureaucratic structures. As a result, the costs of implementation in terms of finances and human energy, and the political dissension which plagues programs such as those established under The Conservation Districts Act (S.M. 1976, c. 38), would be minimized.

CHAPTER FIVE

RECENT DEVELOPMENTS IN AGRICULTURAL TECHNOLOGY

5.1 Introduction

In preceding chapters of this study the environmental impact of various agricultural techniques are discussed. Like other sectors of the economy, however, the agricultural sector is dynamic, constantly responding to, or incorporating, new technological developments. In the past much of the research emphasized the development of techniques designed to increase crop yields. While predictions regarding the nature of new developments are at best tenuous, the consensus of agricultural researchers appears to be, that with respect to increasing yields a plateau has been reached. Basic technology has been exhausted, and researchers are concentrating on fine tuning existing technology. (Geno and Geno 1976; Anderson, March 7, 1977a; Stobbe pers. comm.).

In this chapter, some new developments likely to have an impact on the Prairie agricultural sector are discussed.

5.2 Zero-Tillage

Zero-tillage, a cropping system in which a crop is planted directly into a seedbed which has not been tilled since the harvest of the previous year (Chinsuwan 1976), has the potential to revolutionize a major component (seedbed preparation) of the Prairie cereal grain cropping system. Zero-tillage is based on the premise that a reduction in tillage is beneficial. In several American states, zero-tillage corn production has been a resounding success (Gersmehl 1977).

The findings pertaining to the use of zero-tillage by members of the study area sample populations are summarized in Table 5.1. As the table demonstrates, none of the farmers from this group reported employing this cropping practise; approximately 35 percent (21), however, responded in a manner which suggests that they may consider zero-tillage in the future. Although a majority of farmers reported that they have no interest in zero-tillage, a substantial number of these individuals indicated that the impracticability of investing in new equipment shortly before retirement, rather than technical considerations motivated their response. Additional reasons as to why some individuals consider zero-tillage to be an undesirable or unworkable practise, are summarized in Table 5.2.

Various aspects of zero-tillage cropping have been the subject of study by researchers at a number of Canadian and American locations. The findings of these studies, summarized below, facilitate evaluation of the legitimacy of some of the concerns presented in Table 5.2.

5.21 Soil Management

Although the findings are not conclusive, a review of

Table 5.1 Zero-tillage in the study areas.

Municipality	Sample size	Farmers who practise zero-tillage	Farmers who said they may try zero-tillage in the future	Farmers not interested in zero-tillage	Farmers who are uncertain
Odanah	30	0	11	17	2
Strathcona	30	0	10	18	2

Table 5.2 Reasons as to why farmers in the sample population would not adopt zero-tillage cropping.

Zero-tillage considered to be unacceptable because:	Frequency of response
Soil is too heavy; must be broken	15
Approaching retirement renders investment in new equipment impractical	7
Cultivation is necessary to obtain a crop	6
Cost of herbicides	5
Special seeding equipment is too costly	4
Herbicides may contribute to pollution	3
Weed problems would increase	3
Fibre must be worked in	2
Insufficient information available	2
It is not a proven technique	2
Neighbour tried it and had poor results	2

the related literature suggests that generally zero-tillage can be expected to have a beneficial impact on the soil's structure. Pakaranodom (1972) compared soil moisture content, soil aeration, soil bulk density and soil temperature under conventional and zero-tillage cropping. He found that soil moisture content, bulk density and soil temperature were somewhat higher under zero-tillage. The higher yields were attributed to higher soil temperature and improved soil-seed contact.

Phillips and Young (1973) suggest that reduced tillage will benefit clay and clay-loam soils by preventing erosion, destruction of soil aggregate and reducing compaction. Chinsuwan (1976), Stobbe (1977) and Gersmehl (1977) cite similar benefits. Stobbe also mentions that salinity problems may diminish under zero-tillage. Lindwall and Anderson (1977) observed evidence of compaction in a wheat crop planted in two and three-year rotations in the Dark Brown Soil Zone. With regard to the latter study, it is possible that the absence of a growing crop during the (chemical) fallow year may have contributed to the development of this phenomenon. Lyster (January 1977) suggests that in clay-loam soils, frost counteracts any compaction problems.

5.22 Crop Yields

Most researchers seem to agree that when good management practises are followed, crops grown under zero-tillage yield as well or better than conventionally tilled fields. Pakaronodom (1972) reported that under zero-tillage crop emergence and yield at various Manitoba locations was equal to or greater than under conventional tillage. Anderson (1975) compared pre-seeding tillage with total and minimal tillage by various seeding machines on spring wheat production in the Brown Soil Zone. The results of his 6-year study lead him to conclude that the elimination of preseeding tillage would not result in a significant reduction in yields. Stobbe (1977), Lindwall (1977) and Lindwall and Anderson (1977) also report zero-tillage yields equalling or exceeding the productivity of conventionally produced crops. Lindwall (1977) attributed increased yields to shallower seeding and better soil moisture. Johnson (1977) reported that a 4-year zero-tillage experiment undertaken in Manitoba indicated that on clay-loam soils, crop emergence was significantly higher, and when nitrogen application rates exceeded 30 lbs. per acre, wheat yields were greater on zero-tilled plots than on conventional plots.

5.23 Weed Control

Much of the research associated with zero-tillage has concentrated on the problem of weed control. On zero-tilled cropland all weeds must be controlled with herbicides. Research findings suggest that some weed populations are reduced when zero tillage is practised for a number of years. Practical experience appears to support this finding (Country Guide March, 1977). Weed seeds that remain on the surface of the soil do not germinate (Stobbe 1977).

Unfortunately zero-tilling may cause the entire weed spectrum to shift from annuals to biennial and perennial species. Volunteer crops are also proving to be a problem (Stobbe 1977; Bradley and Donaghy 1977). Lindwall and Anderson (1977) and Stobbe (1977) report that spraying non-incorporated, non-selective herbicides such as Paraquat and Glyphosate, effectively controls the grassy perennial species.

5.24 Herbicide and Equipment Costs

Unlike the research reports pertaining to the technical efficacy of zero-tillage--soil management, crop yields, and weed control, the literature regarding the economic viability of the practise provides very few definitive answers.

With respect to weed control, Johnson (1977) notes that the high cost of herbicides for perennial weed control is a disbenefit of this cropping practise. Donaghy (pers. comm.) indicated that treating a field with the Glyphosate "Roundup" may be 20 times as costly as a single treatment with 2-4-D, a herbicide used to control primarily annual weed species.

Alternatively Lindwall (1977) reported that an application of a non-selective herbicide before, or just after seeding, may be an economic substitute for intensive tillage. Wittmus et al. (1975), Allen et al. (1977) and Stobbe (1977) suggest that reduced tillage cropping systems may offer substantial fuel savings. These could offset the added costs of utilizing greater quantities of herbicides.

The cost trade-offs which characterize zero-tillage weed control are likely also to apply to equipment needs. Stobbe (1977) acknowledges that special equipment is necessary for seeding under zero-till conditions. Stobbe suggests that seeding into stubble and trash can be accomplished by using a triple disc drill. Austenson et al. (1978) recommend a hoe-drill. While the high acquisition cost of these machines may discourage some farmers from adopting zero-tillage, it must be pointed out that the overall equipment needs of a zero-tillage farmer are likely to be fewer than those of a farmer who employs conventional cropping. A reduction in the hours during which tractors are annually subjected to the heavy workloads associated with tillage operations, should be particularily effective in extending their mechanical life. Further, since a farmer's minimum horsepower requirements are likely to be determined by the scale of the tillage operations he undertakes, reducing tillage should enable him to reduce his horsepower requirements per unit of acreage farmed. Thus, in the long term, the capital requirements of zero-tillage relative to conventional tillage, may actually be reduced.

Finally, practical experience, albeit limited, suggests that zero-tillage is economically viable. Bradley and Donaghy (1977) note:

> Although we are still in the infant stage, it has been proven that very good crops can be produced under zero-tillage in Manitoba. As an alternate system for crop production, zero-tillage is likely here to stay;...

During 1978 approximately 15,000 acres in Manitoba were cropped using this system. Much of this land was located in the south-western part of the Province (Partridge pers. comm.).

5.25 Discussion

As the review of the related literature suggests, the major reservations expressed by farmers regarding the technical feasibility of zero-tillage appear to be unwarranted. The frequency with which farmers suggested that "heavy soil must be broken" may in fact be an indication that the soil on many farms is already suffering from the impact of excessive tillage (Sections 3.331 and 3.332). Further, research findings do not support the contention that "cultivation is necessary to obtain a crop". It is probable that this concern reflects the traditional affinity for tillage discussed in Sections 3.345 and 3.43.

Although cursory analysis implies that the overall monetary costs of zero-tillage cropping are likely lower than those of conventional cropping, it is recommended that in order to alleviate the uncertainty expressed by farmers, comprehensive studies be undertaken to determine the benefit-cost characteristics of this cropping practise. Such studies should consider a variety of crops, soil and topographic characteristics, and management procedures.

Finally, with the possible (and potentially decisive) exception of the increased herbicide[1] use associated with zero-tillage, the system exhibits characteristics which benefit the agricultural environment generally, and waterfowl interests specifically. The benefits to agriculture arising from a reduction in tillage are extensively documented in preceding sections of this study. Cowan (1976) found that when zero-tillage was employed, the waterfowl population increased markedly. Among the reasons cited were fewer passes, hence less disruption by agricultural equipment, an abundance of trash for nesting material, and a lower incidence of burning.

Sugden (1976) suggests that retaining harvested fields in an uncultivated state during the fall, provides waterfowl with a place to feed on waste grain and thus reduces depredation of unharvested crops. Since zero-tillage dispenses with fall cultivation, reduced depredation could be an automatic benefit accruing to zero-till farmers.

5.3 Energy

While energy *per se* cannot be regarded as a new "technology" it is a factor of overwhelming importance to the agricultural sector and the technology which is adopted. The role of energy in the agricultural sector has been the subject of numerous studies (Allen et al. 1977; Wittmuss et al. 1975;

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[1] Some implications of increased herbicide use are discussed in a subsequent section of this chapter.

Jensen 1977). While a comprehensive discussion of the relationship between agricultural practises, energy availability, and environmental considerations is beyond the scope of this study, several points regarding the future deserve consideration.

If change in the energy equation as it relates to the agricultural sector is to have a major impact on the environment, this change will have to be felt by the farmer. The main forms of energy used by farmers are fuel and fertilizer (Geno and Geno 1976).

Gersmehl (1977) suggests that the rising cost of energy may prove to be the main economic incentive to adopt zero-tillage cropping. Jamieson (1975) and Tweedy (1974) indicate that reduced cultivation could reduce energy costs from 50 to 80 percent. While higher fuel costs resulting in reduced cultivation would produce environmental benefits, the alternative of higher fertilizer costs must also be considered. A rapid increase in the price of fertilizer relative to other production inputs could prompt farmers to turn to land extensive practises such as summerfallowing.

In recent years forecasts regarding energy prices and availability have been fraught with errors. Consequently they should be viewed with caution. Trends established in the recent past suggest that in the near future the cost of energy, specifically fuel and fertilizer, is unlikely to have a serious impact on the nature of farm operations. As reported in a preceding section of this study, fertilizer consumption in Manitoba has expanded rapidly despite rising costs. The consumption of fuel--diesel and gasoline, is also continuing to increase (Statistics Canada 1971; 1976). In the study areas, 84 percent of the respondents reported that higher fuel prices have in no way affected the manner in which they manage their farms. Those individuals who reported reacting to higher fuel prices, indicated that their attempts to reduce energy costs consisted primarily of acquiring diesel powered equipment and reducing motor idling time.

The main reason that the "energy crisis" has apparently not had a major impact on the nature of farm operations, is that energy costs represent a relatively minor proportion of farm expenditures. Geno and Geno (1976) report that fossil fuel supplies account for less than ten percent of farm cash expenditures. Frequently, these outlays are made in relatively small increments. McConeghy (January 21, 1977) notes that in North America on-farm fuel consumption accounts for less than three percent of total consumption. If this was reduced, it is likely that at least some of the savings would be offset by increased herbicide costs (Allen et al. 1977; Jedele 1974; Heichel and Frink 1975).

5.4 Herbicides

As the discussion of zero-tillage and energy utilization implies, a probable consequence of decreased tillage will be the increased use of some varieties of herbicides.

Among the varieties frequently referred to in the literature, are Glyphosate (Roundup) and Paraquat (Gramoxone) (Molberg and Hay 1967; Stobbe 1977). These herbicides are non-selective, killing all plants with which they come in contact (Stobbe 1977). They are particularily effective in destroying grassy perennial weed species.

Experience in the past has shown that the widespread introduction of new herbicides into the environment may give rise to some serious environmental problems. Thus, it is important that prior to promoting the use of such chemicals, the full environmental implications be considered.

In Table 5.3, some properties of Glyphosate and Paraquat are summarized. In order to provide the reader with an appreciation for the relative environmental risks the use of these chemicals entails, the properties of several herbicides already in common use in Manitoba (Section 3.44) are also listed. Acute oral toxicity to rats and 48-or 96-hour toxicities to susceptible species of fish, usually rainbow trout or blue gills in static water tests, are standard indexes of mammalian and fish toxicity. Where more than one toxicity value is reported in the literature, the values denoting higher toxicity are shown. Fish toxicity values represent concentrations in water; pesticides absorbed by sediment in water are less toxic to fish (A.R.S. 1975).

The values in the table suggest that in general, Glyphosate and Paraquat pose no greater threat to fish and mammals

Table 5.3 Agricultural herbicides: Types, transport modes, toxicities, and persistence in soil.

Common name of herbicide	Trade name	Chemical class	Predominant transport mode	Toxicity: Rat, acute oral LD_{50}, mg/kg	Toxicity: Fish[2] LC_{50} mg/liter	Approximate persistence in soil, days
Glyphosate	Roundup	Aliphatic Acid	Sediments	4320	Low toxicity	150
Paraquat	Gramoxone	Cationic	Sediments	150	400[3]	500
2-4-D Amine	-	Phenoxy compound	Water	370	15[4]	10-30
MCPA	-	Phenoxy compound	Sediments, water	650	10	30-180
Triallate	Avadex BW	Carbamate	Sediments	1675	4.9	30-40
Trifluralin	Treflan	Nitroanilines	Sediments	3700	0.1[3]	120-180

[1]Expressed as lethal does (LD) or lethal concentration (LC), to 50 percent of the test animals.

[2]48- or 96-hour LC50 for bluegills or rainbow trout, unless otherwise specified.

[3]24 hour LC_{50}.

[4]For killifish.

Source: Agricultural Research Service (1975).

that the herbicides already in common use. Studies by the U.S. Fish and Wildlife Service (1977), however, indicate that the addition of a surfactant to Glyphosate may increase its toxicity to fish and invertebrates significantly. Mortalities among rainbow trout eggs and fry increased when exposed to concentrations exceeding 10mg./litre for a period of four hours.

While the direct danger of these non-selective herbicides to animals may be minimal, in some regions their recurring application could reduce the quality of wildlife habitat. Tomkins and Grant (1977) studied the impact of several types of herbicides on plant species diversity along a transmission right-of-way. They found that Paraquat caused rapid reductions in monocotyledons and dicotyledons, thereby reducing ground cover drastically. Recovery of the vegetation in the test plots took approximately two years. In the third year, the complexity of the plant community in the test plots exceeded that of the control plots.

Similarly Yates (1978) reported low level damage symptoms on nontarget plants exposed to Glyphosate drift. Recommendations regarding the application of Glyphosate (Roundup) (M.D.A. 1978c) warn that spray should contact only the mature bark of trees. Contact with foliage, green bark, and suckers should be avoided. This suggests that under some circumstances, the chemical may pose a serious danger to desirable plants.

5.5 Custom Services

As the use of herbicides and other chemicals has increased, custom application has become more popular with farmers (Lyster and Winslow October 1976). Sailoff (pers. comm.) notes that (in Manitoba) during the past five years the number of large machines utilized mainly by custom applicators has increased from 10 or 15 units to approximately 75 units. Donaghy (pers. comm.) suggests that the increasing sophistication of many chemicals frightens some farmers and causes them to turn to custom services.

Within the study areas approximately 30 percent (13 in Strathcona and 5 in Odanah) of the respondents reported that they engage custom applicators. Five of these individuals, however, indicated that they were displeased with custom application and are reconsidering the use of this service.

While proponents of increased custom application emphasize its benefits--primarily speed (up to 75 acres per hour can be treated (Lyster and Winslow October 1976)) and timeliness, further analysis suggests that there are also major disbenefits associated with this practise.

Firstly, the argument that custom application equipment can ensure more timely operations is not strictly valid. Custom applicators are in the business to make a profit. Consequently they can operate machines only in numbers which will ensure an adequate return on capital. This raises the possibility that during peak demand periods an equipment shortage could develop, thereby forcing some farmers to delay treatment and potentially suffer reduced crop yields. Several individuals who indicated that they were displeased with custom services, mentioned this scenario as a reason. Others noted that in their desire to maximize the acreage treated, custom applicators often rush their work and omit treating some areas. Where weed control is concerned, this may contribute to more serious infestation in the following year.

Secondly, increasing the farmers' reliance on custom services is an additional step in the direction of land extensive and capital intensive management. To maximize the benefits of chemicals such as Avadex BW (a wild oats herbicide) for example, immediate incorporation is necessary (M.D.A. 1978c). Thus, farmers who engage custom operators with large equipment have an incentive to acquire incorporating (tillage) implements which match the efficiency of the chemical applicator, rather than the needs of the farm unit they operate. Eventually, this large equipment indirectly creates pressures which encourage the farmer to expand his cultivated acreage.

5.6 Use of Aircraft

In Canada the primary use of aircraft in agriculture is for the purpose of applying various pest and disease control chemicals, and the distribution of fertilizers and seeds. While it would be inaccurate to suggest that the use of aircraft in the performance of agricultural operations represents a new development in agricultural technology, most of the expansion in aircraft treatment has taken place in recent years. Between 1957 and 1971 the agricultural acreage treated with aircraft expanded from 435,000 to 1,000,000 acres. From 1971 to 1976 the acreage sprayed increased by 1,500,000 acres (King 1978). Approximately 80 percent of the acres sprayed were in the Prairies. King predicts that the prospect for agricultural flying is one of rapid growth.

Forbes (pers. comm.) indicated that the expanded use of aircraft in Manitoba mirrors the situation elsewhere in the country. During the last ten years, expansion has been rapid. Currently approximately 45 aerial operators in the Province treat 600,000 to 800,000 acres annually. Aerial operations are especially attractive during wet conditions. Large areas can be treated rapidly and without fear of causing wheel track compaction problems. Although some native pasture and bush is sprayed, aerial operations are associated primarily with cereal crop production. All materials applied by aircraft must abide by the requirements of federal and provincial legislation (Forbes pers. comm.).

While under some circumstances the use of aircraft has certain advantages for the farmer, the environmental implications are cause for concern. Warnings regarding the use of aerial application have come from several sources. According to the

A.R.S. (1975) aerial applications of pesticides are not environmentally favourable and special precautions should be taken when treatment is necessary. Aerial treatments can only be broadcast and the likelihood of uneven distribution increases. Tomkins and Grant (1977) note that if chemical damage to desirable species is to be avoided, "aerial spraying in particular should be examined and strictly regulated".

The main problem associated with aerial operations is off-target spraying resulting from drift. Controlling drift with air spraying is much more difficult than with ground application (Grover 1978). Aerial application increases spray volatilization and drift that may injure susceptable crops in adjoining areas and directly contaminate nearby surface waters (A.R.S. 1975). Grover (1978) notes that with airspraying, droplet drift potential is in the order of 10 to 50 percent at wind speeds of 3.1 to 9.3 miles per hour. Yates et al. (1978) report widespread low level damage symptoms on sensitive plants occurred several miles from application sites when variable winds and a temperature inversion caused air applied Glyphosate[2] to drift. Egley and Williams (1978) reported that direct contact of the seed with Paraquat[2] inhibited the emergence of some crop grasses; direct seed contact with Glyphosate inhibited shoot elongation in some plants.

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[2]Glyphosate and Paraquat are not liscenced for aerial application in Manitoba (M.D.A. 1978c).

Drift damage can be aggravated if chemical applicants are improperly mixed. Many pesticides are mixed with water. In order to decrease their turn-around time and increase the acreage they can spray with a single loading, aerial operators have been known to reduce the water in their mixture, thus increasing chemical concentrations (Forbes pers. comm.). If the chemical drifts, greater damage can be predicted.

In some agricultural regions the land's surface features determine that non-target areas receive chemical treatment regardless of drifting problems. While aerial application is most effective on continuous blocks of land, operators sometimes spray fairly small plots. In regions such as the Minnedosa area, where arable land tends to be interspersed with non-arable plots of varying size, avoiding treatment of non-arable areas is difficult. Where small potholes for example, are concerned, aerial operators are unlikely to make an effort to avoid treatment (Forbes pers. comm.).

5.61 <u>Implications for Waterfowl</u>

Although many of the chemicals applied by air may not pose a direct threat to waterfowl and other wildlife, the effects of these chemicals on various components of the habitat on which they depend for their survival could be significant. The potential impact of herbicides on plant communities has been discussed in this, and other sections of this study. Since fertilizer can also be applied by air (Bates March 1977;

King 1978), direct application to small water bodies such as potholes or sloughs would likely contribute to a deterioration of water quality and perhaps the quality of the habitat it provides.

Finally, it is important to recognize that any increase in aerial agricultural operations is a step in the direction of capital intensive and land extensive farming operations and a movement away from smaller farms and the more finely tuned management they facilitate. The environmental consequences of this pattern of development are familiar.

5.7 Farm Implements

5.71 Introduction

Obtaining information concerning future developments in agricultural equipment design proved to be a difficult task. Attempts to obtain information directly from implement manufacturers were unsuccessful. The major sources, academic journals, industrial and government publications were often inconsistent or contradictory. Nevertheless certain trends could be detected.

As noted in the introduction to the chapter, the literature regarding future implement technology suggests that designers and manufacturers are concentrating on refining implements which are already available rather than developing new types of machines. Much of the research is concentrated in the area of traction power, and electronic monitoring systems for tillage, seeding, and harvesting equipment.

5.72 Tillage and Seeding Equipment

Despite the predicted increase in the size of traction units, McConeghy (January 21, 1977) suggests that tillage widths are unlikely to increase; instead, tandemizing--allowing for "once-over" management and lower labour costs, will probably become more prevalent.

As the discussion of zero-tillage cropping indicates, much of the current research effort is focussed on the development or refinement of equipment capable of operating in, and conserving, surface residues (Chinsuwan 1976). In order to counter the isolating effects of controlled environment tractor cabs, the development of electronic monitoring and warning systems for tillage, seeding, and harvesting equipment is also considered to be a high priority concern (Sammarco 1976; Feldman 1977).

Additionally, scientists are attempting to develop soil management techniques which will permit agricultural use of many soils having a low productive capacity (Anderson March 7, 1977b). The soil combine, a powered tillage implement capable of crushing or pulverizing soils subject to clodding (Wolf and Luth 1977), is an example of one machine which will likely facilitate cultivation of areas currently considered nonarable.

5.73 Tractors

Kulhavy (1977) suggests that the emphasis in tractor design has been on comfort and convenience. The operator is being enclosed in a controlled environment "pod" which isolates him from the operation of the machines he is pulling. Although engines are being made more energy efficient, the parasitic loads for hydraulics and operator convenience have kept overall efficiency about the same. Jedele (1974) predicts increases in horsepower, a proliferation of four-wheel drive tractors, and the development of field equipment which is proportionally larger or able to operate at higher speeds. McConeghy (January 21, 1977) also predicts an expanded use of four-wheel drives, and by 1985, the common use of 350-500 horsepower units. Implement and Tractor (July 15, 1977) hails the development of a tractor with a self-levelling suspension. This enables the cab to tilt by as much as 15 degrees and thus allows for operations on steep hillsides.

Although most farmers utilize a wide variety of equipment in their operations, the fact that the tractor represents the primary source of mobile power means that ultivately the size of the tractor plays a major role in determining the character of other farm operations. The results of a study by Rodewald and Folwell (1977) are illustrative. Their study examined tractor technology in relation to farm size. They found that to be economically viable, a 2000 acre farm is needed to support a four-wheel drive tractor. The researchers concluded that the larger farm can be attributed to the economic pressure applied by the higher costs of new lines of equipment. Increasing the size of farms is one means of spreading the larger fixed investment costs over larger acreages, thereby achieving lower average fixed costs.

From the environmental perspective the trend toward even larger equipment, or equipment designed specifically to operate under adverse soil and topographic conditions, is disturbing. As Kulhavy (1977) reports "large tractors require large fields and promote tearing out of fences to increase the amount of tillable land".

While halting this trend would be a very desirable objective, past experience suggests that that may not be feasible. Some control measures, however, may prove workable.

Friesen (pers. comm.) indicated that most Manitoba farmers have far larger tractors than can be economically justified; thus they are constantly under self-imposed pressures to increase the size of their operations. This suggests that the information upon which farmers base their decisions to acquire equipment is inadequate. By improving this information base, at least some of the pressure to expand farm sizes would likely be avoided.

Finally, the pressures to increase the scale of farm operations emanating from the implement producing sector point to the urgency of taking action to protect lands which are threatened by the development which larger equipment may encourage and facilitate.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

While waterfowl managers are concerned specifically with the destruction of wetlands and upland nesting cover for various waterfowl species, the analysis indicates that many of the practises directly and indirectly related to the management of agricultural lands within the study areas, are contributing to the general degradation of the environment. As pointed out in the text of this study, in some cases the continuation of current management practises is detrimental to the long-term interests of the agricultural sector, and to society as a whole.

The main objective of this study has been to determine areas of common management concern to farmers and waterfowl managers and identify management alternatives which would benefit both resource users. It is hoped that by stressing common concerns, the conflict that has frequently characterized the relationship between waterfowl managers and agriculturalists can be reduced. It is important to note, however, that any actions taken to improve this relationship, would have environmental, social, and economic benefits which would extend well beyond the immediate interests of farmers and waterfowl managers.

The following recommendations are aimed at achieving the goal of reducing the conflict between waterfowl and agricultural interests, while enhancing environmental management generally. The nature of the recommendations determines that some can only be implemented by various government bodies, while others lend themselves to implementation either by private organizations alone, or in cooperation with the appropriate public (government) bodies. With regard to those recommendations whose implementation is solely within the jurisdiction of the government, it is emphasized that private agencies have an important extra-political role to fulfill in influencing legislators (eg. through presentations at public hearings or as political lobbiests) to recognize, and resolve resource conflicts in the desired manner.

6.2 Recommendations and Conclusions

The Province's native grasslands offer tremendous potential for employing multiple-use management concepts. Delayed grazing of native species would benefit farmers and waterfowl interests alike. It is therefore recommended that:

1) A program be established to promote the management of native grasslands in accordance with the principles established by scientific evaluation.

Although a successful Province-wide program would require the resources and cooperation of provincial agricultural personnel, private organizations could likely initiate small demonstration projects on individual farm units. The cooperation of farmers who are skeptical of the benefits of grassland management may initially have to be obtained by providing either monetary or material (eg. fencing) "bribes".

The apparent failure of farmers to recognize the cash crop value of hay suggests that they are not adequately informed as to its marketability. Thus it is recommended that:

2) The Department of Agriculture provide farmers with additional information on the availability of hay markets, and the agronomic benefits obtained from producing a forage crop in rotation.

Given that controlled burning is of some benefit in the maintenance of wildlife habitat, it is recommended that:

3) Wildlife agencies and rural municipalities in cooperation, design a burning program which ensures that the impact of maintenance type burning on wildlife is minimized--that not all potential habitat is burned every year. A system allowing for burning on alternate sections during alternate years, for example, might be appropriate. In areas where burning is inappropriate (as on cropland) continued efforts aimed at discouraging this practise are necessary.

Currently, the Department of Highways and rural municipalities initiate road and highway right-of-way maintenance activities during the month of June. In waterfowl nesting areas, maintenance operations undertaken at this time can have a disruptive impact on nesting activities. Thus it is recommended that:

4) Provincial wildlife management personnel and private wildlife interests, in cooperation with the relevant right-of-way maintenance authorities, design a maintenance schedule which ensures that any conflict between maintenance and nesting activities is minimized.

In addition to providing wildlife habitat, the vegetation on abandoned rights-of-way helps to protect adjacent cropland from erosion. In many areas the rights-of-way represent the only undeveloped land remaining in the public domain. As the process of farm consolidation continues, it is probable that many farmers will bring this land under cultivation. In order to ensure that this process does not continue, it is recommended that:

5) Municipal authorities, in consultation with the relevant senior government departments and private interest groups, take immediate and visible action to demonstrate that these lands are being managed for a public purpose and are not available for cultivation. In some circumstances it may be more appropriate to exchange arable right-of-way land, for an equivalent or larger parcel of privately owned non-arable acreage.

Given that institutions such as the property tax system and the Grain Quota Allotment System provide incentives for farmers to invade non-arable acreage and engage in undesirable management practises, it is recommended that:

6) Municipalities cease taxing all non-arable land, and that the tax saving accruing to the farmer who agrees not to cultivate this land be discretely shown on his tax assessment notice; and that

7) The Provincial government undertake to compensate Rural Municipalities for any tax revenues lost by discontinuing the taxation of such land.

Further, it is recommended that:

8) The Canadian Wheat Board reduce the percentage of summerfallow acreage on which farmers are currently permitted to deliver grain. Concomitantly the delivery quota system should be restructured to allow farmers to deliver grain on some percentage of their unbroken land.

Since damage caused by waterfowl and other wildlife is likely to cause some farmers to be hostile to wetland conservation programs, it is recommended that:

9) The Department of Agriculture in cooperation with public and private wildlife management groups, provide farmers with the best information available regarding techniques for protecting crops from wildlife damage. If necessary, additional research aimed at developing other antidepredation measures should be undertaken.

In order to provide farmers with economic protection against depredation losses which are otherwise unavoidable, it is recommended that:

10) The crop insurance program be expanded so as to provide farmers with the opportunity to recover depredation losses at a level which is commensurate with the compensation available for crops lost to other perils.

Many farmers who are draining small wetlands appear to be unaware of their ecological importance. This suggests that:

11) There is a need to establish education programs designed to impress on the farmers the importance of maintaining these areas in their natural state.

The viability of using the public media, as well as schools and other educational facilities, as channels for distributing information should be considered.

Much of the drainage activity currently taking place within the study areas is motivated by the farmers' desire to improve their cultural pattern. The drainage is frequently unplanned and carried out with little consideration given to its potential environmental impact. Therefore it is recommended that:

12) The current role of the Technical Services Branch of the Department of Agriculture be reassessed. Consideration should be given to establishing a program having the objective of helping farmers plan their field operations without having to resort to drainage and clearing. In some circumstances the viability of consolidating rather than draining wetlands should be considered.

The fact that the area of saline acreage is continuing to expand suggests that some farmers are engaging in cultural practises which are inappropriate for the management of soils prone to becoming saline, while others are draining saline basins having no crop-producing capabilities. In order to counteract this trend, it is recommended that:

13) The Department of Agriculture provide farmers with additional information regarding the management of saline soils;

14) Projects based on the production of salt tolerant crops such as alfalfa be established to rehabilitate or stabilize the development of saline areas. While publically funded projects would be desirable, smaller scale privately initiated programs should also prove beneficial;

15) A publically funded program be initiated to identify and map saline basins. The information obtained should be utilized to discourage farmers from incurring the cost of draining wetlands which have no crop-producing capability.

Many farmers within the study areas have a strong tradition-based bias favouring summerfallow and excessive cultivation of cropland. In order to help overcome this bias, it is recommended that:

16) The Department of Agriculture provide farmers with additional information regarding the negative impacts of excessive tillage on the soil structure;

17) The Department of Agriculture provide farmers with additional information regarding the benefits of displacing cultivated fallow with some other crop planted in rotation;

18) The Department of Agriculture provide farmers with additional information on the benefits of controlling weeds with herbicides.

The benefit-cost relationship between controlling weeds with herbicides, versus controlling weeds by cultivation has (in the minds of many farmers) not been firmly established. Due to the uncertainty, farmers frequently choose to rely on cultivation as a weed control measure. In order to help overcome this uncertainty it is recommended that:

19) The economic relationship between tillage and herbicidal weed control be further investigated.

A study should be undertaken at locations having a variety of topographic, climatic, and soil conditions. While Provincial or university agricultural personnel would likely be best equipped to undertake such an assessment, a privately initiated study should not be ruled out.

The manner in which farmers determine the amount of synthetic fertilizer to apply to their cropland suggests that they may not be maximizing the benefits they obtain from these chemicals. Thus it is recommended that:

20) The Department of Agriculture provide farmers with additional information regarding the use of chemicals on cropland.

The efficient use of large equipment on cropland calls for a highly rationalized cultural pattern and indirectly encourages farmers to invade non-arable acreage. The suggestion that many Manitoba farmers are using equipment which is excessive to their (economic) needs indicates that the information on which farmers base their decision to acquire a given sized implement is insufficient. Thus it is recommended that:

21) The Department of Agriculture establish a service designed to help farmers more accurately assess their equipment requirements.

The use of various herbicides and synthetic fertilizers is likely to continue to expand. There is a possibility that the widespread use of these chemicals could have a detrimental impact on the quality of the waters, and the plant communities located on the non-arable lands which intersperse the cultivated cropland. This could reduce the wildlife-sustaining capabilities of the non-arable areas. Thus it is recommended that:

22) A study be undertaken to determine the impact of increased chemical use on the non-arable acreage adjacent to croplands.

Finally, as this study demonstrates, the natural and artificial environment in which a farmer operates consists of an assemblage of complex and dynamic relationships. If waterfowl managers are to be successful in managing their resource, they must have a thorough understanding of the farmers' position.

In order to assist in gaining this understanding on a "first hand" basis, it is recommended that:

23) Waterfowl interests acquire a farm and while operating it as a self-sustaining economic unit, utilize it as the site for testing the agro-ecological practises discussed in this study. Such a site could also be used for the purpose of demonstrating, testing, and assessing the impact on waterfowl, of the latest technological developments.

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APPENDIX I

FARMER SURVEY QUESTIONNAIRE

1. Is farming your main source of income? — Yes___ or No___
   If Yes, how long has it been your main source of income? — _________ years.

2. How large is your farm, including rented and leased acreage? — ________(sections) (quarters)(acres)

3. a) How much land do you own? — ________(sections) (quarters)(acres)

   Prior to your taking possession of this land, was it farmed by another family member? — Yes___ or No___
   If own: Do you plan to pass this land on to a family member when you retire? — Yes___ or No___

   b) Do you lease (long term) any land? — Yes___ or No___
   If Yes, is it leased from a family member? — Yes___ or No___

   c) Do you rent (short term) any land? — Yes___ or No___
   If Yes, do you rent it from a family member? — Yes___ or No___

4. On your farm do you produce
   a) grain ____acres
   b) livestock _____
   c) forages ___acres

5. In the last 10 years have you increased _____ or decreased _____ your total acreage in cultivated crops?
   By how many acres? — _______

6. How many crop varieties do you produce in the average year (including forages)? — _______

7. Do you summerfallow any cropland? Yes___ or No___
If no, proceed to Question 8.

If Yes:

a) How many acres of cropland to you summerfallow in the average year? ________

b) Why do you summerfallow?

c) Since you started farming have you increased ____ or decreased ____ the percentage of your summerfallow acreage?
If changed: By how much? ________

d) Why have you increased/decreased your summerfallowed acreage?

e) How many separate tillage operations do you perform on summerfallowed acreage between the last harvest and the end of the fallow year? ________

f) Since you started farming have you increased ____ or decreased ____ summerfallow cultivation?

If increased: Why?
If decreased: Why?

g) When do you carry out your first summerfallow tillage operation in the fallow year? (Ask for month and week).

h) Are you currently using any herbicides as a substitute for some summerfallow tillage operations? Yes___ or No___

If No: Why Not?

If Yes: How many tillage operations has chemical summerfallow enabled you to displace? __________

Has chemical summerfallow enabled you to change cultivation dates? Yes___ or No___

If Yes: In what way?

8. a) Do you use liquid herbicides only ____, granular herbicides only ____, some granular and some liquid herbicides ____. If liquids only: Why do you prefer to use liquid herbicides?

b) When do you apply most of your herbicides? - fall (list whether liquid or granular) __________
or spring (list whether liquid or granular) __________
pre-emergent __________
or post-emergent __________

c) Do you, or have you ever, employed custom herbicide applicators? Yes___ or No___

If Yes: Are you satisfied with the job they do? List level of satisfaction.

If no: Why not?

d) Do you plan to employ the services of custom herbicide applicators in the foreseeable future? Yes___ or No___
If no: Ask for reason.

9. Do you apply fertilizer to some ____ or all ____ of your cultivated crops?

If fertilizer is used: List - crop types
- year in rotation
- seeding date

a) Do you plan to increase the use of fertilizer in your cultivated crops in the future? Why or Why not?

b) How do you decide how much fertilizer to apply to your crops?

c) Do you use a legume in rotation ____ or a green manure crop ____ to increase soil fertility or decrease your fertilizer needs?

If No: Why Not?

Do you have any plans to do so in the future? Yes___ or No___

10. After harvesting and before planting the next crop the following spring how many times do you till your fields? State implement used and number of passes.

- In fall

- In spring

a) Are you achieving what you consider to be optimal tillage? Yes___ or No___

11. In the last 5 years have you increased ____ or decreased ____ the number of times annually you till your cropland? If no: check ✓ here ____.

If increased: Why and by how much?

If decreased: Why and by how much?

a) Do you believe it is currently possible to decrease the number of times you till your field without reducing yields? Yes___ or No___

If No: Why not:

If Yes: Are you interested in, or have you considered adopting minimum or zero-tillage cropping practises? Yes___ or No___

Why, or Why not?

b) Would you be willing to accept lower crop yields if it were demonstrated to you that by reducing your tillage operations you would also incur sufficiently lower equipment and fuel costs to compensate for a loss in yield? Yes___ or No___

12. a) In the last 5 years, has the rising cost of fuel changed the way you manage your farm? Yes___ or No___

If Yes: How?

b) In the last 5 years, has the rising cost of equipment changed the way you manage your farm? Yes___ or No___

If Yes: How?

13. Do you own ____ or plan to install ____ any on farm grain drying equipment?

If No: Why not?
If Yes: Why?

14. Do you swath your cereal crops?

Always ____
Usoally ____
Rarely ____

If usually or rarely: How do you decide whether or not to swath?

Questions for farmers who also produce livestock

15. How many acres of your land are not cultivated on a yearly basis? ________

16. How many acres of your uncultivated land is used for pasture, hayland or other forage production? ________ acres

17. Do you have any unimproved pasture? Yes___ or No___

If Yes: How much? ________ acres

a) When, on the average do you begin grazing cattle on your unimproved pasture (State month & week)?

18. Do you have any permanent improved pasture? Yes___ or No___

If Yes: How much? ________

If No: Proceed to question 19.

How often do you reseed it?

19. Do you have any unimproved hayland? Yes___ or No___

If Yes: How much? ________

a) What kind of grass grows on your unimproved hayland?

20. Do you have any permanent improved hayland? Yes___ or No___

If Yes: How much? ________

a) What kind of grasses do you seed there?

b) How often do you reseed your hayland?

21. Do you fertilize your hayland ____ or your pasture ____?

If not: Why not?

22. In the average year, when do you begin cutting hay?

- 1st cut - month and week

- 2nd cut - month and week

23. Have you ever heard of zero-tillage pasture renovation? Yes___ or No___

If Yes: Are you interested in this system?

If Not Interested - Why not?

24. Do you, or have you any plans to produce corn for forage purposes? Yes___ or No___

If not: Why not?

Questions for All Farmers

Uncultivated, vacant or bushland sustains a lot of wildlife so I'd like to ask you a few questions about it.

25. How many acres of your total acreage do you consider to be wasteland for example bush or permanent wetland? List kind and acreage. ________

a) Has this area increased ____ or decreased ____ in size in the last 10 years?

If increased: By how much?

If decreased: By how much?

b) Do you plan to undertake any land clearing operations in the next 5 years? Yes___ or No___

c) Have you removed any windbreaks in the last 10 years? Yes___ or No___

If Yes: Did you, or do you plan to replant them? Yes___ or No___

If No: Why not?

26. Do you have any permanent water bodies or sloughs on your property? Yes___ or No___

If Yes: How many? ________

And what is their total acreage? ________

Have any of them begun to smell unpleasantly in the last few years? Yes___ or No___

a) Have you drained any sloughs or other water bodies in the last 10 years? Yes___ or No___

If Yes: Approximately how many acres does this drained area cover? ________

27. Do you plan to drain any sloughs or other waterbodies? Yes___ or No___

If Yes: Why?

If No: Why not?

28. Do you own ____, have you rented ____, or do you plan to purchase or rent ____ a land leveller or scraper?
If either owned or rented: Why?
What was it used for?

If plans to purchase or rent: For what purpose?

29. If the government told you that they would remove all your unproductive or poor quality lands from the tax rolls, if you agreed not to cultivate, clear, or drain them, would you think of this as a good idea? Yes___ or No___

If No: Why not?

30. In the last 10 years have you taken any action to increase the amount of land you have eligible for inclusion in the grain quota? Yes___ or No___.

If Yes: What have you done to increase the eligible quota acreage?

How much have you increased your quota acreage? ________ acres.

31. If the Grain Board allowed you to include uncultivated, or waste land in the grain quota would you increase ____ or decrease ____ or not change the amount of land you cultivate ____?

32. Is your land crossed by any railway lines or crown-owned rights-of-way? Yes___ or No___

a) Are any of these used ____ or abandoned____?

If abandoned: Do you use them for any purpose? Yes___ or No___

If Yes: What for?

33. Do you have, or have you experienced any erosion problems on your land? Yes___ or No___

If Yes: Was it caused by wind ____ or water ____?

a) If wind erosion: What do you, or did you do to reduce the wind erosion?

If Nothing: Why?

b) If water erosion: What have you done to reduce the water erosion?

If Nothing: Why?

34. Many farmers cultivate into the bottoms of their drainage ditches. Do you do this too? Yes___ or No___

If No: What do you do and why?

35. Do any of your fields contain plots of saline or alkaline soils? Yes___ or No___

If Answer is No - proceed to Question 37.

a) Has the salt or alkaline problem increased at all since you started farming this land? Yes___ or No___
If Yes: When did you first notice it increasing?

If Increasing: Why do you think it is increasing?

b) Where in the fields do the salt or alkaline spots occur?

Approximately how many acres do they cover?

36. Do you manage saline or alkaline areas in any special way? Yes___ or No___

If Yes: How?

If No: Why not?

37. Many farmers use burning as a method of managing heavy stubble or controlling vegetation along fencelines, roadsides, drainage ditches and in pastures, wood lots, and sloughs.

a) Do you do any burning? Yes___ or No___

If No: proceed to question 38.

b) Where do you burn?
- stubble ________
- ditches ________
- fencelines _____
- sloughs ________
- other (explain) ______

c) In what season do you do most of your burning?

d) Why do you burn? (for example sloughs or stubble)

38. If non-burner: How do you control unwanted vegetation in sloughs, along ditches or field edges?

a) In which season do you do this?

39. Do you hunt? Yes___ or No___

40. Do any waterfowl ever nest on your property? Yes___ or No___

If Yes: Any idea of how many? ____

Where have you noticed them nesting?

41. a) How do you feel about the presence of waterfowl or other wildlife on your land?

b) If opposed to it: Why?

42. Do you think waterfowl production should be encouraged? Yes___ or No___

If Yes: Do you personally do anything to improve its chances of survival or encourage production on your property? Yes___ or No___

If No: Would you be willing to do something to enhance its chances of survival if you knew what to do? Yes___ or No___

43. According to the Dept. of Agriculture --excessive water accumulation represents one of the main limitations to crop production in this area. Recent studies suggest that certain land management or snow management techniques can help to decrease some kinds of flooding and ponding significantly. Many people are unaware of the management techniques which are available. Are you aware of any of these? Yes___ or No___

If Yes: Do you use any of them? Yes___ or No___

If Not: Why not:

44. If you could improve some characteristics of the land in this area, what would you do?

45. What do you see as the major problems threatening the future of your farming operation?

APPENDIX II

SOIL CAPABILITY

The Canada Land Inventory (1970) classifies the soils' capability for agriculture in the following manner:

Class 1 - Soils in this class have no significant limitations in use for crops.

Class 2 - Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practises.

Class 3 - Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practises. The limitations may affect timing and ease of tillage, planting and harvesting, choice of crops, and methods of conservation.

Class 4 - Soils in this class have severe limitations that restrict the range of crops or require special conservation practises, or both. The limitations seriously affect one or more of the following practises; timing and ease of tillage; planting and harvesting; choice of crops; and methods of conservation.

Class 5 - Soils in this class have very severe limitations that restrict their capability to producing forage crops. Improvement practises are feasible. The limitations are so severe that the soils are not capable of use for sustained production of annual field crops. The soils are capable of producing native or tame species of perennial forage plants, and may be improved by use of farm machinery. The improvement practises may include clearing of bush, cultivation, seeding, fertilizing, or water control.

Class 6 - Soils in this class are capable only of producing perennial forage crops. The limitations are so severe that improvement by use of farm machinery is impractical.

Class 7 - Soils in this class have no capability for arable culture or permanent pasture.

Subclasses

Excepting Class 1, the classes are divided into subclasses on the basis of kinds of limitations. The subclasses are as follows:

Subclass C - adverse climate.

Subclass E - erosion damage--Past damage from erosion limits agricultural use of the land.

Subclass I - inundation--Flooding by streams or lakes limits agricultural use.

Subclass P - stoniness--Stones interfere with tillage, planting and harvesting.

Subclass R - shallowness to solid bedrock.

Subclass S - soil limitations--Limitations include one or more of the following; undesirable structure, low permeability, a restricted rooting zone because of soil characteristics, low natural fertility, low moisture holding capacity, salinity.

Subclass T - adverse topography--Either steepness or the pattern of slopes limits agricultural use.

LAND CAPABILITY FOR WILDLIFE--WATERFOWL

The Canada Land Inventory (1973) classifies the land's capability for sustaining waterfowl in the following manner:

Class 1 - Lands in this class have no significant limitations to the production of waterfowl.

Class 2 - Lands in this class have slight limitations to the production of waterfowl.

Class 3 - Lands in this class have slight limitations to the production of waterfowl. Capability on these lands is moderately high, but productivity may be reduced in some years because of occassional drought. These lands have a high proportion of both temporary and semipermanent shallow marshes poorly interspersed with deep marshes and bodies of open water.

Class 4 - Lands in this class have moderate limitations to the production of waterfowl. Limitations are similar to those in Class 3, but the degree is greater. Water areas are predominantly temporary ponds, or deep, open waters with poorly developed marsh edges or both.

Class 5 - Lands in this class have moderately severe limitations to the production of waterfowl. Limitations are usually a combination of two or more of the following factors; climate, soil moisture, permeability, fertility, topography, salinity, flooding, and poor interspersion of water areas.

Class 6 - Lands in this class have severe limitations to the production of waterfowl.

Class 7 - Lands in this class have such severe limitations that almost no waterfowl are produced.

Subclasses

With the exception of Class 1 lands, the waterfowl producing classes are divided into subclasses according to the nature of the limitations that determine the class. The subclasses are as follows:

Subclass A - aridity--The limitation is an arid condition of the land or the susceptability of the land to periodic droughts, which results in low pond water levels or premature drying of marshes in the breeding season.

Subclass B - free-flowing water--The limitation is usually due to fast or excess water flow, which inhibits development of marsh habitat.

Subclass C - climate--A combination of adverse climatic factors may act to reduce favourable habitat.

Subclass F - fertility--The limitation is insufficient nutrients in the soil and water for optimum plant growth.

Subclass G - landform--Poor distribution or interspersion of marshes or basins may be a limiting factor of the land and may prevent the development of optimum waterfowl habitat.

Subclass I - inundation--The limiting factor is excessive waterlevel fluctuation or tidal action, which adversely affects the habitat or the nesting success of waterfowl.

Subclass J - reduced marsh edge--The limitations are topographic features that adversely affect development of optimum marsh conditions along the edge of water areas.

Subclass M - soil moisture--Poor moisture holding capacity of soils, which adversely affects the formation and permanency of water areas.

Subclass N - adverse soil and water characteristics--These conditions limit the development of plant and animal communities essential for waterfowl production.

Subclass R - soil depth--Restriction of the rooting zone by bedrock or other impervious layers may limit development of suitable plant communities.

Subclass T - adverse topography--Either steepness or flatness of the land may limit the development or permanency of wetlands.

Subclass Z - water depth--Excessively deep or shallow waters limit the development of optimum waterfowl habitat.

APPENDIX III

RAILBED DISPOSITION

Ownership of the railbeds which were abandoned prior to the initiation of the Hall Commission's studies was retained by the railway companies. These were offered for sale to the Province, public utilities and the municipalities. Since public authorities rarely responded to the offers, many beds were eventually sold to adjacent landowners (Rettle pers. comm.).

The Hall Commission (1977) recommended that the roadbeds abandoned subsequent to the release of its findings, be vested in the provincial Crown for disposition as mutually agreed between the municipalities and the provinces. As a result of a comprehensive agreement between the railway companies and the Federal government (signed after the release of the Hall Commission's recommendations), the Federal government obtained control of abandoned rail R.O.W.'s.

According to an official of the Canadian Transport Commission (1978) (who refused to be named) a decision regarding the final disposition of abandoned railway properties has not yet been reached. During February of 1978, however, Transport Minister Otto Lang stated that the Federal government intends to give benefit of the land, whether it remains in the hands of the farmer, the municipality or the province, to the municipality in question, as compensation for the loss of rail service (Winnipeg Free Press February 8, 1978).

Rettle (pers comm.) suggested that if precedence is followed, the Federal government will give the provinces first option on abandoned R.O.W.'s. If the provinces fail to respond, the R.O.W.'s will be offered to the rural municipalities, and finally adjacent landowners. Whatever decision is finally reached, it is evident that the abandoned railway beds, represent an opportunity for provincial and municipal officials to increase public land holdings at minimal expense.

WHEAT RESIDUE MANAGEMENT SCENARIO

Crop District[1]	5 Year Average Yield 1972-76 Bu/acre[1]	Residue Yield Lbs/acre[2]	Residue Necessary For Erosion Control[3]	Tillage Implements
2. (Strathcona)	25.4	87.5x25.4=2222.5	1375	Rod Weeder - heavy duty cultivator
9. (Odanah)	23.6	87.5x23.6=2065	1375	Rod Weeder - heavy duty cultivator

Crop District	Average Reduction in Wheat Residue/Operation	Frequency of Tillage Operations	Residue Remaining lbs/acre
2. (Strathcona)	10%[4]	5	1313
	15%[4]	3	1365
9. (Odanah	10%	4	1350
	15%	3	1267

[1] M.D.A. Yearbooks, 1972-76.

[2] Holm (1964) and McGuinnis (1973) indicate that for every bushel of wheat harvested, 75-100 lb/acre residue remain on the land. For the purposes of these calculations, an average figure of 87.5 lbs/acre was utilized.

[3] Holm (1964), Johnson (1977), Woodruff et al. (1972) and Lindwall (1976) suggest that 760 to 2000 lbs/acre residue are necessary to provide adequate soil protection. For the purposes of these calculations, an average figure--1375 lbs/acre--was utilized.

[4] Johnson (1977), Holm (1964), Woodruff et al. (1972).

APPENDIX V

1977-78 CROP YEAR

The Canadian Wheat Board

PERMIT BOOK APPLICATION

FORM DP-1E

(1) THE ACTUAL PRODUCER MUST SIGN THE DECLARATION ON THE REVERSE SIDE OF THIS PAGE.
(2) SHOW THE ACTUAL PRODUCER'S NAME OPPOSITE SUFFIX A. THE ACTUAL PRODUCER'S ADDRESS IS TO BE SHOWN IN THE BLUE SHADED AREA IMMEDIATELY BELOW HIS NAME.
(3) THE NAMES OF THE LANDLORDS, VENDORS, AND MORTGAGEES ENTITLED TO A SHARE IN THE GRAIN GROWN ON THE LANDS DESCRIBED ARE TO BE SHOWN OPPOSITE A SUFFIX. ADDRESSES FOR THEM ARE TO BE SHOWN IMMEDIATELY BELOW THEIR NAMES IN THE BLUE SHADED AREAS.
(4) ENTER THE DESCRIPTION OF LAND OPERATED BY THE ACTUAL PRODUCER UNDER THE HEADING "LAND OWNED BY EACH PRODUCER". IDENTIFY THE OWNER OF EACH PARCEL OF LAND WITH THE APPROPRIATE SUFFIX IN THE SUFFIX COLUMN.
(5) LAND RENTED ON A CASH BASIS IS TO BE IDENTIFIED BY AN "X" SUFFIX AND THE LANDLORD MUST NOT APPEAR ON THE PERMIT APPLICATION.
(6) INFORMATION RECORDED IN THE "SEEDED" COLUMN, THE "CALCULATION OF ASSIGNABLE" COLUMN, AND THE "QUOTA" COLUMN SHOULD BE CONSISTENT IN EITHER ACRES ONLY OR HECTARES ONLY THROUGHOUT.
(7) ALL INFORMATION WITH RESPECT TO ACRES OR HECTARES MUST BE RECORDED TO THE NEAREST WHOLE NUMBER

[illegible]	[illegible]	[illegible]
WHEAT – HARD RED SPRING	A	A
WHEAT – DURUM	B	B
WHEAT – SOFT WHITE SPRING	C	C
WHEAT – ALBERTA WINTER	D	D
WHEAT – GLENLEA	E	E
WHEAT – OTHER UTILITY TYPES	G	G
OATS	H	H
BARLEY – TWO-ROW	J	J
BARLEY – SIX-ROW	K	K
RYE	L	L
FLAXSEED	M	M
LOW ERUCIC ACID RAPESEED	N	N
OTHER RAPESEED	P	P
MISC. CROPS	R	R
SUMMER FALLOW	S	S
SUB-TOTAL	T	T
PERENNIAL FORAGE	U	U
NEW BREAKING	V	V
UNCULT. LAND & NATURAL PASTURE	W	W
TOTAL FARM	Z	Z

CALCULATION OF 1977-78 ASSIGNABLE ACRES C	CALCULATION OF 1977-78 ASSIGNABLE HECTARES Q
ENTER 1/3 OF SUB-TOTAL (T) ①	ENTER 1/3 OF SUB-TOTAL (T) ①
ENTER PERENNIAL FORAGE (U) ②	ENTER PERENNIAL FORAGE (U) ②
ENTER ① OR ② WHICHEVER IS SMALLER ③	ENTER ① OR ② WHICHEVER IS SMALLER ③
ADD SUB-TOTAL (T) ④	ADD SUB-TOTAL (T) ④
TOTALS ⑤	TOTALS ⑤

[illegible]	[illegible]	[illegible]
WHEAT – HARD RED SPRING	A	A
WHEAT – DURUM	B	B
WHEAT – SOFT WHITE SPRING	C	C
WHEAT – SELECTED SOFT WHITE SPRING	D	D
WHEAT – ALBERTA WINTER	E	E
WHEAT – CONTRACT GLENLEA	F	F
WHEAT – UTILITY TYPES	G	G
OATS	H	H
SELECTED OATS	J	J
BARLEY	K	K
SELECTED BARLEY	L	L
CONTRACT BARLEY	M	M
RYE	P	P
FLAXSEED	U	U
RAPESEED	W	W
TOTAL QUOTA	Z	Z