AN INQUIRY INTO THE BENEFITS AND CONSTRAINTS OF ALFALFA HAY CUBE PRODUCTION: MANITOBA PERSPECTIVES

by

Andreas Dolberg

A Practicum Submitted in Partial Fulfillment
of the Requirements for the Degree,
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ABSTRACT

Incorporating forages such as alfalfa into crop rotations is a means of providing long-term soil conservation benefits to prairie agriculture. Alfalfa production, however, is limited to local demand for forage unless the product is processed into a form conducive to transport. Processing occurs in western Canada at several small facilities which annually produce approximately 300,000 tonnes of pellets and close to 100,000 tonnes of cubes, primarily for export markets. The cubing sector was the focus of this report.

General objectives of the study were to examine the major benefits and constraints associated with alfalfa hay cube production in a Manitoba context and to identify markets for the product. To meet these objectives, related literature was reviewed, farmers growing alfalfa under contract to a cubing plant situated in Minnedosa were interviewed, path analysis and a crop production simulator were employed, and further information was gathered through personal communications.

The results indicated that the importance of crops such as alfalfa for soil conservation was well recognized by the growers, and that changes in their cropping practices stimulated by the cubing plant reflected these attitudes. The difficulties encountered in maintaining a quality product throughout the production process was found to be the most serious constraint facing the industry. In reference to markets, Japan has been and will continue to be the primary outlet for alfalfa cubes, provided that high quality is attained consistently. Domestic markets are limited because of competition from alfalfa hay. Given the uncertainty of future transportation policy, it was further concluded that alfalfa processors must diversify product disposition and that the impact of any change in transportation policy on this industry must be analysed before implementation.

ACKNOWLEDGMENTS

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Chapter I

INTRODUCTION

1.1 OVERVIEW

The production and processing of specialty crops in Manitoba has long been seen as a means of increasing local employment and incomes (Framingham et al., 1979). In processing alfalfa (*Medicago* sp.), there is an added benefit of expanding the proportion of agricultural land in perennial legumes, which can be an effective means of soil conservation.

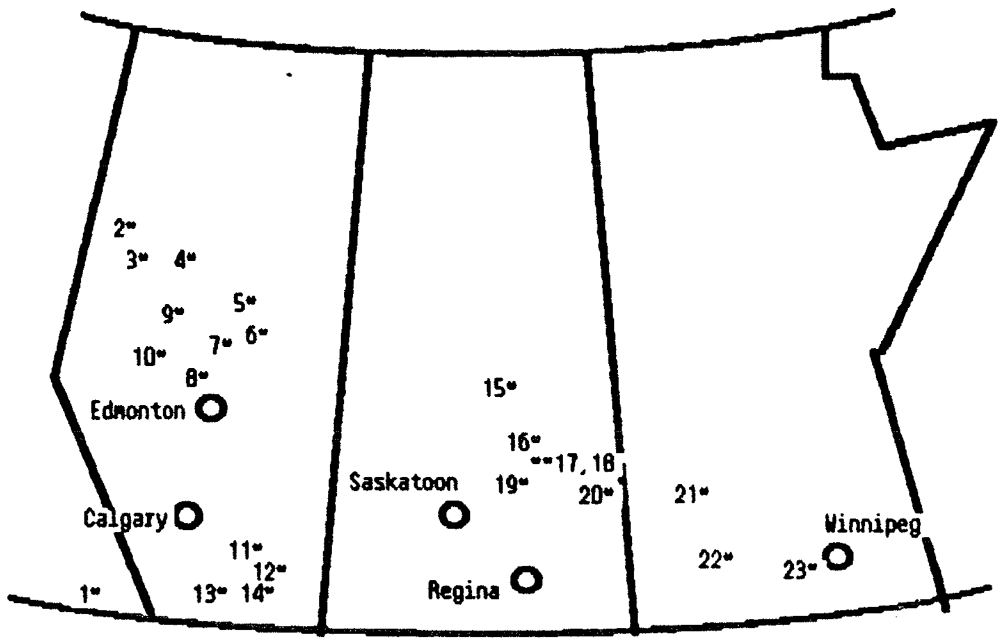
Introducing perennial forages into crop rotations can protect soil from wind and water erosion. In addition to direct erosion prevention, alfalfa can benefit soils by increasing the soil nitrogen reserves and organic matter, improving soil water holding capacity, allowing for ease of tillage, checking salinity problems, and improving internal drainage. Production, however, is limited to local demand unless the product is processed into a form more conducive to transport.

Processing alfalfa was not initiated in western Canada until the the 1960s, but an industry developed quickly. Presently, the alfalfa processing industry consists of several firms located primarily in small rural communities across the prairies (Figure 1). Total direct employment generated by the industry in these communities is estimated at 600 people (Table 1).

Production levels in recent years have reached over 400,000 tonnes annually. The alfalfa products produced are in the form of dehydrated pellets, sun-cured pellets and hay cubes. Hay cubes, presently accounting for less than 25% of total production, are the focus of this report.

Sun-cured alfalfa hay cubes are considerably larger, higher in fibre and generally lower in protein content than pellets. Cubes are approximately 3.5 centimetres square and 5 to 7 centimetres in length. The unique characteristics of cubes allow them to safely supply the total roughage diet of livestock such as dairy cows, beef cattle and horses.

The primary market outlet for alfalfa cubes has been, and will likely continue to be, Japan. The Japanese have increased their meat production 800 percent since 1960, with no significant increase in feed production. Although production has levelled off in recent years, 85-90% of their feed is still imported (Janot, 1985). Other international markets include the E.E.C., Taiwan, Hong Kong, South Korea and the U.S.A. Domestic markets include feedlots, cow-calf producers, dairy farms and horse owners. However, competition from locally produced hay has restricted domestic use of cubes.



1.Creston,B.C.
2.Grimshaw,Ab.
3.Wanham
4.Fahler (2)
5.Boyle
6.Smokey Lake
7.Maillaig
8.Legal
9.Barrhead
10.Mayerthorpe
11.Tilley
12.Rolling Hills *
13.Vauxhall
14.Bow Island *
15.Choiceland,Sk.
16.Aylsham
17.Zenon Park (2)
18.Arborfield
19.Tisdale
20.Hudson Bay
21.Dauphin,Mb.
22.Minnedosa *
23.Fort Whyte

* Cubing Plants

Figure 1: Western Canadian Alfalfa Processing Plants

SOURCE: Canadian Dehydrators Association, 1985.

TABLE 1

1984/85 Alfalfa Plant Employment

	ALBERTA & B.C.	SASK.& MAN.	TOTAL
No. of permanent employees	101.00	58.00	159.00
No. of seasonal employees*	350.00	107.00	457.00
TOTAL EMPLOYMENT	451.00	165.00	616.00
TOTAL PAYROLL(Mill.$)	5.17	3.60	8.77

*seasonal employment from May to Oct.

SOURCE: Stickland, 1985

Prior to 1984, the Crow Rate encouraged production of statutory grain at the expense of other crops, such as alfalfa, by creating a comparatively higher farm-gate payment for statutory grain. The Western Grain Transportation Act (1983) has allowed processed alfalfa to be transported under the reduced rate since January 1984. Consequently, western Canadian hay cube producers have had the opportunity to increase production for the export market.

1.2 PROBLEM STATEMENT

Manitoba Agriculture, recognizing that benefits are associated with the operation of a sun-cured alfalfa cubing plant, required an overall assessment of the activities involved in such an operation. This assessment was to include the cubing process, the product marketability and the effects of a processing plant on production practices of local producers and on the land base.

1.3 RESEARCH OBJECTIVES

General objectives of this study were to examine the major constraints and benefits associated with alfalfa hay cube production and to identify markets for the product. Specifically, these objectives were:

- To outline practices involved in the production of high-quality sun-cured alfalfa cubes, at both primary producer and processor levels.
- To determine the impact of an alfalfa cubing plant on soil conservation in the surrounding area.
- To determine effects of incorporating alfalfa into crop rotations as a cash crop on the primary producer.
- To identify potential domestic and export market outlets for alfalfa hay cubes and outline the constraints to meeting these markets.
- To discuss the overall implications of the industry for the province of Manitoba.

1.4 CLARIFICATION OF TERMS

Several terms used throughout this report should be clearly defined in order to avoid confusion. The following terms are used only in the context outlined:

- "Alfalfa pellets" and "alfalfa meal" are made from finely ground forage and should not be confused with cubes. Alfalfa cubes are used as a source of protein and fibre, whereas pellets and meal are used primarily as a protein source.

- "Dehy" or "Dehydrated" alfalfa has been harvested at 60 to 90 percent moisture and artificially dried for processing.

- "Field chopped" refers to forage which has been dried to at least 35% and harvested with a forage harvester.

- "Forage harvester" is a machine which gathers forage directly from a swath and cuts it into 5 cm. lengths for processing.

- "High-quality" alfalfa cubes contain approximately 15 percent protein, 30 percent fibre, are green in colour, are free of foreign material, are durable and have the desired density (500 kg. per cubic metre).

- "Sun-cured" alfalfa has been preserved by exposure to solar radiation in the field. That is, it has been dried to a moisture level of approximately 15% prior to baling or to at least 35% before being field chopped.

Chapter II
METHODS

2.1 INTRODUCTION

The methods were specifically related to the research objectives outlined in Chapter I. To meet these objectives, the study employed structured interviews of alfalfa producers, a path analysis, a cost of crop production simulation, personal communications and a thorough review of pertinent literature.

2.2 PRODUCER INTERVIEWS

Alfalfa producer interviews were applied as the primary focus of the report and addressed the first three objectives. Data were collected in the spring of 1986 from 25 primary producers growing alfalfa under contract to a cubing plant in Minnedosa, Manitoba (Figure 1). This plant had commenced production during the autumn of 1984. A structured interview schedule (Appendix B) was used in data collection to prevent error associated with open-ended interviews. The schedule was designed to obtain information concerning problems and benefits stemming from cash-crop alfalfa production and to examine the extent and nature of alfalfa production on the individual farms.

2.3 PATH ANALYSIS

Path analysis tests for direct and indirect linkages of cause and effect among the variables of a specified causal model (Asher, 1976). The technique was applied here as a means of addressing the second objective by analyzing some of the variables influencing the extent to which farmers have increased their alfalfa acreage in response to demand from the cubing plant. Related path models analysing agricultural decision-making were presented by Breen (1983) and Napier et al. (1986).

Breen (1983) described the utility of recursive path analysis as being a means of assessing how much of the correlation between an explanatory variable (A) and a dependent variable (B) reflects the causal effect of A on B. A portion of the correlation may be due to a direct effect of A on B and a portion may be due to an indirect effect. The latter is mediated by a third variable, C, such that A is assumed to cause C and C, in turn, to cause B. Another possibility is a spurious effect characterized by both A and B being correlated with the causally prior variable D which, when controlled for, weakens or even removes the association between A and B. The aim of the technique, then, is to decompose the zero-order correlation between two variables of the model into components which disentangle the causal effects in both direct and indirect channels.

The model is described in detail and applied in context of a discussion on soil conservation in the following Chapter.

2.4 CROP PRODUCTION SIMULATION

The cost of production simulator developed by the Department of Agricultural Economics and Farm Management, University of Manitoba (Longmuir et al., 1978) was used to estimate production costs based on the practices employed by the producers interviewed and the guidelines outlined by Manitoba Agriculture (1985a, 1985b, 1986a). The costs of producing and expected returns from flaxseed, feed barley and alfalfa hay are compared for a hypothetical farm in western Manitoba. The results address the third objective and are discussed in Chapter V in light of data secured through the producer interviews.

2.5 PERSONAL OBSERVATION AND COMMUNICATION

Further information concerning all aspects of the study, including alfalfa production and processing, utilization of alfalfa cubes and marketing were obtained from personal communication with several persons directly involved in the industry or appropriate disciplines. Information secured was used throughout the report to supplement other results. Observations were also made by the primary researcher while conducting interviews and when present on site during operation of the Minnedosa cubing plant.

2.6 LITERATURE REVIEW

Considerable research concerning soil conservation and alfalfa production, processing and marketing has been conducted at other universities and institutions. The results of these studies were obtained through correspondence with the appropriate individuals or through library services. This information was used to strengthen results of interviews and to further the analyses conducted in the present study.

Chapter III

THE HISTORICAL BACKGROUND

3.1 INTRODUCTION

Alfalfa, or lucerne, was probably the only forage crop which was cultivated before recorded history and its historical importance was subsequently well documented (see Appendix A). Artificial drying and processing of alfalfa and other forages have undergone important changes since the process was first initiated during the nineteenth century. These developments are presented here in order to bring into focus the present state of the Canadian alfalfa processing industry and, particularly, the hay cube industry.

3.2 EARLY ARTIFICIAL FORAGE DRYING

The idea of artificial crop drying came from western Europe, where natural drying is impeded by the cool, often damp climate. It was not until the nineteenth century, however, that hay and green forage driers were developed.

One of the earliest references to artificial hay drying was given by Denton and Coleman (1869). They described various rather crude driers requiring intensive labour under distressing conditions and which consequently did not become commercially employed. However, these machines did possess the basic principles of artificial drying - the forced ventilation of hay by large volumes of either heated or unheated air.

Hay drying became important in several continental European countries in the early twentieth century. The most common type was a storage dryer which had been initially designed to dry loose unchopped hay and later became modified to accommodate chopped or even baled hay (Nash, 1985). However, these systems were virtually limited to on-farm use, as they required long periods of time to dry relatively small amounts of already partially dried hay.

The principles of drying fresh forage are different to those for drying hay because very hot air is required for the rapid evaporation of plant intracellular water (Nash, 1985). In 1905, the pulp of sugerbeets was being dehydrated in German sugar refineries as a form of food conservation (Oehring, 1973). This process set the stage for the dehydration of beet tops and later fresh grass and grass/legume mixtures utilized for cattle and sheep feed. By the 1930s the construction and installation of hot-air drying equipment was developed so as to facilitate a growing demand for artificially dried livestock forage.

This technology soon spread to other countries. East European countries such as Czechoslovakia, Hungary, Poland

and the German Democratic Republic had developed the industry by the 1950s (Pabis, 1973). Production there changed from the initial chaff form to meal and, most recently, to pellets and briquettes. Similarly, the countries of western Europe, particularly Belgium, the Netherlands, Italy, France, Denmark, Finland and Sweden adopted the industry (Ramburg, 1973; Oehring, 1973). Production was concurrently becoming widespread in the United States of America which had a thriving industry by the 1950s (Arnold, 1978).

3.3 THE CANADIAN PROCESSING INDUSTRY

Sun-cured alfalfa meal was first produced in Canada in the 1930s but artificially dried alfalfa did not come into production until after 1945 (Lindsay, 1984). The early dehydration plants of Ontario used coal-burning tunnel driers similar to driers common in northeastern United States. These were soon replaced by oil-burning rotary driers also of American design which, as it became available, utilized natural gas (Lindsay, 1984). The alfalfa and grass meal produced at these facilities were consumed locally with very limited export development (New, 1985).

In the late 1950s, construction of alfalfa processing plants began in western Canada. Prior to 1969, however, production did not surpass 4 to 10 thousand tonnes of dried alfalfa meal and pellets consumed by local poultry feed manufacturers (Clark, 1973). The following decade marked a rapid expansion in the prairies - peaking in 1978 when 29 plants produced 250,000 tonnes of alfalfa products, primarily pellets.

The end of this rapid growth occurred the following decade. Winterkill of alfalfa was apparently responsible for the loss of four million dollars to the industry in 1981 (McKenzie, 1982). Competition from other feedstuffs and alfalfa products from other countries, primarily the United States and China, and rising energy and transportation costs were also responsible for the decline (New, 1985). Japanese demand had stabilized and anticipated new export and domestic markets had not materialized. Ultimately, several processing plants either shut down completely or reduced their production levels significantly.

More recently, there has once again been an upward trend in the industry. Several events led to a record production level of 360,000 tonnes of alfalfa pellets and cubes during the 1983-84 crop year. Among these events were excellent weather conditions, resulting in outstanding alfalfa yields. Furthermore, the Chinese announced in 1982 that they would no longer export acacia leaf meal, which had been competing with alfalfa pellets. Canadian exports also benefited from favourable international exchange rates (New, 1985).

3.3.1 The Cubing Sector

Early alfalfa cube production did not involve artificial drying or dehydration. Its development was initiated simply to eliminate the problems associated with the storage, transport and feeding of hay.

The concept of cubing alfalfa was first developed in western semi-arid zones of the United States, where the generally dry climate allows alfalfa hay to be harvested direct from the windrow, and made into cubes at 10 percent moisture content, without artificial drying (Nash, 1985). It took several years, however, to develop machines which could produce a consistent product with a density of at least 500 kg./m^3.

The commercial production of alfalfa cubes did not begin until 1960, when the use of field cubing machines began in California (Curley et al., 1973). The first stationary cuber came into production in 1965, and they were common there by the turn of the decade. In the 1970s, technology from the dehydration industry was adapted to produce quality cubes in temperate climates.

The importation of hay cubes into Japan began in 1968 and within four years imports reached 40,000 tonnes, primarily from California, with some coming from Australia (Clark,1973). By 1976, the Americans had more than doubled their exports to 108,000 tonnes, and Australia was no longer in the market (New, 1985). Canada entered the market at that time and, since then, production has been steadily increasing in both the U.S. and Canada.

In Canada, alfalfa cubes have only constituted a very small portion of processed alfalfa production. Alfalfa cubing has been restricted to the western provinces and has become concentrated primarily in southern Alberta. The Manitoba plant, which is the focus of this report, came on stream in late 1984.

Chapter IV
SOIL CONSERVATION

4.1 INTRODUCTION

Since the 1940s, capital intensive, labour-substituting technologies in agriculture have been achieved at the expense of the environment and the natural fertility of many soils (Dumanski et al., 1984). The adoption of more suitable cropping practices such as the inclusion of forages in crop rotations, however, can conserve soil resources and even improve previously degradated soils.

This chapter presents an overview of the problems of soil degradation on the Canadian prairies and focuses on the influence of cropping practices, particularly the impact of forage-based rotations on soil conservation. With this in mind, the extent to which farmers in the Minnedosa area have increased their alfalfa acreage in response to demand from the cubing plant is analyzed. The analysis employs the path model introduced in Chapter 2, the results of which are discussed in light of the soil degradation review and further descriptive results from producer interviews.

4.2 SOIL DEGRADATION

Cropping systems are heavily influenced by agro-economic conditions which dictate what the agricultural sector produces and what production practices are adopted. These practices, in turn, influence the rate at which soil either renews its physical characteristics or, conversely, deteriorates through the effects of wind and water erosion, acidification, salinization, compaction, organic matter and nutrient depletion, or chemical contamination (Senate Standing Committee, 1984; Dumanski et al., 1986).

Dumanski et al. (1986) listed the following factors as giving rise to these various forms of soil quality deterioration in many areas of Canada:

- abandonment of forage-based crop rotations for wide-row monoculture,
- increasing regional specialization of the industry, with livestock farms located ever further from crop farms, leading to reduced regional requirements for forage crops, reduced frequency of forage or small-grains in crop rotations, and reduced use of manure where it is most needed,
- excessive use of summer fallow in the prairie region, leading to a spread of salinity, wind and water erosion, and accelerated loss of organic matter,
- expanding farm size, enlargement of fields, and shifts to more powerful and heavier machinery.

Quantitative estimates of the degree to which the forgoing factors are responsible for soil degradation are limited but, in reference to the prairies, it is generally conceded that they have contributed substantially to salinization, soil erosion, and organic matter and nutrient depletion. These three forms of soil degradation are so severe in the region that the Prairie Farm Rehabilitation Administration (1983) has estimated the present value to the year 2000 of measures to control them at over three billion dollars.

4.2.1 Salinization

Soil salinization takes the form of either primary salinity, which is a natural process, or secondary salinization, which is induced by inappropriate land use. The latter occurs when precipitation in excess of that lost by evapotranspiration drains through the soil, dissolving salts and soluble nutrients. Some of the water then resurfaces in discharge areas where the salts are precipitated and reach levels that inhibit crop growth (Dumanski et al., 1986).

Although secondary salinity has only affected scattered areas of Manitoba, it does account for an added annual input cost of $12 million to Manitoba farmers (Science Council of Canada, 1986). The process is accelerated by cropping practices that do not require as much moisture as indigenous vegetation - summer fallow being the main contributor (Science Council of Canada, 1986). Because there are no crops to utilize soil moisture during fallow years, the practice leads to high water tables and salinization in groundwater discharge areas. Conversely, cropping systems which utilize the excess precipitation, such as those entailing alternating periods of forage crops, can prevent secondary salinization by maintaining a more balanced hydrologic regime (Dumanski et al., 1986).

4.2.2 Soil Erosion

Soil erosion, due to effects of water and wind, is the most widespread soil degradation problem of the prairies. Erosion depletes soil organic matter content and water holding capacity, weakens soil structure and lowers the long-term productivity of the land. Wind erosion is associated with high wind speeds, dry soil conditions and cropping practices which leave the soil unprotected. Similarly, soils are most vulnerable to water erosion in the absence of surface crop residues or a winter cover crop.

In the prairies, the effects of wind can account for erosion of up to 5.6 tonnes of topsoil per hectare annually (Science Council of Canada, 1986), while the effects of water account for approximately half as much soil loss as wind erosion (Prairie Farm Rehabilitation Administration, 1983). The problem is so widespread across the region that the on-farm economic impact has been estimated at 368 to 468 million dollars annually (Table 2). These costs are generally not recognized because increasing fertilizer applications on fields with significant topsoil loss have still resulted in large yield increases (Dyer, 1982).

TABLE 2

Land Affected by Erosion on the Canadian Prairies

	EXTENT OF LAND AFFECTED*		ANNUAL ECONOMIC IMPACT (MILL.$)***	
	AREA (MILL.HA.)	PORTION OF LAND (%)**	LOW ESTIMATE	HIGH ESTIMATE
WATER EROSION	4.64	12.4	155	197
WIND EROSION	6.31	16.6	213	271

* erosion losses >10 t./hect./year.
** based on improved land areas (1981 census).
*** based on inferred yield losses and compensating inputs.

SOURCE: adapted from Dumanski et al., 1986.

Substantial negative off-farm externalities also result from soil erosion. These include air and water pollution, the shortened life of reservoirs due to sedimentation, eutrophication of lakes, and the clogging of roadside ditches and drainage systems (Bentley and Leskiw, 1985). Also, farming practices associated with soil erosion often result in the destruction of wildlife habitat (Sopuck, 1984).

The primary cause of soil erosion on the prairies, summer fallowing, has long been a major source of contention throughout the region. In western Manitoba, most soil erosion was found to have occurred under a two crop-fallow system (Jenkins, 1968; 1969). Despite vast reductions of summer fallowed acreages throughout the province in recent years, the practice still occurs on approximately 400,000 hectares of improved farmland each year (Manitoba Agriculture, 1985c). Furthermore, summer fallowing tends to occur most frequently on light soils, thereby compounding susceptibility to erosion in these areas.

Though wind erosion is most severe on soils that are summer fallowed, many cropped fields are also affected in the spring before seedlings can get properly established. In the spring of 1985, for example, many prairie farmers were forced to reseed entire fields after the initial crop had been blown out by wind storms (Science Council of Canada, 1986). Similarly, water erosion is most serious in the early spring if snowmelt occurs rapidly on partially thawed soil (Dumanski et al., 1986).

Recent advances in the practices of conservation tillage, zero-tillage and the production of fall-sown crops such as winter wheat have to a large extent impeded wind and water erosion during the spring (Poor, 1987). However, their occurrence is still far from widespread in Manitoba. Coupling these practices with the periodic inclusion of legume forage crops could potentially hold soil erosion to a minimum and ensure a high degree of long-term sustainability in agricultural production (Bentley and Leskiw, 1985).

4.2.3 Organic Matter and Nutrient Depletion

Organic matter and associated biota are essential for well-aggregated soil structure and are important as a source of nitrogen and other nutrients. Levels in prairie soils, however, are now only 50-60 percent of levels in 1900 (Figure 2). This depletion, a direct result of inappropriate cropping practices, causes the soil to be highly susceptible to compaction, accelerated erosion and reduced fertility (Dumanski et al., 1986).

Most cropping systems across the prairies, with the exception of some conservation tillage systems, are consistently depleting soil organic matter and nitrogen levels (Dyer, 1982). Where summer fallowing occurs regularly in crop rotation, there is less crop residue available for the soil and decomposition of organic matter is accelerated even further. Consequently, soil infiltration of precipitation is reduced which, in turn, accelerates water erosion due to runoff and contributes to wetness in low lying areas and to a reduction of soil moisture on higher parts of fields (Bentley and Leskiw, 1985). Also, losses of nitrogen by denitrification and leaching are greater on fallowed than on cropped fields.

The forgoing discussion clearly implies that the problems of soil degradation are complexly interrelated and are a direct result of inappropriate agricultural production

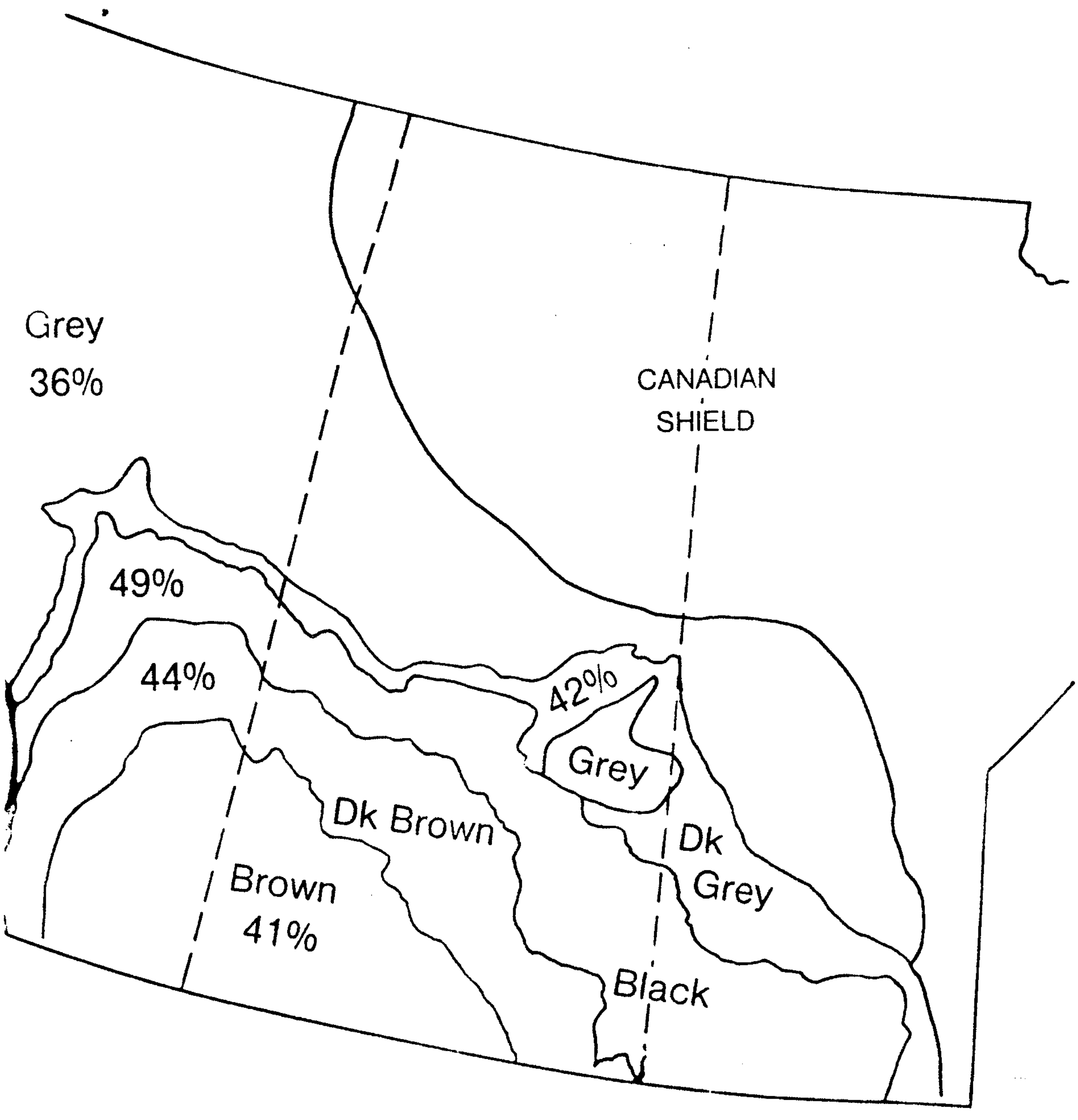


Figure 2: Organic Matter Losses in Prairie Soils

Source: Bentley and Leskiw, 1985.

practices. Given that numerous authors (Dyer, 1982; Papendick and Elliott, 1984; Bentley and Leskiw, 1985) have cited forage-based rotations as being the ideal cropping system for arable lands, a discussion of the potential of this practice to impede further degradation and to rebuild degraded areas is appropriate.

4.3 FORAGE-BASED ROTATIONS

Cropping systems which entail alternating periods of forage crops, preferably including or consisting of a perennial legume, will minimize soil erosion while contributing to the maintenance of soil fertility and to the favourable physical properties of soils (Bentley and Leskiw, 1985). Literature dealing with this question is briefly reviewed here.

Forage-based or forage legume-based rotations prevent soil degradation in two main ways (Stewart et al., 1976):

- soil loss during the forage sequence is negligible after establishment because of the characteristic dense vegetative cover and extensive rooting system;
- when the sod or legume is broken out, the residual effects improve infiltration of precipitation and leave the soil less vulnerable to erosion for several years.

In reference to the latter point, the residual effect of legume forage in reducing soil loss, even under conventional tillage, is evident for 2 to 3 years (Papendick and Elliott, 1984). This effect is primarily a consequence of the extensive root system which, in dry matter weight, is 5,108 kg/ha in an alfalfa field and only 765 kg/ha in wheat (Ripley et al., 1981). Under conservation tillage, the beneficial effects of the forage are extended over a greater time period - keeping soil loss at a minimum for more than 3 years after forage is produced (Papendick and Elliott, 1984).

It must be noted here that alfalfa and other forages are not a panacea to soil degradation problems on the prairies. The deep root system of alfalfa can, in fact, remove much of the subsoil water and cause a loss for the following grain crop in a dry year (Papendick and Elliott, 1984). Water is a severely limiting factor to successful alfalfa production in western Manitoba (Dunlop and Shaykewich, 1984). Since about 25 percent of prairie precipitation comes in the form of snow, alfalfa-based rotations must be coupled with effective snow management. For example, leaving strips of alfalfa on the second cut will trap snow for the subsequent crop, particularly if the spring thaw is not too rapid. In the long-term, increases in soil organic matter from alfalfa will facilitate soil infiltration and holding capacity of spring thaw and precipitation in the form of rain. Clearly, making greater use of available moisture is imperative to maximizing the utility of alfalfa in rotations (Fairbairn, 1984).

Studies from Manitoba evaluating the effectiveness of rotations in terms of soil conservation are limited. Langman (1983), however, described site specific selection of crops for erosion control on given soil and slope conditions in the soil survey of Westbourne, Manitoba (Figure 3). The example plotted illustrates the substantial reduction in erosion susceptibility under forages as opposed to a two crop-fallow system or even continuous cropping of annual grains. Unfortunately, site specific erosion hazard information, which could be used to make effective crop rotation decisions, is not as yet available across the province.

In the U.S., studies evaluating the effectiveness of cropping practices have gone beyond the effects of erosion alone. Crowder et al. (1985) employed the CREAMS (Chemicals, Runoff and Erosion from Agricultural Management Systems) model to estimate soil and chemical losses under various tillage practices and crop rotations. Two years of corn followed by 3 years of alfalfa was the most effective rotation for controlling all runoff losses. Continuous corn, the other extreme, showed substantial soil and chemical losses which could, to a large extent, be controlled by conservation or zero-tillage. Reduced tillage practices, however, could not control pesticide losses. The authors stressed that techniques used to evaluate the effectiveness of management practices should not be limited

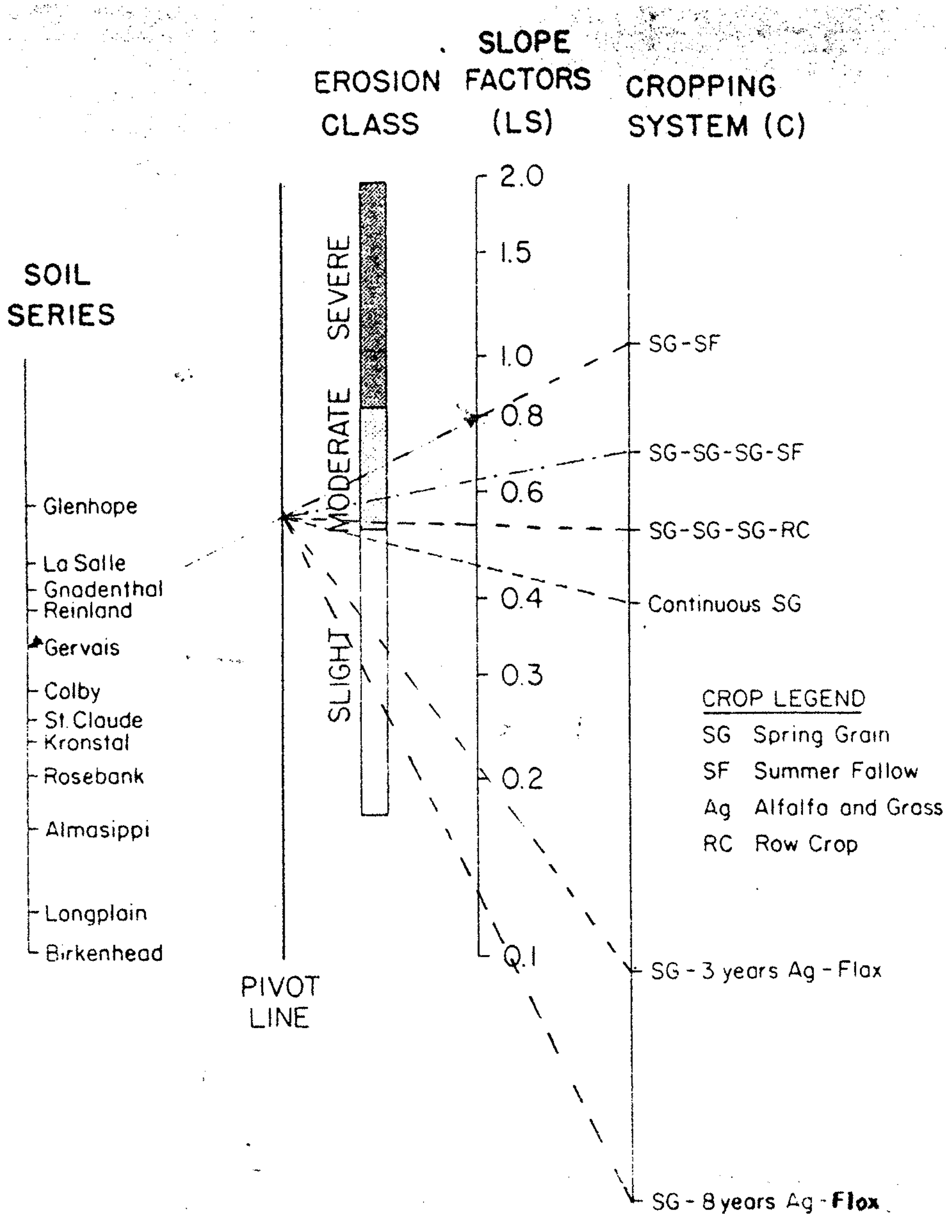


Figure 3: Monograph for Selection of Crops for Erosion Control

SOURCE: Langman, 1983.

to soil erosion but, rather, must consider all elements of field loss including nitrogen, phosphorous and pesticides.

Although forage legumes grown in rotation can reduce chemical and soil runoff, some researchers have shown that they still cannot provide sufficient nitrogen for succeeding nonlegume grain crops (Heichel and Barnes, 1984). Voss and Shrader (1984), on the other hand, found that it is possible for alfalfa to provide all of the nitrogen for the following corn crop and for that corn to outyield heavily fertilized continuous corn. Clearly, the variation in soil types and climatic factors affect the efficiency of nitrogen fixation and use by subsequent crops. In Manitoba, while alfalfa alone cannot eliminate inorganic nitrogen requirements for optimum yields of succeeding nonlegume crops, two or more crops can benefit substantially from the increased soil nitrogen reserves (Baily, 1983). Given these benefits, the long-term use of legume rotations could certainly have buffered the seriously low soil nitrogen levels reported throughout the province in 1986 (Manitoba Agriculture, 1986b).

Perennial legumes such as alfalfa do not provide a simple solution to the soil degradation problems of the prairies. However, if incorporated into crop rotations with careful attention to natural limitations, particularly water, alfalfa can be an effective means of conserving soil resources.

4.4 A PATH MODEL

Forage-based rotations are environmentally desirable cropping systems, but production is restricted because market outlets for forage are inaccessable in many areas (Bentley and Leskiw, 1985). In the Minnedosa area, however, farmers have sown land into alfalfa in response to demand from the cubing plant. A path model was developed to assess the direct and indirect relationships of some of the factors influencing farmers' management decisions with the extent to which they have sown their land into alfalfa. The methodology of path analysis was introduced in Chapter II.

The two dependent variables selected for examination were termed as follows:

- PERCENT ALFALFA (Y1) - the percentage of the total productive acres in each farm which has been sown into alfalfa,
- ACRES ALFALFA (Y2) - the number of acres each farm has sown into alfalfa.

The four explanatory variables selected for examination were termed as follows:

- TOTAL ACRES (X1) - the number of productive acres presently utilized on each farm,
- SOIL CAPABILITY (X2) - a description of the landscape according to its inherent capacity for sustained production as classified by the Lands Directorate (1974). The classification ranges from class 1 soils which have no limitations to crop production to class 7 soils which are incapable of crop production. Each farm was given a value within this range by weighting the respective proportions of each capability classification on the land sown to alfalfa. For

example, the most common classification, $2T^{7}6W^{3}$ was given a value of 2(.7) + 6(.3) = 3.2,

- OUTPUT PER ACRE (X3) - the estimated gross income of each farm divided by the respective number of productive acres,
- DISTANCE TO PLANT (X4) - the approximate distance in miles to the cubing plant in Minnedosa.

Using the above variables, an interactive path model (Figure 4) was developed to assess the relationships of each explanatory variable with both of the dependent variables as well as the hypothesised relationships among the explanatory variables.

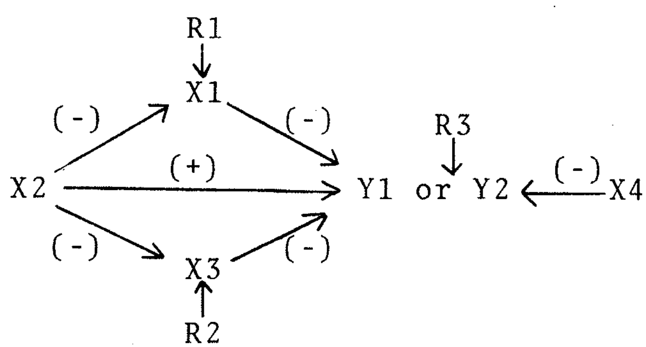


Figure 4: Illustration of the Path Diagram

It was assumed that the soil capability scale (X2; incremental to defective characteristics) would contribute negatively to both total productive acres (X1) and gross output per acre (X3). The latter relationship is of a purely physical nature - that is, soils with few restrictions (lower X2 value) should be capable of producing higher yields. In reference to the former relationship, it was argued that farming larger acreages necessitates certain types of farm technologies requiring immoderate capital investments which are often infeasible for farms located on heavily restricted soils. The positive relationship between X2 and the dependent variables was assumed to be a direct result of the farmer's decision to put more alfalfa into soils which are less productive and generally more susceptible to wind and water erosion. In fact, Jenkins (1968; 1969) found that in western Manitoba class 4-5 soils have eroded to a greater extent than class 2-3 soils.

It was also assumed that the dependent variables are affected negatively by X1, X3 and X4. Specifically, the larger farms should be less likely to adopt alfalfa production because they tend to be more 'locked into' their present practices by high machinery investments. Farmers with a high output per acre may also be less inclined to risk changing their technology and management practices, whereas those with a lower output may try to increase their output by incorporating alfalfa into present crop rotations. It was further assumed that farms situated far from the plant are less likely to grow large acreages because of the added expense and risk of selling the crop in future years.

The path model postulates that X2 should operate indirectly through X1 and X3 to positively influence the dependent variables. It was assumed that linear relationships existed among the variables, that the explanatory variables were the most important in explaining Y1 and Y2, and that all others are the 'residual' (R1, R2, & R3) or 'error' components of the equation. To obtain estimates of the path coefficients, X3 and X1 were regressed on X2 using the SAS 'REG' procedure (SAS, 1982; see Appendix C). Similarly, Y1 and Y2 were regressed on all the explanatory variables.

4.5 PATH ANALYSIS RESULTS

4.5.1 Correlation Coefficients

Table 3 shows the correlation coefficients of the variables used in the model. These correlations revealed several important points concerning the path analytic model.

First, none of the explanatory variables correlated significantly (at the .10 level) with the dependent Y2 variable, and only X2 correlated positively at the .50 level. These weak associations are not overly surprising as the explanatory variables were chosen on the basis of how they influence the decision-making of farmers. Producer decisions are made within the constraints of the resources at hand, therefore the decisions as to which crops will be grown will influence the proportion of the given land base rather than the total amount.

TABLE 3

Correlation Coefficients (Prob>|R|)

	X1	X2	X3	X4
Y1	-.561 (.0036)	-.362 (.0750)	-.110 (.6019)	-.066 (.7557)
Y2	-.096 (.6486)	.189 (.3650)	-.040 (.8483)	.053 (.8026)
X1	-	-.360 (.0773)	-.023 (.9150)	-.042 (.8437)
X2	-	-	-.466 (.0189)	.355 (.0817)
X3	-	-	-	-.210 (.3140)

Only X1 and X2 correlated significantly with the Y1 dependent variable at the .05 and .10 levels, respectively. The expected negative correlation with X1 indicated that as farm size increased, farmers were less likely to seed a large portion of their land into alfalfa. The X2 relationship showed that farmers have taken into serious consideration the type of soil they are seeding alfalfa into. The insignificant and weak association with X3 is somewhat surprising. Gross output was not a major contributing factor in the decision-making process; which may imply that the perceived rate of return from alfalfa is comparable with alternative crops.

The associations among the explanatory variables are also of interest. Expected correlations were the observed negative X2:X1 and X2:X3 relationships. The less productive soils obviously cause a lower gross output per acre and also seem to account for a restriction on the total number of acres managed per farm. The strong X2:X4 relationship was not expected but, interestingly, it implies that producers in the near proximity of the plant seem more inclined to grow alfalfa regardless of soil type; whereas producers on the periphery of the area are more likely to be producing alfalfa on lighter soils. The weak association between X1 and X3 is likely due to a combination of antagonizing factors such as 'economies of scale' enjoyed by larger farms and intensity of production by the smaller ones.

4.5.2 Regression Analysis

Regression analysis was used to determine the relative importance of the explanatory variables in the path model. The variance of the dependent variables was regressed on the explanatory variables in the model.

The only variable which proved significant at the .05 level in reducing the unexplained variance in the Y1 variable was X1. As the total number of acres per farm increased, there was a concomitant decrease in the percentage of the productive acres sown to alfalfa. X2 and X4 were significant only to the .50 level and X3 was not statistically significant. The explanatory variables accounted for 37.3 percent of the variance in the Y1 variable.

Regressing the variance in the total productive acres variable against X2 proved to be significant at the .10 level and indicated that 13 percent of the variance in X1 was explained by soil capability. Similarly, soil capability explained 21.7 percent of the variance in the output per acre variable at a .05 level of significance. These findings were as postulated.

Soil capability was the only variable which reached a .50 significance level when the variance in total alfalfa acreage was regressed against the explanatory variables. This model was consequently not analyzed further as the results would be inconclusive. However, it is interesting to note that soil capability did at least to some extent directly explain the variance in total alfalfa acreage.

4.5.3 Path Analysis

Path analysis was applied to the data in order to determine the relative importance of indirect effects on the percentage of productive acres that farmers have sown into alfalfa. In Figure 5, the path coefficients have been added to the diagram.

Soil capability can be traced through to the dependent variable via either X1 or X3. However, the X3:Y1 path coefficient (-.053) was not significant. Therefore, regardless of the finding that soil capability explained

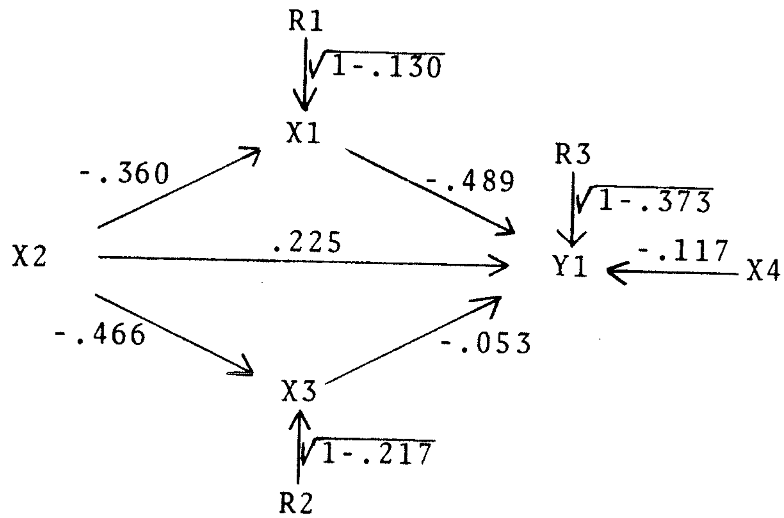


Figure 5: Presentation of Path Coefficients

21.7% of the variance in X3, this indirect path through X3 was not considered. Even if the former coefficient had reached significance, it still would have resulted in a rather low indirect effect (-.466 x -.053 = .025) of X2 on the dependent variable.

The most important result of the path model was the strong indirect effect of X2 on Y1 through the total productive acres variable. The negative X2:X1 and X1:Y1 path coefficients, respectively -.360 and -.489, result in a positive indirect effect of X2 on Y1 (-.360 x -.489 = .176). Therefore, the total observed direct and indirect effects of soil capability on the percentage of productive acres farmers have sown into alfalfa was .401 (.225 + .176).

4.6 THE IMPACT ON SOIL CONSERVATION

The forgoing results demonstrated that an interaction of the variables affected the percentage of land individual farmers have sown into alfalfa (Y1). In light of these findings and further data obtained from farmer interviews, the impact on soil conservation in the local area surrounding the Minnedosa, Manitoba alfalfa cubing facility is discussed.

A high Y1 value is perceived here as having a strong potential impact on soil conservation. This was pointed out in Section 4.3 by demonstrating that alfalfa incorporated into crop rotations is an effective way of conserving soil resources.

The fact that the larger farms were less likely to incorporate alfalfa into a large percentage of land is likely an indication of immoderate capital investments associated with current production practices. However, during the interviews several of these farmers had indicated that they were still being cautious and hoped to produce more alfalfa in the future. The farmer with the largest acreage, for example, had a 70 acre contract and hoped to expand that to 500 acres, "giving me about a quarter of the land in alfalfa (at any one time), which would be ideal for crop rotations". It is therefore quite premature to conclude that the farmers of large acreages are less likely to expand their relative alfalfa acreages but, rather, that they require a longer time period than those who farm fewer acres. Conversely, Napier et al. (1986) concluded that as the number of acres usually farmed increased, there was a decrease in the perceived importance of conservation issues in the adoption decision-making process - a factor which may or may not be playing a role in this case.

Soil capability (X2) had by far the strongest direct causal relationship with the percentage of land sown to alfalfa. As pointed out previously, the more restricted land classes of the area showed the most severe soil erosion. The direct X2:Y1 relationship convincingly shows that farmers have weighted the importance of soil management when making crop production decisions. These assertions were confirmed in the reasons given by farmers for having decided to produce alfalfa (Appendix F). No fewer than 21 of the 25 farmers interviewed made mention that alfalfa was good for the land, added organic matter and nitrogen, or that it prevented soil erosion; and 12 of these growers cited either soil improvement or erosion prevention as their primary reason for going into alfalfa production.

The third direct effect analysed in the model, gross output per acre (X3), did not play a significant role in determining the amount of land farmers seeded into alfalfa. It seems, then, that returns are at least comparable with those from alternative crops, which was no doubt an important incentive required to initially adopt the practice. In fact, when asked to compare net returns from alfalfa and alternative crops, 14 farmers perceived alfalfa returns as higher, 4 estimated equal returns and none perceived net returns from alfalfa as lower. Similarly, Bentley and Leskiw (1985) ranked high costs and uncertain returns as the most critical factor impeding farmers from implementing soil conservation practices. While economic incentive is required for the decision to grow alfalfa, it is evident here that other factors - particularly soil conservation issues - were more important in influencing the decision of how much land to put into alfalfa.

The model also demonstrated that farm size was negatively influenced by soil capability; that is, smaller farms were likely to be located on poorer soils. This translated into a further positive influence of soil capability on land seeded to alfalfa. The X2:X3 relationship is the most important outcome of the path analysis, inasmuch as it suggests that soil conservation concerns have indirectly, as well as directly, influenced the extent to which farmers decided to produce alfalfa on their farms.

The above finding was also confirmed during the interviews. It was primarily the farmers of smaller acreages who intended to have, or already had, alfalfa as their major crop (Appendix D). These were all of the mixed farms and 5 of the cereal/cash crop farms. The operators of these farms adapted much quicker to the new market outlet and, also, perceived the crop as a means of improving long-term productivity of the land. Their intended crop rotations were to keep alfalfa as the major crop for as long as it stayed productive, breaking it up every 5-6 years to have a grain crop and then re-establish alfalfa.

In general, the described rotations had alfalfa incorporated as a secondary crop. Alfalfa had been seeded into one of several fields, often "in a field that erodes badly" or "in the hilly country to stop runoff". Alfalfa was seen as a crop to be slowly worked into cereal/oilseed crop rotations. Most importantly, several farmers specifically referred to incorporating alfalfa into their rotations in place of summer fallow.

The replacement of summer fallow acreage by alfalfa is also evident from observing the overall change in cropping practices by the interviewed farmers between 1983 and 1986 (Figure 6). The 1986 acreage had a substantial increase in alfalfa with a concomitant decrease in summer fallow and annual crops. Figure 5 also demonstrates that alfalfa produced for the plant has not come from existing alfalfa production but, rather, from farmers who have made a decision to grow alfalfa under contract to the plant. In fact, the majority of the respondents have been farming for over 20 years, but have only recently been active in forage production (Table 4; Appendix G).

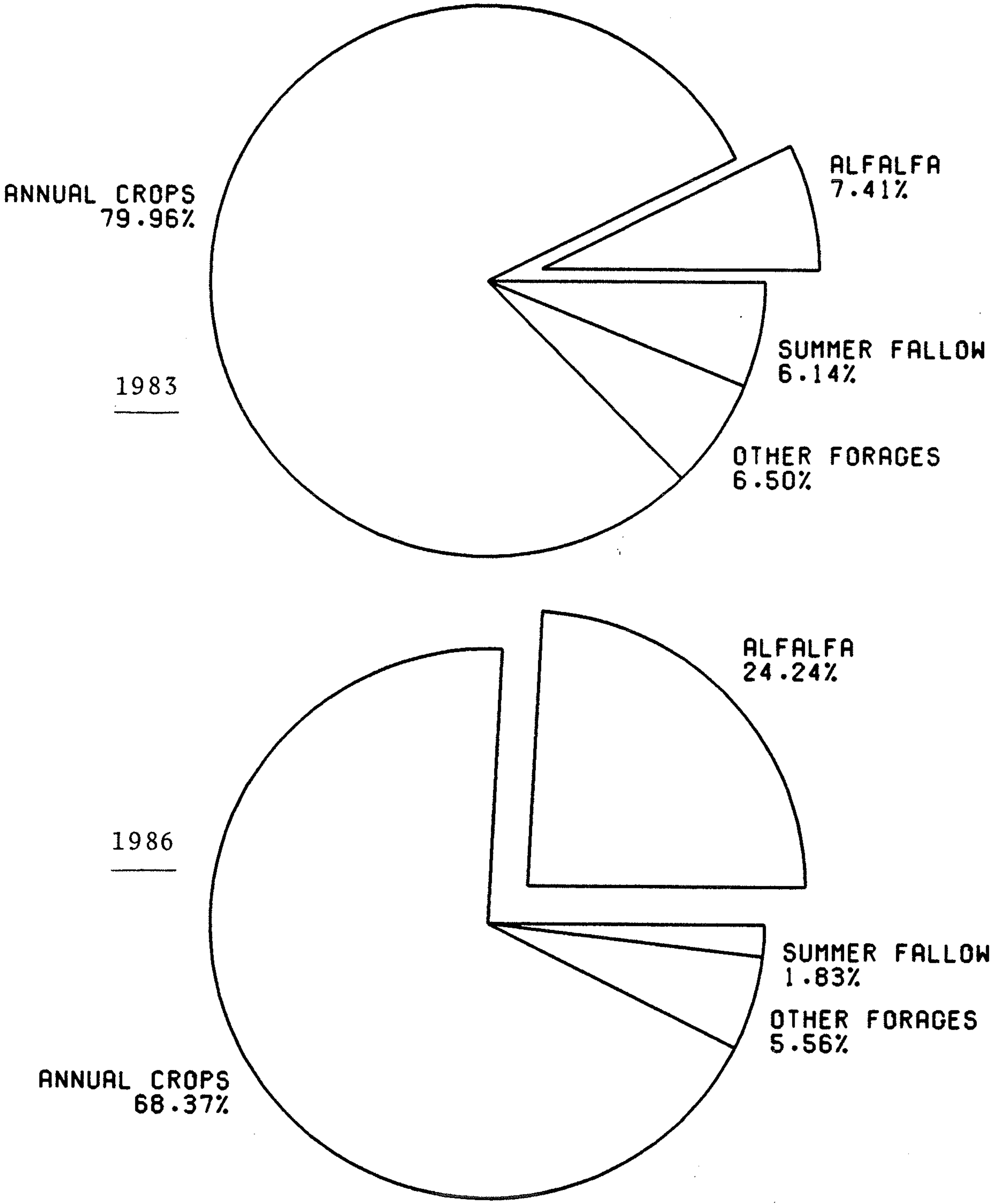


Figure 6: Crop Production on Land Farmed by Respondents

TABLE 4

Farming Experience of Respondents

YEARS EXPERIENCE	NUMBER OF RESPONDENTS	
	FARMING	FORAGE PRODUCTION
1-5	1	11
6-10	4	4
11-20	7	4
more than 20	13	6

Chapter V
ALFALFA PRODUCTION AND PROCESSING

5.1 INTRODUCTION

Potential benefits of cash-crop alfalfa production to farmers are not restricted to soil improvement and prevention of erosion but, also, improved cash-flow and possibly increased incomes. In order to optimize economic returns, however, alfalfa must produce good yields and the product must meet the quality standards of the processing plant.

The activities involved in the initial production through to processing are diagrammatically shown in Figure 7. Details of production practices (Appendix E) - particularly those dealing with quality problems - that alfalfa producers in the Minnedosa area have been following are outlined in this Chapter. Secondly, the crop production simulator introduced in Chapter II was employed to compare costs of production and expected returns of alfalfa and other frequently grown crops (Appendix H). Lastly, the activities involved in cubing sun-cured alfalfa are briefly discussed.

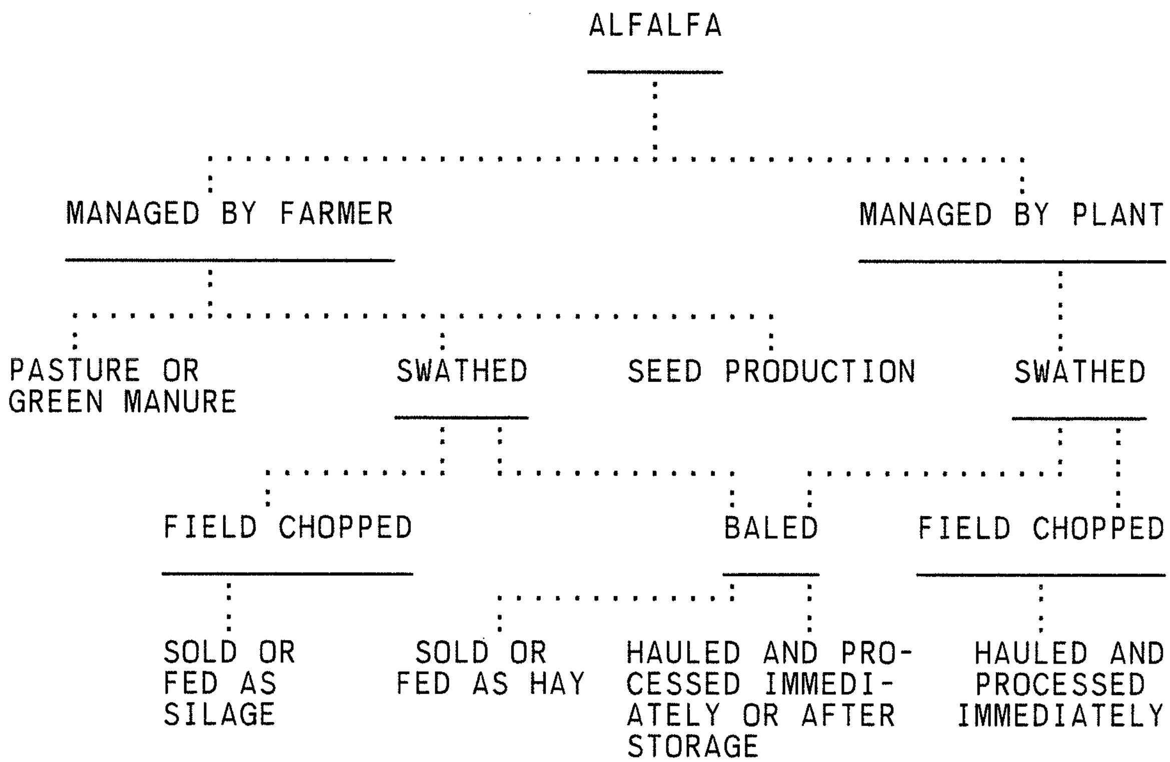


Figure 7: Alfalfa Production Alternatives

5.2 ALFALFA PRODUCTION

Alfalfa and other forages are probably the most poorly managed crops in Canada (Bates and Wilkins, 1986). In Minnedosa, McFarland (pers. comm.) has similarly pointed to a high incidence of low quality hay as being the single most important limiting factor to the production of satisfactory hay cubes in a temperate climate. It is, therefore, imperative that alfalfa management practices and associated quality problems are reviewed here in some detail.

Several varieties, or cultivars, of alfalfa can be grown successfully under Manitoba conditions (Table 5). For use in the production of processed cubes, a variety with good regrowth potential should be used (Clark, 1978). Clark (pers. comm.) also suggested that a selection of both early and later maturing varieties should be considered in order to stagger the harvesting schedule.

Good alfalfa crops can be produced on all soils in the province except organic soils, poorly drained soils, very coarse-textured soils and highly acidic soils (Baily, 1983b). The plant will tolerate moderate salinity during germination and, once established, will tolerate relatively high salt levels.

Alfalfa seed should always be inoculated with an appropriate strain of Rhizobium bacteria immediately before seeding. The bacteria infect the root hairs to form nodules, where nitrogen fixation occurs. Due to this symbiotic relationship, application of nitrogen fertilizer is not required (Baily, 1983b). Other fertilizers, however, are generally recommended. Annual application of phosphorous should be applied on most soil types. Potassium is generally required on coarse textured sands and sandy loam soils, and sulphur is often deficient in well drained sandy soils and the grey luvisols (Baily, 1983b). Baily also pointed out that high yielding alfalfa uses considerably more nutrients, including nitrogen, phosphorous, sulphur and potassium, than cereal crops. This large removal of nutrients makes it essential to annually monitor specific

TABLE 5

Alfalfa Varieties in Manitoba

VARIETY (1./)	WINTER HARDINESS (2./)	BACTERIA WILT RESISTANCE (3./)	RECOVERY AFTER HARVEST	SPRING MATURING
Algonquin (V)	H	R	average	medium
Anchor (F)	MH	R	rapid	early
Angus (F)	MH	VR	rapid	early
Appolo (FV)	MH	VR	rapid	early
Banner (FV)	MH	MR	rapid	early
Beaver (V)	H	VR	rapid	medium
Chimo	MH	MR	rapid	early
Pickstar (V)	H	VR	average	early
Rangelander (V)	VH	S	slow	early
Thor (F)	MH	R	rapid	early
Vernal (V)	H	R	average	early
Vista (F)	MH	MR	rapid	early

1./ V=Variegated; F=Flemish
Medicago media *M. sativa*

2./ VH=very hardy; H=hardy; MH=moderately hardy

3./ VR=very resistant; R=resistant;
MR=moderately resistant; S=susceptible

SOURCE: adapted from Manitoba Agriculture, 1984, 1985a.

crop requirements through soil and/or plant analysis in order to maintain yields and stand longevity.

These recommendations are in sharp contrast to practices followed by the alfalfa growers interviewed. Only five growers were fertilizing on established fields - three with 11-51-0 fertilizer alone, one with both 11-51-0 and sulphate, and one grower had applied sulphate alone on a single occasion. Twelve growers had fertilized their fields on the year of establishment; generally with 11-51-0 alone or supplemented with nitrogen. One grower had used cattle manure in the autumn prior to establishment and one had applied nitrogen alone. The remaining respondents used no fertilizer. Most importantly, potassium, which increases winter survival, had not been applied by any of the growers - with the exception of one who had applied cattle manure.

5.2.1 Winterkill

Winterkill can be one of the most devastating factors affecting alfalfa producers in cold climates (McKenzie, 1982). To minimize winterkill losses, producers must understand the importance of winter food reserves in alfalfa roots and how cutting management can influence the accumulation of these reserves. Plants entering the winter with low food reserves have a high potential for winterkill (McKenzie, 1982). Food reserves will be depleted by cutting during the critical period, which is from mid August to the first killing frost in Manitoba (Baily, 1983b). Generally favourable growing conditions during this period serve to promote regrowth at the expense of food reserves that would otherwise be used for maintenance during the winter dormant period (Figure 8). McKenzie outlined a number of management recommendations which should be considered in order to minimize winterkill losses. Paraphrased, these are listed below.

- Seed a percentage of the total alfalfa acreage every year to avoid having too much land in old stands, which are most susceptible to winterkill. First-year stands rarely winterkill and will provide for good production during years in which portions of old stands have been winterkilled.

- Use only certified seed of recommended varieties.

- Seed both hardy slow regrowth varieties and less hardy rapid regrowth varieties. Theoretically, this should minimize the losses during stressful years and maximize production during good years.

- Avoid cutting during the critical period (Figure 8). If this practice cannot be avoided, the older stands should be harvested as they are generally most expendable. Also, fields that are in the bloom stage should be considered before those in the bud stage.

- An attempt should be made to identify winterkilled fields early, in order to develop an alternative plan. MacKenzie suggested that if there is concern about winterkill in a particular field, samples can be dug, potted and grown indoors to assess plant vigour and survival.

- Good soil fertility should always be maintained. Potassium, particularly, increases the carbohydrate accumulation in the alfalfa root (Baily, 1983c).

Only twelve of the fields managed by the farmers interviewed were reported to have been harvested twice in

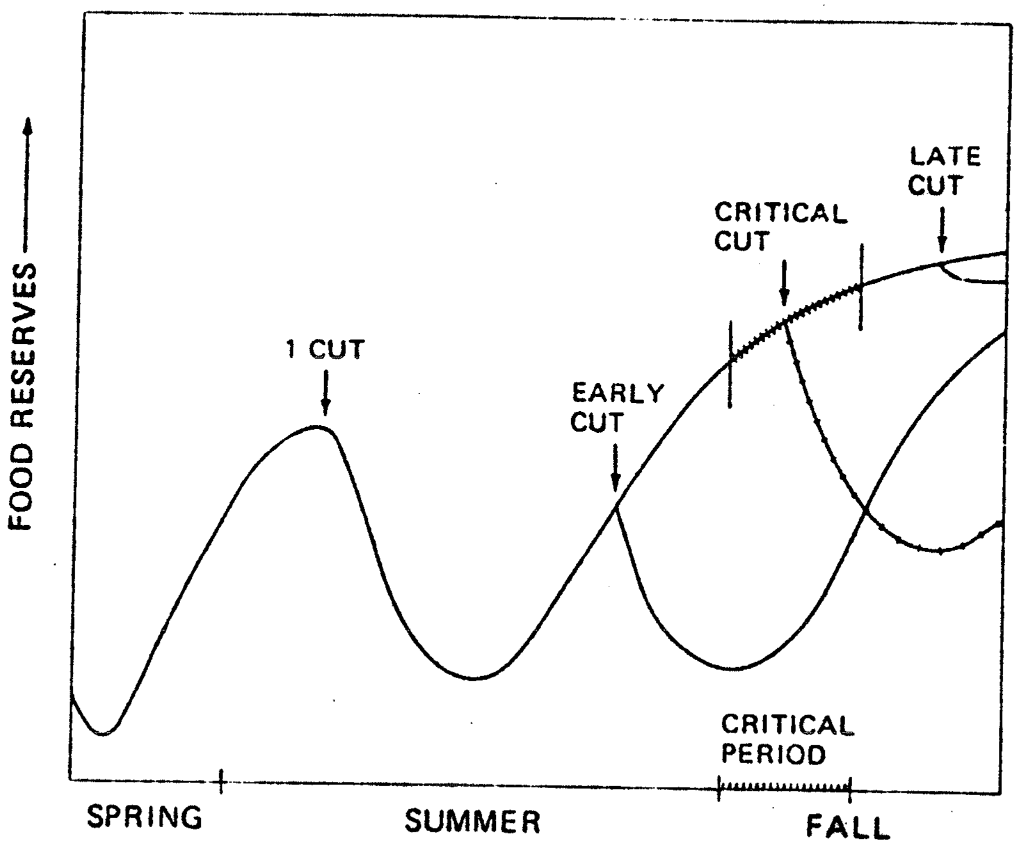


Figure 8: Food Reserves in Alfalfa Roots
SOURCE: McKenzie, 1982.

one season. The second cut on nine of these fields occurred during the critical period and only three fields were harvested either before or after this period. However, only two producers acknowledged that winterkill had been a problem, implying that it is probably not a major concern among these growers. It is important to realize that cutting during the critical period can sometimes not be avoided because of the very short season and frequent ideal drying conditions at that time.

5.2.2 Quality Problems

In 1985, production problems leading to various forms of hay quality deterioration resulted in the rejection of approximately 900 tonnes of contracted hay produced by the interviewed growers. Figure 9 shows relative proportions of contracted hay that were either sold to the plant or rejected for various reasons. The most common reason for hay being rejected by the plant was contamination of alfalfa by weeds or grass. This occurrence, particularly the inclusion of annual weeds, was most common on newly established fields and producers did not foresee it as being a problem in subsequent years. However, four growers opined that quackgrass (*Agropyron repens*) was a serious problem requiring cultivation of at least portions of fields. Because weed control in established alfalfa is virtually impossible, it is essential that only relatively clean fields be considered for the crop.

The timing of harvesting and the procedures used are important in obtaining a quality product. After the late-bud to early-bloom stage, protein and TDN levels decline, the leaf-to-stem ratio decreases, and stems become more brittle and less digestible (Kehr and Ogden, 1978; Lang, 1985). Early cutting is therefore essential in maximizing the nutritional value of the crop. Of the fields managed by the growers interviewed, 21 were harvested at or before the 10% bloom stage and 27 were harvested at a more mature stage.

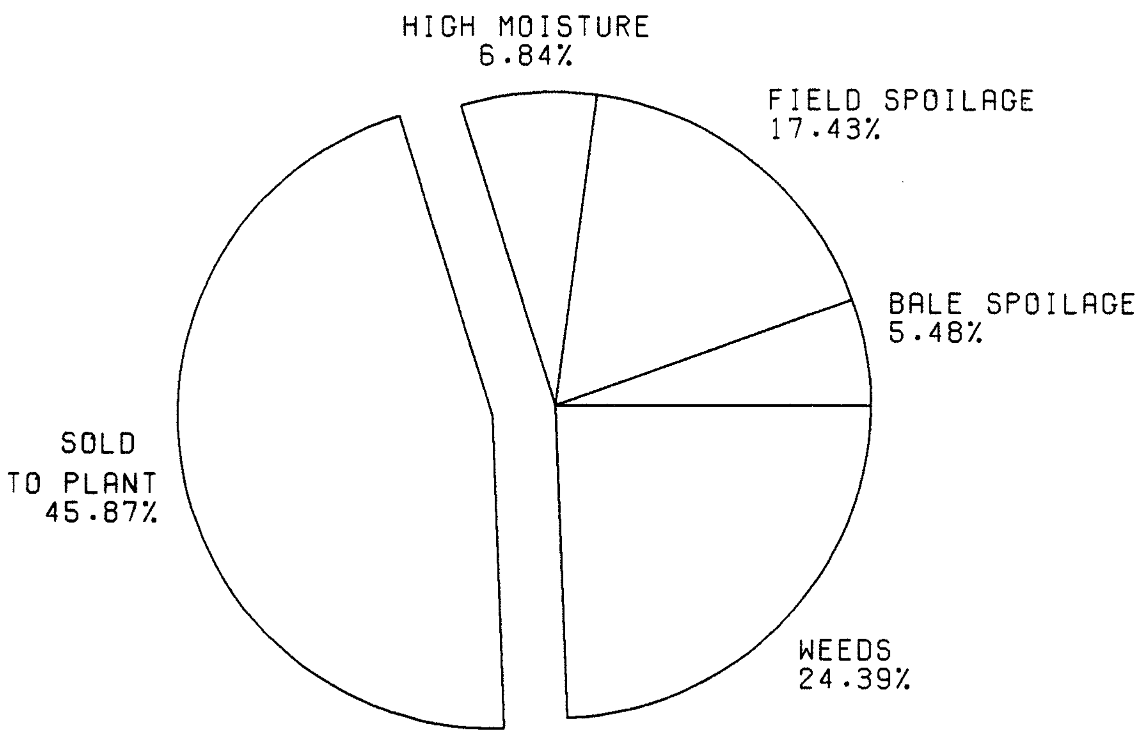


Figure 9: Quality Problems in Contracted Hay

However, of the respondents' hay production in 1985 (Figure 9), none was rejected by the cubing plant as a result of advanced maturity. Though the hay from this stage is used for cubing, the end product is of lower quality.

The decision of when to cut must take into account predicted weather conditions to avoid costly field losses, which is why harvesting dates are often pushed back to stages of advanced maturity. Dry matter losses during harvesting of sun-cured alfalfa can exceed 50 percent of the original crop (Livingston et al., 1978) and nutrient losses due to respiration and leaching can be considerably higher (Blagoveshenskey et al., 1978). Increasing the rate of drying has the effect of minimizing these losses by reducing the risk of adverse weather conditions during the field curing process.

The variable factors involved in drying alfalfa forage in the field are external factors and material factors. The former include air temperature, wind speed, air humidity, field surface wetness and solar radiation; the latter include the absorbency of solar radiation, diffusion resistance of the material to water loss and the material temperature (Ajibola et. al., 1978). Obviously, most of these factors can only be controlled by the important decision of timing the cutting operation in accordance with expected environmental conditions.

The mower-conditioner can increase the drying rate by mechanically crushing or splitting the stems, thereby speeding up the transfer of moisture from the plant material to the atmosphere (Feldman, 1978). This is a critical operation because, without conditioning, the leaves dry much faster than the stems and tend to fall off. Since leaves contain most of the plant nutrients, substantial field losses and quality deterioration can occur without conditioning, even under ideal weather conditions. Still, eight of the interviewed growers had not used a conditioner.

Even with the use of mower conditioners, the time-lapse between cutting and baling alfalfa crops was frequently more than six days. Since weather patterns are impossible to predict with 100% accuracy, this extended drying time results in a high risk of quality deterioration and is likely the most serious constraint facing the production of any sun-cured alfalfa products. Frequent rains during the 1985 harvesting season caused considerable swath quality deterioration and resulted in the rejection of over 270 tonnes of contracted hay (Figure 9). The cubing plant attempted to rectify this problem in 1986 by field chopping swathed alfalfa at moisture levels as high as 35% and immediately processing it (McFarland, pers. comm.). However, this practice is only possible on fields within the immediate vicinity of the plant.

By far the majority of the crop processed at the plant is still harvested with large round balers. Friesen (1977) found that, under Manitoba conditions, large round balers require fewer man hours and cost considerably less to operate than other haying systems. These balers were also found to have doubled, or even tripled, harvesting rates compared to conventional systems, thereby reducing the risk of effects of adverse weather. Unfortunatly, the management practices associated with the packaging of large round bales often seem to neglect the importance of quality (Campbell, pers. comm.). Hay is on occasion baled at a high moisture content because of the relative ease at which it is possible to do so. Nine respondents of this study had used moisture tester and found that baling with a moisture level exceeding 15% caused heating and spoilage of bales and, consequently, the hay was rejected by the plant.

Neglecting the importance of quality has similar detrimental effects during the period after baling. Belyea et al. (1985) determined dry matter (DM) losses of large round bales associated with the following storage methods (Figure 10):

- in a shed,
- outside in single rows and uncovered,
- outside in two-high stacks and covered,
- outside in three-high stacks and covered.

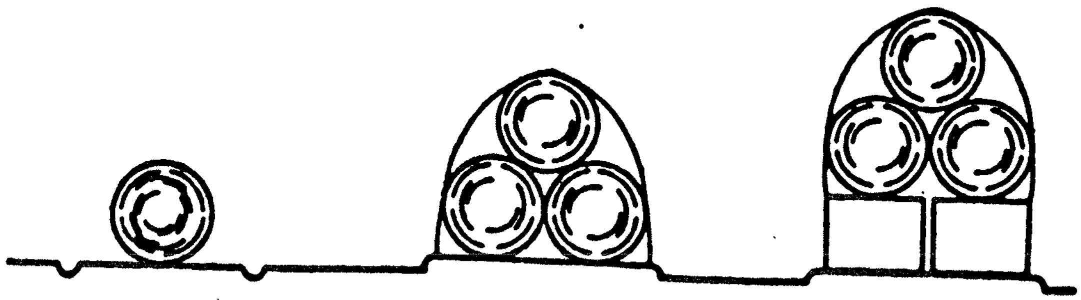


Figure 10: Covering Large Round Bales
SOURCE: Belyea et al., 1985.

Losses of DM during storage were 2% for bales stored inside, 6% for those stored outside with cover and 15% for outside uncovered bales. Other researchers (Nelson et al., In Belyea et al., 1985) found these losses to be 4%, 13% and 25%, respectively. However, storage DM losses are only a reflection of a portion of the total losses when bales are either used for processing or fed directly to livestock. In the Belyea et al. (1985) study, rain had penetrated 10 to 25 cm into uncovered bales, causing severe deterioration in quality of 40% of the original bale dry weight. Losses such as these were held to a minimum if bales were either covered or placed in a storage shed immediately after baling.

None of the respondents from the present study had used a hay shed or any form of tarpaulin for protecting bales from weathering and consequently had a total of 95 tonnes rejected by the plant (Figure 9). This figure only represents a small portion of the actual spoilage because, as in the study described above, rain had penetrated many bales which consequently required the removal of 10 to 30 cm of the outer surface prior to cubing (McFarland, pers. comm.). In order to minimize bale spoilage, the cubing plant provided a premium to producers who used either tarpaulins or a hay shed for storage during the 1986 season. The importance of proper storage cannot be overemphasised because approximately 8,000 tonnes of first cut hay is held over on farms for winter cubing (McFarland, pers. comm.).

It is apparent that the quality problems described above must be kept at a minimum if alfalfa production is to be profitable and if cubes are to be marketable. The latter topic is discussed in ensuing Chapters and the former is presented in the following section.

5.3 COSTS OF PRODUCTION

Chapter III showed that soil conservation issues play an important role in a farmer's decision-making process concerning how much land to seed into cash-crop alfalfa. However, if returns from alfalfa relative to other crops are significantly lower, alfalfa will be dropped from a farmer's production plans. This section employs a crop production simulator to compare the net return from alfalfa as opposed to other frequently grown crops in 1986. The crops' costs of production simulator was introduced in Chapter II. The costs of producing and expected returns from flaxseed, feed barley and alfalfa hay are compared for a hypothetical farm in western Manitoba.

Results of the analysis (Appendix H) show that alfalfa can yield a better return to management than feed barley, but not flaxseed. It was assumed that half of the hay crop (80 acres) was from an established field and the other half was seeded without a nurse crop in the analysed year. Returns from alfalfa are not such that a farmer already involved in grain production will switch entirely to alfalfa but, rather, will tend to incorporate the crop into existing rotations - as shown in the present study.

It could be argued that alfalfa is only competitive presently because of generally depressed grain and oilseed prices. However, an analysis of net returns over a five year period similarly showed that alfalfa hay can compete with barley, but that returns from flaxseed were higher (Figure 11). Prices used to calculate production values from 1982 to 1985 were those reported by Manitoba Agriculture (1985). Assumed yields were 45 bushels/acre, 20 bushels/acre and 2 tons/acre for barley, flaxseed, and alfalfa, respectively. Production practices were assumed to be similar to those used in the 1986 analysis, while costs of production, programed in the crop production simulator, reflected the conditions of each year.

Interestingly, the majority of the farmers interviewed who had sold alfalfa under contract perceived the net return from the crop as higher than commonly grown crops. Fourteen respondents replied that alfalfa had a higher net return, four reported equal returns and one respondent estimated that net returns from barley and other crops were higher. Similarly, in reference to the effect of selling alfalfa on cash-flow, the majority of the respondents (13) found that cash-flow either had improved or they expected it to improve. The most commonly cited reasons for improved cash-flow were lower cash input in spring, earlier return and a relatively low capital investment. Of the four respondents who acknowledged that alfalfa had weakened their cash-flow, all had quality problems and, as a result, were unable to market alfalfa through the plant.

Only five respondents had made capital investments as a result of their decision to produce alfalfa. These ranged from a $1,000 front-end loader to a $13,000 mower-conditioner. Alfalfa cubing is a new industry to the area and few producers are willing to take a great risk. In fact, several respondents acknowledged that they intended to delay any investment into hay production equipment until the plant was more established.

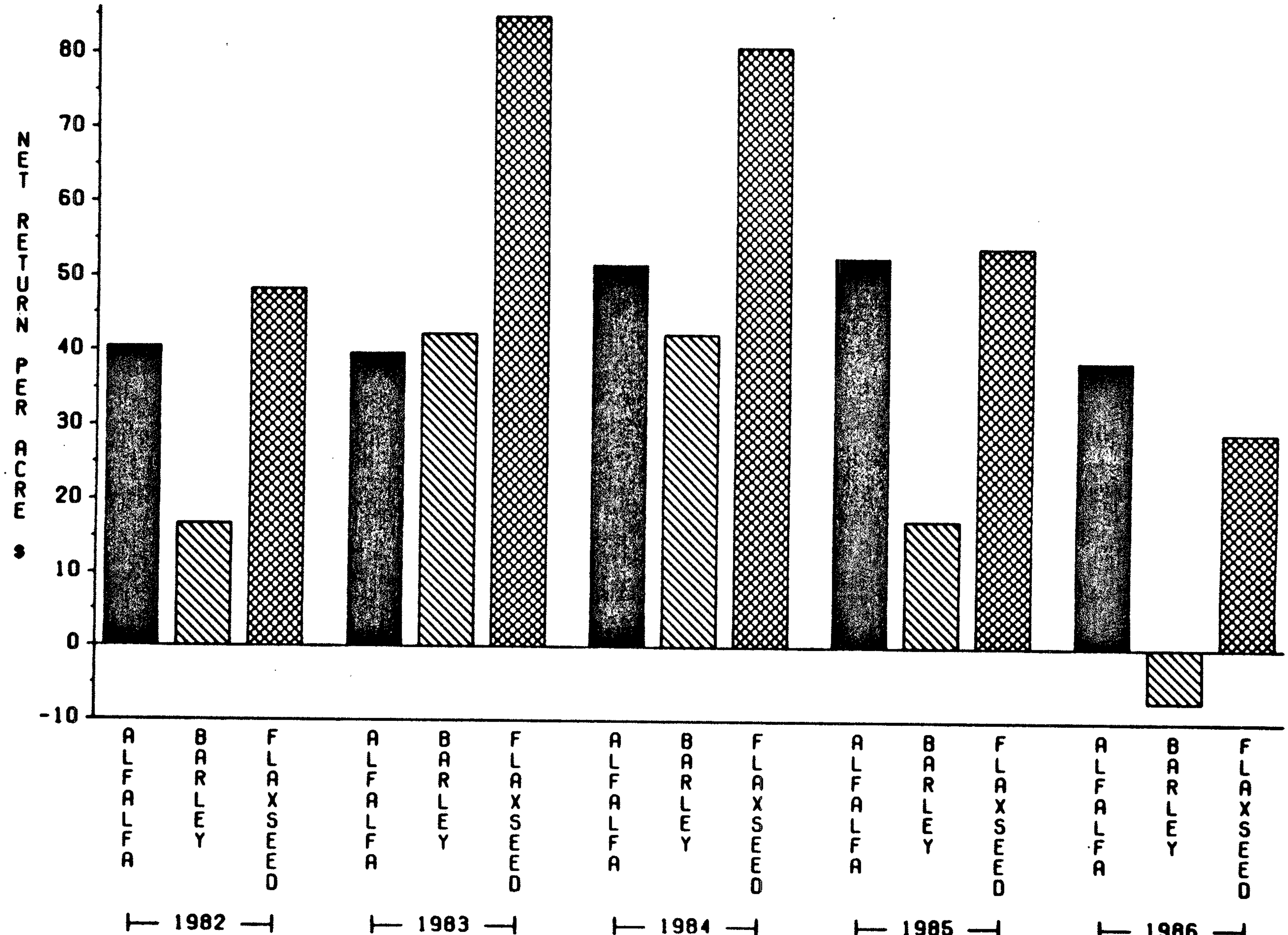


Figure 11: Net Returns from Barley, Flaxseed and Alfalfa

One such investment which should at least be considered by all producers is a hay shed. For the above hypothetical example, storage requirements for 218 tonnes (240 tons) of large round bales would be an approximate $10,000 investment (Goodon, pers. comm.). Amortized over a period of twenty years, this would translate into an annual cost of $1,174. Given that the cubing plant pays a $7.00/tonne premium for covered hay, the annual savings would be $1.62/tonne. This relatively low return would likely be substantially higher for hay sold on the open market because, as demonstrated in the previous section, leaving hay uncovered can result in severe deterioration in quality of up to 40% of the original bale dry weight. Bates and Wilkins (1986) similarly showed a $5.50/tonne annual saving from storing large round bales in a shed as opposed to leaving them uncovered.

The economics of alfalfa production are comparable to other commonly grown crops in the Minnedosa area, but only if the problem of quality deterioration can be overcome. Further benefits associated with soil improvement (Chapter IV) were not covered in this brief analysis but, as previously indicated, were considered in the decision-making process of producers.

5.4 ALFALFA CUBING PROCESS

Packaging alfalfa into cubes is simply a means of reducing the cost and inconvenience of handling the product by making it into a form which is compatible with bulk handling methods. The process involved, and some of the problems associated with it, are briefly reviewed here.

Figure 7 shows that either field chopped or baled alfalfa is processed immediately or baled hay is stored and then processed. The baled hay, at a maximum moisture content of 15%, is placed into a tub grinder at the cubing plant. The coarsely chopped alfalfa is fed from there into a rotary drum drier where the material is continuously raised and dropped into a gas stream generated by a natural gas furnace. During drying, alfalfa moisture diffuses to the surface of particles as fast as it evaporates from the surface until it reaches a uniform 8% moisture level. Field chopped alfalfa, at moisture contents ranging from 15-35%, is directly fed to the rotary drum where it is similarly dried to a uniform level of 8%. This low moisture level is required to produce high density and durability in cubes (British Columbia Agriculture, 1974).

The dried alfalfa passes from the drier into a cyclone where it is separated from the moisture laden gases. A binding agent is added here to a maximum level of 1% if it is required to ensure physical quality. Upon leaving the cyclone, moisture is added to release the natural adhesives in the forage, and to lubricate the dies of the cuber. A metering bin automatically feeds the dies and the product emerges from them in the form of cubes. The final stage of the process is for cubes to pass through a forced air cooler to prevent deterioration during storage.

A common problem among many alfalfa processing plants has been the emissions of dust particles, primarily from the drying operation period. Smith (1980) argued that the key to keeping this problem in check is proper maintenance and operational procedures of the equipment. The knives of the field chopper and tub grinder must be regularly maintained and adjusted to assure a clean, sharp cut with minimum frayed fibre ends. Also, there should be a continuous even feed of material into the drum, the plant should not be run at excessive capacity and temperature control systems must be continually adjusted. Most importantly, the initial hay quality (i.e. maturity and foreign material content) should be of the highest standard to prevent dust emissions.

Alfalfa quality also influences resilience of the material under compression and ultimate bulk density of the end-product. Mature forage, with a low leaf-to-stem ratio, will result in cubes with poor durablity (Marchant and Shepperson, 1973). Similarly, as little as 10% by weight of grass in alfalfa can cause a substantial reduction in the physical quality of cubes (Dobie, 1975). Dobie suggested, however, that grass hay can be used to form good quality cubes, but only with the addition of a binding agent such as ammonium lignin sulphonate at a minimum level of 5-7%.

In Minnedosa, as with any sun-cured alfalfa processing facility located in a temperate climate, the year consists of both a summer and winter processing season. The "winter quality" cubes are generally of lower quality than those produced in the summer. The importance of proper storage methods has already been discussed in some detail but should be emphasised here because, without a quality winter supply, the plant is totally dependent on the short summer season for a return on investment. If adequate supplies of quality hay, approximately 8,000 tonnes, are attainable, the winter processing period can extend through to the month of March (McFarland, pers. comm.).

Chapter VI

UTILIZATION, MARKETING AND TRANSPORTATION

6.1 INTRODUCTION

The crucial importance of quality control throughout the production process of alfalfa cubes was clearly demonstrated in the preceding chapters. Without this emphasis, the product will not meet the standards of the ultimate users and, consequently, market penetration will not be achieved. The present Chapter reviews the utilization of alfalfa hay cubes and later addresses the issue of market potential and concerns in transportation.

6.2 LIVESTOCK FEEDING

Studies demonstrating the utility of alfalfa cubes, in terms of mechanized handling and nutrition, are briefly reviewed here. Emphasis is placed on livestock ideally suited to the utilization of cubes; namely, cattle and horses. Cubes can meet the total roughage requirements of these animals, which are traditionally fulfilled by hay or silage.

The essential difference in handling and feeding cubes, as opposed to hay, is that cubes can be handled as a semifluid somewhat similar to grain (Baily et al., 1974). The ease of transportation and handling of cubes is associated with their high bulk density (Table 6). Although Baily et al. (1974) determined the costs of, and described six different feeder systems for, cubes, there is little evidence concerning the efficiency of these systems. A comparison of cube feeding systems and conventional hay systems is required to determine their relative efficiency.

Sun-cured alfalfa is a source of not only protein, fat, fibre, calcium and phosphorous but, also, it contains numerous trace minerals (Table 7). In addition, a nutrient profile should have values for the major amino acids, have energy values and vitamin levels (Dorman, 1985). This is not as important for cubes as for other alfalfa products such as pellets because the former are generally not used in feed formulations. However, the nutrient profile is still invaluable when cubes are used as roughage, particularly when used for lactating dairy cattle, because a feed concentrate will be required in addition to cubes.

The present system of determining alfalfa cube quality and assigning a grade is almost entirely based on visual evaluation. Generally, a relatively intense green colour will bring a high grade. The Minnedosa plant presently has an 'A-B-C' grading system, 'A' being an intense green colour and 'C' being more towards a brown colour (McFarland, pers. comm.). A more accurate system could be developed by

TABLE 6

Physical Characteristics of Alfalfa Cubes and Hay.

CHARACTERISTIC	CUBES	HAY
1-Bulk Density	420 kg./cubic metre	150 kg./cubic metre
2-Storage Facilities	2.4 cubic metres/tonne	5.7 cubic metres/tonne
3-Handling	Usually fully mechanized: front end loader, side delivery wagons, belt or drag conveyors.	Can be machine piled or transported. Hand feeding is often required.
4-Convenience	Can be formulated into a complete feed.	Must be chopped or ground and mixed with concentrate to give a complete ration.
5-Wastage	Virtually nil.	From little to considerable, dependent upon the construction of the feeder and the quality of hay.
6-Transportation	Much less costly than hay, being about three times as dense.	Impossible for volume reasons to get the load which by weight limitations a truck can handle.

SOURCE: Baily et. al., 1974.

TABLE 7

Nutrient Analysis of Dried Alfalfa

Moisture (%)	8.00
Crude Protein (%)	15.00
Crude Fat (%)	2.50
Crude Fibre (%)	30.00
Calcium (%)	.90
Phos Total (%)	.23
Phos Available (%)	.18
Potassium (%)	2.30
Sodiun (%)	.07
Chloride (%)	.45
Magnesium (%)	26.00
Sulfur (%)	.17
Tot.Digest.Energy,Rumin. (%)	54.40
L-Lysine (%)	1.00
Methionine (%)	.20
Threonine (%)	.68
Tryptophan (%)	.40
Xanthophylls (ppm)	175.00
Vitamin K (ppm)	9.90
Niacin (ppm)	41.90
Beta-carotene (ppm)	102.10
Riboflavin (ppm)	10.61
Thiamine (ppm)	3.00
Pyridoxine (ppm)	6.50
Pantothinic Acid (ppm)	20.91
Folic Acid (ppm)	1.54
Choline (ppm)	1,550.00
Proline betane (ppm)	6,060.00
Copper (ppm)	8.60
Zinc (ppm)	19.00
Iron (ppm)	356.00
Cobalt (ppm)	.34
Manganese (ppm)	27.00
Iodine (ppm)	.12
Selenium (ppm)	.50

SOURCE: adapted from Baily, 1974; Dorman, 1985; and Wolff, 1982.

estimating digestable dry matter intake from an acid detergent fibre (ADF) test (Wolff, 1982) and such a system could be facilitated through the Feed Analysis Section of Manitoba Agriculture. In Alberta, however, where the majority of Canadian cube production occurs, there exists a 3-grade system similar to that used by the Manitoba plant (Schroeder, 1985). Whether any real advantages would be gained from adopting a more costly grading system is questionable because pure alfalfa cubes with a deep green colour will consistently have high nutrient levels.

6.2.1 Dairy Cattle

The dairy industry is by far the most important user of alfalfa cubes. Utility of the product lies in the high fibre content - cubes can safely supply total protein and roughage requirements of dairy cows. Conversely, finely ground forage, such as alfalfa meal and pellets, will depress milk fat in lactating cows, cause feed refusals and disrupt digestability (Van Es and Van Der Honig, 1973).

Feeding alfalfa cubes as opposed to hay of similar quality, can improve yield, fat content and protein content of milk, primarily because of increased daily dry matter intake (Oohara, 1978). In British Columbia, alfalfa cubes are commonly fed along with corn silage. However, when cows are given free choice in selecting the two products, there is a marked difference among cows in the level of cube consumption to the point where it cannot be assumed that requirements for protein are met (Fisher and Shelford, 1978; Shelford and Fisher, 1978). Fisher and Shelford found that adding cubes to corn before ensilage resulted in higher milk fat test, greater efficiency of dry matter conversion and increased digestablity, as compared to adding cubes to silage at feeding time.

Because the highest quality forage must be used to maximize milk production, cubes lend themselves well to this industry. As long as quality standards are met at the processing level, the dairy producer is assured the highest standards. Still, no Manitoba dairy producers are presently feeding alfalfa cubes on a continuous basis - the obvious constraint being higher costs than alfalfa hay.

6.2.2 Beef Cattle

Although the potential of alfalfa cubes in the dairy industry has long been recognized, it is only recently that the beef sector has begun to utilize the product. This lag has occurred because the beef industry generally does not require the high quality forage necessary for successful milk production. However, cow-calf producers have recently begun using alfalfa cubes in the United States to increase beta-carotene levels, as low levels have been associated with decreased fertility in cattle (Poe, 1982). The cows' diets are supplemented with alfalfa cubes in early spring when grass is lowest in beta-carotene and when the highest levels are required for fertility. Cubes are also commonly fed directly to feed lot cattle.

6.2.3 Horses

The discussion of historical developments in Appendix A illustrated a long and important association between alfalfa and horse feeding. In fact, alfalfa is an excellent source of protein, minerals (particularly calcium) and most essential vitamins in horse diets (Hintz et al., 1978). As in dairy rations, horses require a high-quality source of roughage - most importantly, roughage must be entirly dust free. Alfalfa cubes lend themselves well to this requirement and, in addition, are ideal for hobby horse owners because of storage, handling and feeding convenience.

6.2.4 Other Livestock

Most other domestic livestock could potentially have alfalfa cubes incorporated into their diets. However, with the exception of rations for ruminants such as sheep and goats, alfalfa cubes would usually require regrinding before they could become a component of rations. This added expense makes the practical utilization of cubes in most feeds unlikely.

Even if cubes are reground to produce alfalfa meal, the product is not a suitable feedstuff for use at high dietary levels by most nonruminants. Cheeke (1978) suggested that properties of alfalfa which conspire to limit its value in nonruminant diets are high fibre content, low protein digestability, the presence of saponins and phenolic compounds, and low palatability. Exceptions are the rabbit and gestating sow, which can have up to 60% of their diet in the form of alfalfa without reduced palatability (Cheeke, 1978; Harris et al., 1984). Feeding the whole alfalfa cube would be possible only for rabbits but, would still result in considerable waste (Cheeke, pers. comm.). Cheeke noted, however, that adding other components when the alfalfa is being cubed could possibly result in an acceptable complete feed for rabbits.

6.3 MARKET CONSIDERATIONS

Because alfalfa cubes are generally valued more for their fibre content than for protein, they do not compete directly with other protein sources and they have few substitutes in areas of intense livestock production and limited forage production. The cubing process essentially makes it possible to supply such areas with high-quality forage from areas with good production potential. There is, however, considerable market competition from other high fibre sources such as baled hay domestically and grass cubes, dried beet pulp and rice straw in some international markets. Nevertheless, alfalfa cubes are in general considered to be of superior quality.

6.3.1 Export Markets

Exports of Canadian alfalfa products have been fluctuating over the last few years, but are presently approximately 40% higher than in the 1979-80 crop year (Table 8). Over the years, exports have represented close to 70% of total pellet and cube production (Table 9).

Japan, which imports 85-90% of its total feed requirements (Janot, 1985), is by far the largest market outlet for Canadian processed alfalfa. The country imported a record 302,104 tonnes from Canada in the 1985-86 crop year (Table 8), or over 90% of total Canadian alfalfa exports. This marketing success can be primarily attributed to negotiations and competitive pricing of alfalfa pellets by central organizations such as the Alfalfa Group (TAG), KAPT-AL and NEPCAN (New, 1985). These marketing agencies are supported by western Canadian pelleting plants and are responsible for handling the export marketing functions of these plants.

Cubes, on the other hand, are generally contracted directly to Japanese buyers by Canadian cubing plants. Three southern Alberta plants, Tirol, Rolling Hills and Bow

TABLE 8

Canadian Processed Alfalfa Exports

COUNTRY	1979-80*	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86
			Tonnes				
Japan	210,298	148,188	137,270	208,668	280,425	276,497	302,104
E.E.C.	18,678	1,942	14,163	36	6,893	47	-
U.S.A.	1,557	2,145	5,393	6,425	5,060	4,092	12,466
Taiwan	-	9,506	1,386	24	2,817	6,174	8,224
Hong Kong	1,232	1,466	945	509	88	280	-
others	269	155	69	26	271	199	161
TOTAL	232,034	163,402	159,226	215,688	295,554	287,288	322,955
PRICE($/Tonne)	120	110	142	170	178	166	161

* June 1 to May 31

SOURCE: Alberta Agriculture, 1985; 1986.

TABLE 9

Alfalfa Pellet and Cube Production

	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	estimate 1986-87
			tonnes					
PELLETS								
Manitoba and B.C.	21,000	26,000	23,000	16,000	19,000	25,000	18,000	22,000
Alberta	151,000	115,000	86,000	84,000	146,000	166,000	88,000	150,000
Saskatchewan	122,000	92,000	120,000	103,000	137,000	160,000	193,000	112,000
Eastern Canada	29,000	40,000	35,000	38,000	35,000	30,000	26,000	25,000
Total Pellets	323,000	273,000	264,000	242,000	335,000	381,000	325,000	312,000
CUBES								
Western Provinces	38,000	27,000	43,000	55,000	58,000	65,000	85,000	101,000
TOTAL PROCESSED	361,000	300,000	307,000	289,000	392,000	446,000	410,000	422,000

SOURCE: Alberta Agriculture, 1985; 1986.

Island, together produce about 80% of cubes marketed from western Canada, with the balance coming from Manitoba and British Columbia (Alberta Agriculture, 1986). Similar to the pellet situation, the majority of cube production is exported to Japan. Recent increases in the Japanese cube imports (Figure 12) were mainly owing to an increase in direct feeding of cubes to beef and dairy cattle. Also, per capita consumption of beef continues to rise with a concomitant increase in the requirements for alfalfa cubes (Alberta Agriculture, 1985). Figure 12 represents virtually all hay cube imports into the country, with an annual 500 tonnes coming from other sources.

It appears obvious from the level of Japanese imports that cube demand is being met by American, rather than Canadian sources (Figure 12). Though the United States has been displaced as the major supplier of pellets, it is still by far the major supplier of cubes. It should be noted here that Baily et al. (1974) estimated the costs of alfalfa production and cubing to be approximately 25% higher in California, which produces the majority of U.S. cubes, than is the case in western Canada. Canadian producers, therefore, still have an opportunity to increase their market share through competitive pricing and negotiations with Japanese buyers. Gaining only 25% of the present U.S. market share would translate into an additional 100,000 tonnes/year market for Canadian producers, or a 200%

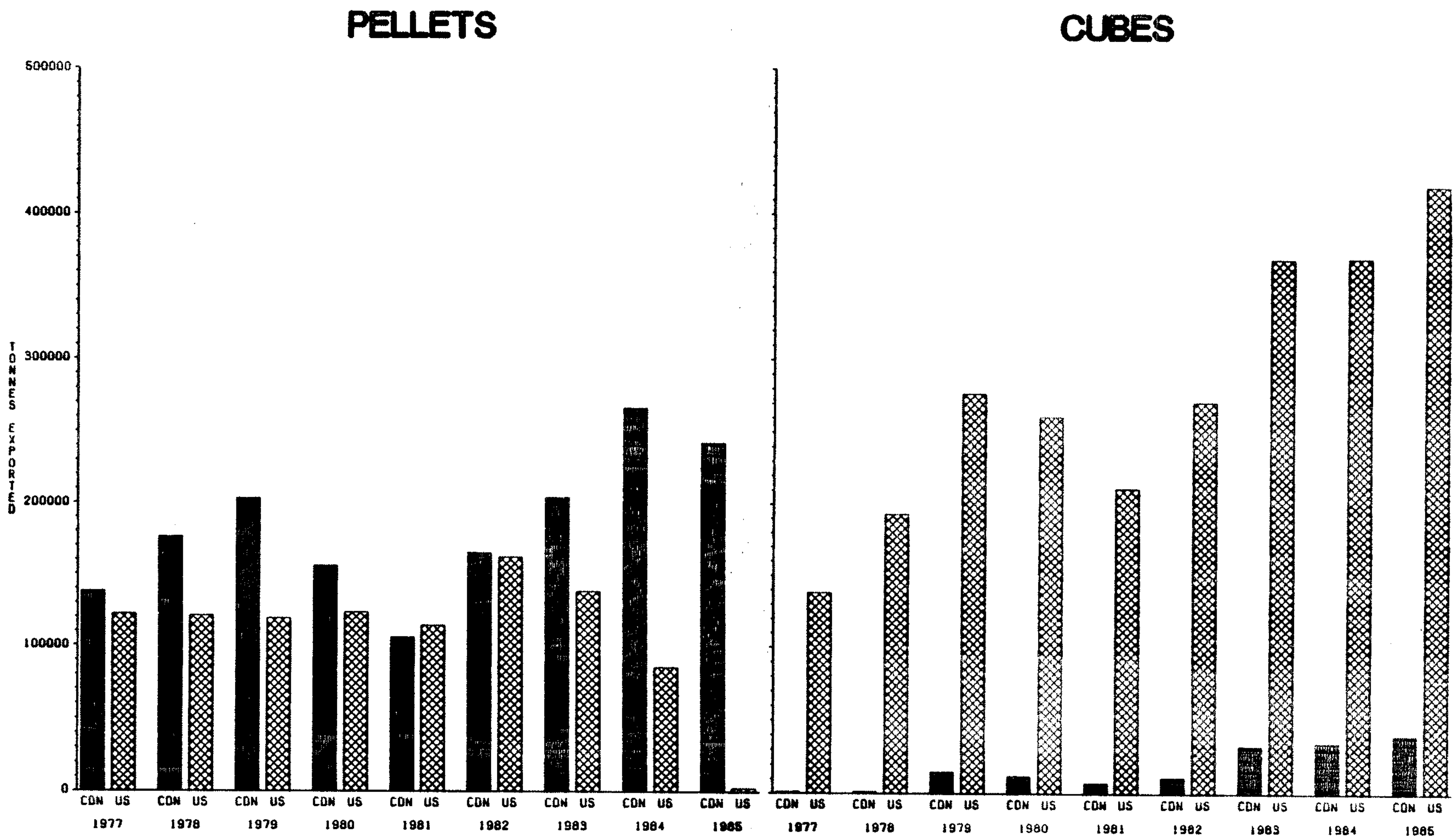


Figure 12: Canadian and U.S. Exports to Japan

increase from present levels. In addition, Japan is expected to increase its hay cube imports by approximately 20,000 tonnes/year over the next 3-4 years (Janot, 1985).

Other Pacific Rim countries, particularly Taiwan, have increased alfalfa pellet imports considerably, but cube imports have remained minimal. Again, the central marketing agencies have been successful in selling pellets to these countries. If the hay cube industry is to expand with any degree of stability, markets must be opened in Taiwan, South Korea and other Pacific Rim countries as a means of creating diversity in demand outlets.

Exports to the European Economic Community are unlikely in the near future, but must be considered over the long term. Manitoba producers, in particular, could potentially take advantage of this market, as they are in an advantageous location relative to Alberta plants. However, the EEC has maintained a steady production of processed forage products over the last several years and imports have fallen dramatically (Table 10). Also, eastern countries such as Hungary have in the past supplied temporary shortfalls and Spain, which recently became an EEC member, is expected to increase output (Alberta Agriculture, 1986). Saudi Arabia and the Irish race horse industry are other possible outlets across the Atlantic (Bates and Wilkins, 1986; Crabbe, 1986).

TABLE 10

EEC Dehydrated and Sun-dried Forage Data

	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86
			'000 tonnes			
Production						
dehy.	1,609.0	1,460.0	1,328.8	1,337.8	1,366.6	1,351.1
sun-dried	100.0	100.0	120.0	117.0	135.0	170.0
Imports	440.5	148.0	250.0	293.2	101.3	74.2
Exports	40.0	70.0	58.0	19.2	25.9	27.9
CONSUMPTION	2,149.5	1,638.0	1,604.8	1,728.8	1,494.5	1,649.9

SOURCE: Alberta Agriculture, 1985; 1986.

Western Canadian hay cube producers have established some good markets in the U.S., but these generally bring a somewhat lower return than exports to Japan (McFarland, pers.comm.). Hay growers from various areas, who are becoming increasingly competitive, have also made inroads into these markets. In particular, Florida is constantly demanding high quality hay products for race horses (Bates and Wilkins, 1986). Again, in order to maintain market outlets over the long term, only high quality products should be marketed - which is where cube producers potentially have a competitive advantage.

6.3.2 Domestic Outlets

The domestic market presently consumes approximately one third of the total processed alfalfa products. In western Canada, domestic consumption has traditionally been directly related to the production which cannot be sold on the export market (New, 1985). Though it is possible that the use of alfalfa cubes will expand domestically if a larger and more continuous supply becomes available through expanded export markets, competition from cheaper locally produced hay is a definite constraint to any sizeable expansion.

The above contention is demonstrated in southern Alberta, which is the primary centre for alfalfa hay cube production in Canada. Even though the province has the largest ruminant livestock population of the western provinces, there are as yet no dairy producers utilizing the product on a continuous basis (Schroeder, pers.comm.). The relatively high cost of cubes simply forces dairy producers into selecting locally produced hay as their roughage source. The southern Alberta plants are, however, strategically located to serve the Fraser Valley where the majority of hay has traditionally been imported from Washington (New, 1985).

Manitoba cube producers presently do not have such an ideally situated market outlet. The majority of dairy producers are located in areas well suited to forage production. A horse population of over 30,000 (Manitoba Agriculture, 1985) represents a sizable market to which considerable quantities of cubes have on occasion gone. However, local horse feed dealers contend that in years when an ample supply of quality hay is available, such as currently, few horse owners will purchase cubes. This could become an outlet if an acceptable product is sold during years of quality hay shortages. Users recognizing the utility of cubes through their own experience could create demand over the long term.

Another market with good future potential is southern Ontario. Current depressed corn prices are encouraging corn producers to grow alfalfa and other forages (Bates and Wilkins, 1986). However, any turnaround in this situation could open a substantial market for Manitoba cube producers.

6.3.3 Alternative Products

Alfalfa hay cubes are ideal for current markets. However, given soil conservation benefits of expanding the forage land base (Chapter IV), the market potential of other forage based products should continually be considered. Alfalfa pellets, of course, are more common than cubes and are produced at two Manitoba processing plants. Briefly, other alternatives include several options which are listed below.

- A special blend of cube forming a complete feed for specific livestock. For example, horse training stables are using an alfalfa-straw blend produced by Alberta cubing plants (Schroeder, 1985). Similarly, adding other components during cubing could result in an acceptable feed for rabbits (Cheeke, pers. comm.). Developing these specific feeds requires both research and effective communication between cube producers and end-users.

- Some research has looked into cubing whole plant corn and barley, but little is known about the market potential of these products (Dueck, 1985). Though this would not expand the forage land base *per se*, it would provide an alternative for processing plants and, possibly, improve their long term viability.

- Various grass species have been used to produce good quality cubes (Dobie, 1975). Peat soils of Manitoba are well suited for nonlegumous forage crops.

- Bagging high moisture compressed alfalfa along with a mixture of soybean oil and molasses is a process used in Ontario (Crabbe, 1986). Because the process involves baling alfalfa at 50% moisture and later compacting it, the end-product is of high-quality and can be readily transported.

- Hay compactors, also used in Ontario, can compress small square hay bales to three times the normal density allowing for efficient transportation (Bates and Wilkins, 1986).

6.4 TRANSPORTATION ISSUES

A crucial link in the successful marketing of any agricultural commodity is an efficient transportation system. Some of the transportation problems, specifically those dealing with proposed legislative changes, facing the western Canadian alfalfa processing industry are briefly discussed here.

Processed alfalfa was included as an eligible commodity for the "Crow Benefit" under Schedule 1 of Bill C-155 (Western Grain Transportation Act, 1983) in November, 1983. Under that legislation (WGTA), the plant share of the freight rate to Vancouver varies across western Canada from $5.11/tonne for Creston,B.C. to $9.50/tonne for Minnedosa (Figure 13).

Since then, the Hall Committee Report (1985) proposed to pay the benefit directly to producers through a Grain Transportation Refund (GTR) on the basis of net sales of eligible grains at the farm gate. Because the benefit would be paid at the farm gate, and because unprocessed alfalfa is not defined as an eligible grain, alfalfa products would no longer receive the government transportation funds (Canadian Dehydrators Association, 1985). This proposal translates into the industry bearing full cost of transportation to Vancouver, which would then range from $23.87/tonne for Creston to $44.39/tonne for the Minnedosa plant. Under this

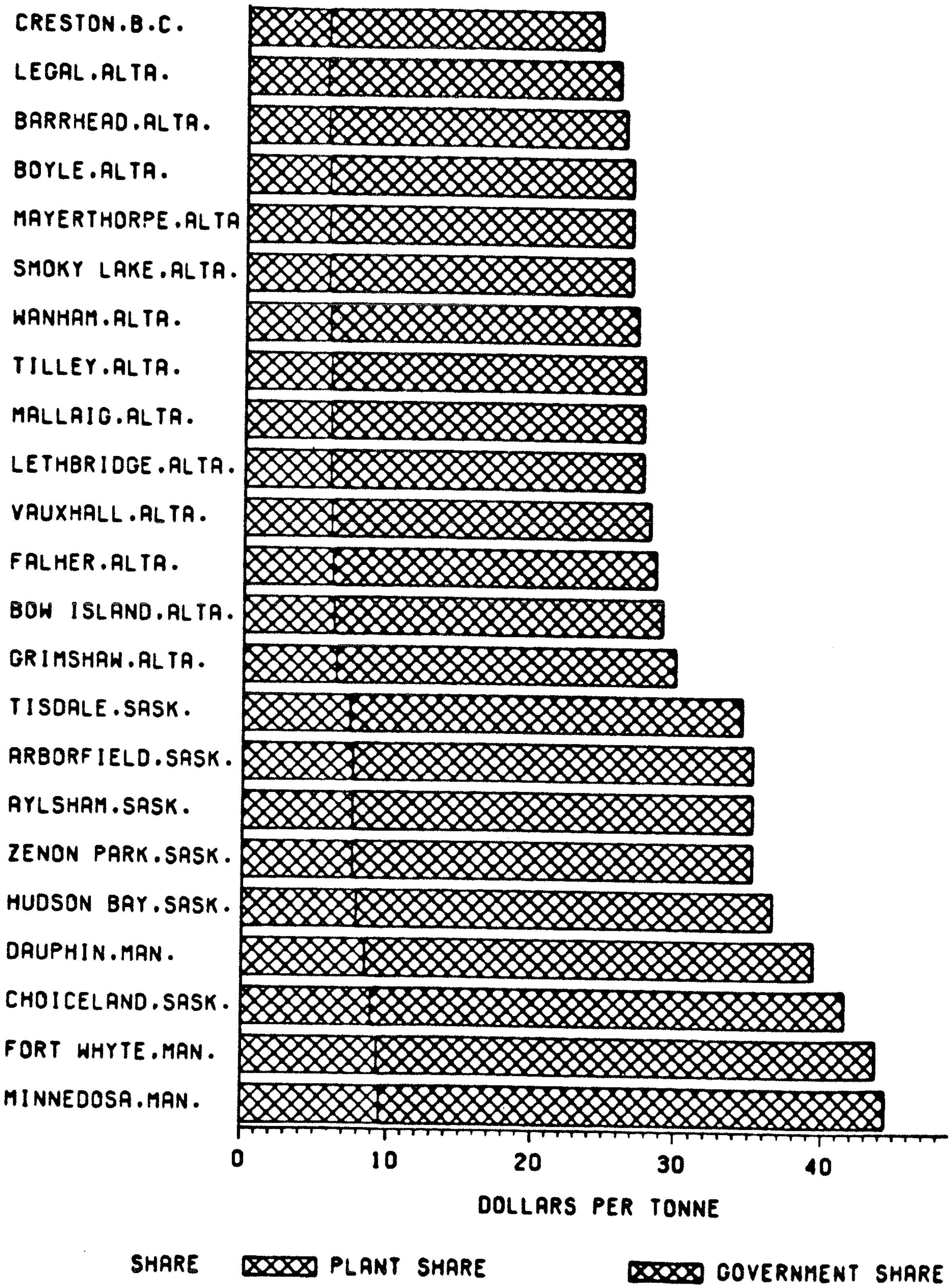


Figure 13: Freight Rates to Vancouver

Source: Stickland, 1985.

scheme, all alfalfa pelleting and cubing plants in western Canada would likely close down, with the possible exception of a few Alberta plants which sell more than 50% of their product domestically (Ulrich et al., 1985).

Obviously, the most severely affected processing plants would be the eastern plants - particularly those in Manitoba and Choiceland, Sask. A sharp increase in the westbound rate scale at 1250 miles, the average distance from Saskatchewan plants, further reduces competitiveness of plants east of this line (Figure 14). Even if the plants could remain on stream, they would be forced into dropping prices paid to farmers. Lower prices, in turn, would force farmers back to alternative crops and processors would have a decreasing supply from within the vicinity of their plants (Ulrich et al., 1985).

It was also recommended by Hall et al. (1985) that the proposed GTR be based on the statutory freight rate to the nearest port. This suggests that even if alfalfa products were eligible, there would be further implication for Manitoba processors because most export sales are to Japan and the nearest port is Thunder Bay. Manitoba plants, therefore, would be faced with the highest transportation costs and the lowest GTR. Furthermore, competition would be biased in favour of alternative crops. Manitoba barley, for example, is primarily priced off Thunder Bay and therefore the price will not drop by the Vancouver freight rate

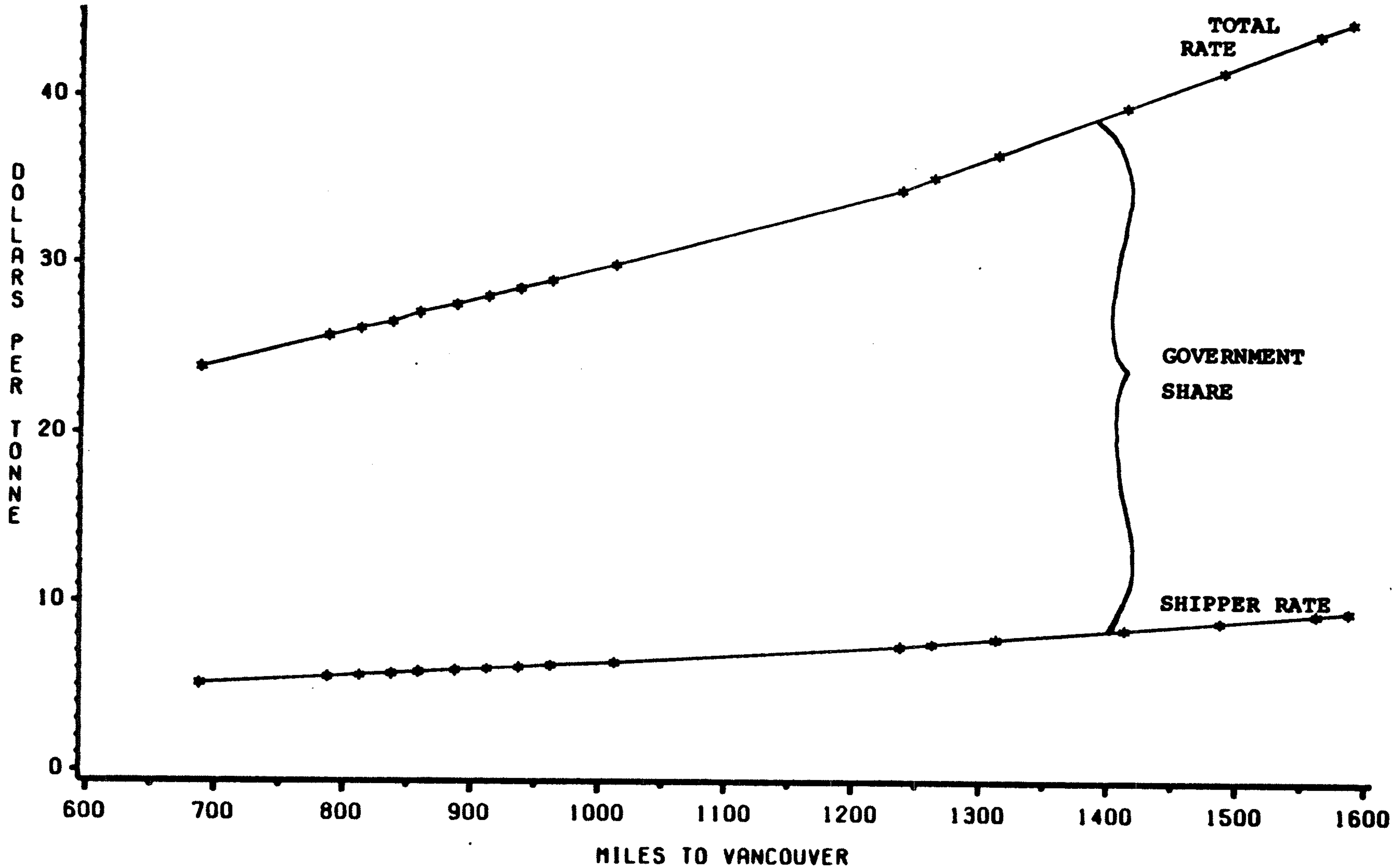


Figure 14: Freight Rates to Vancouver by Distance

SOURCE: Stickland, 1985.

(Stickland, 1985). Consequently, the returns from growing barley in Minnedosa will be virtually unaffected while the returns from growing alfalfa could drop by close to \$20.00/tonne. The Canadian Dehydrators Association (1985) concluded that, if alfalfa products remained in Schedule 1, the alfalfa processing industry could survive the effects of the GTR proposal. However, this would no doubt be at the expense of the eastern plants.

In 1986, the Grain Transportation Agency recommended that the government should not proceed with the proposed GTR. It was recommended that the federal government proceed with paying out its Crow Benefit commitment in full. Though the basis, method and time frame for the payout are still uncertain, it was recommended that all present eligible commodities remain included in Schedule 1.

Although alfalfa products currently enjoy the reduced statutory freight rate, the future of the industry, particularly in Manitoba, essentially hinges on the proposed changes to Canadian transportation policy. Given the uncertainty in future policy, alfalfa processors must make every effort to diversify product disposition.

Chapter VII

SUMMARY AND CONCLUSIONS

7.1 PRACTICUM SUMMARY

Production of sun-cured alfalfa meal began in eastern Canada in the 1930s. Since then, production has spread, primarily in the prairie provinces, and the most common product has been dehydrated pellets. Alfalfa cubes were first produced in 1970 and production levels have been increasing since that time.

Soil degradation, primarily in the form of salinization, soil erosion and organic matter and nutrient depletion, has been caused by current farming practices across the Canadian prairies. Perennial legumes such as alfalfa can benefit prairie soils by increasing soil nitrogen reserves and organic matter, by checking salinity problems, and by improving soil water holding capacity, tilth and internal drainage. In the present study, a path analytical model was employed to determine the relative influence of several factors on the extent that farmers in the vicinity of the Minnedosa cubing plant have sown land into alfalfa. The model revealed that smaller farm size resulted in a greater percentage of land in alfalfa, and that soil capability strongly influenced alfalfa acreage, both directly and indirectly through the farm size variable. In general, the model results were confirmed by descriptive data obtained from producer interviews.

Alfalfa cube quality is directly related to the quality of standing forage and to timing of harvesting operations. The long time period often required for sufficient drying results in a high risk of quality deterioration and is likely to be the most serious constraint facing hay cube producers. Maintaining quality after baling is manageable, but none of the growers interviewed in this study had used a hay shed or tarpaulin to protect baled hay. Forage harvesters can reduce the risk of quality deterioration somewhat, but are only feasible for immediate processing from within very close proximity. Approximately 8,000 tonnes of hay are held over on farms for winter processing at the plant - which puts emphasis on the importance of storage.

Producing cash-crop alfalfa was found to be economically comparable to other crops. In fact, the majority of farmers interviewed perceived the net return from alfalfa as higher than feasible alternatives. Other cited economic benefits were an improved cash-flow, low capital investments and yield improvements accrued to subsequent crops.

The utility of alfalfa hay cubes lies in their high bulk density and associated ease of handling, transportation and feeding. Livestock best suited to cubes are cattle and horses, as the product can safely supply the total roughage requirements of these animals. The most important user is the dairy industry because lactating dairy cows require a consistent high quality source of fibre in order to maintain milk production. Rabbits and possibly other livestock could potentially become important users if a complete feed was formulated at the time of cubing.

Cube production in western Canada has increased steadily over the last few years with an expected record production of 110,000 tonnes in the 1986-87 crop year. The primary market outlet is Japan even though import levels from the U.S. are approximately ten times higher than from Canada. Domestic markets are, with some exception, restricted to areas of intense livestock production and limited forage production, such as the Fraser Valley. The inclusion of alfalfa products under Schedule 1 of the Western Grain Transportation Act (1983) has essentially made production for export possible but, if alfalfa products were to be excluded, transportation costs to Vancouver would be four times the present rate.

7.2 CONCLUSIONS

Based on results of the present study and all other information presented, I have arrived at a number of conclusions. These are presented here under the respective topics.

7.2.1 Soil Conservation

The review of the literature, model results and interview data established some important conclusions relating to long term soil conservation benefits accrued from the operation of an alfalfa processing facility. These are replicated below.

- Soil degradation seriously affects the long term productivity of Canadian prairie agriculture and the process can only be reversed by adopting conservation farming practices.
- Continuous cropping with the inclusion of perennial legumes in crop rotation, particularly when coupled with conservation tillage, can be an effective method of preventing further soil degradation and even improving previously deteriorated soils.
- The respondents of this study took into consideration the importance of soil conservation when making crop production decisions. Though economic incentive was required to make the initial decision to produce alfalfa, soil capability had by far the most important direct and indirect influence on the percentage of land each farmer had seeded into alfalfa.
- The larger farms from this study were more 'locked into' conventional production practices than smaller ones and, therefore, were less inclined to seed significant amounts of their land into alfalfa. Several of the farmers of large acreages, however, indicated that they hoped to produce more alfalfa in the future.

- The productive land base managed by the respondents to supply the cubing plant was, in general, not being previously used for forage production. The overall change in cropping practices from 1983 to 1986 clearly indicates a relative decrease in annual crops and summer fallow in particular, with a concurrent increase in alfalfa acreage.

7.2.2 Production and Processing

The claim made by other authors that alfalfa hay was often a poorly managed crop was confirmed in the present study. In fact, the most serious constraint facing the hay cube industry is the problem of maintaining high quality throughout the production process. Specifically, the conclusions are stated below.

- The time-lapse between cutting and baling must be kept to an absolute minimum to produce quality hay. Unusually adverse weather conditions during the summer of 1985 likely contributed to the frequent extended periods found in this study.

- Alfalfa production was found to be economically comparable to other commonly grown crops, even without hard to estimate benefits of soil conservation. In addition, producing cash-crop alfalfa resulted in an improved cash-flow if quality could be attained.

- If hay is to be used for processing during winter months, it should be placed under cover or preferably in a hay shed immediately following baling. A hay shed was found to be a profitable investment to serve this function.

- Cubing low quality forage not only results in cubes with less nutritive value, but also results in dust emissions from the plant and cubes with poor physical qualities.

7.2.3 Utilization, Marketing and Transportation

The discussion presented in Chapter VI concerning these issues suggested that markets are not the major constraint facing the industry. Effective merchandising and competitive pricing could allow current production levels to increase. More specific conclusions are recapitulated below.

- The present situation of cattle and horses being the primary outlets for alfalfa cubes is not likely to change unless physical and nutritive qualities of cubes are modified to specifically suit the needs of alternative end-users.
- In order for the industry to maintain existing markets and expand into new ones, consistent high-quality products must be produced and alternative products should be explored.
- The potential of domestic markets is limited because of competition from hay producers. A sizeable market in southern Ontario could open if presently depressed corn prices rebound.
- Japan remains the primary market outlet with demand for cubes increasing for at least the next few years. Other Pacific Rim countries also have potential for expansion.
- The possibility of significant exports to the EEC in the near future is unlikely. However, given the transportation advantage Manitoba producers have over Alberta, this situation should be monitored for future potential.
- Without the inclusion of alfalfa products in Schedule 1 of the WGTA, the Minnedosa plant would not be exporting to Japan and would possibly not be in production at all. Given the uncertainty of future transportation policies, the effects of any proposed changes on this important industry must be analysed.

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Appendix A

HISTORY OF ALFALFA

Medicago species are native only to the old world, therefore the genus originated after the European and North American continents had separated. Medicago came into existence from its progenitors, woody Leguminosae, on the northern coast of the Mediterranean some time in the mid to late Tertiary period (Fischer, 1938; Lesins and Lesins, 1979).

A northern population, M.falcata, evolved in a steppe-plant community with thick stands of plants including perennial grasses. The pods of the plant straightened to enhance seed dispersal under these conditions. Upon the retreat of glaciation, vast land areas were open for revegetation and the distribution of the population grew widely northward into areas with severe winter conditions (Lesins and Lesins, 1979). The southern population, M.sativa, evolved in a warm, dry, semi-desert climate with no rain from March to September and very little in winter, such that few other perennial plant species existed. The round, spiral pods adapted for dispersal by rolling from wind action until encountering loose drifted soil, into which the pods anchor (Lesins and Lesins, 1979).

In the early second millennium B.C. nomadic Indo-Europeans introduced the horse into Iran, the area which later became known as the centre of horse-breeding. In all likelihood it was here that the agricultural Kassite inhabitants cultivated M.sativa in irrigated oases to provide horses with forage (Lesins and Lesins, 1979). In fact, the earliest tracing to the name alfalfa is 'aspo-asti' meaning 'horse fodder' in old Iranian (Hendry, 1923). By 1500 B.C. alfalfa cultivation was thought to have generally covered the present territories of Turkey, Syria, Iran, Iraq and Saudi Arabia. Lesins (1976) suggested that the spread was primarily a result of the adoption of the light horse-drawn chariot in warfare.

In 300 B.C., Theophrastus described how alfalfa was brought to Greece by the invading Median armies. Theophrastus indicated that the Medes used alfalfa to feed their chariot horses and other domestic animals (Bolton et. al., 1972). The Greeks later named the plant 'Medicai' to denote its Median (Iran) origin, and this later became 'medicago' in modern botanic nomenclature (Hendry, 1923).

During the second century B.C., Chinese Emperor Wu's desire to obtain specimens of Iranian horses resulted in the movement of both horses and alfalfa seed to China. It was also some time in the second century B.C. that the Romans acquired alfalfa from the Greeks and that its movement into the oases of North Africa took place.

Alfalfa spread quickly throughout Italy and it had been noted by many important Roman writers, including Varo, Pliny, Virgil, Strabo, Columella, Palladius, Cato and Matthiolius (Hendry, 1923; White, 1975). In 60 A.D. Columella discussed alfalfa and cultural practices associated with it in considerable detail (Columella; II,10:24-26):

> The Medic plant is outstanding for several reasons: one seeding affords, for all of ten years thereafter, four harvestings regularly and sometimes six; it improves the soil; lean cattle of every kind grow fat on it; it has medicinal value for an ailing beast; and one 'iugerum' (2/3 acre) of it provides abundant fodder for three horses for an entire year..., break the ground in October and again in February, work it carefully, remove all stones, and break up the clods and harrow it.... Then spread old manure over it, and at the end of April sow at the rate of one 'cyathus' (1/12 pint) of seed to a space 10 ft. long and 5 ft. wide.... The seed should be covered at once...it must be howed with wooden implements and repeatedly freed of weeds, ...make the first cutting rather late, thereafter, you may cut it as tender as you please and feed it to stock, but somewhat sparingly at first, until they have come accustomed to it, so that the novelty of the fodder may not harm them; for it causes bloating and greatly increases the blood supply. After cutting, water it rather frequently, ...weed out all other kinds of growth. If cared for in this way, it can be cut six times a year and will last for 10 years.

Commenting further, on harvesting the crop as hay, he stated (Columella; II,18:1-3):

> It is best that hay be cut before it begins to wither, as a greater quantity of it is harvested and it affords a more agreeable food for cattle. ...gathered neither when very dry nor while still green - in the one case it is no better than straw..., and in the other, if it has kept too much of it (sap), it rots in the loft...breeds fire and starts ablaze..., we shall lose no time in putting it under cover.

During the period of the Roman Empire (27 B.C.-395 A.D.) the crop was introduced into many parts of Europe, although the full extent of the expansion is not known. After the fall of the Roman Empire, *M.sativa* virtually disappeared from Europe, with the exception of isolated pockets in Spain (Langer and Hill, 1982). It was not until the 16th century that *M.sativa* was reintroduced to Italy from Spain. It soon spread all over Europe; Bolton et. al. (1972) cited its introduction to France in 1550, to Belgium and Holland in 1565, to England in 1650, to Germany and Austria in 1750, to Sweden in 1770 and to Russia also in the 18th century.

It is these northern introductions which are of particular interest and importance. *M.sativa* could not readily survive the cold climate of central Europe but, in Thuringia, Germany, it was found to hybridize with the endemic *M.falcata* (Schwanitz, 1967). The hybrids, known as variegated, sand alfalfa or *M.media* combined the large and full growth of *M.sativa* and the winter hardiness and insensitivity of *M.falcata*. The northern species was generally not cultivated without being crossed because the seed pods shatter readily and the plant is a poor producer. However, it is now estimated that of the 33 million hectares presently under cultivation worldwide, over half is seeded with stocks to which both species have contributed their germ plasm in various proportions (Lesins and Lesins, 1979).

The 16th century saw the introduction of alfalfa into Mexico and Peru by Cortez and Pizzaro, respectively. The Mexico introductions were not known to have spread dramatically, but the plant did thrive in the limestone soils and semi-arid climate of the Mexican plateau country (Stewart, 1926). The South American introductions also thrived and soon spread to Chile, Argentina and finally to Uruguay by 1775 (Bolton et. al., 1972). Alfalfa became particularly important in Argentina where planted acreage has grown to a level second only to that of the U.S.A.

Alfalfa was introduced into the northwestern United States in the 1700s and into California, from Chile, during the gold rush of the 1850s (Bolton et. al., 1972). The Chilean sources were well adapted to the southwestern United States but could not survive the cold temperate climates of the north. In 1857 a German immigrant, Wendelin Grimm, brought less than 10kg. of *M.media* seed when he came to settle in Minnesota (Bolton et. al., 1972). Grimm began planting his 'ewiger Klee' (everlasting clover) in 1858 and, after several years of natural selection, this winter-hardy variety was able to advance alfalfa cultivation into the northern United States and Canada.

Other important introductions, outlined by Bolton et. al. (1972), included Baltic alfalfa from Europe. Cossak alfalfa, another *M.media* type, was derived from a single plant grown in the steppes of southwestern USSR. Ladak alfalfa was introduced from in Ladak province of Kashmir in 1910 by the United States Department of Agriculture. Ladak was found to be superior to Grimm in winterhardiness and is still recommended for use in western Canada. Hardistan alfalfa was derived from an importation from Turkestan and is unique in that it is a fairly winter hardy strain of M.sativa not crossed with M.falcata.

The first Canadian introduction was probably made in Welland, Ontario by a shepherd accompanying an importation of sheep from Lorraine, France in 1871. The strain became known as Ontario Variegated and is still used in eastern Canada. In western Canada most major introductions were derivatives of the Grimm variety and were selected for winter hardiness under Canadian conditions during the early 1900s (Bolton et. al., 1972).

Major problems inherent to alfalfa production in its early years in western Canada were described by Spector (1983). These included costs of $85 for 100 pounds of Grimm variety alfalfa, which resulted in seeding costs of eight times that of oats. Seed inoculation was difficult in these years, being accomplished by spreading 200-500 pounds per acre of soil from exhausted alfalfa fields. Furthermore, alternative crops such as wheat had lower costs of production with good returns in most years. Alfalfa hay, on the other hand, was not readily marketable due primarily to transportation difficulties. The crop was therefore restricted to areas where livestock production was common.

Since the early 1900s, the popularity of alfalfa has increased, particularly during the last forty years. Most of the gain in production was a result of reducing risks by using improved cultivars and by applying more efficient management techniques.

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Appendix B

INTERVIEW SCHEDULE

PART A: General land-use

1. Please indicate which of the following best describes your farming operation:

   a) cereal/cash crop farm______.

   b) beef cattle operation______.

   c) pork operation______.

   d) poultry operation______.

   e) dairy operation______.

   f) mixed farm_______.

   g) other (please specify)______.

2. In the spring of 1986 (and 1983), how much of the land which you farm will be (was) in the following:

	OWNED 1986 (1983)	RENTED 1986 (1983)
a) spring-sown annual crops	__________	__________
b) fall-sown annual crops	__________	__________
c) alfalfa	__________	__________
d) other forages	__________	__________
e) native hay & pasture	__________	__________
f) summerfallow	__________	__________
g) woodland	__________	__________
h) other (please specify)	__________	__________

3. Briefly describe your field crop rotations______

____
____
____
____
____

PART B: Forage land-use. Please provide the following information for each field which has been in alfalfa production in at least one of the last three years or which will be seeded into alfalfa in 1986.

FIELD SIZE(acres)________ LEGAL DESCRIPTION______________ DISTANCE TO PLANT__________

		1983		1984		1985		1986 outlook
1)	CROP HISTORY (Please indicate yield & grade of grain crops)							
2)	METHOD OF SEEDING ALFALFA (with nurse-crop; seeder attachment; Cyclone packing; etc.)							
3)	FERTILIZER (analysis and rate used on alfalfa)							
4)	ALFALFA PRODUCTION PROBLEMS(ie. Winter kill; low fertility; weeds; drought; insects; disease; poor establishment; etc.)							
5)	METHODS FROM MOWING TO STORAGE (ie. equipment to crimp, rake, bale, etc.)							
6)	APPROXIMATE DATES OF 1st & 2nd CUTS	1st CUT	2nd CUT	1st CUT	2nd CUT	1st CUT	2nd CUT	
7)	STAGE AT CUTTING (prebud; full bud; 10% bloom; full bloom)							
8)	YIELD (tons/acre)							

	1983		1984		1985		1986 outlook
	1st CUT	2nd CUT	1st CUT	2nd CUT	1st CUT	2nd CUT	
9) MOISTURE CONTENT AT BALING (indicate if a moisture tester was used)							
10) TIME LAPSE BETWEEN CUTTING & BALING							
11) STORAGE METHOD (ie. automatic stack; shed; tarp; single bales in rows)							
12) QUANTITY SOLD TO CUBING PLANT (please indicate approximate dates sold)							
13) QUANTITY REJECTED BY CUBING PLANT (ie. low quality)							
14) REASON FOR LOWER QUALITY (ie. advanced maturity; leaf loss; weathering; high moisture)							
15) QUANTITY SOLD TO OTHERS (ie.livestock producers)							
16) QUANTITY USED ON FARM							

PART C: Farm Business Management

1. Why did you decide to produce alfalfa as a cash crop?

____
____
____
____
____
____
____

2. From where do you generally obtain the information to decide which crops to produce and which crops not to produce?

   a) neighbors ________

   b) farm magazines ________

   c) agri-business ________

   d) agricultural representative (prov.) ________

   e) Agriculture Canada ________

   f) other (please specify) ________

3. Have you made any major capital investments as a result of your decision to produce alfalfa under contract to the cubing plant?________ If yes, please give an estimate of and describe the nature of the investment:

____
____
____
____

4. On average, can you estimate the net return after costs ($ returns/acre - total costs/acre) from:

   a) alfalfa?________

   b) your most frequently grown alternative crop (please specify)?

   ____

5. On average, is the contract price of alfalfa higher, lower or equal to the price received for alfalfa which you have sold to other outlets?__________By approximately how much?__________

6. Do you feel that your yearly cash-flow has improved or weakened as a result of producing and selling alfalfa under contract?_____________Please explain:

____

____

7. Please add any other comments you may have concerning the advantages and disadvantages of producing and selling alfalfa under contract:

____

____

____

____

PART D: Background

1. What is your age? (please check)

   a) under 30_______

   b) 31 to 40_______

   c) 41 to 50_______

   d) 51 to 60_______

   e) over 60 _______

2. What level of education do you have?

   a) some high school_______

   b) high school graduate_______

   c) diploma: agriculture_______ other_______

   d) some university: agriculture_______ other_______

   e) university graduate: agriculture_______
   other_______

3. How many years experience have you had producing forages ?_______

4. How many years experience have you had farming?_______

5. Please indicate the total gross (before expenses were deducted) income from your farm in 1985:

   a) $9,999 or lower _______

   b) $10,000 to $29,999_______

   c) $30,000 to $49,999_______

   d) $50,000 to $69,999_______

   e) $70,000 to $89,999_______

   f) $90,000 to $109,000______

   g) over $110,000 _______

Appendix C

REGRESSION ANALYSIS DATA

ALFALFA SURVEY

OBS	Y1	Y2	X1	X2	X3	X4
1	3.5	35	1000	3.20	100.0	12
2	100.0	90	90	3.20	100.0	1
3	46.2	240	520	3.20	115.4	20
4	43.6	255	585	4.00	102.5	25
5	100.0	220	220	5.50	87.7	10
6	75.0	90	120	5.50	75.0	11
7	8.4	150	1790	3.20	67.0	10
8	100.0	450	450	4.60	88.9	10
9	21.3	65	305	5.50	65.5	10
10	100.0	320	320	3.20	62.5	1
11	8.4	55	655	4.60	122.1	8
12	6.8	40	590	4.60	33.9	10
13	15.6	70	450	3.20	88.9	23
14	21.1	60	285	3.15	118.8	45
15	13.4	80	595	3.20	100.8	15
16	16.7	100	600	3.20	66.7	20
17	40.0	40	100	3.20	90.0	6
18	17.5	100	570	3.20	105.3	7
19	6.0	85	1400	4.00	85.7	37
20	7.8	40	510	3.20	156.9	7
21	27.0	37	137	4.50	65.7	16
22	2.7	30	1100	3.20	36.4	6
23	74.4	250	336	5.50	59.5	45
24	42.3	110	260	5.50	34.6	45
25	60.0	150	250	6.00	36.0	40

ALFALFA SURVEY

VARIABLE	N	MEAN	STD DEV	SUM
Y1	25	38.30800000	34.42212128	957.70000000
Y2	25	126.48000000	105.96073172	3162.00000000
X1	25	529.52000000	412.17938247	13238.00000000
X2	25	4.05400000	1.01877377	101.35000000
X3	25	82.63200000	30.64315747	2065.80000000
X4	25	17.60000000	14.04753834	440.00000000

CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 25

	Y1	Y2	X1	X2	X3	X4
Y1 PERCENT ALFALFA	1.00000 0.0000	0.70749 0.0001	-0.56092 0.0036	0.36242 0.0750	-0.10964 0.6019	-0.06551 0.7557
Y2 ACRES ALFALFA	0.70749 0.0001	1.00000 0.0000	-0.09583 0.6486	0.18923 0.3650	-0.04031 0.8483	0.05265 0.8026
X1 TOTAL ACRES	-0.56092 0.0036	-0.09583 0.6486	1.00000 0.0000	-0.35980 0.0773	-0.02250 0.9150	-0.04153 0.8437
X2 SOIL CAPABILITY	0.36242 0.0750	0.18923 0.3650	-0.35980 0.0773	1.00000 0.0000	-0.46609 0.0189	0.35488 0.0817
X3 OUTPUT PER ACRE	-0.10964 0.6019	-0.04031 0.8483	-0.02250 0.9150	-0.46609 0.0189	1.00000 0.0000	-0.20968 0.3144
X4 DISTANCE TO PLANT	-0.06551 0.7557	0.05265 0.8026	-0.04153 0.8437	0.35488 0.0817	-0.20968 0.3144	1.00000 0.0000

DEP VARIABLE: X3 OUTPUT PER ACRE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	1	4895.697	4895.697	6.383	0.0189
ERROR	23	17640.377	766.973		
C TOTAL	24	22536.074			

ROOT MSE	27.694276	R-SQUARE	0.2172
DEP MEAN	82.632000	ADJ R-SQ	0.1832
C.V.	33.5152		

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|	STANDARDIZED ESTIMATE
INTERCEP	1	139.466	23.167092	6.020	0.0001	0.000000
X2	1	-14.019222	5.548897	-2.526	0.0189	-0.466088

COLLINEARITY DIAGNOSTICS VARIANCE PROPORTIONS

NUMBER	EIGENVALUE	CONDITION INDEX	PORTION INTERCEP	PORTION X2
1	1.971	1.000	0.0145	0.0145
2	0.029001	8.244	0.9855	0.9855

DEP VARIABLE: X1 TOTAL ACRES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	1	527853	527853	3.420	0.0773
ERROR	23	3549551	154328		
C TOTAL	24	4077404			

ROOT MSE	392.846	R-SQUARE	0.1295
DEP MEAN	529.520	ADJ R-SQ	0.0916
C.V.	74.18915		

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|	STANDARDIZED ESTIMATE
INTERCEP	1	1119.663	328.628	3.407	0.0024	0.000000
X2	1	-145.570	78.711721	-1.849	0.0773	-0.359803

DEP VARIABLE: Y1 PERCENT ALFALFA

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	4	10603.075	2650.769	2.973	0.0445
ERROR	20	17834.104	891.705		
C TOTAL	24	28437.178			

ROOT MSE	29.861433	R-SQUARE	0.3729
DEP MEAN	38.308000	ADJ R-SQ	0.2474
C.V.	77.95091		

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|	STANDARDIZED ESTIMATE
INTERCEP	1	41.689073	47.628363	0.875	0.3918	0.000000
X1	1	-0.040807	0.016353	-2.495	0.0214	-0.488637
X2	1	7.588293	7.821326	0.970	0.3435	0.224587
X3	1	-0.059527	0.231165	-0.258	0.7994	-0.052992
X4	1	-0.432778	0.466640	-0.927	0.3648	-0.176615

COLLINEARITY DIAGNOSTICS VARIANCE PROPORTIONS

NUMBER	EIGENVALUE	CONDITION INDEX	PORTION INTERCEP	PORTION X1	PORTION X2	PORTION X3	PORTION X4
1	4.198	1.000	0.0009	0.0121	0.0018	0.0043	0.0135
2	0.407907	3.208	0.0000	0.3621	0.0030	0.0047	0.3615
3	0.280441	3.869	0.0035	0.3540	0.0061	0.0811	0.3421
4	0.103229	6.377	0.0072	0.0031	0.1380	0.3691	0.2700
5	0.010471	20.023	0.9884	0.2688	0.8512	0.5408	0.0129

DEP VARIABLE: Y2 ACRES ALFALFA

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	4	10556.130	2639.032	0.204	0.9333
ERROR	20	258908	12945.406		
C TOTAL	24	269464			

ROOT MSE	113.778	R-SQUARE	0.0392
DEP MEAN	126.480	ADJ R-SQ	-0.1530
C.V.	89.95721		

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > |T|	STANDARDIZED ESTIMATE
INTERCEP	1	24.788130	181.473	0.137	0.8927	0.000000
X1	1	-0.00474325	0.062308	-0.076	0.9401	-0.018451
X2	1	22.146830	29.800775	0.743	0.4660	0.212934
X3	1	0.193692	0.880783	0.220	0.8282	0.056015
X4	1	-0.090051	1.777988	-0.051	0.9601	-0.011938

COLLINEARITY DIAGNOSTICS VARIANCE PROPORTIONS

NUMBER	EIGENVALUE	CONDITION INDEX	PORTION INTERCEP	PORTION X1	PORTION X2	PORTION X3	PORTION X4
1	4.198	1.000	0.0009	0.0121	0.0018	0.0043	0.0135
2	0.407907	3.208	0.0000	0.3621	0.0030	0.0047	0.3615
3	0.280441	3.869	0.0035	0.3540	0.0061	0.0811	0.3421
4	0.103229	6.377	0.0072	0.0031	0.1380	0.3691	0.2700
5	0.010471	20.023	0.9884	0.2688	0.8512	0.5408	0.0129

Appendix D

GENERAL LAND-USE

<u>Question 1</u>

FARM DESCRIPTION	NUMBER OF RESPONDENTS
cereal/cash crop	18
beef cattle	2
mixed farm	5

<u>Question 2</u>

CROP	TOTAL ACRES	
	1983	1986
annual crops	10,742	8,960
alfalfa	995	3,177
other forages	873	728
summer fallow	824	240

<u>Question 3: Field Crop Rotations</u>

- Alfalfa (5-6 yrs.) --> cereal grains (2 yrs.). This is what I hope to do - before it was cereal grains for 2-3 yrs. and one year of summer fallow.
- Wheat --> barley --> rape --> flax. I doubt that alfalfa will ever play a major role.
- Alfalfa (5 yrs.) --> cereal grain (1 yr.).
- I hope to keep the alfalfa for as long as possible - I'll maybe try sod seeding.
- Ideal will be alfalfa for 4-5 years and grain for 2, but in the past I have been summer fallowing every few years.

- Alfalfa (5 yrs.) --> grain (nurse crop, 1 yr.).

- Summer fallow --> rape --> barley(seed) --> grain (3 yrs.). This is what I have been doing, but now I hope to be getting more out of summer fallow and into alfalfa (i.e. keep alfalfa for 4 years instead of summer fallow for one).

- All in alfalfa (450 acres) --> break up approximately 45 acres each year and seed back into alfalfa with a cover crop (usually barley).

- Retain in alfalfa for as long as possible --> break about 25 acres each year and seed back into alfalfa.

- 5-7 yrs. alfalfa --> break portion each year as it is required.

- No definite pattern, I just sort of see what could be profitable each year. But I was using summer fallow more in the past and I hope to use alfalfa more to put land back into shape.

- Rape --> wheat/barley --> summer fallow (generally). I have alfalfa in the hilly country to stop runoff - hope to keep it there as long as possible.

- Rape --> barley --> alfalfa (4-5 yrs.).

- 2-3 yrs alfalfa --> after breaking will benefit grain crops for 1-2 years (i.e. nitrogen). Depending on what the market is like, will dictate what I will grow (i.e. continue in grain or put back into alfalfa).

- Rape --> wheat --> flax. This is what I have been doing. Also try for malting barley almost every year. If it works out with the plant I will definitely put more into alfalfa - a 4-5 year rotation with other crops would be ideal.

- Alfalfa (or alfalfa/grass, 3 yrs.) --> wheat --> lentils --> cereal. I'm trying to work in Artichokes and more pure alfalfa.

- Continuous grain (whatever I think is marketable). Last 4-5 years I've been using clover plow-down instead of summer fallow. I hope that the alfalfa will stay productive for 5-6 years. I plan on breaking some every year and there should be a good cereal crop the following year.

- Continuous grain with clover plow-down. I plan on putting more alfalfa in now.

- 2 yrs. grain --> 1 yr. pulses (i.e. peas, lentils, spuds). I have put alfalfa into one really light field and hope it stays for quit a few years. I'm not sure if I will put more into my other land - see how this one works out.

- Rape --> barley --> wheat --> Flax. Alfalfa will go into land which had not been in forage previously and I'll keep it for about 4-5 years.

- Summer fallow --> rape --> wheat --> barley. I put alfalfa into one field that erodes badly; see how it works out, would like to put in more.

- Alfalfa (4-5 yrs.) --> wheat/barley --> rape --> winter wheat --> alfalfa (with cover crop). This is what I hope to do.

- Alfalfa (4-5 yrs.) --> break up after first cut (i.e. summer fallow that year) --> cereal/oilseeds (3-4 yrs.) --> alfalfa (rape nurse crop).

Appendix E

FORAGE MANAGEMENT

DISTANCE FROM PLANT (MI.)	NUMBER OF FARMS
0-10	12
11-20	6
21-30	2
31-40	2
41-50	3

<u>Question 1</u>

YEAR ESTABLISHED	NUMBER OF FIELDS	TOTAL ACRES
1985	13	913
1984	18	1,268
1983	6	501

<u>Question 2</u>: <u>Seeding Method</u>

- Broadcast; followed by tooth harrows; no nurse crop.
- Broadcast; green feed oats nurse crop (cut Aug.9).
- Broadcast after tillage and 'Roundup' spray; no nurse crop.
- Broadcast followed by harrows; wheat nurse crop.
- Broadcast and harrowed; canary seed nurse crop.
- Broadcast and harrowed; barley nurse crop.
- Broadcast followed by packer and harrows; barley nurse crop (2 respondents).

- Broadcast and harrowed; flax nurse crop.
- Broadcast and harrowed; wheat nurse crop.
- Air seeder; barley nurse crop (3 respondents).
- Air seeder; wheat cover crop (2 respondents).
- Air seeder; mustard cover crop.
- Double-disc drill; barley nurse crop.
- Double disc drill; oats nurse crop.
- Double-disc press drill; no nurse crop.
- Disc drill; barley nurse crop.
- Double disc drill and harrowed; flax nurse crop (alfalfa/flax sown together). Hoe drill with rod weeder set low followed by harrows; barley cover crop.
- Hoe press drill; no nurse crop.

<u>Question 3: Fertilizer Application</u>

- 50 lb./ac. nitrogen and 20 lb./ac. phosphate (P_2O_5) on establishment year.
- 50 lb./ac. 11-51-0 on establishment year (4 respondents). (Note: 11-51-0 is 11% nitrogen & 51% phosphate fertilizer)
- 70 lb./ac. nitrogen and 40 lb./ac. phosphate on establishment year.
- 50 lb./ac. anhydrous ammonia (80% nitrogen) and 50 lb./ac. 11-51-0 on establishment year (2 respondents).
- 80 lb./ac. 11-51-0 and some sulfate on establishment year.
- 100 lb./ac. 11-51-0 on an established (4 years old) field.
- 60 lb./ac. nitrogen and 50 lb./ac. 11-51-0 on establishment year.
- 20 lb./ac. 11-51-0 on establishment year.
- The field was manured (cattle) in the autumn before establishment; 75 lb/ac. 16-23-0 on establishment year; and 11-51-0 was broadcast at a low rate the following year.

- 28-0-0 at a low rate on year of establishment.

- 70 lb./ac. nitrogen, 30 lb./ac phosphate, and 15 lb./ac. sulphate on establishment year.

- 60 lb./ac. 11-51-0 on established (5 yrs. old) field.

- 30 lb./ac. 0-0-0-90 (90% sulphate) on established (2 yrs. old) field in autumn, after harvest.

- 90 lb./ac. 11-51-0 and 30 lb./ac. 0-0-0-90 first 3 years after establishment.

Question 4: Production Problems

- Weed problems: 4 respondents had moderate to severe quackgrass (*Agropyron repens*) problems. 9 respondents had extensive weed problems during the year of establishment and the following year; most frequently mentioned weed problems were flix weed (*Descurainia sophia*), wild mustard (*Sinapis arvenis*) and pigweed (*Amaranthus spp*.)

- Low Yields: 6 respondents reported very low yields in 1984 due to drought. 1 respondent found that a tissue test reveled very low sulfate (1985).

- Poor germination: 3 respondents reported poor germination due to drought (1984) and 1 because the stand had been seeded to deep (i.e. disc drill).

- Winter-kill: on hill tops (1983-84) on 1 field and extensive winterkill was reported by 1 respondent in 1985 (from dry 1984 conditions).

- Heavy frost in mid May (1985) caused considerable yield reduction in one field.

- Seedling damage: young seedlings blew out on the hills of one field in 1985.

Question 5

HARVESTING METHOD	NUMBER OF RESPONDENTS
Mower-conditioner; round baler.	9
Swather without crimper; round baler.	6
Mower-conditioner; square baler.	2
Swather without crimper; square baler.	1
Sickle-bar mower; rake; round baler.	1

Questions 6 & 7.

APPROXIMATE HARVESTING DATES AND GROWTH STAGE		NUMBER OF FIELDS
1st CUT	2nd CUT	
Mid July, 50% bloom	none	10
Early July, 50% bloom	none	7
Early July, 10% bloom	none	3
Late July, 75% bloom	none	3
Early July, full bloom	none	2
Late June, 10% bloom	Mid-late August 50% bloom	2
Mid July, 10% bloom	Mid October, 10% bloom	2
Early July, 10% bloom	Mid August, 10% bloom	2
Late June, mid-bud	Mid August, 10% bloom	1
Mid July, 50% bloom	Early September 10% bloom	1
Mid June, pre-bud	Early August, 50% bloom	1
Late June, 10% bloom	Early September 10% bloom	1

NOTE: 21 fields were harvested at 10% bloom or earlier and 27 were harvested at 50% or later.

Question 8: Alfalfa Yields

- FIRST CUT: From a total of 35 reported fields, the average yield was 1.4 tons/acre with a range of .3 tons/acre to 2.5 tons/acre.
- SECOND CUT: From a total of 12 reported fields, the average yield was 0.89 tons/acre with a range of .4 tons/acre to 1.25 tons/acre.
- TOTAL YIELD: From a total of 35 reported fields, the average yield was 2.0 tons/acre with a range of .3 tons/acre to 4.0 tons/acre.

Question 9: Moisture Content

- Of the 9 respondents who had used a moisture tester, the moisture content before baling ranged from a low of 10% to a high of 20%. If the moisture content was over 15% the hay was later rejected because of heating in the bale.

Question 10

TIME LAPSE BETWEEN CUTTING & BALING	NUMBER OF FIELDS
2-3 days	5
4-6 days	30
7-10 days	13
11-14 days	4
>14 days	2

Question 11

STORAGE METHOD	NUMBER OF RESPONDENTS
round bales in rows	12
round bales left single	6
round bales piled	2
square bales stacked	2

Questions 12 to 16

1985 HAY PRODUCTION	TOTAL QUANTITY (TONNES)
swath weathered (rejected)	270.2
bales weathered (rejected)	84.9
bales heated (rejected)	136.0
weeds/grass (rejected)	378.2
sold to plant	711.1
sold to others	1,773.5
used o farm	870.0
not sold	150.0

Appendix F

FARM BUSINESS MANAGEMENT

Question 1: Reasons for Alfalfa Production

- The land has been cropped heavily over the years. I hope to build the soil up again and give it a rest from continual cultivation. It would be a big gamble to totally rely on it.

- I would like to get alfalfa into my crop rotation, which is simply wheat-barley-rape-flax. This should improve the soil and give better yields of the other crops.

- The land was simply an investment for me. I needed a crop which didn't require constant inputs, and since they do the harvesting, it is very little work for me.

- The costs of growing wheat etc. is becoming much too expensive - too many inputs required each year. With alfalfa I get some nitrogen back into the land. I plan on keeping more cattle in the future, but until the herd in built up, I want to sell alfalfa as a cash crop.

- To give the land a rest and to get some organic matter back in. With the low price of grain, alfalfa is a good alternative. Most years I had problems with custom combiners, so I decided to sow the land down to alfalfa. Alfalfa returns are higher than for grain.

- It's good for the land - cleans it up (i.e. from wild oats and other weeds). If alfalfa is broken up in five years or so the land will be like new again. It is a good cash crop because you don't have the high expenses each spring. It also prevents soil erosion and keeps a much better snow cover than a cultivated field.

- The main reason I went into it is because it is good for the land. Since then I've seen that the return per acre is better than most of my other crops. I used to summer fallow more, but can cut down on this by having alfalfa. It should be expanded to about 500 acres, giving me about 1/4 of the land in alfalfa, which would be ideal for crop rotations.

- Less cash input spring and fall. Much less work required in the spring and fall. Lower machinery costs. We've lost money over the last three years of grain farming and cleared $50 per acre selling hay last year.

- I had been growing mixed forages for my own cows so I had the equipment. I wanted to expand my cropping acres and it would have been too expensive to repair or replace my swather and combine which is quite run down. If I cannot sell the alfalfa I can feed it to my own cows next year if it's covered. This land is also light and would blow much more if it was cultivated every year.

- Farming is my secondary income and I needed something with low labour input - the plant has bought it standing, so it suits my needs. My initial 60 acre field produced a good crop so I seeded the rest of the land to alfalfa too. The crop is very good for the land and prevents erosion.

- It sounded like good money. It's good to have a crop like alfalfa to put land that has been cropped for many years back into shape.

- To prevent soil erosion. I'm only growing 40 acres now to see if the return is good and will hopefully be putting in more because the land really needs it.

- Frost in the area is a problem for many other crops so our choices are limited. I have always been getting a better return from hay than from other crops.

- There is a good market outlet if you have a contract and can produce a good quality crop, that is the real advantage. I would like to get more into crop rotations rather than depending on expensive chemical fertilizer and herbicides. Chemicals are much too expensive and over the long term will have detrimental effects.

- Because this soil is stony and light it is not a good idea to be cultivating every year. The costs for producing grain are high and prices are low.It should improve cash-flow.

- I have always been in forage production, so it was no major change or investment for me. It cuts down on spring work. Alfalfa will hopefully improve my land so that yields of my other crops will improve.

- To keep costs of production down. It is also a good crop for conserving soil and it is better for wildlife.

- This farm has not had a crop such as alfalfa for many years, and it would do the land good. The grain prices are all low now anyway, if it gets better and we grow more grain a few years from now the yields should be better. There are very low costs of production for 5-6 years after seeding. There is a sure market and we are selling it standing, so there is very little risk to us.

- Mainly because it is a good cash crop with a reasonably secure market. I have seeded it on my lightest land, which has given me many problems in the last years. Alfalfa should hold it down and improve the soil.

- I've been waiting for a good market for hay ever since I went out of cattle. The reason I jumped at the opportunity when they (Alfa Mills) did open is because this land is very good in alfalfa and needs a crop like that for soil conservation. I will hopefully be getting a good cash return for it, but time will tell.

- To help build up the land, it is sandy and erodes easily. The farm magazines have been showing good yields and returns from hay crops, so I decided to give it a shot.

- The crop is good for the land. To spread out our work load. It should bring a good cash return. It is a new industry and we wanted to have first crack at it.

- I'm inexperienced in growing most crops. Alfalfa was relatively easy to grow, so it was a good crop to go into.

- Alfalfa is very suitable for our conditions because of the land type and hilly topography. Under continuous alfalfa, moisture becomes depleted - we have to look at rotating a few years of grain crops.

- I had the equipment, and thought it would be a good market outlet with low costs of production. It's good to get it on the hilly land.

Question 2: Management Information Sources

INFORMATION SOURCE	NUMBER OF TIMES CITED
neighbors	13
farm magazines	12
agri-business	3
agricultural representative	9
Agriculture Canada	4
own needs/experience	9
intuition	2
radio broadcasts	4
producer organizations	1

Question 3: Capital Investments

Five respondents have made capital investments:

- Used Round-baler ($8,000) because there is less labour and time involved during harvesting.
- Used Round-baler ($9,000)
- Mower-conditioner (9 ft., $3,000)
- Front-end loader ($1,000)
- Mower-conditioner (14 ft. pivot-tongue, $13,000)

Question 4: Net Returns

- On average, alfalfa is as good or better than grain.
- $10-20/acre from alfalfa and a little more for barley and other crops. But it is hard to get quality alfalfa; I didn't net anything from it last year.
- Alfalfa will net more per acre.
- My other crops gross about the same as alfalfa but I have much lower input costs for alfalfa.

- Alfalfa should be about $80/acre. For grain crops it would normally be about $50/acre, but it will be much lower this year; we may not net anything.

- Normally they would be about equal ($50/acre), but this year the return from our grain crops will be much less.

- Hopefully $80/acre for alfalfa - our grain crops generally net considerably less, and they will for sure this year.

- In the long run alfalfa should net more and it will also improve the yields of other crops.

- The way grain prices are now, alfalfa will definitely be more, but on average it might be about the same as grain crops.

- Alfalfa will net a better return as long as you can get the quality.

- Alfalfa - $60/acre. Wheat and barley - maybe $30-40/acre on average.

- Alfalfa - $100/acre. Grain crops - $50/acre, but this should be improved by alfalfa.

- Both about $50/acre, but we sure won't be getting that for wheat this year.

- Well, I hope to gross about $100/acre off of the alfalfa. I'll likely net more from alfalfa because of lower costs than the grain crops.

- Alfalfa - $75/acre. Our grain crops would normally be at least $20- 30/acre, but we won't be getting that this year.

- Alfalfa - $50/acre. Barley - $40/acre (but much less this year). It should be good in comparison - I can't say by how much.

- Alfalfa - $50/acre. Wheat - $20/acre.

- On average, I would say about the same - maybe $40/acre.

- Alfalfa - $60/acre. Average from other crops - $40/acre.

Question 5: Contract/Noncontract Alfalfa Prices

- Lower: $10-15/tonne (2 respondents).
- Lower: $10/tonne; but we have a guaranteed sale, which is worth quite a bit.
- Higher: $10/tonne; but only if the quality is there.
- Its about the same for that quality (i.e. the plant only takes "dairy quality").
- About equal (3 respondents).
- Possibly somewhat lower, but very little and you don't have the hassle of selling it so I would prefer to sell to the plant.
- Higher: $15/tonne.
- Higher: $10/tonne; as long as quality is there.
- Lower: very little, comes close when you consider you have a sure sale as long as we can put up quality.

Question 6: Effects on Cash-flow

- Weakened: I've had poor hay quality and other production problems - it has not been the fault of the plant (Alfa Mills).
- Improved: there is a lower cash input, earlier return, lower capital investment and the hay is relatively easy to sell (i.e. you don't have it sitting around forever).
- Improved: now we have money coming in in July/Aug.
- No change (2 respondents).
- Hopefully will improve; that is the main reason why we went into it.
- Improve: should get money in July/Aug.
- Improve: getting cash return in mid-summer. It also works in well with growing other crops because the work load is off season to growing grain.
- Improve: My normal cash income is from cattle; the alfalfa should reduce risks of being dependent on income from one source.

- Improve: I do not have to worry about the high costs of seeding every spring - often had a problem getting a good cash advance.

- Improved: it accounted for over half of what we got in August. It cuts down on spring seeding/fertilizer expenses.

- I'm quite confident it will improve. There is a set price and a sure market, as long as the quality is there.

- Normally it should improve, but last year it weakened because it (alfalfa crop) didn't meet the quality.

- Improve: (assuming you meet quality) you will generally get paid in July - much better than with growing grain.

- Improved: we sell hay for 8 months of the year (both to the plant and other outlets) - much better than with grain.

- Improved: cuts down initially on seed/fertilizer costs and you get money much earlier.

- Improved: get money much earlier (as long as quality is there).

- Depends on the condition of the crop. The advantage of the contract is a guaranteed sale.

- Weakeded: I haven't got a good crop off it yet.

- Weakened: I was unable to market the alfalfa.

- It all depends on when they take it (i.e. if the quality is not really good they take it for winter processing and you get money much later - so you can't really count on it).

<u>Question 7: Further Comments</u>

- There is a great advantage in producing alfalfa under contract. But it is very hard to produce acceptable alfalfa on our hilly land, so it is not really a dependable outlet for us.

- Generally pleased.

- Overall, the cubing plant will put lots of hay into the area; therefore there will be a great effect on soil/water conservation. The dust from the plant is something that they will have to deal with.

- Very low labour (which suits me) because they harvest the crop, therefore more time for other work.

- The real advantage is that you know you have the outlet. On other crops we use more chemicals which they say can be unhealthy in the long-term.

- I've been growing (hay) for years, but now I have to try to sell to them because they dump refused hay onto my market - which will make the price go down.

- I'm still quite insecure about the plant and will therefore not put lots of land into alfalfa. If they (cubing plant) go under lots of farmers will be stuck with hay.

- My involvement with the plant has been excellent. There will be a great improvement in the land, especially 5-10 years from now. There will be less of a weed problem and and other crops will produce more.

- No quota - definite benefit.

- It is unsatisfactory unless a market of some kind (even if quality is low) can be assured.

- It sure beats summer fallow - it is definitely good for the land and the work load is off-season to grain.

- I was able to diversify without making new investments in machinery (I had been growing forages for on-farm use previously).

Appendix G

BACKGROUND OF RESPONDENTS

<u>Question 1</u>

AGE	NUMBER OF RESPONDENTS
under 30	5
31 to 40	9
41 to 50	5
51 to 60	3
over 60	3

<u>Question 2</u>

EDUCATION	NUMBER OF RESPONDENTS
some high school	7
high school graduate	13
diploma (agriculture)	1
some university (agric.)	1
some university (other)	1
university grad. (other)	2

QUESTION 3

YEARS EXPERIENCE GROWING FORAGES	NUMBER OF RESPONDENTS
1 to 5	11
6 to 10	4
11 to 20	4
more than 20	6

Question 4

YEARS EXPERIENCE FARMING	NUMBER OF RESPONDENTS
1 to 5	1
6 to 10	4
11 to 20	7
more than 20	13

Question 5

GROSS INCOME	NUMBER OF RESPONDENTS
$10,000 or lower	3
$10,000 to $29,999	6
$30,000 to $49,999	4
$50,000 to $69,999	5
$70,000 to $89,999	2
$90,000 to $109,000	2
over $110,000	3

Appendix H

CROP PRODUCTION SIMULATION

Year 1986 Crop Enterprise Summary for Record # 1 for Feed Barley

Input	Physical Record	Acres	Cost/Acre	Total	Total	Total
Fuel & Lubrication		320.0 X	12.87	4119.26 V		
Repairs		320.0 X	10.54	3373.57 V		
Fertilizer	120.0 Lbs / Acre 23-23-0	320.0 X	15.35	4911.91 V		
	100.0 Lbs / Acre 34-0-0	320.0 X	10.57	3382.02 V	8293.93	
Chemicals	0.6 Litres/acre 2,4-D Amine 500	320.0 X	1.75	558.72 V		
	0.1 Litres/acre Banvel (Barley)	320.0 X	2.05	656.76 V	1215.48	
Seed Costs Including Seed Cleaning	1.75 Bushels/Acre	320.0 X	9.63	3080.00 V		
Labor	396.89 Hours @ 6.50	320.0 X	8.06	2579.77 V		
Interest on Operating Capital		320.0 X	3.69	1179.39 V		
Taxes		320.0 X	5.27	1684.81 F		
Machine Insurance		320.0 X	0.47	149.60 F		
Overhead, Miscellaneous		320.0 X	5.35	1712.26 F		
Total Cash Costs		320.0 X	85.59		27388.04	
Investment in Land		320.0 X	28.60	9152.37 F		
Machinery & Building Investment		320.0 X	14.02	4487.88F		
Total Machinery & Building Depreciation		320.0 X	16.33	5225.67 F		
Total Non Cash Costs		320.0 X	58.96			18865.92
Total Cost		320.0 X	144.54			46253.95
Output (Price X Yield = 1.55 X 45.00)		320.0 X	69.75			22320.00
Net Returns to Management		22320.00 -	46253.95			-23933.95
Returns to All Labor and Management		22320.00 -	46253.95 +	2579.77		-21354.18
Returns to Investment Labor & Management		-21354.18 +	4487.88 +	9152.37		-7713.93
Returns to Investment Depreciation Labor and Management						-2488.26

Year 1986 Crop Enterprise Summary for Record # 1 for Flaxseed

Input	Physical Record	Acres	Cost/Acre	Total	Total	Total
Fuel & Lubrication		320.0 X	12.30	3935.41 V		
Repairs		320.0 X	9.96	3186.98 V		
Fertilizer	150.0 Lbs / Acre 34-0-0	320.0 X	15.85	5073.02 V	5073.02	
Chemicals	1.1 Litres/acre Asulox F	320.0 X	9.57	3062.40 V		
	0.5 Litres/acre Buctril M	320.0 X	4.97	1592.00 V	4654.40	
Seed Costs Including Seed Cleaning	34.00 Pounds/Acre	320.0 X	7.48	2393.60 V		
Labor	378.09 Hours @ 6.50	320.0 X	7.68	2457.58 V		
Interest on Operating Capital		320.0 X	3.84	1229.74 V		
Crop Insurance Premiums		320.0 X	6.50	2080.00 V		
Taxes		320.0 X	5.27	1684.81 F		
Machine Insurance		320.0 X	0.47	149.60 F		
Overhead, Miscellaneous		320.0 X	5.35	1712.26 F		
Total Cash Costs		320.0 X	89.24		28557.39	
Investment in Land		320.0 X	28.60	9152.37 F		
Machinery & Building Investment		320.0 X	14.02	4487.88F		
Total Machinery & Building Depreciation		320.0 X	16.33	5225.67 F		
Total Non Cash Costs		320.0 X	58.96			18865.92
Total Cost		320.0 X	148.20			47423.30
Output (Price X Yield = 5.50 X 22.00)		320.0 X	121.00			38720.00
Net Returns to Management		38720.00 -	47423.30			-8703.30
Returns to All Labor and Management		38720.00 -	47423.30 +	2457.58		-6245.72
Returns to Investment Labor & Management		-6245.72 +	4487.88 +	9152.37		7394.53
Returns to Investment Depreciation Labor and Management						12620.20

Year 1986 Crop Enterprise Summary for Record # 1 for Tame Hay

Input	Physical Record		Acres	Cost/Acre	Total	Total	Total
					Dollar Record		
Fuel & Lubrication			80.0 X	10.13	810.25 V		
Repairs			80.0 X	7.08	566.36 V		
Fertilizer	100.0 Lbs / Acre 11-51-0		80.0 X	18.14	1451.51 V	1451.51	
Chemicals	1.2 Litres/acre Embutox E		80.0 X	8.70	696.00 V	696.00	
Seed Costs Including Seed Cleaning	1.13 Pounds/Acre		80.0 X	2.20	176.28 V		
Twine Costs			80.0 X	0.90	72.01 V		
Labor	90.37 Hours @	6.50	80.0 X	7.34	587.40 V		
Interest on Operating Capital			80.0 X	2.95	236.09 V		
Taxes			80.0 X	5.27	421.20 F		
Machine Insurance			80.0 X	0.47	37.40 F		
Overhead, Miscellaneous			80.0 X	5.35	428.06 F		
Total Cash Costs			80.0 X	68.53		5482.57	
Investment in Land			80.0 X	28.60	2288.09 F		
Machinery & Building Investment			80.0 X	14.02	1121.97F		
Total Machinery & Building Depreciation			80.0 X	16.33	1306.42 F		
Total Non Cash Costs			80.0 X	58.96			4716.48
Total Cost			80.0 X	127.49			10199.04
Output (Price X Yield = 55.00 X 1.00)			80.0 X	55.00			4400.00
Net Returns to Management			4400.00 -	10199.04			-5799.04
Returns to All Labor and Management			4400.00 -	10199.04 +	587.40		-5211.64
Returns to Investment Labor & Management			-5211.64 +	1121.97 +	2288.09		-1801.58
Returns to Investment Depreciation Labor and Management							-495.16

Year 1986 Crop Enterprise Summary for Record # 1 for Tame Hay

Input	Physical Record	Acres	Cost/Acre	Total	Total	Total
Fuel & Lubrication		80.0 X	9.21	736.68 V		
Repairs		80.0 X	7.39	591.01 V		
Fertilizer	70.0 Lbs / Acre 11-51-0	80.0 X	12.70	1016.06 V		
	50.0 Lbs / Acre 0-0-60	80.0 X	3.40	272.16 V	1288.22	
Chemicals	No Chemicals Used					
Seed Costs Including Seed Cleaning	1.13 Pounds/Acre	80.0 X	2.20	176.28 V		
Twine Costs		80.0 X	1.80	144.01 V		
Labor	127.02 Hours @ 6.50	80.0 X	10.32	825.60 V		
Interest on Operating Capital		80.0 X	2.61	209.18 V		
Taxes		80.0 X	5.27	421.20 F		
Machine Insurance		80.0 X	0.47	37.40 F		
Overhead, Miscellaneous		80.0 X	5.35	428.06 F		
Total Cash Costs		80.0 X	60.72		4857.64	
Investment in Land		80.0 X	28.60	2288.09 F		
Machinery & Building Investment		80.0 X	14.02	1121.97F		
Total Machinery & Building Depreciation		80.0 X	16.33	1306.42 F		
Total Non Cash Costs		80.0 X	58.96			4716.48
Total Cost		80.0 X	119.68			9574.12
Output (Price X Yield = 55.00 X 2.00)		80.0 X	110.00			8800.00
Net Returns to Management		8800.00 -	9574.12			-774.12
Returns to All Labor and Management		8800.00 -	9574.12 +	825.60		51.49
Returns to Investment Labor & Management		51.49 +	1121.97 +	2288.09		3461.55
Returns to Investment Depreciation Labor and Management						4767.96

Cost and Return Per Acre Per Crop For Record Number 1 In 1986

	Feed Barley	Flaxseed	Tame Hay	Farm Average
I. Acreage By Crop(acres)	320.	320.	160.	1.
II. Cost of Production				
1. Fuel & Lubrication	12.87	12.30	9.67	12.00
2. Repairs	10.54	9.96	7.23	9.65
3. Fertilizer	25.92	15.85	17.12	20.13
4. Chemicals	3.80	14.54	4.35	8.21
5. Seed Treatment Costs	0.0	0.0	0.0	0.0
6. Seed & Cleaning Cost	9.63	7.48	2.20	7.28
7. Twine Costs	0.0	0.0	1.35	0.27
8. Labor	8.06	7.68	8.83	8.06
9. Custom Charges	0.0	0.0	0.0	0.0
10. Interest Oper. Cap.	3.69	3.84	2.78	3.57
11. Crop Insurance Prem.	0.0	6.50	0.0	2.60
12. Drying Costs	0.0	0.0	0.0	0.0
13. Equipment Rentals	0.0	0.0	0.0	0.0
14. Rent	0.0	0.0	0.0	0.0
15. Taxes	5.27	5.27	5.27	5.27
16. Machinery Insurance	0.47	0.47	0.47	0.47
17. Overhead, Misc.	5.35	5.35	5.35	5.35
18. Total Cash Costs	85.59	89.24	64.63	82.86
19. Investment in Land	28.60	28.60	28.60	28.60
20. Invest. in Mach&Bldg	14.02	14.02	14.02	14.02
21. Mach & Bldg Depr.	16.33	16.33	16.33	16.33
22. Total Non Cash Costs	58.96	58.96	58.96	58.96
23. Total Cost	144.54	148.20	123.58	141.81
III. Gross Returns				
24. Average Yield/Acre	45.00	22.00	1.50	N/A
Breakeven Yield/Acre	55.22	16.23	1.18	N/A
25. Average Price	1.55	5.50	55.00	N/A
Breakeven Price	1.90	4.06	43.08	N/A
26. Crop Insur. Revenue	0.0	0.0	0.0	0.0
27. Straw ($/Acre)	0.0	0.0	0.0	0.0
28. Grazing ($/Acre)	0.0	0.0	0.0	0.0
Total Gross Returns	69.75	121.00	82.50	92.80
IV. Net Returns to Mgmt.	-74.79	-27.20	-41.08	-49.01
V. Returns to Labor & Mgmt.	-66.73	-19.52	-32.25	-40.95
VI. Returns to Investment Labor & Mgmt.	-24.11	23.11	10.37	1.68
VII. Returns to Investment Depr. Labor & Mgmt. or NET CASH RETURNS (See Note)	-7.78	39.44	26.71	18.01

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

	Type of Enterprise				
	Feed Barley	Flaxseed	Tame Hay	Tame Hay	Total
I. Acreage By Crop(acres)	320.	320.	80.	80.	800.
II. Cost of Production					
1. Fuel & Lubrication	4119.26	3935.41	810.25	736.68	9601.59
2. Repairs	3373.57	3186.98	566.36	591.01	7717.92
3. Fertilizer	8293.93	5073.02	1451.51	1288.22	16106.67
4. Chemicals	1215.48	4654.40	696.00	0.0	6565.88
5. Seed Treatment Costs	0.0	0.0	0.0	0.0	0.0
6. Seed & Cleaning Cost	3080.00	2393.60	176.28	176.28	5826.15
7. Twine Costs	0.0	0.0	72.01	144.01	216.02
8. Labor	2579.77	2457.58	587.40	825.60	6450.35
9. Custom Charges	0.0	0.0	0.0	0.0	0.0
10. Interest Oper. Cap.	1179.39	1229.74	236.09	209.18	2854.40
11. Crop Insurance Prem.	0.0	2080.00	0.0	0.0	2080.00
12. Drying Costs	0.0	0.0	0.0	0.0	0.0
13. Equipment Rentals	0.0	0.0	0.0	0.0	0.0
14. Rent	0.0	0.0	0.0	0.0	0.0
15. Taxes	1684.81	1684.81	421.20	421.20	4212.03
16. Machinery Insurance	149.60	149.60	37.40	37.40	373.99
17. Overhead, Misc.	1712.26	1712.26	428.06	428.06	4280.64
18. Total Cash Costs	27388.04	28557.39	5482.57	4857.64	66285.62
19. Investment in Land	9152.37	9152.37	2288.09	2288.09	22880.91
20. Invest. in Mach&Bldg	4487.88	4487.88	1121.97	1121.97	11219.70
21. Mach & Bldg Depr.	5225.67	5225.67	1306.42	1306.42	13064.16
22. Total Non Cash Costs	18865.92	18865.92	4716.48	4716.48	47164.79
23. Total Cost	46253.95	47423.30	10199.04	9574.12	113450.31
III. Gross Returns					
24. Average Yield/Acre	45.00	22.00	1.00	2.00	N/A
Breakeven Yield/Acre	55.22	16.23	1.25	1.10	N/A
25. Average Price	1.55	5.50	55.00	55.00	N/A
Breakeven Price	1.90	4.06	68.53	30.36	N/A
26. Crop Insur. Revenue	0.0	0.0	0.0	0.0	0.0
27. Straw ($/Acre)	0.0	0.0	0.0	0.0	0.0
28. Grazing ($/Acre)	0.0	0.0	0.0	0.0	0.0
Total Gross Returns	22320.00	38720.00	4400.00	8800.00	74240.00
IV. Net Returns to Mgmt.	-23933.95	-8703.30	-5799.04	-774.12	-39210.42
V. Returns to Labor & Mgmt.	-21354.18	-6245.72	-5211.64	51.49	-32760.05
VI. Returns to Investment Labor & Mgmt.	-7713.93	7394.53	-1801.58	3461.55	1340.57
VII. Returns to Investment Depr. Labor & Mgmt. or NET CASH RETURNS (See Note)	-2488.26	12620.20	-495.16	4767.96	14404.74