THE UTILIZATION OF BOGS FOR GRASSLAND FARMING: A COMPARATIVE STUDY OF RESOURCE DEVELOPMENT IN NEWFOUNDLAND AND ICELAND

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by

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ABSTRACT

The two North Atlantic islands, Newfoundland and Iceland, have many parallels one of which is the abundance of boglands. In Iceland they play an important role in a flourishing grassland industry while in Newfoundland bogs have generally been considered wasteland. An examination of these contrasts forms the focus of this thesis. More specifically its objectives are:

i. to examine efforts that have been made to establish bogland farming in Newfoundland,

ii. to determine the most suitable target(s) for a renewed bogland programme, and

iii. to examine the potential use of technology and experience from Iceland in such a programme.

The methods used in the study include structured, face-to-face interviews with government officials and farmers, both in Iceland and Newfoundland; a mailed questionnaire to agricultural representatives in all agricultural regions in Iceland; and correspondence with bogland scientists in selected countries.

In this study bogland farming is treated as an agricultural innovation, the adoption of which was not successful in Newfoundland in the past. A modified innovative decision process model is used as the framework within which the data collected is analysed.

The study reveals that machinery problems were the main reason for the failure of the bogland programme of the 1960's in Newfoundland. Because of the overriding emphasis on keeping reclamation costs low, drainage intensity was minimized which in turn led to severe flotation problems with ordinary farm machinery. Furthermore, follow-up of the projects by the agricultural authorities was inadequate, and some of the farmers concerned never put any effort in making use of the reclaimed bogs.

In Iceland the bogs have different physical characteristics due to recent volcanism, and traditionally they have been important as a fodder resource. However, for climatic reasons intensive drainage is required for successful grassland bog farming. For that purpose a special "tunnel drainage" concept has been developed, which combines efficiency, durability, and low costs. Similar technology has been used in Ireland, and it is suggested that tunnel drains be employed in a renewed bogland programme in Newfoundland, which, for a number of reasons, should be focused on provision of fodder for the dairy industry particularly in the St. John's region.

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

The Newfoundland economy has been dominated for decades by the three resource based industries of fishing, forestry, and mining, while the fourth; i.e., agriculture, is of negligible proportions. To many this would appear only natural; the bountiful resource base for the first three industries simply did not exist for agriculture. On the other hand it is recognized by others that there does indeed exist a resource base for considerably more local agricultural production. Furthermore, the peripheral location of Newfoundland, so often referred to in economic studies on Newfoundland, should serve as an incentive to agricultural production for the domestic market.

There are, however, a number of constraints to farming in Newfoundland, some of which will be dealt with later in this thesis, but there is one in particular that has been identified as the limiting factor for cattle and sheep farming, and that is the lack of winter-feed. Due to the long winter experienced in Newfoundland considerable amounts of feed are required to carry the livestock through the winter.

The production of winter-feed has traditionally been restricted to mineral soils, but further land reclamation of such soils is usually an extremely expensive undertaking due to tree cover, stoniness, unfavourable surface contours, and thinness of the soil. As a result, production of winter-feed has been restricted requiring that considerable amounts of hay be imported every year in spite of very high freight costs for such a commodity.

Reclaiming boglands for winter-feed production is an alternative. There are several aspects that make the bogland option attractive; the bogs are often thick, stone-free, have favourable surface contours, do not usually have alternative uses, and often extend over large continuous areas making large scale reclamation and harvesting particularly attractive. Notwithstanding these favourable characteristics, bogland farming has not been successful in Newfoundland. In the late 1950's and early 1960's bogland reclamation was actively pursued by the agricultural authorities, but in spite of a promising start further developments in this regard have been disappointing. Several reasons have been suggested for this, and these will be examined in some detail later in this thesis.

In general terms the thesis examines the feasibility of reclaiming boglands in Newfoundland for grassland farming. More specifically its objectives are:

i. to examine why previous efforts to reclaim the Newfoundland bogs have been unsuccessful,

ii. to determine if renewed efforts in this regard are warranted, and

iii. assuming such efforts are found to be justified, examine whether technology and experience from large scale bogland reclamation in Iceland can be utilized.

The general approach is therefore comparative; it is felt that a close look at "successful" bogland farming in Iceland might shed some light on the "failures" in Newfoundland. The methods used include structured interviews with farmers in both countries, literature research, and correspondence with bogland scientists in a number of countries. Furthermore, scientists and others involved with bogland research and reclamation, both in Iceland and Newfoundland, were interviewed using a structured but informal approach in order to obtain information on the general productivity of reclaimed boglands and any difficulties encountered in their reclamation and use. The voluminous files of the Newfoundland Agricultural Division were particularly revealing for the study of the bogland reclamation programme of the 1950's and 1960's as they contain both intra-departmental correspondence and correspondence with prospective bogland farmers.

The thesis is divided into seven chapters. Following the Introduction, Chapter II attempts to put the study in a theoretical context by treating bogland farming as an agricultural innovation. In Chapter III previous bogland reclamation attempts in Newfoundland are examined in detail. Chapter IV focuses on bogland reclamation from two particular perspectives. First it is examined in the wider context of grassland farming in Newfoundland in order to assess the potential need for bogland reclamation within each of the three grassland farming sectors; dairy, beef, and sheep farming. Secondly, as drainage was found to be a particularly critical factor in bogland reclamation in Newfoundland an examination of the various aspects of drainage intensity follows. In Chapter V attention is shifted to Iceland where bogland reclamation is carried out on a large scale using different methods and techniques from those used in Newfoundland. The extent, organization, and financing of bogland reclamation in Iceland is examined, but the main concern is with drainage technology. In the sixth chapter bogland farming in a particular area in Southern Iceland is examined in some detail and comparisons made with farming in Newfoundland. The seventh chapter considers various approaches for a renewed programme of promoting bogland farming in Newfoundland, and examines the different drainage technologies suited to such a programme. The eighth and concluding chapter summarizes and synthesizes the conclusions that can be drawn from the preceding chapters and makes some specific recommendations for a policy of promoting the future use of boglands for grassland farming in Newfoundland.

In summary then, the study reveals a number of factors that help to explain the failure of the bogland programme of the 1960s in Newfoundland, and, with input from Iceland and other countries, suggests a course of action for action for another, albeit different future bogland programme for a particular section of the grassland farming industry in Newfoundland.

CHAPTER II

CONTEXT OF STUDY

2.1 Introduction

This thesis does not fit neatly into an established tradition of similar studies. In one sense it represents a comparative land-use analysis, but such studies are rare, at least as topics for postgraduate theses. Only two comparative studies are known to the author. One of these, Kikuchi and Hayami's (1978)[1] study of the agricultural histories of four East-Asian countries, will be considered in a later chapter, but the other is Khan's study of the agricultural geography of East Pakistan[2] and Louisiana, in which he analyses how the two areas have many physical parallels but because of vastly contrasting cultural heritages agricultural practices are markedly different (Khan, 1958).

This study, however, is not only a comparative study, it goes further and considers the feasibility of transferring technology and management methods from one area

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1 Their paper is mainly based on Kikuchi's Ph.D. dissertation: "Irrigation and Rice Technology in Agricultural Development: A Comparative History of Taiwan, Korea and the Philippines" (Hokkaido University, 1976; unpublished).

2 Now Bangladesh.

to another, or more specifically, how the successful development of a resource in area A may help to remedy the unsuccessful attempts to develop a similar resource in area B. Thus, comparison in and of itself is not the main objective, but it is the possible transfer of experience which necessitates comparison. The heterogenous literature on technology transfer is unfortunately not very relevant to the specific problem under study here; it typically deals with issues like transferring science to technology, international licencing, and third world development. The literature on diffusion, however, is of more relevance. First, the rather unsuccessful bogland reclamation program in the 1960's in Newfoundland is an example of an innovation that was not widely adopted, and secondly, the ultimate objective of the study is to establish if a renewed bogland program involving a modified version of the innovation could be made more successful. The thesis may, therefore, be considered to be primarily an examination of the potential for diffusion of an agricultural innovation, the study of which draws upon comparative experience in an area where diffusion has been successful (Figure 1).

2.2 Diffusion studies in general

The literature on diffusion of innovations is abundant. In a standard reference work on the subject

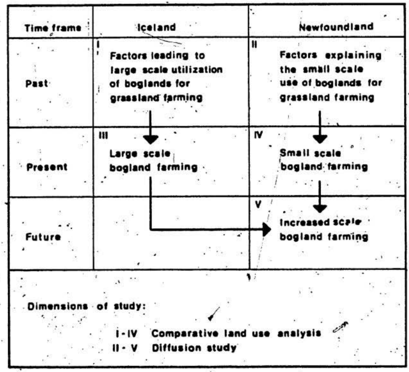

Figure 1 Dimensions of study

Rogers and Shoemaker (1971) quoted about 1500 diffusion reports. Additional reviews on the topic include Lewis (1979), and Stofferahn and Korsching (1980), whereas the reviews by Lionberger (1960) and Jones (1967) focus on agricultural innovations in particular.

Practically all empirical diffusion studies have one thing in common, they are retrospective. Usually they examine how a particular innovation was adopted, and by whom, either temporally or spatially, or both. In what is now considered a classic study, Ryan and Gross (1943) examined the diffusion of hybrid corn seed in two Iowa communities. For the first time, the acceptance of a new practice was clearly recognized as a combination of several stages where the individual was shown to be involved in a personal process of decision-making, using different sources of information at each stage. This study served as a prototype for a great number of later diffusion studies where the emphasis has been on the adoption process, and on the identification of variables related to innovativeness. This typical emphasis on the process of the individual's decision-making is apparent in the generalized innovation decision scheme in Figure 2. However, for our purposes the model and the bulk of past diffusion studies are only of peripheral relevance as the particular innovation under study was not widely adopted. Rogers and Shoemaker (1971) did, however, modify the innovation decision paradigm to

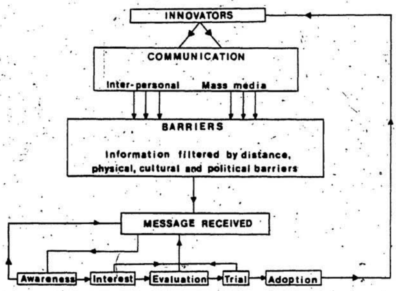

Figure 2 Generalized innovation decision scheme (Lewis, Rural Communities, 1979)

account for the rejection, and discontinuation of innovations (Figure 3). The process model is modified from the classical five-stage adoption process (Figure 2) to four main stages; knowledge, persuasion, and decision, whereas the fourth, confirmation, either represents a reinforcement or reversal of the decision stage.

Temporally, the model contains three major divisions; antecedents, process, and consequences. Antecedents are those variables present in the situation prior to the introduction of an innovation, consisting of things like the individual's personality and social characteristics, and the perceived need for the innovation. The social system variables such as society's norms (e.g. modern or traditional) may serve as incentives or restraints on the individual's decision while communication sources and channels provide stimuli to the individual during the innovation decision process, and the individual forms his perception of the innovation which in turn affects his decision.

Generally speaking, most empirical diffusion studies deal with the adopter's characteristics, as opposed to innovation characteristics or system characteristics. Thus, of the approximately 1100 diffusion studies content analysed in Rogers and Shoemaker (1971) only 59 studies examine the innovation characteristics, and only seven the social system effects.

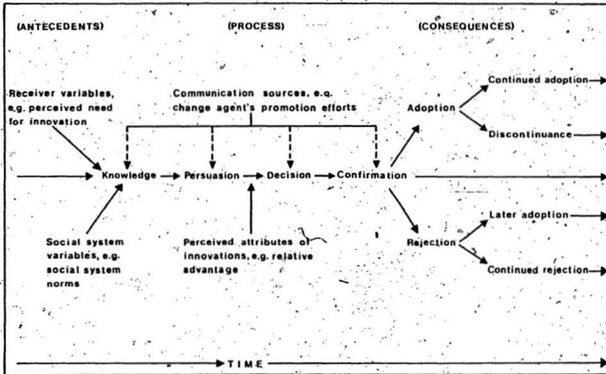

Figure 3 Paradigm of the innovavation decision process . (Modified from Rogers and Shoemaker, Communication of Innovations, 1971)

Time constraints in particular did not allow an examination of all the variables depicted in Figure 3. Instead the analysis focuses on the planning and implementation of the bogland policy; the characteristics of the innovation and how they affect the adoption decisions of the farmers; and the social system variables.

2.3 Innovation attributes

Based on past writings and research as well as a desire for maximum generality, Rogers and Shoemaker (1971) selected five innovation characteristics as being most important in influencing the adoption rate of innovations; relative advantage, compatibility, complexity, trialability, and observability.

The degree of <u>relative advantage</u> is usually 7
expressed in terms of economic profitability, but it may be measured in other ways as will be explained later. Some economists have maintained that economic variables are the major determinants of technical change (e.g. Griliches, 1957), and some have even argued that there is no need to attend to cultural factors when explaining adoption of innovations (Schultz, 1964). A great number of studies have, however, challenged these assertions and it is now generally recognized that both economic and sociological variables need to be considered. There are indications that economic motives are less important for predicting rate of

adoption for small farmers than for larger farmers (Kivlin and Fliegel, 1967), and less for peasant farmers, oriented largely to subsistence living (Fliegel et.al., 1968).

Given the traditional small-scale nature of farming in Newfoundland it is reasonable to expect that non-economic factors are relatively important when it comes to adoption of innovations such as bogland farming. But there are more dimensions of relative advantage than economic profitability. In a study of small-scale farmers in the U.S. Kivlin and Fliegel (1967) found that a decrease in discomfort, one subdimension of relative advantage, was positively related to rate of adoption, whereas economic profitability was not. The sheer discomfort of farming soft, wet bogs as compared to firm mineral soil may therefore have overshadowed any potential economic rewards from bogland farming. Other subdimensions of relative advantage include initial and continuing cost, perceived risk, and the immediacy of reward, but these will be considered in a later chapter.

Rogers and Shoemaker (1971, 145) define compatibility as the degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of the receivers. In the context of this study, it may be that the traditional "wasteland" consideration of bogs in Newfoundland, and the failure of attempts to encourage bogland farming in the 1930's served as constraints to bogland farming in the 1960's, but the attitudes may well have been more important here. The Royal Commission on Agriculture in Newfoundland emphasized that the real obstacle in the way of producing livestock and livestock products efficiently was "the crying need...for feed crops" (Shaw <u>et.al.</u>, 1956, 102). However, that the typical Newfoundland farmer saw the situation from a different perspective; he was not prepared to make the various commitments associated with expansion (e.g. using credit), and this idea of increasing his acreage under cultivation was not attractive to him.

<u>Complexity</u> of an innovation has generally been found to be negatively related to its rate of adoption. The concept of bogland farming can hardly be considered complex, but the management of bogland fields turned out to be more problematic and complex than that of mineral soil fields, and this probably increased the discontinuance rate.

<u>Trialability</u> concerns the ability to experiment with an innovation on a limited basis. An innovation that is trialable is less risky for the adopter and, not surprisingly, it has been found (e.g. Fliegel and Kivlin, 1966) that trialability of an innovation is positively related to its rate of adoption. There is also evidence (e.g. Ryan and Gross, 1943) that trialability is more important to relatively earlier adopters than later adopters. The bogland reclamation machinery was heavy and costly to transport so a large acreage in any one location was preferred, and a

small-scale trial was therefore hardly possible for the farmer. Economies of scale in the bogland policy may thus have been detrimental to the overall success of the program.

The observability, i.e. the degree to which the results of an innovation are visible to others, can exert considerable influence on whether or not it is accepted. This concept should not have slowed down the adoption rate of bogland farming, as the results, i.e. crops, are highly visible. Furthermore, regional demonstration plots were established and, as will be considered later in the thesis, they seem to have served their purpose well.

But how closely are the above attributes related to the actual rate of adoption? Rogers and Shoemaker (1971) quoted eight investigations, in each of which a number of different innovations were examined as were also a number of attributes of those innovations. The percentage of the variance in rate of adoption explained by the above five major attributes ranged from 49 to 87 per cent. Any single attribute is usually a poor predictor; in Kivlin's (1960) comprehensive study, for example, of 229 Pennsylvania farmers, the combined effect of the eleven innovation attributes explained only 51 per cent of the variance in the rate of adoption and none of the attributes explained more than 16 per cent of the variance. It has been suggested that this low level of explanation may be attributed to the tendency for different innovation attributes to be significant at each stage in the innovation decision process.

Klonglan and Coward (1970) have suggested an interesting modification to the conceptualization of the adoption process (Figure 4). Their two-phase model is not only significant in the above context of considering innovation attributes as explanatory variables for the rate of adoption, it is also useful in the context of the bogland study where the focus is on rejection and discontinuances.[1] Klonglan and Coward distinguish between symbolic adoption and use adoption. They point out that most innovations contain both an ideational component and an object component. Symbolic adoption refers to the acceptance of only the idea component of an innovation whereas use adoption involves acceptance of both components. The authors argue that sociological variables are most important in explaining symbolic adoption, whereas economic variables are relatively more important in explaining use adoption. Hence, one can deal methodologically with symbolic adoption and use adoption as separate dependent variables to be explained by different sets of independent variables. It is therefore not surprising that any single innovation

1 Rejection refers to the decision not to use an innovation whereas discontinuance refers to the decision to stop using an innovation which has been used.

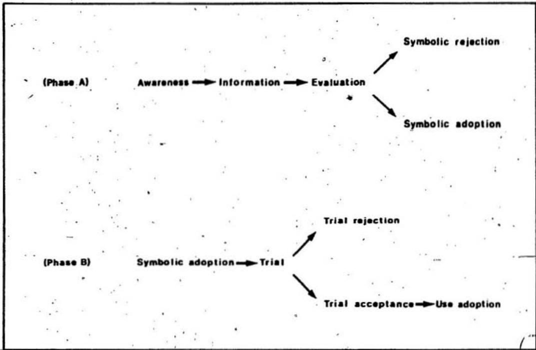

Figure 4 The place of symbolic adoption in the adoption process (Klonglan and Coward, Rural Sociology, 1970)

attitute only explains a relatively small part of the variance in the use adoption rate.

Discontinuances are a neglected aspect of diffusion research. In the only major investigation of the subject, Leuthold (1967) found that the greater the discontinuance of an innovation the lower the subsequent rate of adoption by potential adopters. Furthermore, the impact of discontinuance in curtailing subsequent adoption by potential adopters was found to be greater than the impact of continuance in promoting adoption. Relating Klonglan and Coward's model to the bogland program, one can therefore hypothesize that the numerous applications received in the early 1960's represent symbolic adoption whereas the many abandoned projects represent trial rejection which in turn affected the decreasing rate in symbolic adoption amongst other farmers, and the eventual abandonment of the bogland programme by the Government. On the other hand only a handful of farmers continued bogland farming beyond the trial stage; i.e., got to the use adoption stage.

2.4 Social system variables

Social system characteristics are one of the sets of variables affecting the innovation decision process (Figure 3). They are, however, even to a greater extent than the innovation attributes, a neglected dimension in diffusion studies. In Rogers and Shoemaker's (1971) review of the literature, only seven empirical studies were found to have examined the relative importance of social system effects, but all seven studies supported the generalization that system effects may be as important in explaining individual innovativeness as such individual characteristics as education and cosmopolitaness. Van den Ban's (1960) study illustrates this concept well. In a study of over 900 farmers in 47 townships in Wisconsin, she examined the effects of traditional and modern norms on the innovativeness of the farmers. She found that individual characteristics such as farmer's education, size of farm, and net worth were positively related to his innovativeness, but township norms were even better predictors of farmer innovativeness. To put it another way, a farmer with a high level of education, on a large farm and with a high net worth, but residing in a township with traditional norms, will probably adopt fewer improved practices than a farmer with a lower level of education and a smaller farm in a township where the norms are modern.

Now this important question arises: Is the social system of farmers in Newfoundland characterized by traditional norms or by modern norms? This is a difficult question to answer; traditional and modern norms refer to ideal types, they are the end points of a continuum on which actual social system norms may range. Furthermore, no specific studies seem to have been undertaken to address this issue in Newfoundland, neither for Newfoundland society in general nor for farmers in the province in particular. There is, however, some indirect evidence that traditional norms, such as lack of favourable orientation to change, have been persistent. McCay (1976, 82) noted, for example, that fishermen along the Northeast coast of Newfoundland were slow to adopt the longliner vessel-type, despite the efforts of government fisheries biologists in the 1950's that demonstrated the potential of fishing in deeper waters.

The following quote relates to farming in particular:

"A study of stock raising as it has been carried on in Newfoundland from a very early date up to the present impresses one more and more with the fact that in all this time little change has occurred in the general practice and methods employed. Why should this be so? Why have the changes that have taken place in the raising of livestock in all other parts of this continent not occurred here?" (Shaw, et.al., 1956, 92).

The Royal Commission's answer was that the difficulty of providing an adequate supply of winter feed was the reason, but the sociocultural norms of the farming community may well have played an important role in this respect.

Another subdimension of social system variables is communication integration, i.e., the degree to which the units in a social system are interconnected by interpersonal communication channels. There is consistent evidence from empirical studies that the degree of communication integration in a social system is positively related to the rate of adoption of innovations (Rogers and Shoemaker, 1971, 352). The scattered distribution of farmers in Newfoundland and their lack of organization probably result in less communication integration amongst the farmers, and hence the adoption rate of innovations in general is slower. The field research in Newfoundland gave further indications in this regard; the bogland farmers were in most cases unaware of other bogland projects in the province.

To conclude this context chapter, it should be emphasized that the study addresses a complex practical problem, and attempts to give a meaningful solution to it. No strictly parallel studies have been found to guide this study, but that does not mean, however, that there is no relevant litarature on the subject. The purpose of this chapter has indeed been to gain whatever insights from the general theory of diffusion to guide this specific study of bogland farming in Newfoundland, and perhaps, in a small way, increase the breadth of diffusion type studies by looking at this particular type of question.

CHAPTER III

BOGLAND RECLAMATION IN NEWFOUNDLAND
- A HISTORICAL OVERVIEW -

3.1 Introduction

Boglands in Newfoundland cover an estimated land area of 2,000,000 ha in insular Newfoundland (Pollett and Wells, 1980, 1). Traditionally, their agricultural use was limited to making fish-peat compost but in some areas peat was used as fuel. Otherwise boglands have generally been treated as wasteland. Their potential as a grassland resource has, however, long been recognized (e.g. Howley, 1886, and McDonald et.al., 1899), but that recognition came from scientists and intellectuals rather than the farm community.[1]

3.2 Bogland reclamation efforts by the Commission of Government

The first serious efforts to reclaim boglands in Newfoundland for grassland farming were undertaken by the

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1 Howley (1886,7) mentions, however, that Mr. Francis Peddle, a settler in New Harbour, T.B., was making an experiment of draining and cultivating bogland. Nothing is known of the outcome of this experiment. An editorial in the Evening Telegram on June 16th, 1938, states that in various parts of Newfoundland peat lands have been successfully converted into farms in the past. No further references to that effect have been found except for the Royal Commission's examination of vegetable gardens on boglands discussed later in this chapter.

Commission of Government in 1935-39 at three locations on the Avalon peninsula: Colinet, Harbour Grace, and Markland. The drainage system used was based on techniques employed in Scotland at the time (Ogg, 1936), but modified in order to make it cheaper.[1] The reclamation efforts, however, did not trigger any further utilization of boglands in Newfoundland. Various reasons for this lack of success have been suggested. Archibald (1944), who was in charge of the project in Harbour Grace, maintained that the Harbour Grace experiment yielded some extremely good results, but that it was abandoned before definite results were obtained. In discussing the land settlement at Markland, Handcock (1970, 55) argued that settlers' prejudice and ignorance, and technological inadequacy were the reasons why the reclamation scheme proved abortive. An agriculture professor from England, J.A. Hanley, discussed the reclamation efforts in some detail in his reports to the Commission of Government (Hanley 1938 and 1940). In his first report, Hanley (1938) criticized the projects at Colinet and Markland for not

1 The system consisted of lateral ditches 18 yards (16m) apart and 4 feet (1.2m) deep that were to feed into collector ditches 4.5 feet (1.4m) deep and 300 yards (274m) apart which in turn were to feed into a 5 feet (1.5m) deep main perimeter ditch. Box drains were to be installed in the lateral ditches which would then be filled in again but instead a method known as French draining was employed, i.e. the bottom of the lateral ditches was lined with stumps and tree roots and then filled in again. This method turned out to be unsatisfactory.

giving sufficient attention to adequate drainage prior to cultivation. In particular he questioned the use of French draining instead of box drains. The Harbour Grace project he felt was more promising and should be handed over to a reliable farmer who could farm the reclaimed land on a commercial basis. When Hanley came back to Newfoundland in 1939 he found that no progress had been made in those projects since he came there first in 1937, except for Markland, where further experience had not been too encouraging (Hanley 1940, 26). As the deeper bogs had been found to be exceedingly difficult to drain he suggested that every effort should be made to drain adequately the experimental plots after which they should be cropped to test their farming potentials. He also emphasized that an agricultural officer should be made responsible for the reclamation projects. It appears, however, that his suggestions were not heeded. The war years brought military base construction and an increased demand for fish, wood, and mineral products which combined to revitalize the economy, and governmental interest in bogland reclamation and agriculture in general faded away.

In retrospect, it seems that the lack of consistent long-term planning was the major reason why the Commission of Government's effort to encourage bogland reclamation came to naught. The organization of the reclamation projects was inadequate in the first place, and political backing proved to be lacking when difficulties were encountered. The desperate economic situation in Newfoundland may also have played a part here. The measures taken by the Commission of Government were mainly emergency measures and only partly experimental in nature. This may explain that more than 28,000 dollars had been spent on the Harbour Grace project alone by 1938[1] (Evening Telegram, 1938), but when results were not immediate, resources were swiftly diverted into other more conventional avenues. The abandonment of the experimental projects was particularly unfortunate as,

> "...the average Newfoundlander steers clear of drainage whenever possible" (Hanley, 1940, 25).

Traditionally, the Newfoundland farmers had not demonstrated to themselves that boglands could be valuable farm land, and the failure of expensive expert-guided experiments probably reinforced their "wasteland" image of the bogs.

3.3 Royal Commission's interest in bogland reclamation

Following the abandonment of the bogland projects by the Commission of Government, apparently no further development took place during the 1940's. The Harbour Grace plot had been leased in 1939 to a local farmer, but low yields following a particularly cold and wet season, and the

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1 In Walwyn (1938, 16) the cost is given as $17.402.

inability of the Government to provide machinery as stipulated in the lease, resulted in the abandonment of the fields, probably in 1940. In 1939 a number of crops and crop varieties were planted on the Colinet plot with different lime and fertilizer rates. A report on the results stated that yields ranged from "total failure" to "excellent". Plans were made to continue these experiments but little more was done except to fence the area (Shaw et.al., 1956, 100). The Markland bog was apparently never brought into production.

The 1940's were a decade of rapid change in agriculture in Newfoundland. Subsistence agriculture declined during the war years as employment and cash wages increased. When Newfoundland joined Confederation in 1949 farmers lost the previous tariff protection, and the availability of the Canadian social insurance system, especially unemployment benefits, accelerated further the discontinuance of a subsistence type of agriculture. In the wake of these developments, a Royal Commission was appointed in 1953 to survey and appraise the possibilities for developing agriculture in Newfoundland. In their study the Commission identified the difficulty of obtaining winter-feed at a reasonable cost as the real obstacle in the way of producing livestock and livestock products efficiently (Shaw, et.al., 1956, 1). Considering the great expense incurred in the importation of a bulky product like hay, and costly clearance of the often forested and stony mineral soils, the Commission paid particular attention to the possibility of using boglands for this purpose. They found existing vegetable gardens established on boglands to be of special interest, as well as the appearance of the old experimental plots in Harbour Grace and Colinet. They examined many of the bogland gardens all around the province, and found them all to follow the same pattern. They consisted of an area only a few yards wide and some 20 yards long, around which ditches about 18 inches wide and about two feet deep had been dug, and the earth from the ditches had been spread on the surface of the area enclosed. These ditches did not act as drainings in the ordinary sense as they remained filled with water to the level of the water table in the surrounding bog, but an artificial lowering of water table had been effected by raising the land surface. The gardens were found to be successfully producing ordinary vegetables, usually without any fertilizer but kelp, and the soil had every appearance of good garden soil. The Commission was also much impressed with the growth of native and domestic grasses in the old experimental plots in Harbour Grace and Colinet, the firmness of the sod, and the structure of the soil.

The Commission found the above evidence to be of sufficient importance to convince them that the boglands had potential value for agricultural purposes. At this time it was felt unwise, however, to arrive at definite conclusions as to the ultimate value of boglands in Newfoundland as farm land. It was noted that much experimental work on bogland reclamation had been undertaken in many countries of northern Europe and that bogs were being reclaimed there on a large scale, but

> "Success, however, has not always been achieved. There have been many failures. Many experimental projects have been undertaken in the past, and much money and labour spent in connection with them only to be abandoned as impracticable" (Shaw, et.al., 1956, 88).

The Commission realized that bogland reclamation might be problematic in Newfoundland but in spite of mixed success in Europe, and no conclusive results of the Commission of Government's efforts in the 1930's, they felt that the available evidence strongly indicated that at least some of the boglands of Newfoundland might be worth reclaiming. The Commission therefore recommended that a well-planned experiment, including a careful consideration of costs of reclamation compared to clearing mineral soil, should be undertaken immediately to test the validity of the assumption that bogland could be reclaimed and converted into valuable farm land. The Commission suggested that the project be carried on over a period of years and financed jointly by the federal and provincial governments.

The government of Newfoundland responded favourably to these recommendations. In 1955 two members of the Royal

Commission travelled to Great Britain and Scandinavia to study bogland reclamation. They were much impressed by the similarity of the bogs in Norway and Newfoundland, and in light of the large scale of bogland reclamation in Norway, arrangements were made to have the Director of the Norwegian Bog Association study the potential of bogs in Newfoundland. He toured the province for three weeks in September 1955, and in his report he concluded that a large part of the Newfoundland bogs could be cultivated to economic advantage, first and foremost for hay and pasture. He also recommended that a sub-station of the Canada Experimental Farm in Mount Pearl should be established to deal with experiments on bog soils, possibly at Colinet (Lödesöl, 1955).

Also resulting from the Commissioners' visit to Europe, orders were placed for drainage machinery. Excavators and disc ditchers were considered to be too expensive (Newfoundland Agricultural Division, 1959, 8), instead a Scottish Cuthbertson type F drainage plough, which made open drains 2 feet (60cm) deep, was purchased, with a Cuthbertson Water Buffalo tractor. The machinery arrived in November 1955, and was tried briefly at Markland but as the bog was already frozen and snowcovered further testing of the equipment was deferred until the spring of 1956. In March 1956, J. V. Healy, an experienced bogland engineer from Ireland came to Newfoundland under contract with the Newfoundland Department of Mines and Resources to supervise the experimental programme of bogland drainage and cultivation. His arrival marked the beginning of a new phase in the development of bogland farming in Newfoundland.

3.4 Experimental programme 1956-59

The objectives of the experiment, as laid down by the Newfoundland Minister of Mines and Resources, were as follows:

(1) Determine whether bogland soils could produce hay and forage crops.

(2) Determine what vegetable crops, if any, could be produced on these soils.

(3) Determine the most efficient machines for the required reclamation.

(4) Investigate and determine the most suitable machines for the efficient harvesting of hay and silage crops.

(5) Determine the average cost per acre of such reclamation.

(6) Determine what grass and clover mixtures were most suitable to this type of soil.

(7) Investigate lime and fertilizer requirements of bogland soils. (Newfoundland Agricultural Division, 1959, 3).

A comprehensive experimental program was thus envisaged in which all the major factors relating to an economical production of forage and vegetable crops on boglands would be examined.

As in all bogland reclamation projects drainage was the first operation to be carried out. The Cuthbertson drainage plough made open drains to a maximum of two feet, and it was decided that they would be spaced 50 feet (15m) apart. This was necessarily an arbitrary spacing, but based on experience gained in Ireland under somewhat similar climatic conditions. The parallel drains discharged into collector drains which in turn discharged into nearby low-lying areas.

As soon as the drainage operations got under way at Colinet in April 1956, frequent stoppages were encountered due to spoil jamming under the plough beam and between its slitting discs. Thus, it became immediately apparent how wise it had been to hire an experienced bogland engineer to adapt the machinery to Newfoundland conditions. As it was felt vitally necessary to get an area drained and seeded during the 1956 season it was decided to drain manually while the plough was further tested and modified. 350 acres (140ha) were drained during the season of which 100 acres (40ha) were limed, fertilized, and seeded. Lime was spread by a modified lime distributor pulled by a Bombardier Muskeg tractor with no difficulties encountered except that it was a time-consuming and costly operation as only relatively small loads could be taken out on the bog at a time due to the low bearing strength of the bog. The application rate was two tons per acre. As no rotovator was available, disc harrows were used for mixing the lime in the top layer and preparing a seedbed. The harrows did not perform well as the elasticity of the bog caused the sliced strip to fall back in one piece into its original position. The same spreader as used for liming was successfully used for fertilizing and seeding after which a light rolling was applied. The fertilizing rate was 1000 lbs. per acre (1100kg per hectare) of standard 6-12-12 fertilizer fitted with trace elements. Germination was good and a top dressing of 100 pounds per acre (110kg per hectare) of Ammonium Nitrate was then applied. This application rate is very high but it was felt to be justifed as the primary objective in 1956 was to establish if grass crops could be grown on bog soils. Grass seedings were begun on June 8th, and by mid-August the earliest sowings had to be cut and saved for hay. Partial success was achieved in producing vegetables on the original partially drained experimental plot.

In looking back on the experimental project in 1956 it is clear that only one of the seven objectives referred to above was achieved; i.e., that grass could be grown on boglands. Some loosely organized experiments had been started on suitable grass and vegetable species without any conclusive results. The machinery was found to be inadequate but some progress was made in adapting it to

Newfoundland conditions. The cost of reclamation was extremely high as manual labour had to be relied upon for draining. Liming and fertilizing rates were decided upon arbitrarily, as was the drainage intensity. Finally, the importance of separating the drainage and cultivation operations became apparent. As no pre-drained area was available all reclamation operations were collapsed into one season so that the bog did not get time to dewater and settle before being brought under cultivation. This resulted in severe damage, and in places closure of the ditches, and cultivation operations were generally hampered.

Notwithstanding the difficulties encountered in 1956, the experimental project was continued in 1957. The Federal Department of Agriculture Experimental Farm Service set up a comprehensive series of experiments to determine lime, fertilizer, and seed requirements, in addition to drainage experiments. Further progress was made in adapting machinery to local conditions. A bigger drainage plough had been purchased in the fall of 1956, capable of making 3 feet (90cm) deep drains, which indicates that the two feet (60cm) deep drains were felt to provide insufficient drainage. A further 100 acres (40ha) were seeded to grass, and 550 additional acres (220ha) were drained at Colinet, but the emphasis was on investigating the acre cost of reclamation using the machinery that by then had been modified to suit Newfoundland conditions. Great care was taken to arrive at realistic costs of reclamation, depreciation of machinery was included at a flat rate of 20 per cent and another 20 per cent were added to the hourly charge of each piece of machinery to cover future overhaul and repair. The results of these cost investigations are displayed in Table 1.

Table 1

Cost per acre of reclamation at Colinet in 1957

Limestone @ 2 tons per acre (5 tons per ha), $11.70 per ton, including rail and road transport	$ 23.40
Fertilizer @ 400 lbs. per acre (450kg per ha), $80.00 per ton, including transport	$ 16.00
Seeds @ 30 lbs. per acre (34kg per ha), $0.60 per lb.	$ 18.60
Operational costs	$ 45.93
Managerial/supervisory overhead	$ 10.00
Total cost per acre	$113.93

Source: Healy, 1958.

In spite of the high cost of liming it was argued that the figure of $113.93 per acre was as low as that of any land development in the province, and a great deal lower than average (Newfoundland Deputy Minister of Resources, 1958). Thus, the results of the first two years of the experimental project were interpreted as extremely successful. In a "Summary Report with Suggestions for Future Action", it was pointed out that, "Since it appears that bogland can be used advantageously for agriculture and can be developed more cheaply than mineral soil, it may be well to concentrate a major part of future agricultural development on bogs, not only for their inherent value but also to conserve the mineral soil for much-needed forest production.

The time has now arrived when some major decisions must be taken on a policy for bogland development. For example: (1) where and when will boglands be developed; (b) who will use it when it is developed; (c) what assistance will Government give in development; (d) should bogland be farmed in small lots, i.e. 10 to 100 acres, or large lots of 100 to 1000 acres.

Obviously, if our bogland is to be used people must be made interested in it. To do this we believe it will be necessary to demonstrate its development and use, not only at Colinet but also at such other points as Musgravetown, Lamaline and St. George's. We think these demonstrations should not be less than 100 acres, but bigger lots should be developed as soon as people are anxious to obtain the land to work it. Further development at these points will, of course, then depend on the demand for developed bogland. Developed bogland can be useful in all size lots, from 10 acres for family use to grow some vegetables and keep a cow, to 1000 acres or more lots for large-scale farming. We should be prepared to encourage the use of peat lands in all size lots. However, the size of the lots will depend on the ability of interested persons to acquire and develop and economically farm the lots in their possession. This in turn will be influenced by the degree of Government assistance given in the form of (a) technical advice; (b) cash grants; (c) development loans; (d) loans for working capital. It is unlikely that there will be much development without some substantial Government gifts and financing...In either case carefully worked out conditions for the maintenance and use of the land should be imposed and provision made for inspection to see that the necessary maintenance was carried out. This is most necessary, as neglected bog farms would deteriorate to their original condition fairly rapidly...The disposal of the land developed raises many issues. For example, how should the land be apportioned among applicants? One firm criterion which should be applied, however, is that the applicant should show ability to produce efficient stock, equipment and working capital to use the land to advantage". (Newfoundland Deputy Minister of Resources, 1958).

From the above it is clear that the Agricultural Division of the Department of Mines and Resources regarded reclamation of boglands in Newfoundland as the way to dramatically increase agricultural production in the province. In light of later developments it is interesting that the agricultural authorities were well aware of the importance of farmers' interest in bogland reclamation and their proper management of the fields for a successful policy of bogland reclamation.

Decisions on the policy of commercial bogland reclamation were deferred, however, for another two seasons. The experimental project in 1958 consisted of further cost investigations under more varied conditions; testing of farm machinery to harvest hay; drainage of demonstration plots; sheep grazing experiments; and continued experimental work by the Federal Department of Agriculture. A standard farm tractor fitted with half-tracks and dual front wheels was found to perform well for harvesting hay, as did mounted types of a mower and a rake while the baler and tedder did not perform adequately. The cost investigations resulted in an increase in operating cost of $13.03, from $45.93 to $58.96, giving the total reclamation cost per acre as $126.96, or $114.96 if the normal lime subsidy was taken into account. The increase in operating costs was explained by the limited size of the operation in 1957 and by the partial unreliability of certain machines when subjected to continuous double shift operations in 1958. A small flock of sheep had overwintered on the reclaimed boglands during the 1956-57 and 195758 seasons without any shelter or loss, and thrived generally well. The Federal Department of Agriculture extended those grazing investigations in 1958, and for that purpose 600 sheep were satisfactorily pastured on the reclaimed bog from June to November. Three additional demonstration plots were drained in 1958; 100 acres (40ha) in Winterland, 90 acres (36ha) in Musgravetown, and 150 acres (60ha) in St. George's.

A comprehensive report of the experimental project in 1956-58 was compiled by the Agricultural Division of the Department of Mines and Resources (Newfoundland Agricultural Division, 1959), apparently to facilitate decision-making as to whether or not a policy of bogland reclamation should be adopted. A decision to go ahead with a full-scale commercial reclamation programme for farmers was not taken, however, until late in 1959. In the meantime, the boglands at Colinet were maintained and cropped. A lightweight baler was purchased and tested, and performed well after being fitted with tracks. Forage harvesters were found to perform adequately after being slightly modified. Preliminary investigations were undertaken of peat moss production on the Avalon and Burin peninsulas. Approximately 100 acres (40ha) were seeded to grass on the demonstration plot at Winterland. On account of the lateness of the season and indications from experiments at Colinet it was decided to rotovate only half of the seeded acreage. Grass catch on the rotovated section was excellent but patchy on the remainder. At Musgravetown approximately 80 acres (32ha) were seeded to grass, but grass growth was patchy due to impeded drainage. The bog at Musgravetown was only lightly humified and the drainage plough was found to do a poor job in such types of bog. Already in 1957 a prototype ditch cleaner of a disc type had been constructed and tested further during the 1958 season, and in 1959 a full-size disc-ditcher was constructed. Apart from the ability to successfully ditch the low humified bog, the disc-type of ditcher has other advantages over the drainage plough. Flotation is much better and spoil removal is not a problem as the material from the ditch is scattered over the adjacent field during ditching.

After four years of experimental work it was decided to embark upon a commercial bogland reclamation programme for farmers in Newfoundland (Appendix C). To sum up, the accomplishments of the experimental programme up until then, were as follows:

i. Drainage. A new type of machinery (disc-ditcher) had been developed in favour of the original drainage equipment. An efficient machine had been produced to maintain ditches. Design was under way of a cambering machine to facilitate surface run-off.

ii. Cultivation and harvesting. Cultivation machinery was adequate, but had to be operated from full-tracked tractors. A half-tracked tractor was found to be well suited to the various aspects of hay-making. A baler and a forage harvester had to be modified for use on boglands but standard mower and rake were adequate. A tedder did not perform well. Problems of transporting heavy loads of hay or silage across the bog remained unresolved.

iii. Treatment rates, etc. Liming, fertilizing, and seeding rates had only been tentatively determined, and the same applied to drainage intensity. Winterkill did not appear to be a problem. Sheep had pastured well for four seasons, but cattle for only one season. Reclamation of the three demonstration plots at Winterland, Lethbridge, and St. George's had been only moderately successful.

It is clear from the above that it had been proved that forage crops could be produced on reclaimed boglands, and that the bogs could be reclaimed economically. What was not so clear were the economics of farming those reclaimed fields. What were the fertilizing requirements? What about the long-term persistence of the seeded grass species under variable conditions? How costly were the modifications to harvesting machinery? Were the parts readily available to the farmers? And finally, how typical was Colinet of the bogs of Newfoundland? There are some indications that the Agricultural Division was aware of at least some of the above unknowns, but felt that since so much progress had been made so far, the remaining problems would be ironed out with input from farmers getting involved, and ongoing experimental work by the Federal Department of Agriculture.

3.5 Commercial bogland reclamation

The bogland reclamation bonus policy was introduced by the Newfoundland Agricultural Division in 1960 and offered farmers a grant of up to $125 an acre for bogland reclamation as had been the case for the clearing of mineral soil (Appendix C). Farmers responded with some enthusiasm; during 1960 fifty-four applications were received with about twenty additional ones per year for each of the next three years (Figure 5). Most of these applications were from farmers whereas a few were from labourers or unemployed people. In 1960, for instance, about two-thirds of the applications were from farmers who had some farm machinery, about ten per cent from part-time farmers without any farm machinery, and a quarter of the applications came from people who were not farming at all. To put these figures in perspective it may be noted that according to the 1961 Census there were 1752 census-farms in the province,

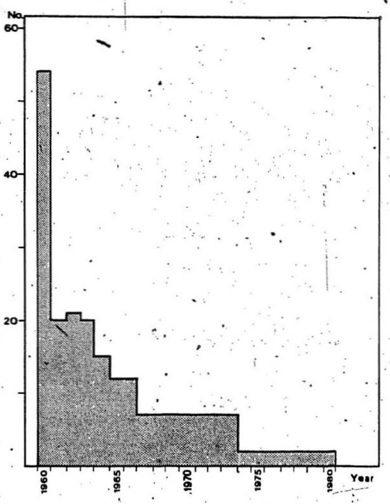

Figure 5 Annual number of applications for bogland reclamation in Newfoundland 1960-1980 (Data only available in aggregate form for 1965-66, 1967-73, and 1974-80)

Source: Files of the Newfoundland Agriculture Branch, unpublished data

462 of which were commercial farms[1]. The spatial distribution of the applications shows a striking correlation with the location of the demonstration plots (Figure 6) which indicates that in the context of innovation diffusion they were indeed successful in increasing the observability of the particular innovation under study, i.e. bogland farming.

During the 1960 season only half a dozen projects were started. This was due to time spent on maintenance and completion of the reclaimed boglands at Colinet, Winterland, Lethbridge, and St. George's, additional work on the utilization of peat moss, and the preparation for a full-scale reclamation programme for farmers. The processing of applications was as follows: Once an application for reclamation had been received the Assistant Bogland Development Supervisor inspected the bogland in question and interviewed the applicant after which he made recommendations as to whether or not that particular piece of bogland should be developed for the applicant. The final decision was made by a special Bogland Development Committee[2] after which an

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1 A Census-farm was defined as an agricultural holding of one acre or more with sales of agricultural products during the past 12 months of $50 or more, but commercial farms had sales of $1200 or more.

2 The Committee consisted of the Deputy Minister of Agriculture, the Assistant Deputy Minister of Agriculture, the Director of Agriculture, the Assistant Director of Agriculture, the Bogland Development Supervisor, and the Assistant Bogland Development Supervisor.

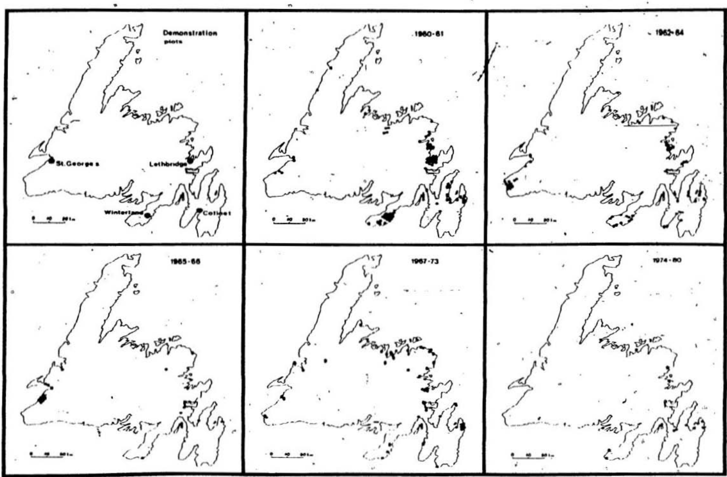

Figure 6 Location of demonstration plots, and spatial distribution of applications for bogland reclamation, Newfoundland 1960-1980. (Based on unpublished data, Newfoundland Agriculture Branch)
Note: Each dot represents one application

agreement was signed between the approved applicant and the Department (Appendix D). The criteria applied by the bogland inspector included acreage, depth, grade, type of growth on bog[1], number of ponds, accessibility from road, and distance to farmstead. When it came to screening the applicants the main criterion seems to have been whether the applicant was actively farming or not, so that farmers' applications were generally approved if sufficient acreage of suitable bogland was to be found near the farm in question whereas applications from non-farmers were generally not approved. In almost all cases the Bogland Development Committee concurred with the recommendations made by the bogland fieldman.

During 1960 five plots of bogland were drained under the bogland reclamation policy for eight individuals, totalling about 180 acres (73ha) (Figure 7). One of the projects was for a big dairy farmer from Bishops Falls who had to buy most of his winter-feed from the mainland, three projects were for root crop farmers interested in sheep and cattle raising, and the fifth was a joint venture for three men interested in sheep-raising but without any farm machinery. In 1961 three of the five plots were seeded to grass (Figure 8), the seeding of one was delayed until 1962

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1 No brush cutter was available until 1962 so before that date scrubby bogs were normally not considered suitable for development.

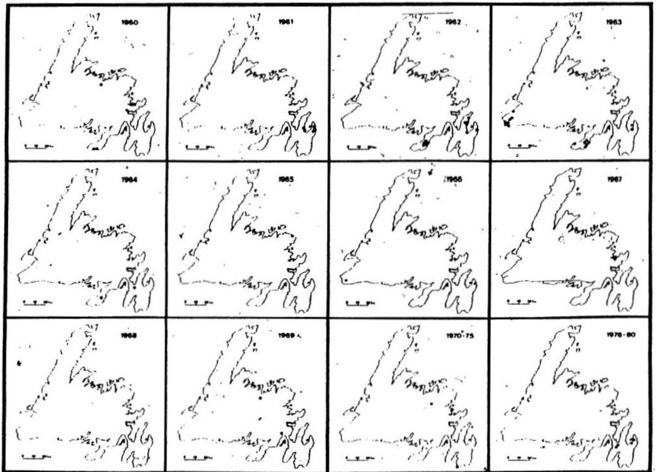

Figure 7 Spatial distribution of bogland draining for farmers, Newfoundland 1960-1980. (Based on unpublished data, Newfoundland Agriculture Branch)
Note: Each dot represents drainage for one farmer

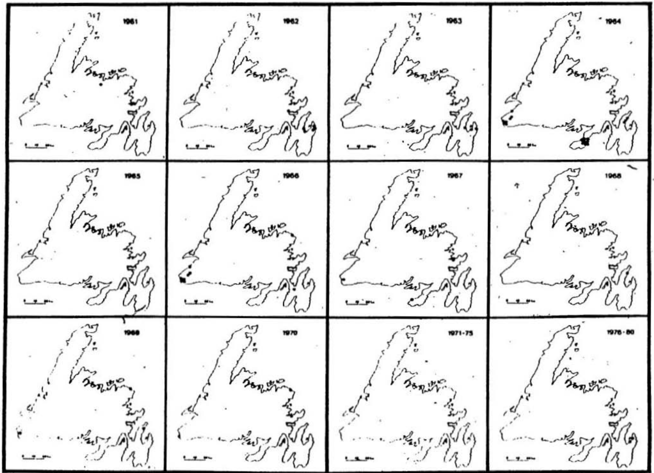

Figure 8 Spatial distribution of bogland seeding for farmers, Newfoundland 1961-1980. (Based on unpublished data, Newfoundland Agriculture Branch)
Note: Each dot represents seeding for one farmer

because of a disputed title to the land, but the fifth, the one for the three "interested" sheep-farmers, was never completed.

The cultivation and seeding operations on all three projects were carried out shortly before and during a severe drought and germination was consequently poor, resulting in a patchy grass growth. The bogs in question were of a low humified type[1], and on one project the top layer of the bog literally blew away. All three plots would have needed at least a partial reseeding in 1962, but the follow-up on behalf of the Department appears to have been inconsistent. The project in Bishops Falls was surface-reseeded and fertilized, whereas nothing seems to have been done to rectify the patchy grass growth on the other two projects. In the case of the Bishops Falls project germination of the reseeding was excellent but as the season progressed it became apparent that the grass was not growing satisfactorily. The farmer had by this time purchased and adapted equipment to work on the bog, but during haymaking further inadequacies of the project appeared. Rainfall was above average and it became apparent that the layout of the drainage system was incorrect, resulting in ditches remaining

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1 Bog are commonly rated on a so-called von Post scale of 1-10. A low rating refers to a bog-layer consisting of relatively undecomposed plant remains, and a high rating to highly decomposed peat. Low rating layers are considered best for peat moss production, medium rating layers for agricultural purposes and high rating layers for use as fuel.

filled with water. A further problem arose from the fact that the growing surface was composed of bumps and hollows which created difficulties in mowing and raking, as well as the fact that the hollows acted as catch basins for the rain. Grass growth was, however, also poor on the better drained areas of the bog, indicating that fertilization had been insufficient, or that the plants from the surface seeding had not succeeded in penetrating the 1961 sod.

In the spring of 1963 further surface seeding and liming was undertaken by the Department, along with fertilizing. The twenty-three fields received different treatments and the different results were recorded at harvesting time, but as no comparative check plots were used no scientific deductions could be made as to the reasons for inadequate yields. The local agricultural fieldman felt, however, that inadequate fertilizing rates were an important factor in explaining disappointing yields. This explanation was further substantiated by the fact that when the farmer fed the bogland hay to his dairy herd milk production dropped but when he switched to mineral soil hay again milk production increased. In discussing further the problem of fertilizing rates and plant nutrients the fieldman noted that:

> "Variations in results on different sections of bogs point to factors involving plant food availability, and plant absorbtion of nutrients applied. These factors cannot be assessed by visual observation only, other than it can be seen that some areas look better than others. I

believe that it is essential to institute a soil testing and plant analysis programme on bogs being developed. This is the only way in which it is possible to find, and correct, the deficiencies existing in organic soils, the finding and correcting of which are essential for economic production on such soils" (Wood, Oct. 1963).

There is no indication that these constructive suggestions were ever heeded by the Department. The fieldman was further critical of the fact that the necessary work of re-ditching had not been carried out as previously arranged, and pointed out that the failure to reset the drains would make it virtually impossible for the project to be a success. In concluding his report on the project the fieldman stated that:

"There are definite indications that the farmer is losing interest in the area being developed for him. This has been due primarily to:-

(a) The work called for on his part, and which he has definitely given to the development, has not shown the results promised.
(b) Very little care has been taken to insure (sic) that the project would be a success, from the start the operation was rushed, and the follow up has been spotty, confused and makeshift.
(c) Obviously necessary corrections for the improvement of production conditions have not been carried out.
(d) No definite indication has been given whether the project is to be continued to the promised stage of 48 acres of reclaimed bog.
(e) The ditching equipment promised to correct existing drainage problems during 1963 was not forthcoming.
(f) He feels that as a result of the bog development and the supposed production from it, that he has been, and is being restricted on mineral soil clearing.
(g) That unless 48 acres of bog are developed it will not pay him to buy the type and quantity of equipment needed for bogland production, and that unless production increased considerably on the bog the marginal mineral soil

available to him for clearing will produce more profitably.

It is my opinion that unless some positive plan and action is undertaken, the farmer will refuse to go further with the project. It is also my opinion that he is justified in many of his assumptions and speculations. The planning, management, and follow up has been inexcusably poor, the production entirely uneconomic, the latest effort has not produced one ton of dried hay per acre. In view of these facts, I suggest that a review of the situation is called for at an early date, that a clear cut and reliable programme of development be instituted, that the interested parties meet and work out such a programme, and that unless some such decision is reached the project should be abandoned. As a pilot project of bog development in Central Newfoundland, it has little to recommend it to possible producers" (Wood, Oct. 1963).

The above has been quoted at length, not only because it relates to one of the very first bogland reclamation farm projects, but also because it is relevant to problems and issues in other subsequent bog reclamation projects. The work called for on the part of the farmer was road construction to the bog, fencing of the seeded area, and, if necessary, the clearing of trees and brushes off the bog.[1] The road construction often proved to be quite costly, and in some cases the farmer was later reimbursed by the Department but no consistent policy seems to have been adhered to. It should be noted here that the farmers involved in the three projects of 1961 all appear to have put a great deal of effort and money into the projects, but eventually only one of the bogs in question was ever brought into full

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1 After a brush cutter became available in 1962 this became the responsibility of the Department.

production. Secondly, the quesiton of the Department's commitment to reclaim all of the 48 acres (19ha), preferably within three or four years, was often raised, both by agricultural fieldmen and farmers themselves. If the agreement is carefully read (Appendix D) it is clear that it was up to the Department to decide whether or when it would complete the 48 acres for any one farmer. This reservation clause was probably included in the agreement so that the Department would not be committed to continue a reclamation project if the farmer concerned showed signs of inability or unwillingness to maintain and utilize the reclaimed bogland. There were numerous instances, however, where the farmers who were successfully using the boglands for hay had to wait for a number of years to get additional acreage reclaimed. As mechanized harvesting of the bog needed somewhat specialized, or at least modified machinery this factor of waiting and uncertainty may have deterred farmers from taking the full step of equipping themselves properly for farming the reclaimed boglands. A related point here is the general issue of follow-up of projects and extension service. When the bogland reclamation was being planned, Healy advised that:

> "I think that a great deal of trouble may be avoided and acceptance of bogland farming be more easily gained if the necessary information is made available to the farmer. There are, after all, many differences in practical operation of bog and mineral soils which the average farmer is not aware. I suggest that an attractive and succinct

booklet telling in a practical manner what should and should not be done, what advantage to expect, etc., would be of great value to the prospective bogland farmer. I consider the matter important enough to say that I think a lot of time and thought should be given to its production" (Healy, 1960).

Unfortunately, this suggestion appears to have fallen on deaf ears in the Department, and as a result there was in several instances confusion on the part of farmers over the proper procedures in bringing boglands into full production.

Referring back to the project in Bishops Falls, the ditching machinery carried out the upgrading in the late fall of 1963, and in a letter to fieldman Wood, the Director of Agriculture stated that:

"I trust that this latest development will complete our commitments in respect of this project, and it can now be regarded as a completed project" (Badcock, 1963).

In a reply to the Director of Agriculture, fieldman Wood acknowledged that the work carried out on drainage was highly satisfactory and should eliminate former drainage problems. He pointed out, however, that the surface of the reclaimed bog was still extremely uneven making it virtually impossible to use equipment efficiently. He added that:

"From my understanding of bog development for private farmers, and based on the understanding which the farmer himself has expressed to me as related to his agreement with the Department, the Department is committed to the development of 48 acres, if the available bog area so permits. If this is not correct, or if the Department has decided to change the original development plan, I

> suggest that the farmer be advised, by the Department, at the earliest possible date" (Wood, Nov. 1963).

Gerald Williams, a bogland fieldman who had been involved with the bogland reclamation programme since its inception in 1960, also expressed concern about turning the Bishops Falls project over to the farmer, and referred to the lack of established criteria for determining when projects should be considered completed:

> "Of the twenty-three fields seeded only eleven, or about half have better than a good yield and stand. I hardly think that this is good enough to say that the project has been completed. One thing that has not been clarified is what yield of cured hay per acre should be expected before a project is considered completed. How many tons of cured hay per acre is indicated by "good" yield or "excellent" yield. My own rule of thumb estimate is that a "good" yield is two to two and one half tons per acre and an "excellent" yield is three or more tons per acre. In my opinion, unless we can produce an average of two or more tons per acre on bogland the first year after seeding, we are wasting our time by developing bogs. I don't think we should turn a bog over to a farmer until it is producing an average of two or more tons of cured hay per acre or the equivalent for pasture. I don't believe this project averaged anything near two tons per acre on the twenty-eight acres developed. I don't believe we should lease this bog at this time to the farmer until further investigation or treatment can be made" (Williams, 1964).

Notwithstanding the advice from the two fieldmen, the Department informed the farmer in April 1964 that the project was considered completed. The reclaimed bogland was inspected in 1967 when weeds and mosses were found to have taken over practically the whole bog. The farmer claimed that he was unable to carry out the required topdressing, etc., of the bog because of the fact that the Trans Canada Highway now cut through his farm leaving no access to the bog area. He had repeatedly requested government permission to construct a road leading off the TCH, but without success.

The development of this particular project is interesting for a number of reasons. It was the first one undertaken under the Bogland Reclamation Policy, and the farmer in question was a big dairy farmer who greatly needed winter-feed for his herd. As the local agricultural fieldman was particularly critical of his Department's performance in bringing the bog into production, the voluminous correspondence in the Department's files is particularly revealing in exposing the weaknesses in the implementation and administration of the policy, and the difficulties that can be encountered in bogland reclamation.

In 1962 five additional projects were seeded to grass (see Figure 8). As the season progressed it was noted that in spite of good germination the grasses developed a somewhat stunted appearance. With the experience from the project in Bishops Falls in mind, it was decided to reseed and refertilize the plots to bring the fertilizer rates up to 800-900 lbs/acre (800-1000kg/ha) instead of the hitherto recommended rate of 500 lbs/acre (560kg/ha). This resulted in a much improved grass growth and in April 1963 it was decided to raise the fertilizer rate for initial bogland seedings in the future to 1000 lbs/acre (1120kg/ha), while 300-500 lbs/acre (340-560kg/ha) of standard 6-12-12 fertilizer fitted with trace elements was recommended for yearly topdressing. This revision of fertilizer rates shows clearly that the bogland reclamation was still in its experimental stages in Newfoundland, and that a fullfledged commercial reclamation programme may have been somewhat premature.

In 1963 three new projects were seeded with satisfactory results. 1963 was also a year of an extensive drainage programme focused on the Burin Peninsula and the West Coast. It is apparent from Figure 6 that the greatest number of applications for bogland reclamation were received from the Winterland and Lethbridge areas. Surveys were undertaken in the two areas in 1960 and 1961, and extensive areas of bogs suitable for reclamation were located in the Winterland area, but the Musgravetown farmers were interested in a bogland area near Glovertown. As the acreage near Glovertown was smaller than previously reported, and because it was located over forty miles (25km) from Musgravetown, the Department decided that it would be unwise to undertake this project. Instead it was decided to reclaim a number of scattered bogs in the Lethbridge-Musgravetown area in 1961, but due to lack of funds that project was not undertaken that year, and for reasons unknown this project was not undertaken until a community pasture was initiated there in 1970. In Winterland the demonstration plot was used as a community pasture as early as 1960, and in 1961 a couple of farmers grew vegetables in it and cut some hay. In 1962 drainage was undertaken for five farmers in Winterland, and for three additional farmers there in 1963. In a preliminary survey report of the Winterland area it had been pointed out that:

> "This can be, if handled right, a big operation and on it may hinge the success of bogland development in Newfoundland. A lot of discussion and careful planning will be needed before final plans are carried out" (Williams, 1961).

The outcome of reclamation efforts for the Winterland farmers were thus considered to be of vital importance for the future of the bogland reclamation policy. It should be noted that the farmers in question were mainly root crop farmers farming on relatively small acreages of land but with few prospects of enlarging their farms onto mineral soil as there was little mineral soil left in the area. Most of the farmers had a tractor and a mower, but that was in essence all the hay machinery they possessed. It was probably in light of these circumstances that the acreages seeded for them in 1964 were limited to five acres each. With one exception the fencing of the seeded plots, which was the farmers' responsibility, was not carried out after seeding, and at least one of the plots was completely destroyed by grazing horses a few weeks after seeding. A road had been constructed to the bogland plots, apparently at the expense of the Department, but the roads were in a rough condition and in May 1965 four of the farmers stated that they would be unable to fence the bog haylands unless the roads to the bogs were made passable by truck or tractor. The roads were repaired but nevertheless the four men in question did not fence or topdress their hay boglands. The other four farmers had their bogs fenced and topdressed. None of the eight farmers made any hay on the reclaimed boglands in 1965 nor at any time after that. They all grew vegetables, however, in the bog but that subject is beyond the scope of this thesis. Reference was made above that the Winterland farmers were for the most part root crop farmers and in retrospect it appears that their expressed interest in raising beef and sheep was superficial rather than real. The Winterland farmers who had been described by a bogland fieldman as,

> "having proven their ability to successfully carry on commercial farming and should therefore be given every consideration in this development" (Williams, 1961).

had in fact most "nonchalantly" abandoned the hayland prepared for them, and seriously undermined the continuation of the bogland reclamation programme.

In section 3.4 of this chapter the establishment of three demonstration plots was discussed. One of those demonstration plots was located on the West Coast, in the St. George's area. The drainage with the Cuthbertson plough had been inadequate, and it was decided to redrain the plot in 1960 with the new ditcher, after which the plot was seeded to grass. In 1961 it was fenced and topdressed, and reseeded where necessary, but for the next few years only a couple of acres were cut for hay, apparently because of the lack of interest from people in the area. Farmers in Robinsons, South Branch, and the Codroy Valley became interested, however, in bogland reclamation (see Figure 6), and in 1963 seven projects were started and in 1964 112 acres (45ha) were seeded (see Figures 7 and 8). The projects were quite successful, as witnessed by the following quote from a press release from the Newfoundland Minister of Agriculture:

> "Two farmers with beef herds used the land for grazing while the others cut the grass for winter feed. Whilst the dry and warm weather conditions favoured bogland operations this year, the results achieved far exceeded farmers' expectations. Crops of two and a half tons of hay or more, per acre were harvested with normal hay making equipment. The aftergrowth was lush and several farmers took off a second cut. As pasture, the bogland stood up particularly well, offering both a firm surface over which the cattle could travel and feed of excellent quality and quantity. The reaction of farmers for whom these projects were developed is one of enthusiasm as well as enquiry as to when more bogland can be reclaimed. The reaction of the farmers is when can the drainage equipment come to the Valley to ditch and drain more land. All farmers are looking with a keen interest and a new outlook at every piece of bogland in the area and now regard what heretofor was

> wasteland as most desirable land for production of grass" (Keough, 1965).

As a result of the success of the reclamation projects referred to above an additional 114 acres (46ha) were seeded for the seven farmers in 1966. But the success and enthusiasm was shortlived. Two of the farmers gave up farming in 1967, and a power transmission line cut through a third farmer's bog in 1968. At least three of the projects were turned into community pastures in 1967 and 1968, while two were taken over by an eighth bogland farmer who later had 45 acres (18 ha) reclaimed for him in 1967 and 1969. In a report from 1968, the boglands farmed by this farmer were all found to show signs of infertility, and the plot seeded in 1967 had not even been topdressed.

Judging from the scanty correspondence between the Department and the farmers involved, and from interviews carried out with three of the eight farmers involved, it seems that the farmers had taken advantage of the available bogland reclamation policy, partly because some of the farmers had exhausted their quota for clearing mineral soil, and partly because of lack of machinery to clear mineral soil. It so happened that the summer of 1965 was an exceptionally dry one, grass growth was excellent, and the farmers found that they could use ordinary machinery in the harvesting of the bogs, but under more normal conditions in subsequent years they experienced difficulties in this regard. More importantly, some of the farmers applied very little topdressing, if any, with the inevitable result that the reclaimed boglands reverted rather quickly to their original type of vegetation.

It is obvious from Figure 7, that drainage for individual farmers was practically abandoned after the 1963 season. There are a number of reasons for this. Firstly, a big beef ranch, the Flying L, was initiated on the Burin Peninsula, and during the 1965 season, the bogland reclamation unit was heavily engaged in reclaiming boglands to provide winter-feed for the beef herd. Secondly, during the late 1950's and throughout the 1960's a number of communities were incorporated and the newly established Town Councils frequently issued orders forbidding cattle or sheep to roam at large within the Council area. As a consequence livestock owners suddenly found themselves without their traditional grazing grounds. Communal pasturing had been carried out at Colinet and Bay Roberts since 1958 and at Winterland since 1960, and this had been quite popular as these pastures were fenced and thus provided refuge for livestock hitherto roaming at large. This use of the demonstration plots at Colinet and Winterland thus marked the beginning of using reclaimed boglands on a communal basis. Thirdly, there appears to have been considerable concern within the Department over:

> "the continued expenditure of public funds...for the development of property for a single individual" (Newfoundland Minister of Agriculture, 1963)

With an increasing number of requests for community pastures coupled with the lack of success in some of the bogland reclamation projects undertaken for individual farmers, the Department seems to have swiftly channelled funds[1] and resources into the community pasture program, at the expense of reclamation for individual farmers. Funding of community orientated projects as opposed to projects for individuals seems to have been preferred under the ARDA programmes, and management of the bogland pastures by trained personnel was probably seen as an attractive alternative when compared to some of the projects undertaken for individual farmers where management and maintenance on behalf of the farmers was found to be inadequate.

There were also some concerns over the increasing cost of reclamation of boglands. According to the agreements made between the farmers and the Department, the farmers were supposed to reimburse the Department for any expenses incurred by the Department in reclaiming bogland if the cost was in excess of $125.00 an acre ($309 per

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1 Since 1952 the Government of Canada had cost-shared land clearing with the Provincial Government on a 50-50 basis. Bogland Reclamation was included under this cost-sharing agreement. This agreement was terminated in 1962 after which arrangements were made for federal assistance to agricultural development in Newfoundland under the new ARDA program.

hectare). For some reason this was never applied to actual reclamation, but in 1963 the actual cost of reclamation amounted to $163.00 an acre ($403 per hectare) as depicted in Table 2. At the same time the average cost of developing mineral soil was estimated at $330.00 an acre ($815 an hectare), but the government subsidy was only $125.00 ($309) in that case. On an acreage basis the government was thus subsidizing bogland reclamation more heavily than the development of mineral soil and it is therefore understandable that there was some concern over the continuation of the bogland policy, particularly in light of lack of proper maintenance and utilization of some of the reclaimed boglands. No formal evaluation of the program seems to have been undertaken, but in 1967 the agricultural fieldmen in Central and Eastern Newfoundland reported, at the Department's request, on the status of the reclaimed boglands.

Table 2

Cost of Bogland Reclamation

Ditching @ acre	$ 11.40
Liming @ acre	32.86
Rotovation @ acre	16.32
Seeding and fertilizing @ acre	64.89
Rolling @ acre	6.53
Transportation @ acre	12.50
Overhead @ acre	18.50
	$163.00

Source: Newfoundland Agriculture, 1964.

There is no evidence to indicate when or if the bogland policy was changed or discontinued, but around 1966 the Bogland Development Committee ceased to function and applications were subsequently dealt with on an ad hoc basis. In 1972 and 1973 the development of boglands for individual farmers again attracted some attention, as the bogland development phase of the community pastures had been greatly reduced. The backlog of applications from individual farmers for bogland reclamation was screened under a new Bogland Development Committee, and as a result fifteen applicants were advised in April 1973 to apply under the newly established ARDA-funded Capital Assistance Programme which provided for a $200.00 grant an acre ($494/ha) for developed bogland or mineral soil, and seventeen additional applications were considered to require checking and were referred to the extension service. In a document written in 1976, however, it is stated that only two projects of bogland reclamation for individual farmers had been initiated since 1970. In discussing the reasons for this lack of development it was pointed out that present development costs amounted to $300.00 an acre ($741/ha) or more, whereas the assistance available to the farmer was only $200.00 an acre ($494/ha). It was also argued that the reluctance on the part of farmers to engage in something unfamiliar to them was an important factor in this regard (Anon. 1976). Departmental policy was not conducive to development either, as in 1975 and 1976 there was some confusion between senior officials in the Extension Division of the Department as to whether or not there was a policy of bogland reclamation in effect.

Today less than half a dozen farmers are utilizing the boglands for pasture and hay, excluding the community pastures. In Table 3 a summary is given on the fate of each individual project. A few of the projects were never brought under grass, i.e. only drainage was undertaken, and the majority of the remainder were only cropped for a few years. In some cases the individuals concerned gave up farming and thus gave up the boglands but the most common reason for abandoning the projects appears to have been the machinery issue; in the 1960's only three farmers appear to have availed themselves of tracked tractors to harvest the bogs.

When considering the feasibility of undertaking another attempt to get farmers in the province to utilize the bogs, it is of vital importance to discover why the extensive efforts of the 1960's were so unsuccessful. As early as 1957, Healy noted that "Peat and Poverty" or "Turf with Trouble" were notions firmly rooted in the minds of the farming population that would have to be overcome before any progress could be made.

Table 3

Bogland projects undertaken for individuals in Newfoundland, 1960-1980

Approximate Location	Drained	Seeded	Abandoned (approx.)	Comments
Bishops Falls Central Nfld.	33 a 1960	25 a 1961	1964	Never in full production, cut off by TCH.
Bloomfield Bonavista Bay	38 a 1960	23 a 1961		Never properly established (drought at seeding).
Bloomfield Bonavista Bay	18 a 1960	18 a 1961	In use	Used for hay.
Milton Trinity Bay	27 a 1960	27 a 1962	1965	Never in full production, farmer retired 1966.
Lamaline Burin Peninsula	40 a 1960			Never seeded.
St. John's East	5 a 1961	5 a 1962		Never used.
St. John's West	50 a 1961	15 a 1962	1968	Used for pasture, farmer retired around 1970.
St. John's West	42 a 1961	14 a 1962 16 a 1964	1969	Used for pasture, farmer retired around 1970.
Hodgewater Line Conception Bay	50 a 1961	15 a 1962	1970	Used for hay. Abandoned as ditch cleaner not available.
Hodgewater Line Conception Bay	36 a 1961	16 a 1963	1964	Farmer disposed of his sheep flock in 1964.
Avondale Conception Bay	12 a 1961	12 a 1962	1967	Used for hay for two years, then pasture

Approximate Location	Drained	Seeded	Abandoned (approx.)	Comments
St. John's West	23 a 1962	16 a 1963	1968	Used for pasture, farmer gave up farming around 1970.
Carbonear Conception Bay	10 a 1962	10 a 1964		Never used. Expansion of dairy operation fell through.
Western Bay Conception Bay	35 a 1962	10 a 1964 15 a 1968 6 a 1969	1979	Used for hay. Farmer retired 1979. Now used for vegetables.
Carbonear Conception Bay	10 a 1962	10 a 1964	1966	Too wet to harvest with wheeled tractor.
Carbonear Conception Bay	10 a 1962			Used for vegetables 1971-73.
Winterland Burin Peninsula	30 a 1962	5 a 1964		Never used(see text).
Winterland Burin Peninsula	30 a 1962	5 a 1964		" " " "
Winterland Burin Peninsula	30 a 1962	5 a 1964		" " " "
Winterland Burin Peninsula	15 a 1962	5 a 1964		" " " "
Winterland Burin Peninsula	10 a 1962	5 a 1964		" " " "
Winterland Burin Peninsula	30 a 1963	5 a 1964		" " " "
Winterland Burin Peninsula	30 a 1963	5 a 1964		" " " "
Winterland Burin Peninsula	30 a 1963	5 a 1964		" " " "
Burin Burin Peninsula	12 a 1963			Never seeded.
Burin Burin Peninsula	20 a 1963			Never seeded.

Approximate Location	Drained	Seeded	Abandoned (approx.)	Comments
Fortune Burin Peninsula	30 a 1963	25 a 1967	1976	Used for hay and pasture. Needed ditch-cleaning when abandoned
Foxtrap Conception Bay	5 a 1963	5 a 1963	In use	Used for pasture.
South Branch West Coast	35 a 1963	16 a 1964 20 a 1966	1968	Used for pasture and hay.
South Branch West Coast	23 a 1963	16 a 1964 9 a 1966	1968	Used for pasture and hay.
Searston West Coast	48 a 1963	16 a 1964 16 a 1966	1967	Farmer gave up farming. Bog turned into a community pasture in 1967.
Searston West Coast	48 a 1963	16 a 1964 16 a 1966	1967	Turned into a community pasture in 1967.
Doyles West Coast	26 a 1963	16 a 1964 16 a 1966	1968	Used for hay and pasture.
Doyles West Coast	27 a 1963	16 a 1964 11 a 1966	1968	Farmer gave up farming.
Robinsons West Coast	48 a 1963	16 a 1963 32 a 1966	1968	Turned into a community pasture in 1968.
Whitbourne Avalon Peninsula	11 a 1964	11 a 1966	1969	Used as pasture for beef cattle by a St. John's real estate man.
Winterland Burin Peninsula	30 a 1964			Never seeded.
Lumsden North East Coast	70 a 1965	20 a 1966 10 a 1969 28 a 1970	In use	Used for pasture and hay. Farmer probably going out of farming.
Doyles West Coast	45 a 1966	15 a 1967 30 a 1969	1970	Farmer had considerable acreage of mineral soil as an alternative.

Approximate Location	Drained	Seeded	Abandoned (approx.)	Comments
St. John's East	15 a 1966			Never seeded.
Bloomfield Bonavista Bay	25 a 1967	25 a 1967	In use	Demonstration plot reditched. Used for pasture and hay.
Bishops Falls Central Nfld.	40 a 1969			Made part of a community pasture in 1970.
Swift Current Placentia Bay	11 a 1969			Never seeded. On a senior politician's property.
St. Shotts St. Mary's Bay	30 a 1970	5 a 1971	1973	Used as geese pasture.
Gander Central Nfld.	5 a 1974			Used for vegetables.
Spencer Bridge Bonavista Bay	5 a 1974			Used for vegetables.
St. John's East	25 a 1974			Never seeded. Planned for disposing of swine manure.
Kelligrews Conception Bay	2 a 1977	2 a 1978	(1978)	Not been harvested (hay) as it is too wet.
Portugal Cove Conception Bay	15 a 1977	15 a 1979	In use	Used for hay and pasture.
Argentia Access Rd. Avalon Peninsula	10 a 1978			Not seeded yet.
Argentia Access Rd. Avalon Peninsula	15 a 1978			Not seeded yet.
Northern Arm Central Nfld.	100 a 1979			Used for vegetables.

A similar explanation is frequently given today, i.e. that the reason for the lack of success of the bogland program was the farmers' prejudiced attitude towards the agricultural potential of the bogs. While this factor should not be overlooked, it should not be accepted as a full explanation. The problems encountered in the establishment of satisfactory grass stands on the demonstration plots reclaimed under the supervision of an experienced bogland farm specialist, and the difficulties associated with the first commercial project, in, Bishops Falls, are enough evidence that successful bogland reclamation is not always an easy task.

The decision to import expertise from countries where bogland reclamation was being actively carried out was undoubtedly a wise one. In the literature on international transfer of technology it is well recognized that:

> "...the most effective and efficient transfer of technology is the long-term transfer accomplished through the transfer of people" (Cetron, 1974, 7).

Furthermore, adaptive research and development have been identified as the critical elements in the international transfer of agricultural technology. Hayami and Ruttan (1971, 170), for example, point out that inadequate recognition of the location-specific character of agricultural technology was a major reason for the lack of effectiveness of much of the technical assistance effort of national and international agencies during the 1950's and 1960's. In the Newfoundland case the numerous modifications and alterations designed and carried out by Healy on the necessary equipment for drainage, cultivation, and harvesting made it at least possible to carry the programme through its experimental stage. In addition expertise was applied to the programme with the establishment of Colinet in 1957 of the Peat Sub-Station of the Canada Experimental Farm, St. John's West, and a judicious system of processing applications was set up. These efforts notwithstanding not all of the preconditions necessary for successful development were met.

The earliest projects turned out to be problematic at first, mainly due to adverse weather conditions at the time of seeding. Furthermore, it was eventually discovered that fertilizing rates were inadequate. It is at this stage that the scheme can be criticized for its organizational inadequacy. The follow-up of the projects appears to have been insufficient, and efforts were focused on additional projects rather than the successful completion of existing ones.[1] It is notable, for example, that there is no

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1 It should be remembered though that a backlog of applications was immediately created, survey work was time-consuming, and farmers were pressing for further reclamation.

reference in the voluminous documentation of the first project in Bishops Falls to advice being sought from the Federal researchers who were involved in bogland experimentation at Colinet. There is also some evidence to indicate that the follow-up that did exist during the first two or three years of the programme was sometimes of an indifferent nature.[1] If there was indeed a widespread attitude of pessimism towards using bogland as farm land, the difficulties encountered during the first years of commercial reclamation will likely have served to reinforce that attitude.

In terms of Klonglan and Coward's model (cf. Figure 4) it thus appears that the critical breakdown occurred at the trial stage in Phase B. Instead of trying to ensure that trial acceptance occurred and use adoption followed, the emphasis was on getting as many farmers through the trial stage as possible. The numerous trial rejections as witnessed by Table 3 then probably had the double effect hypothesized by Klonglan and Coward, i.e. increased the rate of symbolic rejection and the rate of trial rejection by other farmers.

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1 A bogland fieldman questioned the stewardship of one of the bogland farmers in 1963 whereas another bogland fieldman pointed out that the low yields were caused by factors beyond the farmer's control, and added that "in the past, officers of this Division have tended to stand on the edge of a bog and give their opinion of the growth of the whole bog" (Williams, 1963).

Another important factor in the failure of the programme is the matter of machinery. Referring back to Rogers and Shoemaker's model (cf. Figure 3) it appears that too little attention was paid to this particular innovation characteristic of farming boglands. Extra flotation is required, for example, in the form of tracks instead of wheels, but as Newfoundland farming has been of a small scale nature and low degree of mechanization this additional machinery requirement was a serious hurdle for the small producer. In other words the "antecedents" combined with this particular innovation characteristic to make the adoption of the innovation slow. To aggravate the problem for the bigger farmers only relatively small lots were normally reclaimed for each farmer making it less economical to make the necessary investment in machinery. In this respect it is interesting to note that the only two farmers using bogland for hayland in 1981 were farmers who had considerable acreage reclaimed, and who had availed themselves of a modified type of machinery.

Another important dimension is the way in which farming is pursued in Newfoundland (cf. the "antecedents" in Figure 3). Beef and sheep farming in Newfoundland is generally of an extensive rather than intensive nature. Minimum amounts of inputs are supplied to the operation with low levels of output resulting, rather than managing the land and animals intensively for maximum returns per animal or per acre of land. This will be considered in more detail in the next chapter, but this type of management is particularly badly suited for bogland farming, especially under conditions of minimum drainage. The seeded grass species need ample fertilizer to establish themselves; and if they do not get that nourishment, the more water-tolerant species take over. An intensive extension effort to make the farmers aware of these two vital points, machinery and fertility, might have prevented the premature downgrading and abandonment of some of the projects but this was never undertaken.

But if the reclamation of boglands is so problematic why bother reclaiming them? One of the answers to this question is that if boglands are subjected to a certain type of management they should make ideal farmland, particularly for grassland production. They are nearly level, stone-free, fertile once established, and lend themselves well to mechanization. Few boglands have been well established and full advantage has not been taken of the mechanization potential. In large part this appears to have been due to inadequate drainage. The implications of introducing more intensive draining, will be examined in a later chapter.

CHAPTER IV

GRASSLAND FARMING IN NEWFOUNDLAND AND BOGLAND RECLAMATION

4.1 Introduction

So far in this thesis bogland farming in Newfoundland has been examined in isolation from farming in general in the province. But there is a need for a closer look at grassland farming in general as many of the general issues would apply to bogland farming in particular. The historical context of farming in Newfoundland will be briefly examined, and a statistical overview of the present grassland farming industry follows. Then the physical and socio-political factors affecting the development of these industries will be considered briefly after which a somewhat detailed analysis of the existing farms follows. The purpose of considering the above mentioned factors is to determine whether the grassland farm sectors are likely to provide an outlet in the near future for a possible renewed bogland programme.

4.2 Historical background

Agriculture in Newfoundland is of a fairly recent origin. The resource of the region most attractive to Europeans for exploitation was the rich fishing grounds off the island. Apart from a few settlement schemes in the seventeenth century permanent settlement was generally discouraged until the nineteenth century for strategic and mercantile reasons. At the end of the eighteenth century the population became more of a permanent nature (Handcock, 1977, 21) which stimulated a demand for locally grown agricultural produce which in turn encouraged settlers to make and expand gardens. It was not until 1813, however, that the colonial authorities were allowed to lease land to be used for farming. Even so MacKinnon (1981) has demonstrated that prior to that a considerable amount of farming was carried out in the vicinity of St. John's, and by 1840 some 400 farms had been established, providing mainly root crops and fresh milk for the rapidly growing population of the colony's capital. Agricultural production increased steadily throughout the nineteenth century (Figure 9) and in aggregate terms the agricultural sector became a significant part of the economy; in 1911 it accounted for an estimated 21 per cent of the total gross value of production in Newfoundland, and in 1921, admittedly a bad year for the fishery, the figure had risen to 28 per cent (Alexander, 1978, 56).

The cattle industry slowly declined during the interwar years but since World War II there has been a dramatic reduction in the number of cattle and sheep kept in the province. This is particularly true for the sheep industry which has almost disappeared. When Newfoundland joined Confederation in 1949 Canada's extensive social welfare programme suddenly became available to

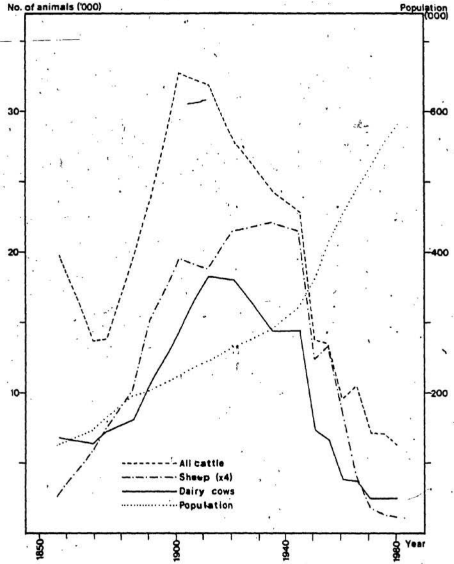

Figure 9 Number of sheep (x4), cattle, and dairy cows (on farms and elsewhere 1857-1966, on farms 1971-1980), and population, in Newfoundland, 1857-1980

Source: Census of Newfoundland, 1857-1945; Census of Canada, Agriculture-Newfoundland, 1951-76; Newfoundland Agricultural Statistics, 1980/81

Note: Numbers of sheep refer to winterfed sheep (estimated for 1951-80 from numbers in summer)

Newfoundlanders. The availability of unemployment insurance to a society that was geared to seasonal industries, such as fishing and logging, served to broaden the income generating possibilities and to reduce the incentive to carry out a subsistence type of farming to supplement the seasonal industries. A further deterrent to farming in general, at least in the short run, was the loss of protective measures, such as tariffs to Newfoundland farmers when Newfoundland joined Confederation.

In this context of decreasing agricultural production Kikuchi and Hayami's (1978) study is of interest. They did a comparative study of the agricultural histories of Japan, Taiwan, Korea and the Philippines, especially as it related to adoption of high yielding rice varieties and the associated irrigation technology. By using indicators such as agricultural output per worker and per hectare of cultivated land area, i.e. labour and land productivity, they argued that in each of these countries population pressure, while causing deterioration in the land/labour ratio, induced an increase in land productivity. Analogously, in the case of Newfoundland it can be argued that the reverse process has occurred, the population pressure decreased when Newfoundland became a province of Canada in 1949, and the produce of the vast and superior lands of Central and Western Canada became more readily available to Newfoundlanders. Hence, agricultural production decreased as did the impetus for the development and application of innovations such as bogland farming.

Accompanying the rapid decline in subsistence farming there has been a gradual increase in a more commercial type of farming. In 1951, for example, there were 51 farms in the province with annual sales of $10,000 or more, but by 1980 there were 208 such farms. Notwithstanding the effects of inflation this increase reflects the expansion of the hog and poultry industries, but there has also been gradual increase in herd and flock size of cattle and sheep farms. In 1951 there were 30 farms reporting 18 dairy cows or more, and two farms reporting 78 sheep or more, whereas in 1976 there were 41 such dairy farms and 19 such sheep farms (Census of Canada. 1951, 1976; Newfoundland Agricultural Statistics 1980-81).

4.3 Grassland farming in Newfoundland today - An overview

In 1980 there were 390 farms in Newfoundland with annual sales of $2,000 or more (Newfoundland Agricultural Statistics 1980-81), roughly half of which provided the farmers concerned with 75 per cent or more of their income. There are thus only around 200 full-time farmers in the province. Land in production amounts to 12400 acres (5600 ha), of which 85 per cent is used for pasture and hay, i.e. for grassland farming. There are 127 grassland farms, as defined in Table 4, 49 of which are dairy farms. The scale

Table 4

Number of farms, by commodity,
in Newfoundland and Labrador, 1980

Type of Farm[1]	Number of Farms	
Dairy	49	
Beef	49	
Sheep	20	
Dairy Replacement	5	
Livestock Feed	4	
Total Grassland Farms		127
Poultry	51	
Hogs	25	
Vegetables, Greenhouse Prod., etc.	147	
Mixed	40	
Total Other Farms		263
Total Number of Farms		390

[1]Note: 51 per cent or more of sales from a particular commodity.

Source: Newfoundland Agricultural Statistics, 1980-81.

of the dairy farm operations is substantially different from the other types of grassland farming (Figure 10). Only two of the 49 dairy farms had annual sales of less than $10,000 whereas all but eight of the 78 other grassland farms have annual sales in this category. In fact, about 95 per cent of the dairy farms provided more than half of the income of the farmers in question whereas only 20 per cent of the other grassland farms generated the level of income. Generally speaking dairy farming is a commercial venture in Newfoundland whereas sheep and beef farming are of a supplementary nature.

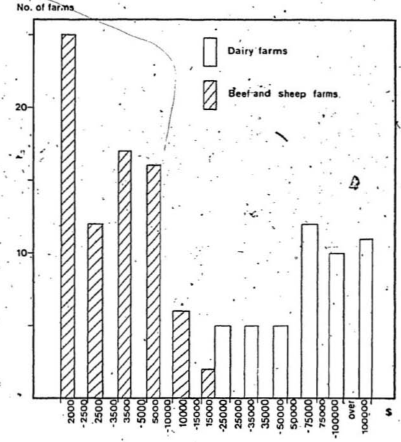

Figure 10 Annual sales of dairy, beef, and sheep farms in Newfoundland, 1980

Source: Unpublished farm survey data, Newfoundland Agriculture Branch

About 21 per cent of the total farm cash income in the province came from grassland farming in 1980 (Newfoundland Agricultural Statistics 1980-81, 77), and as the agricultural industry as a whole contributed only 0.6 per cent to the Gross Domestic Product in Newfoundland in 1979 (Newfoundland Government, 1980, 12) it is obvious that contribution of grassland farming in Newfoundland is negligible to the provincial economy. In fact the province is a long way from self-sufficiency in the various grassland farm products (Table 5). No dairy products, such as cheese or butter, are manufactured in the province, and beef production is negligible compared to imports.

Given the above facts of low self-sufficiency rates of grassland farm products in Newfoundland, the next section examines the various kinds of constraints and incentives affecting the grassland farm industry in the province.

Table 5

Production and Consumption of Grassland Farm Products in Newfoundland, 1979

Type of Product	Production -tons-	Per Cent of Consumption
Fresh Milk	8490	52
Beef	351	2
Veal	47	17
Mutton and lamb	79	18

Source: Newfoundland Agricultural Statistics, 1980-81, 59.

4.4 Constraints and incentives to grassland farming in Newfoundland

Soils. The factor most commonly cited as inhibiting agricultural development in Newfoundland is the scarcity of good farm soil. The Avalon peninsula, for instance, on which most of the agricultural production takes place, has no soils in agricultural capability Classes 1-2[1], and soils in Classes 3-5 occupy only 0.1 per cent of the land area of the peninsula (Heringa, 1981, 54). Notwithstanding scattered pockets of better soil to be found elsewhere in the province, e.g. on the West Coast, the soils are, in the Canadian context, generally not well suited for agricultural development. Excessive clearance costs are frequently involved in preparing the land for production, and liming has to be carried out to correct for acidity. The discussion above refers to the mineral soils; until recently organic soils were not included in the identification of potential farm land, but some of the limitations of the mineral soils are notably absent from the organic soils; factors such as topography, stoniness, and low moisture retention capability.

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1 Canadian soils are grouped into seven classes in which the degree of limitation to agriculture becomes more severe from Class 1 to Class 7 (Canada, Land Inventory, 1966).

Climate. Another factor often suggested as inhibitive to agricultural development in Newfoundland is the harshness of the climate. Again, in the Canadian context, this argument is justified. In particular, the spring and summer seasons normally arrive late compared to the rest of Southern Canada, resulting in a shorter growing season. The growing season begins[1] in the early part of March on Vancouver Island, B.C., a month later in Southern Ontario, just after Mid-April on the Prairies, the latter part of April in the Maritimes, but not until Mid-May in Newfoundland (Chapman and Brown, 1966). The summers are also cooler; the July mean temperature in Newfoundland is commonly between 58 and 60°F (14-16°C) whereas the corresponding figures for the Maritimes are 62-66°F, 64-68°F on the Prairies, and 68-72°F in Southern Ontario. Not surprisingly the number of degree-days[2] in Newfoundland is substantially lower than in the other provinces; around 2000 compared to 2500-2750 in the Maritimes, just under 3000 on the Prairies, and 3000-4000 in Southern Ontario. This degree-days differential is particularly important for

1 Defined as the first date of occurrence of a mean temperature of 42°F (5.6°C) in the spring.

2 Defined as the accumulated difference between the daily mean temperatures and 42°F for the period between the dates of occurrence of 42°F in the spring and in the fall

growing certain high temperature demanding crops such as corn and soybeans, but less so for grassland farming. In fact, the relatively cool and moist summers in Newfoundland are actually conducive to good grass yields, though making hay under such conditions poses some problems. It would appear that the most serious climatic limitation to efficient grassland farming in Newfoundland is not the quality of the summer season as such, but the late arrival of the season which increases the amount of winter-feed needed to carry the stock through the winter.

Location. Whereas the two physical factors already discussed, soil and climate, tend to put the Newfoundland farmer at a disadvantage compared to his Canadian colleagues, he enjoys a locational advantage, i.e. the proximity to the Newfoundland market for farm products. The locational advantage stems from two related factors, one is the cost of transporting the produce, the other is the perishability of certain products. For fresh milk both of the above factors serve to increase the locational advantage for the Newfoundland dairy farmer, but with the availability of refrigerative transportation facilities the provincial beef and lamb production enjoys only the former factor of locational advantage. This factor is also less important as various inputs for the production of these meats are subject to high transportation costs,[1] this applies to hay in particular. Hence, economical production of winter-feed from boglands would serve to make the beef and sheep industries more competitive with production from the mainland and abroad.

Organization and marketing. There are, of course, not only physical factors that influence agricultural development in Newfoundland; dimensions of a more human nature are also relevant in this respect. As has been mentioned before, farming in Newfoundland was until recently predominantly of a subsistence type. Therefore, the farmers have traditionally not bargained collectively for a minimum guaranteed price for their products. As far as the sheep and beef industries are concerned the bulk of existing production is sold directly from the producer to the consumer, i.e. the so-called freezer trade, and the product is usually not subjected to official inspection or grading.

The situation of the dairy farmers is different. On the West Coast the farmers own and run the processing facility as a co-operative, whereas in Eastern Newfoundland there are three processing companies; each of which negotiates with its suppliers for the price paid to the

1 The freight of feed grain is, however, subsidized by the Federal government.

producer, and the wholesale price. Nova Scotian interests own two of the three St. John's dairies, representing about 80 per cent of the local market. As there is substantial surplus production of fresh milk in Nova Scotia, part of which is trucked to Newfoundland, the dairy farmer in Newfoundland is left in the precarious position of not having any formal guarantee of disposing of his milk, even if the local market is far from being saturated with fresh milk from the area. Whereas restrictions on inter-provincial trade are usually illegal in Canada, a few commodities are exempted from this rule. Fresh milk is one of these commodities and through the establishment of a Milk Marketing Board a province can exert certain control on imports of the product. It is perhaps a measure of the traditional independence and lack of co-operation amongst the Newfoundland farmers that in spite of a steady increase in the amount of fresh milk trucked in from Nova Scotia during the last decade such a Milk Marketing Board has not yet been established.

Government assistance. Another possible reason for the low level of agricultural development in Newfoundland is that government support towards the industry is inadequate. In reviewing the history of agriculture in Newfoundland Close (1978) argued that the "stop-and-go" nature of governmental assistance to agriculture had resulted in its development as a "shadow" resource, i.e. its full potential had not yet been exploited. Whereas his analysis seems justified for the pre-Confederation administrations it appears that a more balanced and consistent agricultural policy has since been pursued, particularly in recent years. Given the limited number of farmers in the province the amount of public resources devoted to support the industry is substantial; the staff of the Provincial Agriculture Branch numbers around 150 with another 95-100 employed in the province by Agriculture Canada. On the other hand this activity may represent a "go" phase of Close's model and the farming industry could be in for a "stop" phase if the exploitation of the offshore oil and gas resources gets under way.

One aspect of governmental administration that has, however, impeded commercial agriculture in recent decades is the problem of land titles. For historical reasons possessory titles to land became a dominant form of land tenure (McEwen, 1977). The Newfoundland Royal Commission on Agriculture identified the land tenure problem as one of the most serious obstacles to agricultural development. Accordingly, a major recommendation of the Commission was to introduce a nominal land tax which would at least allow the Crown to regain some of the idle land by default (Shaw et.al., 1956). This recommendation was not heeded by the government of the day, and it was not until the late 1970s that outright grants of agricultural land were replaced with long-term leases. As a result the numerous problems of land tenure and land use have been allowed to accumulate. As many occupants do not hold a legal title of land ownership, the land may not be marketable nor usable as a collateral when lending institutions are involved. Consequently land fragmentation, idle or underutilized land, and non-farmer ownership have combined to restrict farm development and expansion. However, in 1980 legislation was passed to exempt productive farmland from property taxes, and thus encourage that idle land be brought back into production (Newfoundland Agriculture Branch, 1980/81). Other measures taken to protect the agricultural land base include a land-freeze on agricultural land in and around St. John's to prevent land speculation that would alienate agricultural land from farming (Crammer, 1974, 26).

4.5 Grassland farm management in Newfoundland

Having briefly considered the environmental and political context of grassland farming in Newfoundland an examination of the farm operations themselves is in order. Generally speaking one would expect that the low self-sufficiency rate referred to above indicated that large scale local production was not economical. The following examination of the existing production units will attempt to test the validity of that generalization.

Production economics of different commodities appear to be a somewhat neglected aspect of agricultural research in Newfoundland. However, in the Canada/Newfoundland Agriculture Development Subsidiary Agreement for 1978-1983 funds were made available to undertake cost of production studies for all major commodities produced in the province, on a priority basis. It was planned to utilize the results of the relevant production studies for this thesis, but so far only the sheep study has been completed, the dairy study is incomplete due to the low number of farmers that provided usable information for the study and the suspected unreliability of the data, and no cost of production study has been initiated for the beef industry. There are, however, earlier economic studies of the dairy and beef industries in the province, and these will be examined here along with the farm survey data collected annually by the Newfoundland Agriculture Branch. Concern is mainly with the current economic viability of each of the three grassland farming sectors, i.e. the sheep, beef, and dairy industries, and whether there is a latent need for bogland reclamation in the future development of these industries.

The sheep industry. A cost of production study was initiated by the Newfoundland Agriculture Branch in early 1981 to examine the financial costs and returns associated with sheep production in the province. Each of the 35 producers who had 30 or more ewes was contacted, but only 13 co-operated and provided primary data of cost inputs and dollar returns.

The size of the flocks ranged from 30 to 120 ewes but averaged 54 ewes. Lambing percentage was only 1.0 per ewe, and the average number of marketed lambs per ewe was 0.8. The average lamb carcass weight was 32.5 lbs. (14.8kg) and sold for $1.80/lb. ($3.96/kg). Marketed wool averaged only 3 lbs. (1.4kg) per ewe selling for 75 cents/lb. ($1.65/kg). Assuming that the thirteen sheep flocks are representative of the industry[1] it appears that sheep farming, as presently practiced in Newfoundland, is highly uneconomical (Table 5). Not only are the receipts low but the returns to management are actually negative. 1980 was not considered a particularly bad year for the industry, and as it is most unlikely that the operations are actually carried out with a continuous direct financial loss, a closer look at the study is in order. All the variable expenses reflect actual payments, except that for hay, and possibly for marketing. Average cost of a ton of hay was estimated at $80; hay was purchased at higher prices but as the farmers estimated their hay production costs to be considerably lower the $80 figure was used as an estimated

1 The thirteen flocks might actually well represent the better producers as one would expect them to be more co-operative in providing data for such a study.

average. As the amount fed per ewe is also an estimate based on recommended feeding practices the figure of $24.06 is probably an over-estimate for these operations which appear to minimize inputs. The figure for marketing costs may also be somewhat inaccurate as it reflects mainly the truck cost of the operations, as stated by the producers, but as these costs may involve other things than just marketing, the $7.22 figure may be an overestimate of actual marketing costs. On the other hand the quoted pasture cost does not reflect real costs as the $3.20 figure is based on community pasture fees, but the community pasture programme has been funded to a considerable degree by public funds.

From Table 6 it is clear that even if the actual expenses may be somewhat overestimated in the cost of production study the industry provides extremely low returns to the producer. This need not, however, be the case as there is room for better management at the farm level, which could greatly increase returns. As a lambing percentage of 1.0 per ewe is quite low, the cost of production study also projected income and expenses for increased lambing rates. The assumptions were that the average lamb carcass weight and the price per pound would remain constant at $32.50/lb. and $1.80/lb. respectively, average cull sales per ewe would increase from $3.88 to $7.50, and that expenses per ewe would remain constant except for "other feed". It is clear from Table 7 that increasing the lambing rate has dramatic

Table 6

Production economics of 13 sheep flocks in Newfoundland 1980

	Receipts per ewe	%	Fixed expenses per ewe	Variable expenses per ewe	%
Lamb sales	$46.80	88.4			
Cull sheep sales	3.88	7.3			
Wool sales	2.25	4.3			
Ewe deferred replacement costs			$ 6.80		10.6
Ram deferred replacement costs			.75		1.2
Hay				$24.06	37.7
Other feed				8.89	13.9
Marketing				7.22	11.3
Building repairs and maintenance				4.24	6.6
Fence repairs				4.18	6.5
Pasture				3.20	5.0
Electricity				1.95	3.1
Shearing expenses				1.25	2.0
Veterinary expenses and drugs				1.03	1.6
Identification tags				.33	0.5
Total	$52.93	100.0	$ 7.55	$56.35	100.0
Returns to cover labour, interest, taxes, and depreciation			-$10.97 per ewe		

Source: Unpublished cost of production study, Newfoundland Agriculture Branch.

Table 7

Effects of increasing lambing rates on gross income per ewe

	Marketed lambs per ewe			
	0.8[1]	1.3[2]	1.5[2]	1.8[2]
Lamb sales	$46.80	$76.50	$87.75	$105.30
Cull sheep sales	3.88	7.50	7.50	7.50
Wool sales	2.25	2.25	2.25	2.25
Total receipts	$52.93	$85.80	$97.50	$115.05
Expenses	$63.90	$63.90	$63.90	$ 63.90
Additional "other feed"		7.45	10.00	13.82
Total expenses	$63.90	$71.35	$73.90	$ 77.72
Gross income per ewe	-$10.97	$14.45	$23.60	$ 37.33
Gross income per 54 ewe flock	-$592	$780	$1274	$2016

1 Actual figures

2 Projected figures

Source: See Table 5.

effects on the economic viability of a sheep operation. The effect is somewhat exaggerated though as expenses per ewe would generally increase, i.e. not only "other feed" costs, particularly if a constant average carcass weight is to be attained.

Increasing the lamb carcass weight at constant lambing rates would have similar but less dramatic effects; average carcass weight of 40 lbs. (18kg), with 0.8 lambs marketed per ewe, would increase total receipts per ewe by \$25.20, and 50 lbs. (23kg) would yield \$96.13 compared to the existing \$52.93. The corresponding increase in expenses is difficult to estimate, but of the two options the increase in lambing rate appears to be a more rewarding alternative than increased carcass weight.

It was noted in the study that the physical production units usually consisted of older buildings and equipment fully depreciated but still utilized in the operation. In light of the above fact; the recent decline in the number of sheep kept in the province;[1] the continuous problem with dogs;[2] the adverse economic returns from the industry; and the recent decision to discontinue the operation of the Sheep Breeding Station, the outlook for the industry is

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1 On survey farms there were 6040 sheep in 1978, 5097 in 1979, 4298 in 1980, and 3509 in 1981 (Newfoundland Agricultural Statistics 1980-81, 38).

2 In Newfoundland roaming dogs frequently attack and kill sheep.

extremely serious. This scenario is in marked contrast to the optimism of a 1973 report, written by the former Director of Agriculture, where it was forecast that there would be 100,000 sheep in the province by 1984 (Badcock, 1973). This optimism was founded on the alleged existence of farmers' skills in sheep raising, a new dog act and livestock insurance policy, and the establishment of a Sheep Breeding Station. As it turned out the dogs appear to be as much a problem as ever, the Sheep Breeding Station was not the expected success,[1] and, judging from the 1981 cost of production study, the often stated skills of the Newfoundland sheep farmers are not apparent in the economic management of the flocks.

Two basic inefficiencies appear to exist: low ewe fertility, and low lamb carcass weight. The low fertility is probably due to two factors; inadequate winter-feed, and lack of selective breeding with respect to fertility. It is well known that to increase fertility the ewes need additional nutrition just before breeding, and again during the last few weeks of gestation, and the first weeks of the

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[1] The Sheep Breeding Station at Victoria, Conception Bay, was established to provide superior stock to sheep farmers in the province, and was to be the focus of governmental encouragement to the sheep industry. The farmers have complained, however, that the stock from the station has been of indifferent quality and ridden with diseases, and a decision has recently been made to discontinue the operation of the station.

lactating period. Whereas improved feeding practices would undoubtedly increase ewe fertility immediately, the selective breeding process necessary for really high fertility and carcass weight is more of a long term issue. It appears that high fertility has never been emphasized in the sheep industry in Newfoundland, at sheep fairs, for example, sheep were prized for their physique, with little or no consideration for their inherent fertility. Whereas this system of production may have been well suited to subsistence farming in the past[1] it is inadequate and inefficient for commercial sheep farming today. However, even well managed flocks with relatively high returns per ewe appear to be only marginally viable in Newfoundland when costs of land clearing and investments in buildings and equipment are considered. That was the conclusion of a three year Sheep Pilot Project that was initiated in 1978, involving three farmers, in an attempt to determine the economic viability of well managed sheep farms.

Generally speaking there are four important dimensions that determine the economic viability of sheep farming: summer pasture, winter-feed, market, and farm management. To a certain extent farm management is

1 An important factor here is that in raising sheep for subsistence purposes wool was an important product, and there was therefore less concern for maximizing lamb production.

dependent upon the other three factors, and there is considerable market potential for lamb within the province.[1] The other two factors, summer pasture and winter-feed, relate directly to soil resources. So far, boglands in Newfoundland have been reclaimed mainly for providing pasture (i.e. the community pastures) but it is clear that grazing sheep on reclaimed boglands throughout the summer is problematic from a nutrient provision viewpoint (Rayment and Winter, 1976). However, as will be further demonstrated later in this thesis, using the reclaimed boglands to provide winter-feed, instead of pasture, appears to be a much more promising option, and would probably induce better sheep production management at the farm level and therefore make the industry more viable. Thus, there may be room for the use of reclaimed boglands in sheep farming in Newfoundland in the future, but because of the present precarious state of the industry, any development in this regard would likely be on a small scale in the foreseeable future.

<u>The beef industry</u>. No up-to-date cost of production study exists for beef farming in Newfoundland. Certain characteristics of the industry may, however, be inferred from the available farm survey statistics. As with sheep raising, beef farming is usually carried out on a

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1 Not only is there a low self-sufficiency rate for lamb, but consumers prefer local lamb to imported lamb (Omnifacts, 1979).

part-time basis. Thus, of the 148 farmers who kept beef cattle in 1980 only two farmers had 30 beef cows or more, and farm sales from beef farms are relatively low, especially when compared to dairy farming (cf. Figure 10). Another parallel to the sheep industry is a steady decline in the number of beef animals kept on survey farms in recent years,[1] which probably reflects low returns from the industry as there is an ample market for beef in the province (cf. Table 5).

In 1976 a study was made of the economics of beef farming in Newfoundland (Johnson and Barnes, 1976). The study compared several scenarios; 10 or 50 brood cows, calves sold in the fall or overwintered and marketed in the following fall, hay produced on the farm or imported, new or old machinery and buildings, owned or rented machinery, and feeder calf operations. It was assumed that there would be a 90 per cent calf crop, and that calves would weigh 500 lbs. (227kg) in the fall and 1000 lbs. (454 kg) if they were overwintered. The amount of hay fed and the acreage needed to produce it was also estimated, and pasture costs were based on community pasture fees. Given these assumptions the study concluded that the smaller operations (ten brood cows) were a long way from justifying the investment

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1 There were 2918 beef cattle reported on survey farms in 1978, 2810 in 1979, 2689 in 1980 and 2124 in 1981.

in buildings and equipment, and while increasing the herd size to 50 brood cows substantially reduced operating costs per animal these operations were viable only if the farmer was established to some extent and items like tractor cost and depreciation would not have to be charged solely against the beef operation. On-farm production of hay, as opposed to importing hay, was found to be vital to the economic viability of a beef enterprise, and overwintering calves also increased returns per cow.

Unfortunately, the study did not establish how valid its assumptions are of actual beef production units in Newfoundland. For instance, were the live weights of 500 and 1000 lbs. representative of animals coming off the community pastures? At least in one instance there was considerable discrepancy between assumptions made and reality; the study assumed a hay yield of 3.2 tons/acre (7.9 tons/ha) whereas the average yield on Newfoundland farms is 1.5-2.0 tons/acre. But whether or not the assumptions of the study were generally consistent with real costs and returns there is a reason to believe that beef farming is more economically viable in Newfoundland now than when the study was undertaken as prices for beef have increased dramatically in recent years. Between 1976 and 1980 the average price paid to producers for hogs decreased by three per cent, for eggs and broilers it increased by about 18 per cent, for milk the price increased by 23 per cent, but for beef the increase was 114 per cent. While returns have increased the comparative position of the industry against the other grassland farming sectors and as beef farming creates a fair amount of farm income in Newfoundland, substantially more, for example, than sheep raising, the apparent low priority given to the industry by the Agriculture Branch is somewhat surprising.

While the beef industry is currently declining in Newfoundland it is likely that on-farm production of winter-feed will be a necessary prerequisite for any expansion that might take place in the future. But as with sheep farming it is not likely that bogland reclamation will be of much importance in raising beef in the province in the foreseeable future, simply becaue these two industries appear to be on a steady course of decline. The low returns relative to the necessary investment in land, machinery and buildings needed to establish a commercial beef or sheep farm make the reversal of this trend unlikely.

The dairy industry. In contrast to the sheep and beef industries dairy farming in Newfoundland is slowly expanding. Thus, while the number of sheep and beef on survey farms decreased by 42 and 27 per cent respectively between 1978 and 1981 the number of dairy cattle increased by 14 per cent during the same period, and the number of dairy farms increased from 41 to 49, suggesting better economic returns in that industry.

As mentioned earlier, a cost of production study for fresh milk was recently initiated by the Agriculture Branch in order to examine the economic returns from dairy farming in the province. Unfortunately, only 12 farmers, nine in the Eastern region and three in Western Newfoundland, co-operated and provided data for the study; moreover the Agriculture Branch considers data from some of these 12 farms to be inaccurate. Furthermore, as this is not a random sample it is open to question how representative those 12 are of the 49 dairy farms in the province and it is in fact almost certain that the better producers are over-represented. For example, the average amount of milk sold per cow on the survey farms is 5627 litres (12394 lbs.) compared to around 4000 litres (8800 lbs.) which the Agriculture Branch considers to be the provincial average, and the average herd size of 63 cows on study farms is also considerably bigger than the overall average. Notwithstanding the doubtful reliability and representativeness of the data a cost analysis of the twelve operations is presented in Table 8. The data indicates that unlike beef and sheep raising, dairy farming provides reasonable returns to the producer for his labour. The great number of items in Table 8 serves to illustrate how the economic performance of a dairy operation is dependent upon a number of factors, but it is beyond the scope of this thesis to examine in detail

Table 8

Production economics for 12 dairy operations in Newfoundland in 1980[1]

Revenues	Percentage	Per farm	Per cow	Per 100 litres
Fresh milk	88.2	$154344	$2466	$ 43.8
Stock dairy sales	9.4	16371	262	4.6
Other livestock sales	2.2	3818	61	1.1
Field crop sales	0.3	494	8	0.1
Total Revenues	100.0	$175026	$2797	$ 49.7
Expenses - variable				
Dairy feed	30.2	$ 42254	$ 675	$ 12.0
Other crop expense	16.6	23255	372	6.6
Labour	14.9	20836	333	5.9
Stock purchases	11.1	15500	248	4.4
Tractor & machinery repairs	3.9	5434	87	1.5
Utilities	2.3	3166	51	0.9
Truck and auto	1.8	2480	40	0.7
Building and fence repairs	1.4	1891	30	0.5
Vet and drugs	0.9	1309	21	0.4
Breeding	0.6	836	13	0.2
Dairy Supplies	0.3	443	7	0.1
Miscellaneous	5.2	7305	117	2.1
Total variable expenses	89.0	$124709	$1993	$ 35.4
Expenses - fixed				
Building depreciation	4.4	$ 6221	$ 99	$ 1.8
Machinery depreciation	3.3	4693	75	1.3
Interest	2.1	2893	46	0.8
Insurance	1.1	1537	25	0.4
Taxes	0.0	38	1	0.0
Total fixed expenses	11.0	$ 15381	$ 246	$ 4.4
Total expenses	100.0	$140091	$2238	$ 39.8
Returns to operator labour and investment		$ 34936	$ 558	$ 9.9

1 Note: Figures may not add up due to rounding.

Source: Unpublished cost of production study, Newfoundland Agriculture Branch.

each of these items. However, two items are of particular significance and relevance here: dairy feed and other crop expenses (i.e. feed grain, and hay/silage and pasture). Together these two items account for 46.8 per cent of total expenses or $1,049 per cow. In comparison similar studies of the dairy industry in Nova Scotia and Prince Edward Island (Hayman, 1981; and Oxley and Andrew, 1981) reveal that the corresponding figures for those provinces are 34.7 and 30.7 per cent, at $834 and $713 per cow. As the price of feed grain is roughly similar in all three provinces, due to the federal freight subsidy, the substantial difference in feed costs between Newfoundland on the one hand, and Nova Scotia and Prince Edward Island on the other reflects the high production costs of locally grown forage in Newfoundland and the expenses involved in importing hay. It can therefore be inferred that forage production on boglands could improve the economic viability of the dairy industry assuming of course that the bogland reclamation itself is a viable alternative to clearing mineral soil.

A comprehensive study on dairy farming in the St. John's area done in 1967 examined in some detail the implications of the small land base of the industry and the associated feeding practices (Retson and Hanlon, 1967). While the study concluded, after detailed analysis of the data collected, that in order to cut costs or increase returns attention must be given to all major factors influencing the farm business, it identified the heavy dependency on purchased feed as a major characteristic and problem of dairy farming in Newfoundland. In this regard the study revealed two important characteristics. First, on average each pound of feed grain produced only 1.4 lbs. of milk on the dairy farms in the St. John's area whereas on dairy farms in the state of Maine, U.S.A., a pound of feed grain produced about 2.6 lbs. of milk; and second, while in the St. John's area each cow eats about 5500 lbs. (2500kg) of feed grain and 5000 lbs. (2300kg) of forage, on the Maine farms 5500 lbs. of feed grain is associated with 8400 lbs. (3800 kg) of forage.

This heavy dependence on purchased feed reflects peculiar feeding practices used on Newfoundland dairy farms. Due to urban encroachment and high development costs hay and pasture land is small in relation to herd size. On-farm forage production has therefore been limited and due to a number of other factors[1] farmers have preferred to import

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1 On the basis of available nutrients one pound of grain is roughly the equivalent of two pounds of forage (Retson and Hanlon, 1967, 26). Since the federal feed grain subsidy was extended to Newfoundland at Confederation in 1949, the Newfoundland price differential between imported hay and feed grain has usually been less than twofold, and as the imported hay is often of uncertain quality farmers have preferred to substitute grain for hay, as opposed to the substitution of forage for grain usually recommended in other dairy areas.

feed grain rather than hay. These abnormal feeding practices not only inhibit milk production per cow, they also depress the butterfat content of the milk and may lead to problems in breeding, higher incidence of milk fever and mastitis, and a shorter cow life. The study demonstrated that on local farms where there was an above average use of forage the result was increased milk production per cow, lower milk costs, and higher labour earnings.

Now it might be argued that the situation has improved since 1966 but Table 9 provides evidence to the contrary. The table compares certain results of the 1967 study with information contained in the annual farm survey data collected by the Newfoundland Agriculture Branch. While herd size has increased considerably, production per cow has remained at the low level of under 8000 lbs., and hayland and pasture per cow has actually decreased, as have hay yields. Admittedly the farm survey data does not include data on feeding practices but the cost of production study does provide an indication that they have not changed much: in 1966 feed grain accounted for 35 per cent of total farm cash expenses but according to the 1980 study that proportion was only slightly lower at 33 per cent.

Another consequence of the small land base is the approach taken by the majority of dairy producers with

Table 9

Some Characteristics of the Dairy Industry in the St. John's Area in 1966 and 1980

	Number of Farms	1966	Number of Farms	1980
Number of cows	19	28.8	37	49.6
Milk production per cow				
high production herds	9	9138 lbs(4149kg)	16	9539 lbs(4331kg)
average of all herds	19	7918 lbs(3595kg)	33	7937 lbs(3603kg)
low production herds	10	6822 lbs(3097kg)	17	6430 lbs(2919kg)
Hay yields				
high yield farms	9	2.52 tons/acre (6.23 tons/ha)	13	2.21 tons/acre (5.46 tons/ha)
average of all farms	19	2.07 tons/acre (5.11 tons/ha)	27	1.83 tons/acre (4.52 tons/ha)
low yield farms	10	1.67 tons/acre (4.13 tons/ha)	14	1.48 tons/acre (3.66 tons/ha)
Hayland per cow	19	1.25 acre (0.51ha)	29	0.82 acre (0.33ha)
Pasture per cow	19	1.09 acre (0.44ha)	34	0.94 acre (0.38ha)

Source: Retson and Hanlon, 1967.
Unpublished farm survey data, Newfoundland Agriculture Branch.

respect to raising replacement heifers. Instead of raising their own heifers from the best cows, and in that way improve milk production per cow and the general economic viability of the operations, many producers import all their replacement heifers and cows.

In light of the above facts it is not surprising that the lack of locally grown forage has often been identified as the main obstacle to both the expansion of the industry and the efficient management of the existing operations. It is thus argued here that increasing the land base for hay production could significantly benefit the dairy industry and the means by which this could be achieved is to utilize boglands.

It should be noted, however, that increasing the land base alone is not enough to make the operations well managed, the management of the existing land base has been inefficient. Use of fertilizer has been small and low hay yields have ensued. According to the 1967 study an average of 5 tons per acre (12.4 tons per hectare) of manure was applied to the hayland, but on only 12 of the 19 study farms was any commercial fertilizer applied on hayland. Not surprisingly, analysis of soils indicated deficiencies in plant nutrients, and a low ph of 4.8. With regard to pasture, ten of the 19 farms applied manure and eight some fertilizer, but on seven farms no fertilizer or manure was applied on pasture. Apparently these practices have not changed much since 1966: according to the 1980 farm survey only 21 of the 38 dairy farms in the area used any commercial fertilizer. All 19 farms in the 1967 study pastured aftermath but the usefulness of this was severly restricted due to the late dates of cutting hay. Dates on which farmers began cutting hay ranged from July 7th to September 1st with an average date of July 25th. Average date of completion of haying was September 2nd but for individual farms the period extended up to October 5th. From a management point of view this late date[1] for haying is undesirable for at least two reasons. First, one of the chief factors influencing forage quality is the stage of maturity at which the crop is cut, with early cutting tending to improve forage quality. Second, early cutting facilitates increasing yields, either as aftermath for pasture or a second crop of hay.

It is clear from the foregoing that soil management and crop production have been inefficient; paradoxically, the small and valuable acreage of grassland has not been

[1] It should be noted that the summer in question was a good one from the point of view of crop production: "The hay crop in 1966 was excellent both in quality and quantity. Grass grew well under adequate moisture conditions during the early part of the growing season and reached maturity before the drier weather set in. It was harvested and cured under excellent hay making conditions" (Newfoundland Agriculture 1966-67, 5).

farmed intensively. However, notwithstanding the above limitations to efficient management there are indications that dairy farming in Nefoundland is an economically viable industry (cf. Table 8). Admittedly, the investment outlays for entering the dairy business are high and if the opportunity costs are considered (cf. Table 10), i.e. interest on the farmer's equity in the farm business, the returns to operator labour appear to be negative. The Newfoundland Agriculture Branch is, however, actively encouraging new entrants to enter the field of dairy farming by providing grants up to $75,000 per new entrant (Newfoundland Agriculture Branch 1980/1981, 41). It is therfore reasonable to expect an increase, albeit small, in the number of dairy farms in the province, particularly since increased availability of fresh milk has resulted in a dramatic increase in consumption over the last decade[1] and marketing the product should therefore not be a problem.

It has already been demonstrated how badly the existing production units are in need of increased grassland so the potential for bogland reclamation, both for the existing farms and new farms, certainly exists within the dairy industry. About 75 per cent of the existing fresh

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[1] Between 1972 and 1980 total consumption of whole milk in Newfoundland increased by 116 per cent. During the same period local production has increased by 25 per cent. As a result 47 per cent of total consumption was satisfied by imports in 1980 as compared to 8 per cent in 1972 (Newfoundland Agricultural Statistics 1980-81, 55).

Table 10

Balance sheet for 12 dairy operations in Newfoundland 1980, and effect of interest on equity on net returns[1]

Assets	Percentage	Per farm	Per cow	Per 100 litres
Land	39.8	$215017	$3436	$ 61.1
Buildings	24.1	130083	2079	36.9
Machinery & equipment	10.3	554433	886	15.7
Livestock	25.8	139242	2225	39.5
Total assets	100.0	$539785	$8625	$153.3
Liabilities				
Short term	7.8	8438	$ 135	$ 2.4
Medium term	19.6	21270	340	6.0
Long term	72.6	78750	1258	22.4
Total liabilities	100.0	$108457	$1733	$ 30.8
Owner equity		$431328	$6892	$122.5
Interest on equity (13.5%p.a.)		$ 58229	$ 930	$ 16.5
Net returns to operator labour		$-23293	$-372	$- 6.6

1 Column totals may not sum due to rounding.

Source: Unpublished cost of production study, Newfoundland Agriculture Branch.

milk production in the province is located in the vicinity of St. John's where the biggest market exists, and as there are urban pressures on the limited mineral soil base in the area the bogland alternative is particularly attractive.

The foregoing examination of grassland farm management in Newfoundland has revealed that the sheep and beef industries do not appear to give adequate economic returns in Newfoundland, and that the utilization of boglands is not likely to remove the basic constraints to the development of these industries, at least not in the short term. Dairy farming, on the other hand, appears to be economically viable in Newfoundland, with considerable room for increased production. There are indications, however, that there are two related factors which have prevented the industry from reaching its true potential. The remedy of one of these two factors is more of a long-term nature; i.e., more intensive management of the utilized land and animal resources whereas the other, the scarcity of grassland, might be partially removed by using boglands, particularly in the St. John's area where there is a heavy demand on the mineral soil resource for non-agricultural uses. Also, as further clearing and cultivation of mineral soil in the area is an extremely expensive undertaking, the justification for considering the bogland alternative certainly exists. The next section examines that alternative further, with special attention given to increased drainage intensity.

4.6 Grassland farming and drainage intensity

At the end of Chapter III it was suggested that owing to inadequate drainage the mechanization potential of farming boglands had not been realized. In fact, it appears that the approach taken in recent years in Newfoundland has failed to recognize the option of increasing the drainage intensity. Instead considerable resources have been devoted to designing and manufacturing new machinery that could be used for farming boglands, particularly for root crops, under conditions of minimum drainage, with little consideration given to increasing the drainage intensity and thereby overcoming the machinery problems.

Generally speaking, to reclaim boglands for agriculture it is necessary to drain them so that sufficient aeration will allow the seeded species to take hold and give good yields. Increasing drainage intensity makes the boglands better suited to conventional mechanized farming, but correspondingly bigger drainage costs and subsidence rates tend to offset that advantage. Furthermore, under certain soil and climatic conditions overdrainage may occur, especially where evaporation substantially exceeds precipitation during the summer months, but under the relatively moist and cool climatic conditions in Newfoundland this is not likely to occur when using the bogs for grassland farming. Optimum drainage intensity for a particular crop is thus a trade-off between costs, yields, ease of harvesting, and lifespan of the soil resource. Of these four elements costs, initial costs in particular, appear to have been the main concern. The drainage system adopted in the bogland reclamation programme for pasture and hay in the 1960s consisted of open ditches two feet (61cm) deep and 75 feet (23m) apart. A drainage experiment was laid out at Colinet in 1957-60, and between 1961 and 1966 data were collected on the influence of spacing and depth of ditches on water table and forage yields (Rayment and Cooper, 1968). Three ditch depths (two, three and four feet (0.61m, 0.91m, 1.22m)) were examined, and three ditch spacings (75, 100, and 150 feet (23m, 30m, 46m)). The open ditches spaced 75 feet were found to cause an appreciable lowering of the water table midway between them on an average year, while those at 100 and 150 feet were usually not effective. Deepening the ditches from two to four feet did not significantly change this situation. However, later observations showed that in the long term the deeper ditches resulted in more desirable surface contours and remained more effective in the absence of regular maintenance (Rayment and Penney, 1980). Forage yields were not significantly affected by the different treatments, but bearing in mind the ability of the peat surface to support animals and/or machinery it was recommended that the spacing of ditches should not be much greater than 75 feet. It should be noted, however, that in greenhouse studies on vegetable crops higher water tables have been associated with a significant increase in fertilizer leaching which, paradoxically, was not found to be associated with lower yields (Rayment et.al., 1975). Additional experimental work appears therefore to be necessary to examine further the effects of drainage intensity on forage yields.

During the experimental bogland programme, in the late 1950s a mole drain plough[1] was constructed in Newfoundland to provide supplementary drainage. This was a particularly cheap way of providing additional drainage; in 1957 the cost per acre amounted to only $1.53 ($3.78/ha) or 1.4 per cent of the total reclamation costs (Healy, 1958). It has repeatedly been recommended that mole draining should be used for grassland production (e.g. Rayment, 1970, 1981) but, unfortunately, it was never used in the bogland reclamation programme during the 1960s. The tractor used to install the mole drains during the experimental programme be-

1 A mole drain is usually formed by an egg-shaped metal bullet which is pulled through the soil leaving a drain that opens into an open ditch.

tween 1957 and 1959 had a two-way hydraulic three point linkage whereas the tractors used in the commercial reclamation programme only provided an upward thrust which proved to be inadequate for operating the mole plough. The machinery flotation problem experienced by the farmers involved was thus aggravated due to lack of concern for cheap additional drainage by the bogland reclamation authorities.

Another factor referred to earlier as influencing optimum drainage intensity is the lifespan of the soil resource. In extreme cases the peat soil may practically disappear due to what is generally termed subsidence. Subsidence involves a number of processes but the two most important ones are shrinkage and biological oxidation. Shrinkage is most pronounced immediately after drainage as it is due to the physical loss of water that is associated with drainage, whereas biological oxidation, which involves the conversion of organic material into CO_2, H_2O, and humus, is an on-going process. The combined result is a continuosly decreasing soil thickness. In certain areas, e.g. in the East Anglian fens (Richardson and Smith, 1977) and in the Netherlands (Schothorst, 1977), centuries of drainage and cultivation of low-lying fens have necessitated an intricate network of expensive pump drainage, as opposed to the relatively cheap method of gravitational drainage.

Rayment and Mathur (1978) reported on the rate of subsidence at Colinet for the period between 1957 and 1975. The drainage system studies consisted of open ditches of varying depths (one, two and three feet (0.61m, 0.91m, 1.22m)) and different spacings (75, 100 and 150 feet (23m, 30m, 46m)). The subsidence between 1957 and 1963 amounted to between 9.1cm and 28.3cm, presumably largely due to shrinkage, compression, and settlement, but from 1964 to 1975 the elevation of the less intensively drained plots actually increased, and the others subsided only a few centimetres. The report concluded that under the relatively high water tables, cool climate, and low ph conditions of forage production in Newfoundland, subsidence could be reduced to negligible proportions while maintaining satisfactory crop production. Furthermore, it has been found that trace element fertilization, which is necessary for adequate crop growth on reclaimed bogs in Newfoundland, significantly reduces the rate of subsidence (Mathur and Rayment, 1977). While increasing the drainage intensity would undoubtedly increase the subsidence rate it would hardly pose a serious problem especially since grassland farming minimizes subsidence as compared to other kinds of farming.

In recent years drainage research in Newfoundland has focused on vegetable production where drainage requirements are generally more stringent due to specific crop demands, and machinery flotation problems that are particularly severe in the absence of a grass sod. Plastic pipes and "Norwegian" covered drains[1] in combination with self-closing silt drains and crop ridging have been compared for their effectiveness on lowering of water tables, yields, and soil aeration (Rayment and Campbell, 1980). Little difference was found between the efficiency of the plastic pipes and the Norwegian drains. Unfortunately, the comparative efficiency of mole drains has not been tested under Newfoundland conditions, but while they are extremely cheap to install their lifespan is often relatively short as they tend to deform and get plugged up. Clogging up is, however, also frequently a problem with the perforations of the plastic pipes (Kuntze, 1979). But while the high returns per acre for certain vegetable crops may justify the relatively high cost of installing plastic or Norwegian drains the economics of same for grassland farming are less certain. In the Newfoundland context there is thus a need for drains cheaper than the plastic or Norwegian ones, but more efficient and durable than the mole drains. Such a drainage technique has been developed in Iceland and the following examination of bogland development in Iceland will therefore not only provide a comparative analysis of how a

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1 Norwegian drains consist of open ditches which are backfilled with peat and have a timber supported drain at the bottom of the ditch (see Crotty, 1977, 6-13).

similar resource has been subjected to different levels and kinds of exploitation, it may also suggest a way by which the grassland farm industry in Newfoundland can develop more fully the available soil resources.

CHAPTER V

BOGLAND DEVELOPMENT IN ICELAND

5.1 Introduction

Contrary to Newfoundland, agriculture in general and boglands in particular have played a major role in Icelandic economic history. Iceland was settled in the 9th and 10th century mainly by Norsemen who came there to farm, and for centuries the country was almost exclusively a society based on agriculture.[1] There is thus a marked difference between the settlement histories of Newfoundland and Iceland, a contrast between an agricultural settlement and a fishery oriented society.

The climate of Iceland, however, is much less conducive to farming than that of Newfoundland. The summers are short and extremely cool (Table 11), and under such climatic conditions one would expect thin and stony soils but due to active volcanism and the associated prevalence of easily weathered bedrock, namely palagonite and basalt, soils are better for agricultural use than otherwise would be the case. Grass is practically the only crop that can be grown but until recently only a minor part of the winter-feed that was needed to carry the livestock through the winter came from cultivated fields. Instead, most of it

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1 As late as 1880 about 75 per cent of the population was employed in agriculture (Statistical Bureau of Iceland, 1976, 32), but in 1979 that figure was down to about 8 per cent (Central Bank of Iceland, 1982).

consisted of sedge-hay (Figure 11), that was cut from the extensive boglands that cover an estimated area of 1,000,000 ha. As Fridriksson (1972) has demonstrated the island's population was directly dependent on its fodder-producing capacity, and it is therefore clear that the bogs were of paramount importance in providing livelihood for the nation. But not only were the bogs a major source of fodder for the livestock, they also provided the farmers with fuel, and material for buildings, packsaddles, dyes, and ink. The boglands were thus in many ways a valuable resource to the farming community, as opposed to their "wasteland" image in Newfoundland.

Table 11

Mean monthly temperatures (°C) for St. John's, Newfoundland (1941-70); and Reykjavik, SW-Iceland, and Hraun, N-Iceland (1931-60).

	St. John's	Reykjavik	Hraun
January	-3.2	-0.4	-1.5
February	-3.8	-0.1	-1.6
March	-1.8	1.5	-0.6
April	1.8	3.1	0.8
May	6.3	6.9	4.6
June	11.1	9.5	7.0
July	15.8	11.2	8.6
August	16.1	0.8	8.6
September	12.2	8.6	6.9
October	7.8	4.9	3.7
November	4.1	2.6	1.6
December	-0.4	0.9	-0.1

Source: Environment Canada (n.d.) and Einarsson (1976, 70).

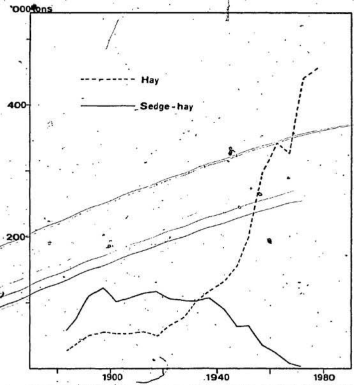

Figure 11 Production of hay and sedge-hay in Iceland, 1882-1980 (5-year averages)

Source: Statistical abstract of Iceland 1974;
Unpublished data from Landnám ríkisins

The boglands in Iceland are different from those in Newfoundland in one respect: their mineral content is much higher. Volcanic activity has been relatively intense during the postglacial period, and this has greatly influenced the boglands. Throughout the bog soil profile there often are a number of separate ash layers representing particular volcanic eruptions, and between those layers the mineral content of the bog soil is often quite high, due mainly to aeolian dust deposited in the bog from the easily weathered palagonite bedrock formation (Johannesson, 1960). Soil erosion intensified greatly after man and grazing animals became established in the country over 1100 years ago (Ashwell and Jackson, 1970). Accordingly, the mineral component of the uppermost part of the bog profile frequently amounts to between 20 and 60 per cent of its dry matter. As a result the bogs are less acidic and more fertile in their natural state, i.e. undrained; hence their importance for sedge-hay production. The bogs in Newfoundland, on the other hand, are much more organic in nature. Their mineral component is often in the range of 2-5 per cent of dry matter and they are more acidic and less fertile in their natural state as witnessed by the frequent dominance of Spaghnum moss vegetation.

Given these basic differences between the bog soils in Newfoundland and Iceland it might be argued that the differences are of such a basic nature that techniques and management methods applied in their utilization in Iceland would not be applicable in Newfoundland. This argument is, however, not justified. Whereas the difference in mineral content is probably important for the nutrient availability to plants under natural conditions, i.e. while the bogs are undrained, the bogs behave and respond in a basically similar way to treatment once they have been drained. In terms of the necessary nutrients for commercial forage production boglands in both areas are basically nutrient-poor, especially during the first years under cultivation, and therefore have to be treated generously with fertilizer.

A detailed comparison of the various physical, chemical, and vegetational characteristics of the boglands in Newfoundland and Iceland will not be attempted here as that would be beyond the scope of this thesis. Furthermore, it is well recognized that there is great variability in bog properties from one region to another in Iceland and even within a particular farm, but this has hardly been studied scientifically at all as soil surveys are practically non-existent in Iceland. In addition boglands in Iceland and Newfoundland are difficult to compare because of different classification systems. These problems notwithstanding, a brief discussion of the classification systems applied in Iceland and Newfoundland follows as they relate to some extent to the utilization of the bogs.

5.2 Classification

The system most commonly used in Iceland for classifying boglands is based on the level and fluctuations of the ground water (Steindórsson, 1975, 20). Three main types are identified; flói, flaedimýri, and mýri. In the flói (level mire) water floods the surface or reaches its uppermost portions for at least a part of the year, and a sheet of ice covers it in winter time. The surface is generally level and the land so flat or so slightly sloping that the ground water is almost stagnant. The flaedimýri (alluvial mire) has approximately the same degree of moisture as the floi but the water is in constant motion. Its total areal extent is small as it only forms along rivers and lakes, and the surface is level. In the third category, the mýri (sloping mire) water never floods the surface but the ground water level varies. The land slopes somewhat so that the water is never stagnant, and the surface is most often mound patterned. Of the three types mýri is the most common one, but the flaedimýri gave the best hay-yields (i.e. of sedge hay). The flói category covers extensive areas in the south and southwest portions of the island. All three types have been drained and cultivated extensively. Getting adequate outfall for draining the flaedimýri is often a problem, however, and seepage from adjoining hills or mountains is sometimes a problem with the mýri type.

In Newfoundland, Pollett and Wells (1980) have distinguished between five bog types and three fen types. The bog types are generally nutrient-poor as they are ombrotrophic, i.e. receive atmospheric nutrition only, while the fens are richer in nutrients due to terrestrial nutrient supply, i.e. they are minerotrophic. Based mainly on topographic and surface features the five bog types include raised, basin, blanket, string, and slope bogs whereas the three fen types are termed slope, ladder, and patterned fens. It appears that the boglands reclaimed so far in Newfoundland are mainly blanket bogs and raised bogs. The Newfoundland blanket bogs appear to be similar to the Icelandic myri type, but raised bogs are not found in Iceland.

5.3 Irrigation

As already pointed out the bogs used to provide the bulk of the winter-feed needed for the livestock, particularly sheep. The bogs were usually harvested under natural conditions with each field being cut annually or every second or third year, depending on the fertility of the field in question. From references in the Sagas (e.g. Benediktsson (ed.), 1968, 184) and old law codes it is clear, however, that irrigation has been practiced in Iceland since the country was settled by the Norsemen. The irrigation involved seasonal flooding of the boglands and resulted in better yields. This was only done on a small on a small scale but in the latter half of the 19th century, this activity greatly intensified; between 1843 and 1892 some 1840 km of shallow irrigation ditches were dug (Bjarnarson, 1982). These efforts were mainly made and financed by individual farmers but during the first four decades of the 20th century a number of communal irrigation projects, involving over 20,000 ha were undertaken with some financial assistance from the government (Jónsson, 1975). The biggest of these extended over some 11,500 ha, the government bore one quarter of the costs, and the project was considered to be the biggest in Europe "north of the Alps", involving some 200 farmers. Ditching for these communal projects was done manually until two excavators were imported in 1919 and 1927. The first one was mounted on rails on each side of the ditch while the other was a floating barge excavator. The bogs that were irrigated were mainly of the floi type, but also some flaedimýri bogs.

Irrigating the bogs effected a vegetational change, _Carex nigra_ usually became dominant while _C. lyngbei_ and _C. rostrata_ also thrived well. Concurrent with the vegetational change yields increased, sometimes up to threefold, and became more independent of climatic fluctuations, and the often hummocky surface became more level. The yields were normally between one and three tons per ha (0.4-1.2 tons per acre), which was a substantial improvement, but it fell considerably short of the old mineral soil fields.

Furthermore, hardly any machinery was available for harvesting the irrigated boglands as they were quite soft.

5.4 Bogland reclamation prior to 1942: A manual effort

The early part of this century witnessed a major restructuring of the Icelandic economy. In 1901 about 68 per cent of the population were employed in agriculture but in 1930 that proportion was down to 37 per cent (Statistical Bureau of Iceland, 1976, 32). At the same time the population increased by almost 40 per cent. While agricultural production increased approximately in line with the increase in population the agricultural labour force was rapidly decreasing and there was therefore a need for increased mechanization. The imported machinery was, of course, better adapted to the cultivated mineral soils than the irrigated boglands. Furthermore, the use of commercial fertilizers started to increase dramatically during the late 1920s, making the yield differential between the fertilized and cultivated fields, and the irrigated boglands more pronounced.

Thus, the scene was set for more emphasis on draining and cultivating bogland, and in 1923 the Icelandic Parliament passed an Act on Land Cultivation to stimulate production and make the farm operations more economically viable. According to the Act farmers were entitled to government grants that covered up to one third of the costs of various farm improvements including bogland drainage and cultivation. Prior to this legislation a few farmers had undertaken some bogland drainage and seeded them down to grass, but after the grants became available this activity increased considerably (Table 12).

However, the bogland cultivation proved to be problematic during the 1920s. At the time, farming in Iceland was almost totally unmechanized (Eylands, 1950); in 1920, for example, there were only 300 mowing machines in the country, all horse drawn, i.e. on only about five per cent of all farms. Between 1921 and 1927, however, the Agricultural Society of Iceland imported seven big cultivating machines, the so-called "thúfnabanar" (hummock destroyers). These machines consisted of a tractor with an attached rotovator. They were massive structures; the tractor weighed 6.6 tons, the back wheels were two metres high and 135 cm wide, and the rotovator made a seedbed over two metres wide. These machines were used on both mineral and bogland soils, but they were found to be far too cumbersome and expensive to use on the often small and scattered farms. Furthermore, the results of the bogland cultivation were disappointing. The "hummock destroyers" could rotovate an acre in an hour or two, and, not surprisingly, the time-consuming and labour intensive drainage operations did not keep pace with cultivation. Lack of experience was also

Table 12

Annual bogland drainage (5 year averages) in Iceland 1915-1980

Year	Sod Drains	Gravel Drains	Pipe Drains	Brush Drains	Plastic Pipes	Mole Drains	Cuth-bertson Drains	Tunnel Drains	Manually Dug Ditches	Mechanically Dug Ditches	
	km	km	km	km	km	km[a]	km	km	'000 m^3	km	'000 m^3
1915-19	1.5	4.4	0.7								
1920-24	14.5	8.0	1.1								
1925-29	31.9	14.0	0.3						73.1		
1930-34	49.7	19.1	0.3	1.6[c]					124.6		
1935-39	56.6	23.2	1.3	0.9					123.9		
1940-44	24.2	10.8	0.1	0.5					69.3	16.8[l]	41.4[l]
1945-49	21.4	14.9	2.1[b]	0.5[b]		584.8[f]			92.6	239.6	867.3
1950-54	17.5		9.9			na			41.8	644.6	2584.9
1955-59	11.6		3.2			na			14.1	859.4	3794.5
1960-64	4.6		7.0			na		1218.1[j]	5.8	805.4	3483.2
1965-69		6.9				na	145.2[h]	4686.3	2.9	1199.6	4923.6
1970-74		6.5[d]				333.7[g]	103.4[i]	3892.3	0.8[k]	1060.7	5054.1
1975-79		3.4[e]			2.2[e]	381.4		1726.2		686.9	4066.2
1980		2.4			7.0	148.0		1021.5		355.8	3193.7
Total		1878.7					393.6	56200.1	2742.5	28339.3	127285.1

a ha for 1972-80, b 1945-48, c 1931-34, d 1970-71, e 1972-79, f 1947-49, g 1972-74, h 1968-69, i 1972, j 1962-64, k 1970-72, l 1942-44, na Not Available.

Source: Bjarnarson (1974, 1976, 1982).
Búnadarfélag Islands (1973-78).
Unpublished data from Bunadarfelag Islands.

a factor; some had argued, for instance, that after the land had been rotovated and seeded it should be drained. Later it became apparent how important it is that the land is drained prior to cultivation (Eylands, 1943, 18). It is interesting that similar confusion arose in Newfoundland when the experimental program was getting under way in the mid-1950s, and it could in fact be argued that in many ways bogland development in Newfoundland during the 1950s and 1960s parallels the Iceland situation of the 1930s and 1940s.

No systematic experiments were undertaken to establish optimum drainage intensity but on basis of the experience of a few farmers who were pioneers in bogland drainage between 1910 and 1920 it was recommended to use sod or gravel drains about 1.10-1.20m deep and spaced 1015m apart which would drain into open ditches which were at least 1020cm deeper (Grimsson, 1941, 69). Each kilometer of covered drains would thus drain about one hectare. A meter of an open ditch usually measured about 1.3 cubic meters; if the open ditches were on average spaced 50m apart, each thousand cubic meters would have represented about four hectares. Given the above assumptions it appears that between 1930 and 1940 about 500ha were drained annually with open ditches, and that supplementary sod or gravel drains were only used on about 75ha annually. As the average annual acreage of new cultivated fields amounted to just under one thousand hectares during that same decade it seems that fields, drained with open ditches only, accounted for a substantial part of the land cultivation effort in Iceland during this period.

The results of these bogland reclamation efforts were, however, often disappointing. The reasons for these failures were probably twofold: insufficient drainage and inadequate tilling of the soil. Eylands, the editor of Freyr, the Farmers' Journal, wrote in 1942 that many of the ditches and drains were too shallow. Furthermore, draining of boglands was concentrated in a few areas, mainly around a few villages, but good drainage ditches around the countryside were a rare sight:

> "The ditching of good, deep drainage ditches is considered a hard and expensive undertaking. Farmers tend to compromise in this regard, or even totally ignore what is necessary to make bogland cultivation successful" (Eylands, 1942, 158).

Eylands also pointed out that tilling the soil was not traditional in Iceland,[1] and it was therefore not surprising that drainage operations, that were only a preparatory measure for cultivation, tended to be neglected. Futhermore, there was a serious lack of know-how:

> "Last spring I visited a big farm in one of the best farming areas in Iceland. On the farm there was a newly cultivated field with excellent grass

1. Farming in Iceland prior to 1920 may even be termed Carex-farming, as opposed to the more usual way of tilling the soil for various crops.

> growth considering the time of year. "It took us a lot of work and effort to drain this bog", the farmer told me when he showed me the field. The field was all drained with gravel drains. Another piece of bogland with open drains, adjacent to the cultivated field was ready for further development. "It will take us a long time to fill them", the farmer added, "because there is no gravel to be found around here". I mentioned that the bog appeared to be well suited for sod drains. "Yes, but we don't know how to make them, and to my knowledge no one in this area does". Unfortunately, this state of affairs is common" (Eylands, 1941, 38).

Grimsson (1941), an agricultural fieldman, suggested an additional explanation for low yields from the cultivated boglands. He pointed out that the cultivated layer of the bog was frequently only two to three inches deep. The grass roots were therefore short and the fertilizer tended to leach through beyond the reach of the roots. In their virgin state the bogs usually have a thick root mat and the available cultivating machinery had difficulty in breaking it to a desirable depth.

An attempt was made in 1929 to improve the drainage situation when two horse-drawn mole drain ploughs were imported. The concept was an attractive one; agricultural labour was getting scarcer and it seemed that here was a way to mechanize the installation of covered drains. But the working depth of the ploughs was only 60-65cm and the drain was narrow in diameter. The drains were found to cave in quickly, and the use of the ploughs never went beyond the experimental stage. Bigger ploughs were not tried as the machinery needed to pull them was not available in the country, and another 16 years passed until mole drains were tried again (Eylands, 1950, 86).

An additional factor in the problems encountered in bogland reclamation was the total lack of systematic experiments to determine optimum drainage intensity. To this day no such investigations have been undertaken, something which is truly amazing considering the substantial amount of funds devoted to bogland reclamation in recent decades. By trial and error farmers discovered that spacing of sod or gravel drains at 15-20m was too great, i.e. yields were inadequate. It thus soon became accepted to space covered drains 10-15m apart. The depth of drains was similarly guesswork, but a frequently recommended depth was 110-120cm. Deeper drains were considered beneficial, however, both in terms of immediate efficiency and durability (Kristjansson 1942, and Josafatsson 1940).

Efforts were also made to mechanize the excavation of ditches. In 1930 an Act was passed in Parliament in which it was stated that the government was permitted to buy one excavator a year. The excavators were to be provided free to farmers' Irrigation and Drainage Associations, together with a grant amounting to one third of operational costs. There was some concern, however, whether suitable excavators were available, and the law was never put into effect except that the floating barge excavator mentioned earlier was operated under this law. Mechanized excavation of drainage ditches was still some 12 years away (Eylands, 1967, 14).

On reflection it is clear that farming on drained and seeded boglands got off to a relatively slow start in Iceland. Systematic experiments on suitable reclamation methods were non-existent, mechanization of operations was unsuccessful, and manual draining was restricted due to widespread lack of know-how. In terms of the Rogers and Shoemaker's paradigm (cf. Figure 3) the process part appears to have been the main hurdle to be cleared for widespread adoption to occur, whereas the antecedents were more favourable, specifically an industry undergoing rapid change that involved the need for large scale land reclamation if it were to survive as an important industry. In this context it should be noted that the farmers in Iceland have to this day been very strong politically; not only has this been so in Parliament, the same applies to the organizational structure of the industry. With increased national income, especially from fish export, public funds were increasingly made available to the farming section of the economy. What was needed, however, before large scale bogland reclamation could take place, was mechanization of operations.

5.5 Bogland reclamation since 1942: The mechanized effort

In 1939 a representative of the Agricultural Council toured the United States and Canada to search for farm machinery that would be suited to Icelandic conditions. In an Icelandic settlement in Manitoba he saw a dragline excavator at work on roadside drainage for highway construction, and became convinced that this was the right kind of machinery to drain the bogs in Iceland (Eylands, 1943, 19). Then in 1941 the Agricultural Council asked the legislature and the government to provide funds for purchasing two such excavators. The response was favourable and in 1942 two dragline excavators were imported, marking the beginning of what was later to become a massive bogland reclamation effort in Iceland. The excavators weighed about 8.8 tons each and had short and narrow tracks so they tended to sink in soft spots. In fact, the purchasing of these machines was somewhat controversial as it was argued by many that due to their weight they would be unusable on the bogs, at least on those that were so soft that not even a horse could get across them, but to circumvent this problem it was found sufficient to position wooden planks under the excavators, reducing ground pressure from 12 lbs/in^2 (0.84 kg/cm^2) to about 1.5 lbs/in^2 (0.11 kg/cm^2).[1] While this solution reduced ditching output per hour by up to one third, at least the work could be done.

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1 In this context it is interesting to note that Healy, who was in charge of the bogland reclamation programme in Newfoundland, often stated that the ground pressure of bogland ditching and cultivating machinery should not exceed 1.5 lbs/in^2.

5.5.1. Organization and financing of bogland reclamation.

In 1943 Parliament passed an Act establishing The Agricultural Machinery Fund (Velasjodur rikisins). Its purpose was to purchase excavators and hire them out to farmers' organizations, or to carry out the ditching operations itself at actual costs (Eylands, 1967, 16-17). The fund was also charged with the responsibility of experimenting with new farm and cultivation machinery. In 1943 it imported the first bulldozer to Iceland, mainly for the purpose of levelling out the spoil from the drainage ditches. It soon became apparent that with the proper cultivation machinery these machines were ideal to level and break up the often tough bogland sod. As the purchasing of these machines was beyond the financial resources of farmers themselves an Act was passed in Parliament in 1945 on Land Cultivation and Farm Buildings. In the act there were provisions for local agricultural associations to form Land Reclamation Organizations (Raektunarsambond) for the purpose of purchasing heavy farm machinery, such as bulldozers, and heavy-duty plows and harrows, etc., for land reclamation work. As a result 48 such Land Reclamation Organizations had been formed by 1950, covering almost all rural areas. According to the Act government financing provided for 50 per cent of the cost of purchasing the machinery. In 1954 the machinery owned by the 68 Land Reclamation Oganizations included 10 excavators, 116 bulldozers, and 173 heavy-duty harrows (Eylands, 1955, 13-14). At the same time the Agricultural Machinery Fund possessed 30 excavators which had been purchased with special government funding. Concurrent with this considerable mechanization of land reclamation operations, the farmers themselves were mechanizing their own operations. Some 80 tractors had been purchased around 1930 by local agricultural associations for land cultivation (Eylands, 1950, 437), but in 1944 farmers started to buy their own farm tractors, and by 1954 the number of wheeled farm tractors had increased to just under 3000.

It is clear from the above that, like other sections of society, farming was rapidly transforming in the wake of World War II[1]. A substantial part of that transformation involved bogland reclamation with substantial financial aid from public funds. Drainage grants amounted to one third of ditching costs for the 1942-49 period, one half for 1950-54, 65 per cent for 1955-1963, and 70 per cent for the period 1964-1980. The cultivation phase of bogland reclamation has also been subject to a government grant, as has cultivation on mineral soils.

In 1954 an important change was implemented with respect to the ditching operations themselves when the excavator operators were paid in accordance with the number of

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1 For a useful account of the structural changes in farming in Iceland during this century see Ashwell, 1963.

cubic metres dug. After that only two men worked on each excavator, instead of 3-4 before, and the output per excavator increased considerably. In 1965 hydraulic excavators were introduced and as they were superior to their dragline predecessors, both in terms of output and versatility, and the dragliners rapidly fell into disuse. At the same time the Land Reclamation Organizations increasingly acquired their own excavators, as did also private operators, and the Agricultural Machinery Fund was left with work in the more isolated and smaller communities. The cost of ditching in each region used as a basis for government grants was estimated by the Agricultural Society of Iceland in consultation with the Agricultural Machinery Fund, but since 1968, public tenders have been called annually for ditching in all regions with the local Land Reclamation Organization having the right to step into the lowest bid. The accepted tenders formed the new basis for grant determination, except for areas where no one applied for undertaking ditching; in that case the Agricultural Society of Iceland estimated the cost, the Agricultural Machinery Fund undertook the ditching, and the government provided the funds. Tendering the operations resulted in considerably lower costs and gradually the Land Reclamation Organizations and private enterprise took over the drainage operations, and in the early 1970s the Agricultural Machinery Fund was dissolved.

5.5.2 Drainage intensity and subsurface drains

When the first excavators were introduced in 1942 there were no experimental results to consult with regard to drainage intensity, i.e.. the depth and spacing of ditches. However, it soon became a standard practice to have the ditches 200-220cm deep, and the spacing was initially up to 100 metres. It was known that the bog settled and subsided considerably after drainage and that the ditches tended to fill in with vegetation, and it seemed that when ditches extended down to the underlying mineral soil drainage was much more effective as the mineral soil layer often functioned as a continuous gravel drain. This ditch depth, i.e. 200-220cm, is still recommended today but the spacing has decreased as ditches spaced 100m apart were found to provide inadequate drainage and correspondingly low grass yields.

In 1945 another attempt was made to introduce mole drain ploughs to provide further drainage. These were bigger than the ones tried in 1929 but the machinery to pull these bigger ploughs was now becoming available with the introduction of bulldozers. The plough tried in 1945 made drains to a depth of 36 in. (91cm) and the drain diameter was adjustable to six, seven, or eight inches (15, 18, or 20cm). A small drainage experiment was carried out in

1945-46, the only one so far in Iceland,[1] comparing the effectiveness of mole drains with sod drains. The sod drains were 110cm deep and spaced 10m apart but the mole drains were installed at a depth of approximately 90cm and the spacing varied between 10, 8, 6 and 3 metres, in two replicas. The experiments were done on two kinds of bogland soils; one was on a pure bogland soil while the other had a slightly clayish texture. Between November 1945 and December 1946 eighteen water level measurements were taken midway between drains. The results are displayed in Table 13. During the year the soil above the drains subsided approximately 15cm. The mole drains remained open but their diameter decreased from six to three and a half inches. An inspection in 1952 revealed that the mole drains were still working, with a diameter of 3.5 inches, and it was concluded that mole drains could effectively be used in bogland drainage, at least on relatively pure bogland soils, but a narrower spacing, 6-8m, should be used, as compared to 10m between sod drains (Kristjansson, 1954, 36).

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1 However, a drainage experiment comparing different ditch depths and spacings was initiated in the early 1960's. Ditching was undertaken but apparently no measurements were ever taken.

Table 13

Comparison of efficiency of sod and mole drains at Samsstadir, Iceland, 1945-46

	Spacing of Drains	Depth of water table	
		Pure Bog	Clayish Bog
Sod drains	10m	78.1cm	67.1cm
Mole drains	10m	57.6cm	36.4cm
Mole drains	8m	72.3cm	41.1cm
Mole drains	6m	75.1cm	53.4cm
Mole drains	3m	75.1cm	59.5cm

Source: Kristjansson (1954, 36).

Given these relatively favourable results, seventeen mole drain ploughs were imported between 1945 and 1949, mainly by the Land Reclamation Organizations which had the necessary equipment to pull the ploughs. Statistics on the extent of mole draining are available for 1947-49 when just under 1800km were installed, but for the period 1950-71 no statistics are available as due to the cheapness of installation it was not considered worth measuring the length of the mole drains. In 1972 mole drains once again became eligible for government funding, now on an acreage basis. It appears, however, that the farmers have been rather reluctant to have mole drains installed. Table 8 indicates that only 100-400ha are drained that way annually, representing less than one per cent of all cultivated bogland fields in the country. This low level of activity is in spite of improvements in plough design.

In 1956 a new mole drain plough was designed and constructed in Iceland (Anon., 1957), consisting of a simple cutter fastened to a bulldozer's blade frame with a bullet shaped piece of metal attached to the lower end of the cutter. The older imported ploughs weighed close to two tons, so that this simple design was a definite improvement. Later, a similar plough was made to fit the three point hitch of small bulldozers. Articles on drainage by extension staff in the farmers' journal, Freyr, have frequently complained about the low level of use of mole drains, as they were a cheap way of providing extra drainage which was often badly needed. The total lack of experiments to demonstrate the effects on yields may partly explain this apparent reluctance of farmers to employ mole drainage.

In 1962 a new concept in bogland drainage was introduced in Iceland, tunnel drains. Ever since the excavators had been introduced to replace manual ditching there had been speculation over how the construction of sod drains could be mechanized, but without success. But a Finnish professor, Pentti Kaitera, succeeded in designing and constructing such a tool. After some preliminary testing in Finland he decided to try it out in Iceland where tree trunks and roots were less common in the soil profile. The tunnel drain plough consisted essentially of two ploughs built in one (Figure 12). The upper one makes an L-shaped cut at a depth of 70, 80, 90 or 100cm, and as the plough is

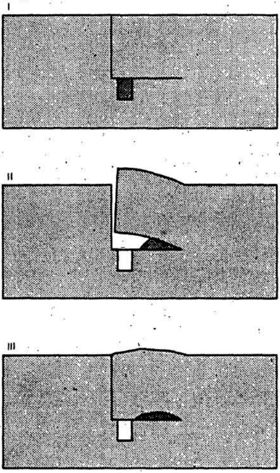

Figure 12 Principle of the Kaitera tunnel drain plough
Source: Field research in Iceland 1981

pulled through the soil the chunk of soil inside the "L" is lifted momentarily while the lower plough extrudes soil from a 30cm deep and 20cm wide tunnel and places it underneath the temporarily lifted "L" soil chunk. As a result an open tunnel is left in the ground, wtih only a slight bump on the surface (Ásgeirsson, 1964; and Jónsson, 1963). The plough was pulled by a bulldozer equipped with a winch for lifting the plough, and to pull it when the bulldozer hit a soft spot. Considerable draught power was needed to operate the plough; a bulldozer weighing 18 tons with engine power of 110hp was found to be adequate, or two smaller dozers used in tandem. The working depth of the plough was adjustable, but in order to change it the plough had to be stopped and it was therefore not practical to adjust the depth of the tunnel to minor changes in surface elevations. In 1962 a drainage experiment was layed out comparing different lengths and spacing of drains but unfortunately the experimental field was soon after cultivated and no measurements were ever taken. The results were quite promising, however, and there was almost immediately a great demand from farmers to have boglands drained using this technique. The Finnish tunnel drain plough was imported and operated under the auspices of the Agricultural Machinery Fund, and during the first two years of operation several modifications were made to the plough, and two replicas of it were also made in response to the demand for tunnel drainage.

But in 1964 another tunnel drain plough was constructed in Iceland, substantially different from the Kaitera design but utilizing the same general principle, i.e. the two-ploughs-in-one concept. The designer and builder of this plough was a bulldozer operator who wanted to purchase a new bulldozer, but to qualify for financial assistance the new bulldozer had to be capable of operating the Finnish plough (G., 1964). This made the operator, Eggert Bjarnason, wonder if a lighter and more easily maneuverable tunnel drain plough could be made. He came up with a design (Figure 13a) that needed less draught power, could be easily transported by hooking it to a jeep or pick-up truck, made a theoretically more stable drain than the Kaitera plough, and the working depth could easily be adjusted during the installation of a drain. Eggert's plough was later modified to a single-cutting upper plough (Figure 13b) to lessen the necessary draught power, to make the extrusion of the plough at the end of a tunnel drain smoother, and to make the operation of the plough on sloping ground easier. In 1967 a similar plough was constructed, except that it was on skids instead of wheels. Finally, in 1968, yet another tunnel drain plough was designed and constructed, again by a bulldozer operator, Reynir Ragnarson. The operator was concerned with the potentially negative effects of the pressure exerted by the wheels of the Kaitera plough directly above where the tunnel is being formed.

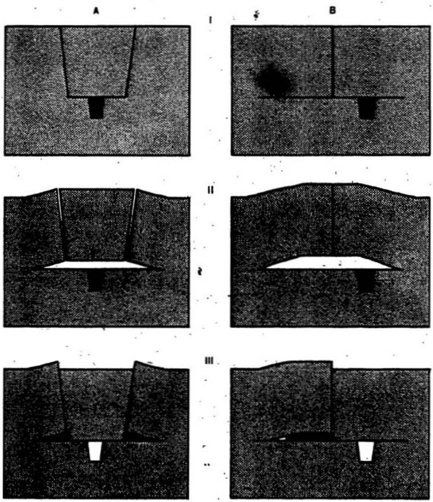

Figure 13 Principle of the Eggert tunnel drain plough
A: Original version, B: Modified version
Source: Field research in Iceland 1981

Hence, he came up with a plough that is not on wheels, but one which is attached to the bulldozer itself. As illustrated in Figure 14 a ribbon of soil is left on the surface of the bog, and if the field is to be cultivated the ribbon has to be rotovated prior to the overall breaking of the existing sod.

No systematic comparisons have been made as to the efficiency of the four different plough types described above, but, in areas where more than one kind has been used it has been suggested that the skill of the operator was more important than the type of plough. The ploughs are not suitable for use on any kind of a bog; it has to be at least 1.5-2.0m deep, and preferably free from sandy material, and prevelance of fibrous roots in the soil profile makes installation of a drain difficult. Furthermore, pre-draining by open ditches has been found to be beneficial for a number of reasons: the installation is easier, the drain is more stable (i.e. less danger of it caving in), and as initial settling of the bog has already taken place a preferable long-term depth of the drain in the soil profile is achieved.

The farmers were quick to adopt this type of drainage as it combined efficiency and cheapness. The organization and financing of the effort was similar to that of ditching: initially the Agricultural Machinery Fund carried it out whereas later the Land Reclamation Organizations

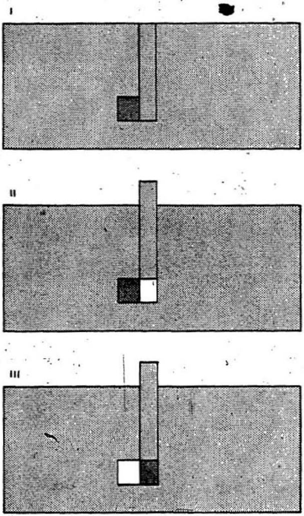

Figure 14 Principle of the Reynir tunnel drain plough
Source: Field research in Iceland 1981

and private operators took it over. The cost of installation was shared between the farmers concerned and the government, with the government grant amounting to 75-80 per cent of the costs. The installation of tunnel drains has all but stopped; it appears that farmers have already drained what they think is worth draining for them.

Figure 15 gives a spatial overview of ditching and tunnel draining, showing both total amount undertaken in each region and proportionally according to the number of farmers. Ditching is most extensive on the coastal plains in the southern and western parts of Iceland, but least in the fjord landscape of the northwestern and eastern regions of the island. The pattern for tunnel draining is similar but with even more pronounced regional differentiation: 80 per cent of all tunnel drainage is located in the southern and western regions. This spatial concentration of the use of tunnel drains reflects the extensive acreage of thick boglands in the southwest where topography (i.e. the coastal plain) and heavy precipitation combine to make for the existence of such boglands.

Most of the bogs that were drained with tunnel drains were drained with the purpose of improving them for grazing, as opposed to seeding and cultivation. It was well known that by drainage alone bog would often increase in value as a grazing resource. In 1935-37 an hectare of bogland was drained at one of the experimental farms. The bog

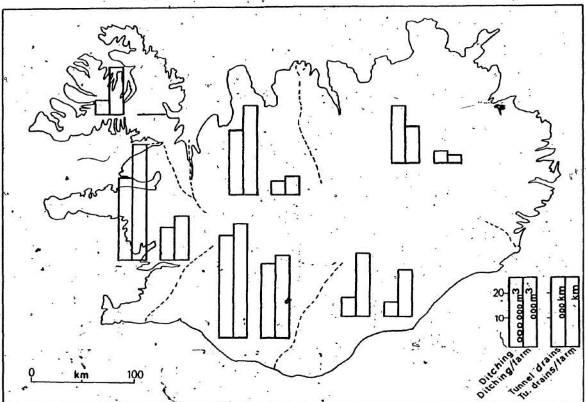

Figure 15 Regional distribution of ditching and tunnel draining in Iceland 1942-1980
Source: Eylands, Skurdgröfur Vélasjóds 1942-1966, 1967; Búnadarrit, 1968-1978; Iceland Minister of Agriculture, Tillaga til thingsályktunar um stefnumörkun i landb., 1978-79; Unpublished data, Búnadarfélag Íslands

was drained with sod drains, 110cm deep and spaced 11m apart, and 95m in length. No fertilizers or seed were applied to the bog, but the yield was measured annually for ten years (Figure 16). The draining was found to have dramatic effects. In ten years a wet and low-yielding bog had changed, just by draining it, into a fertile grass-field. Concurrent with the sevenfold increase in yields the species composition of the vegetation changed. Prior to drainage the most common species were Carex nigra, Menyanthes trifoliata, and Equisetum palustre, but after ten years of drainage grasses were dominant: Festuca rubra, Agrostis stolonifera, Poa pratensis, and Deschampsia caespitosa; making the increase in grazing value even more pronounced than the sevenfold increase in yields (Kristjansson, 1953, 34-35). While the effects of draining are not always so dramatic, the beneficial effect on the grazing capacity of the boglands greatly encouraged farmers to employ the cheap and effective technique of tunnel drainage. However, recent grazing experiments have demonstrated that weight gains of lambs grazing exclusively on drained bogs throughout the summer compare unfavourably with lambs grazing the traditional grazing grounds in the interior highlands (Gudmundsson, et.al., 1978), but some progress has been made in identifying the causes underlying this difference which include parasitic infection (Dýrmundsson and Jónmundsson, 1980), and probably also the nutritive value

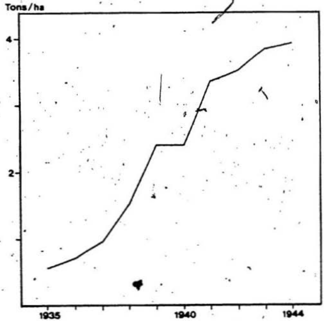

Figure 16 Effect of sod drains on yields from a virgin bog

Source: Kristjánsson, Skýrsla Tilraunastöðvarinnar á Sámsstöðum 1928-50, 1953.

and digestibility of the grazed herbage, particularly in late summer.

In the next chapter the study of bogland farming will be extended to a detailed examination of bogland farming in a particular area of Iceland. Furthermore, the results of this micro study will be compared with a parallel survey of farming in Newfoundland.

CHAPTER VI

BOGLAND FARMING - A MICRO STUDY

6.1 Introduction

So far in this thesis bogland development in Iceland has been considered in general terms, i.e. on a macro scale: identifying the development of drainage technology, the organization and financing of the reclamation efforts, and the extent of those efforts, both temporally and spatially. The main purpose of this general overview was twofold: first, to provide a comprehensive analysis of the differences and parallels in bogland utilization in Iceland and Newfoundland; and second, to demonstrate the importance of the development of drainage technology in general, and to identify a specific drainage technique that may be suited to the successful reclamation of boglands in Newfoundland. As the context of this thesis relates primarily to decision-making at the farm level, i.e. farmers' adoption of agricultural innovations, bogland farming in Iceland will also be examined here at the farm level, i.e. on a micro scale. As scientific studies on bogland farming are practically non-existent in Iceland an investigation of farmers' experiences in bogland farming is a particularly appropriate approach when it comes to identifying the relative pros and cons of boglands for grassland farming as compared to mineral soil, the appropriate cultivation and management practices, and generally to identify the problems peculiar to bogland farming and how they have been dealt with. It has been examined earlier in this thesis how a particular system of bogland reclamation and utilization that was acclaimed by agricultural authorities in Newfoundland proved to be unattractive to the farmers. Drainage considerations have been identified as key factors in this respect, and a close look at a situation where widespread farmers' adoption of bogland utilization goes hand in hand with intensive drainage was anticipated to yield some useful information on the implications of increasing drainage intensity in Newfoundland.

After consideration of several alternatives it was decided to undertake this micro study in a community on the south coast of Iceland called Mid-Mýrdalur (Plate 1). A number of reasons led to the choice of this particular area. First, a random sample of the more than 3,000 dairy and sheep farmers in the country was not attempted, mainly for budgetary reasons, but also because of regional differences in bogland characteristics and as these differences have hardly been studied at all it was felt that a case study of a particular area would be a more appropriate choice here. Second, when it came to selecting a specific problem area as regards bogland reclamation the Mid-Mýrdalur area was chosen

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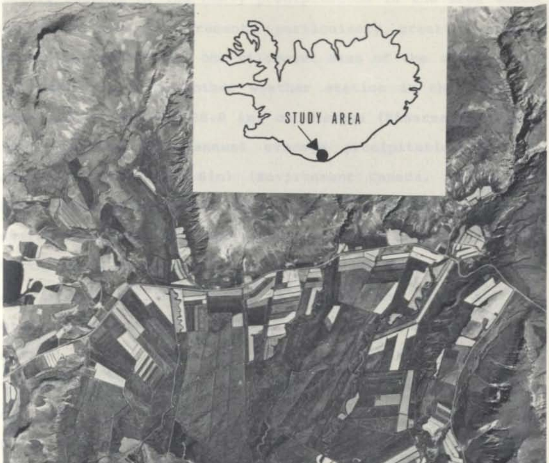
Plate 1 (next page)

The Mid-Mýrdalur study area in Iceland. (Air photo no. 8375, Landmaelingar Islands, July 27, 1980). Scale of air photo is approximately 1:35000. The white fields have just been harvested.


STUDY AREA

mainly because of the heavy precipitation in the area which makes drainage requirements particularly great. Annual precipitation at Vík, one kilometer east of the study area, is more than at any other weather station in the country, amounting to 2,256mm(88.8 in) on average (Einarsson, 1976). In comparison, the annual average precipitation in St. John's is 1,387mm(54.6in) (Environment Canada, n.d., 52), and the annual number of days with measurable precipitation averages 175, but the corresponding figure for Vík is 231. Furthermore, in terms of size and type the farms in the area are typical for the country as a whole and while all the study farms are primarily bogland farms they also have some mineral soil in grassland cultivation and the farmers are therefore familiar with the comparative productivity of the two soil types. In order to assess the typicality of the boglands and the reclamation methods in the study area compared to the country as a whole nineteen district agricultural advisers were also consulted.

The study area consists of parts of two parishes: Hvammshreppur and Dyrholahreppur, but physically it is a well defined area; a central bogland plain encircled by mountains and uplands on three sides, and by a barachois on the seaward side. All the farmsteads are located on mineral soil on the periphery of the bogland plain. At the time of the fieldwork (summer 1981) 22 farms were occupied in the area. One farm was being vacated and was not visited; the other 21 farms were all visited, but as one farm had just changed hands and another was not farmed by the occupant (an electrician) a total of 19 detailed interviews were carried out (see Appendix B). The questionnaires used in interviewing farmers in Iceland and Newfoundland contained a number of similar questions to permit comparisons between the areas. The main results of the Newfoundland questionnaires are also included in this chapter, but for a fuller analysis of the Newfoundland data the reader is referred to Appendix E.

6.2 Bogland farming on survey farms in Iceland

An attempt was made to do a detailed land use analysis of the cultivated land of the survey farms in Iceland (see Appendix B, question 10), i.e. get detailed information on inputs and outputs of each single field, in order to get some concrete figures on the comparative productivity of boglands and mineral soils under the drainage and management systems applied. This attempt was unsuccessful. Most of the farmers did not have records of the amount of fertilizer spread per field, the amount of hay or silage harvested, or even the exact acreages. A complicating factor is that many farmers vary the size of the bales depending on how dry the hay is when it is baled. Grazing is another factor. Even if the number of animals and number of days are known and an estimate can be made of the crop removed, the indirect effects, such as increased susceptibility to winterkill, and change in grass species composition, make comparisons difficult. The general perceptions of the farmers based on years of experience will therefore have to suffice in regard to this important issue of comparative productivity.

An attempt was also made to reconstruct the development of the survey farms for the last thirty years in terms of drainage, land cultivation, and livestock production. Data on land improvement on each survey farm were recorded from files of the Bunadarfelag Islands (Agricultural Society of Iceland) and data on livestock and harvested hay from files of the Landnam rikisins (Homestead Administration). During the interviews information was then sought on the reasons for each individual land improvement operation, why it was done there, at that time, and in this particular way. Changes in livestock numbers were also examined. As it turned out farmers were not able to identify each annual statistic to a particular field; however, some general patterns were identified.

The rapid transformation of society in general that took place during and after the World War II has already been referred to in this chapter. Rural out-migration and to a lesser degree farm abandonment had increased considerably during the war years and partly to counteract this development public funds were increasingly channelled into the agricultural sector with the main emphasis on subsidizing land improvement and farm building construction in an effort to enlarge operations and thus make them more economically viable. This expansion in the size of the farm operations is reflected in data on livestock numbers on individual farms, which are available on an annual basis back to 1958, and as all the survey farms have been almost exclusively dairy or/and sheep operations the increase in livestock numbers may be expressed in sheep-equivalent units (Figure 17).

A practically uninterrupted increase in livestock numbers took place up to 1974 at an average annual rate of 5.3 per cent, but since then the numbers have levelled off and decreased slightly reflecting nationwide trends in response to surplus production. At the end of the period each farm had on average 176 (winterfed) sheep, 17 dairy cows, and 6 other cattle; the respective numbers in 1959 were 112, 10, and 3. The increase in production is in fact more than these figures indicate; between 1951 and 1976 milk production per cow in Iceland increased by 40 per cent due to improved feeding, grazing and breeding practices (Iceland Minister of Agriculture, 1978/79). Similar increases in productivity per ewe have taken place in the sheep industry. The survey farmers generally agreed that increasing the number of livestock was a necessary prerequisite to make a reasonable living at farming. In other words, it was imperative to take advantage of economies of scale within the family farm unit; farm labour was becoming increasingly scarce and expensive, mechanization was a necessity and to

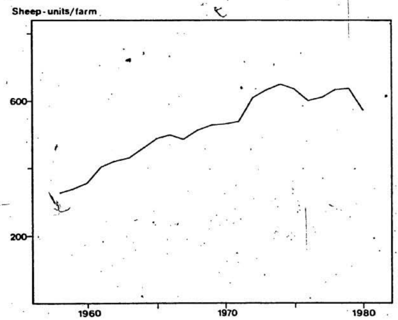


Figure 17 Livestock (cattle and sheep) on survey farms in Iceland, 1958-80

Source: Unpublished data from Landnám ríkisins pay for that the farms had to be expanded. But this expansion did not, of course, take place in a vacuum; it required land cultivation to provide fodder for the livestock and buildings to house the animals.

Figure 18 gives an overview of annual land cultivation since 1950, both for the survey farms and for all farms in the country. Due to the small number of farms involved the fluctuations are greater in the study area, but the figures do indicate, however, that there was a time-lag involved between the thrust of land cultivation in the two areas. The reasons for this time-lag may well include the dominance of bogland on the survey farms compared to the country as a whole, and there was therefore limited room for expanding land under cultivation in the survey area before the use of excavators there in 1954, while greater availability of mineral soil elsewhere in the country and earlier use of drainage excavators gave those areas a head start. The records do not distinguish between cultivation of boglands and mineral soils but practically all the survey farmers indicated that they had cultivated all the available mineral soil before turning to bogland cultivation. On many of the farms all the available mineral soil had already been cultivated back in the 1950s and the peaks in land cultivation in the late 1950s and early 1960s do in fact represent a few farms where the last areas of mineral soil were cultivated. Since then all expansion of the cultivated acreage has been confined to boglands.

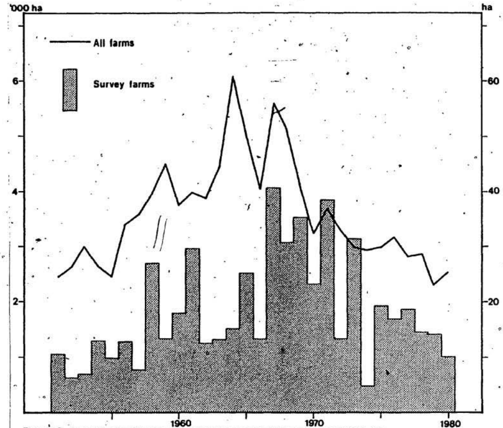


Figure 18 Annual land cultivation on survey farms and all farms, Iceland 1951-80
Source: Icel. Min. of Agric., Till. t. thingsál. um stefnum. í landb., 1978-79; Unpubl. data, Bún.fél. Íslands

As explained earlier in this thesis drainage is the first step in bogland reclamation. Figure 19 shows the annual ditching effort for both the survey farms and all farms in the country. There was a big demand to have boglands drained in the late 1940s and early 1950s, particularly in areas like Mid-Myrdalur where the mineral soil base was very small, but it was not until 1954 that the first excavators began working in the study area. There was considerable ditching done on every single study farm in 1954 and 1955, reflecting the need for farm expansion which could now proceed once the drainage machinery was available to farmers. The ditching was mainly of two kinds, perimeter ditches that encircled the individual farms, and ditches next to the farmsteads. The former served to enclose each farm and improve the bogs for grazing while the latter was meant for immediate extension of the cultivated fields.

The three peaks in ditching efforts on the survey farms (Figure 19) can all be attributed to the advent of new technology. The first reflects the first use of excavators in the area, the second coincides with the availability of the tunnel drainage technique to provide for secondary drainage; and the third represents the introduction of hydraulic excavators. Many of the older ditches were in need of maintenance for which, in contrast to the old dragline excavators, the new hydraulic excavators were well suited. Since then the bulk of the ditching efforts on the survey farms has consisted of maintenance of the existing ditches.

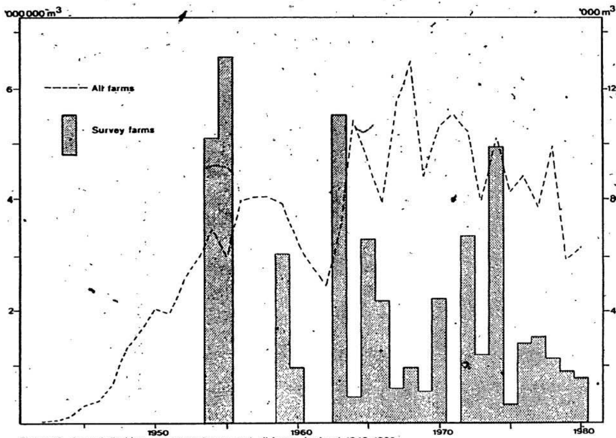


Figure 19 Annual ditching on survey farms and all farms, Iceland 1942-1980
Source: Bjarnarson, Framraesla á Mýrlendi, 1976; Búnadarrit, 1975-78; Unpublished data, Búnadarfélag Íslands

However, the bogland cultivation in the late 1950s and early 1960s turned out to be quite problematic, and the farmers generally agreed that insufficient drainage was to blame for the often low crop yields. As has been explained before, the spacing of ditches was determined on a trial and error basis, and it was soon discovered that the 60–100m spacing that was found to be adequate in some nearby areas was too great in the Mid-Mýrdalur area. A combination of factors was probably responsible for this discrepancy; precipitation, soil characteristics, and topography. It has already been mentioned that climatically the study area is the wettest farm area in the country, and although it has not been studied specifically the hydraulic conductivity of the soil may be unusually low. Also, in a nearby community, Landeyjar, earlier bogland drainage had been particularly successful as the ditches normally extended down into a gravelly riverplain which functioned as a continuous band of subsurface drains, and this may have caused the agricultural advisor, who determined the drainage intensity in both areas, to be too conservative in determining the required drainage intensity in Mid-Mýrdalur. Later the farmers have realized that drainage on the periphery of the bogland plain itself has been more problematic than out on the plain. Several factors may be at work here; seepage from nearby uplands and mountains, different soil particle size distribution due to dust deposition from the adjacent wind eroded interior, and less permeable bedrock on the eastern flank of the area where an interglacial basaltic lava flow borders the bogland plain. The bogland reclamation was thus most problematic near the farmsteads and as farmers normally farm the area nearest to the farmstead more intensively than outerlying fields, and the survey farmers were no exception in this regard, they inadvertently chose these problem areas when they embarked on what was later to become a major bogland reclamation effort.

Another problem that the farmers encountered during this period was in regard to methods of tilling the soil. A number of Norwegian ploughs had been imported in the mid 1950s which were capable of deep-ploughing to a depth of 60cm (2 feet) and these were heralded by the farm extension service to be ideal in breaking up the often tough and hummocky bog surface. Many of the farmers had a field or two ploughed in this way, and almost without exception they claim that those fields are the most unproductive ones on their farms. In this case, as in many other asepcts of land cultivation, experiments were only undertaken after this type of plough had been used extensively. These experiments have shown that deep-ploughing of bogland may have a beneficial effect on drainage and general productivity if certain measures are taken (Geirsson, 1967), but in the Mid-Myrdalur case the harm was already done; the fields had been brought too quickly into production after ploughing, insufficient attention had been given to ensure that the plough furrows opened into the ditches, and the final tilling of the plough ridges to form a seedbed was also inadequate, hence the presentday problems of low productivity.

In order to address the problem of inadequate drainage the local Land Reclamation Organization had a cheap and simple mole drain plough constructed around 1960, and soon mole drains had been installed in most of the cultivated bogland fields resulting, in most cases, in some, if only temporary, improvement. The advent of the new tunnel drainage technology was therefore welcomed by the farmers (Figure 20); in 1964, the first year that the technique was available to the survey farmers they had 141 km installed. As the distance between the drains was usually kept at 10 metres (33 feet) this represents an average acreage of 7.5 ha (16.1 acres) per farm, In 1968 a local tunnel drainage plough was available, and in light of the success of the earlier ones the survey farmers had extensive acreages drained in this way. Since then the activity has decreased and has now almost stopped. An anamolous peak is apparent for the year 1974 in the survey area (Figure 20). The installation of tunnel drains had been paid for by the State at a rate of 75 per cent of installation costs, but in 1974 the local Land Reclamation Organization decided not to charge the farmers for their 25 per cent share, arguing that the job was not completed until the spoil (see Figure 14) had been rotovated. Not surprisingly the farmers responded by having practically all the remaining boglands treated. Almost all the fields that have been cultivated on the sur-

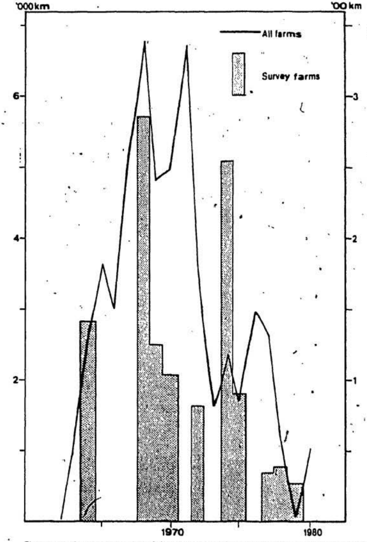


Figure 20 Annual tunnel draining on survey farms and all farms, Iceland 1962-80
Source: Bjarnarson, Thaettir um Mýrajardveg á Íslandi, 1982; Búnadarrit, 1974-78; Unpublished data, Búnadarfélag Íslands

farms for the last 15 years are drained with tunnel drains, and there was a general feeling amongst the survey farmers that tunnel drains were a key factor in making bogland reclamation feasible in the area.

With reference to the Newfoundland context it should be noted that bogland farming in the Mid-Myrdalur area has by no means been an outright success story; on the contrary, it has at times been quite problematic and it was not until tunnel drains became available that it can be termed successful.

6.3 Survey farms and survey farmers in Iceland and Newfoundland, and the farmers' perceptions of boglands

One of the main objectives of this thesis is to examine the potential use of technology and experience from Iceland in a programme of establishing bogland farming in Newfoundland. Therefore this section will take a comparative look at the survey farms and survey farmers in Iceland and Newfoundland and, in particular, the farmers' perceptions of farming the boglands.

Table 14 indicates that while farmers' age and background are generally similar in the two samples, it is more common in Iceland that farmers take over their parents' farm, reflecting the more longstanding farming tradition in Iceland. Five of the survey farms in Iceland are owned by

Table 14

Some farm and farmer characteristics on survey farms in Iceland and Newfoundland

	N	Mean farmer age	Mode age-group	Years farming	Raised on a farm	Took over family farm	Same farm always	Own their farm	Agricultural schooling
Iceland	19	52±6.1	41-50	23±6.0	19	18****	18	14	3
Newfoundland	28	48±4.8	41-50	21±4.8	25	13****	26	28	1

	Member of farm. org.	Private Marketing	Livestock in sheep-equivalent units	Hayland in acres	Number of Tractors	Annual Gross Sales in $	Per cent of income from farming
Iceland	19	0****	567±131	70.7±17.8	3.2±0.5	54236± 7795	95± 4.1
Newfoundland	20	20****	497± 68	32.1±14.2	1.6±0.4	28830±14950	71±14.2

****Significant difference at 0.001 level of confidence.

1 Cattle two years or older equals 20 sheep-equivalent units, other cattle 10 sheep-equivalent units, a winter-fed sheep is one sheep-equivalent unit. This is the system used by Landnam rikisins for comparing sizes of dairy/sheep farms.

Note: 95 per cent confidence limits are given for all sample means, e.g. there is a 95 per cent probability that average farmer age in Iceland is between 45.9 and 58.1 years.

the state but the farmers concerned only pay a nominal rental fee and have life-long leases. With regard to the number of survey farmers with some agricultural schooling it should be pointed out that there are two long established agricultural schools in Iceland, but in Newfoundland there is only one agricultural training program which was recently initiated at Stephenville Community College. However, this is in danger of being discontinued because of lack of enrollment in the program (The Western Star, 1982), further indicating the marked difference in attitudes towards farming and the difference in farming tradition.

There is also a particularly marked difference in marketing structure. All the Icelandic sample farmers sell their products on an organized basis; the milk is sold to a dairy owned by a farmers' co-operative, and lamb and beef are sold to one of two local slaughterhouses, one owned by a farmers' co-operative and the other by a group of merchants. It should be noted in this context that since 1947 pricing of Icelandic grassland farm produce has been determined according to the principle that people engaged in grassland farming would enjoy a similar standard of living as those engaged in certain other occupations, and practically all processing and wholesale marketing of the produce is in the hands of farmers' co-operatives or the general co-operatives. Grassland farmers in Iceland have thus for 25 years had prices virtually guaranteed for their products; this stands in stark contrast to Newfoundland farmers during this period as their price support system seriously deteriorated at Confederation in 1949.

Another marked difference is the amount of hayland per farm, and the degree of farm mechanization. This relates to great differences in on-farm forage production; 42 per cent of the dairy, beef, and sheep farmers in the Newfoundland sample had purchased hay in 1980, but not a single one of the survey farmers in Iceland. Annual gross sales are also considerably higher in Iceland than Newfoundland, partly due to higher prices in Iceland.[1] All the survey farmers in Iceland may be termed fulltime farmers, but a few of them also work in the local slaughterhouses for 1-2 months a year, one is a part-time policeman while another is a school-bus driver. In Newfoundland most of the sheep and beef producers are only part-time farmers whereas the dairy producers are usually fulltime farmers.

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1 The average farm-gate price for milk in Iceland in 1980 was approximately $64.40 per 100 litres (Bureikningastofa Landbunadarins, 1980), whereas in Newfoundland it was $43.98 (Newfoundland Agricultural Statistics 1980-81, 70). Corresponding figures for lamb are $2.43 and $1.80 per pound respectively (the latter figure is based on section 4.5 of this thesis). It should be pointed out, however, that the very high inflation rate in Iceland makes comparison very difficult. For example, on Jan. 1st, 1980 one Canadian dollar equalled 3.37 Icelandic kronur, twelve months later it equalled 5.24, and during 1980 it averaged 4.10 kronur. A complicating factor is that payments to the farmer are not spread evenly through the year.

Table 15 gives a statistical breakdown of responses to specific questions that the survey farmers were asked relating to their opinions of the boglands, and for comparative purposes the responses from the Newfoundland random sample of farmers to similar questions are also tabulated. The Newfoundland farmers usually declined to comment as they had no practical experience in bogland farming, but a more detailed analysis of the Newfoundland data is provided in Appendix E. Many of the Icelandic farmers also pointed out that as they had been reclaiming boglands exclusively for the last 10-20 years they were not in a good position to give reliable answers to the specific comparative questions comparing boglands and mineral soil. Notwithstanding those limitations Table 15 provides some illuminating information on bogland reclamation and cultivation.

In response to a question on the general comparative productivity of the two soil types in Iceland mineral soil had the edge over the boglands, but a number of the farmers pointed out that it was hard to generalize in this regard because of variability within each of the two soil types. They generally agreed though that the boglands were more expensive to reclaim, but in the Newfoundland context it should be noted that the mineral soil in Iceland is usually relatively deep and free from stones and drainage represents therefore an added cost factor when it comes to bogland cultivation. It was generally felt that there was

Table 15

Farmers' perceptions of bogland cultivation in Iceland and Newfoundland

		More productive?				More expensive to reclaim?				Needs more fertilizer?				Gives more hay?			
	N	Bogl.	Min. Soil	Equal	Don't Know	Bogl.	Min. Soil	Equal	Don't Know	Bogl.	Min. Soil	Equal	Don't Know	Bogl.	Min. Soil	Equal	Don't Know
Iceland	19	5	9	3	2	17	0	1	1	3	4	10	2	8	7	2	2
Newfoundland	28	0	3	1	24	3	2	1	22	7	1	3	17	3	1	3	21

	Gives better hay?				Better for grazing?				Animal health affected?			Same machinery usable?			Animals get stuck?			
	Bogl.	Min. Soil	Equal	Don't Know	Bogl.	Min. Soil	Equal	Don't Know	Yes	No	Don't Know	Yes	No	Don't Know	No	Don't Know	Yes	Seri-ous
Iceland	0	7	11	1	0	13	5	1	0	18	1	19	0	0	3	0	16	0
Newfoundland	1	1	6	10	1	10	1	16	4	9	15	0	19	9	3	12	7	3

Source: Field research 1981.

little difference in fertilizing requirements, but opinions were divided on which soil type yielded more hay. Five of the eight farmers who claimed that boglands gave higher yields qualified their answers by pointing out that this was particularly true during the first few years of cultivation. Seven of the nineteen survey farmers in Iceland felt that mineral soil hay was superior to bogland hay. This preference for mineral soil hay probably reflects species composition of the hay; seeded grass species, such as timothy, often give way to native grasses or even non-grass species which depresses the nutritional value and, particularly in the case of cows, decreases palatability. The reasons for this differential in endurance of high yield species, such as timothy, are not clear but inadequate drainage is a likely factor in this regard. The preference for mineral soil was even more marked as regards grazing, but when the survey farmers in Iceland were asked to compare drained but uncultivated bogland to uncultivated mineral soil for grazing the majority of the farmers chose boglands. Bogland cultivation is not considered to involve any particular animal health problems, and while most farmers said that occasionally animals would get stuck in ditches none of the Icelandic farmers felt that it was a serious problem, and a few of the Newfoundland farmers mentioned that time was a factor here; the animals appeared to learn to stay away from the ditches. The question on machinery requirements yielded the most pronounced response difference between the farmers in Iceland and Newfoundland, all the Icelandic farmers said there was no difference in this regard between the two soil types, but in Newfoundland not a single farmer was of that opinion, reflecting both the difference in bogland soil characteristics and the difference in drainage intensity. Many of the Icelandic farmers pointed out, however, that in a very wet season the boglands were at a disadvantage in this regard, i.e. the farm machinery tended to sink. A number of farmers also mentioned that due to levelness the bogs were in fact better suited for mechanization than the mineral soil.

Table 16 gives further information on how the farmers feel the two soil types compare, but in the Newfoundland case only the bogland farmers were asked these questions. The first question, which soil type was more affected by climatic extremes, yielded varied responses in Newfoundland, but many of the farmers in Iceland pointed out that while boglands suffered more in an exceptionally wet season the reverse was true for an abnormally dry season. In regard to the question of winterkill the farmers pointed out that it was usually a function of the surface contours, i.e. winterkill tends to occur in minor depressions which are more characteristic of the bogs than the mineral soils. Cambering of the bogland fields should therefore help to eliminate this factor. The overwhelming majority of the

Table 16

Bogland farmers' perceptions of bogland cultivation in Iceland and Newfoundland

		More affected by climatic extremes?				More affected by winter-kill?				Which to choose if to expand?		
	N	Bogl.	Min. Soil	Equally	Don't Know	Bogl.	Min. Soil	Equally	Don't Know	Bogl.	Min. Soil	Don't Know
Iceland	19	11	2	2	4	12	1	4	2	2	16	1
Newfoundland	8	0	3	2	3	1	2	3	1	1	3	2

Source; Field research, 1981.

survey farmers in Iceland stated that if they were to expand their farm operations and had a choice between mineral soils and boglands they would choose the mineral soil. Ten of these sixteen farmers indicated that higher developing costs were a key factor and five mentioned durability of fields in this regard. In fact, many of the survey farmers said that they often got extremely good hay yields from the boglands during the first few years of cultivation but after that they tended to fall off.

These two issues, i.e. high development costs and inadequate durability, appear to be the main negative aspects of bogland farming in the area, whereas good initial yields and ease of harvesting are the positive ones. Applying this to Newfoundland the problem of high development costs would probably be relatively less important due to the comparatively high clearance and other development costs of the mineral soils, but the durability issue needs further study, both in Iceland and Newfoundland. On the other hand the mechanization potential has not yet been exploited in Newfoundland, but from bogland farming in Newfoundland there is also some evidence that initial yields are at times exceptionally good.

When asked about the best drainage system for their farms seventeen farmers said that open ditches and tunnel drains would be best; one farmer preferred open ditches with tunnel, mole, or plastic drains depending on the bog in question; and one farmer indicated his preference for narrowly spaced ditches without subsurface drains. In light of this overwhelming preference for tunnel drains it is not surprising that in response to the question if they would have their fields drained differently now, the most frequent comment was that tunnel drains should be used and the ditch spacing could therefore be increased which would result in larger fields that would be more economical to harvest. Another frequent comment was that it was important that the ditches had sufficient grade as that would minimize maintenance requirements.

Table 17 concludes the statistical overview of the results from the questionnaires. About half of the farmers in both Iceland and Newfoundland felt that governmental assistance to agriculture and availability of farm credit was not a problem, but in regard to the respectability of farming as an occupation half of the survey farmers in Iceland felt that farming was not considered an inferior occupation, but in Newfoundland the corresponding proportion was about one third. Only one survey farmer (five per cent) in Iceland felt that he would be better off financially if he was not farming, but the corresponding figure for the Newfoundland farmers was seven, i.e. 25 per cent. It may therefore appear somewhat surprising that 32 per cent of the Icelandic farmers had considered giving up farming and only 11 per cent of the Newfoundland farmers, but the explanation

Table 17

Farmers' attitudes towards farming in Iceland and Newfoundland

		Government assistance adequate?				Comments on farm credit?			Farming as respectable as other occupations?			
	N	More	Adequate	Less	Don't Know	OK	Problematic	No Comment	More	Equally	Less	Don't Know
Iceland	19	3	6	5	5	10	4	5	1	8	9	1
Newfoundland	28	1	13	10	4	15	8	5	0	9	11	8

	Financial condition if not farming?				Considered giving up farming?			Future for farming?			Why farming?		
	Better	Equal	Worse	Don't Know	Yes	No	Don't Know	Good	Bad	Don't Know	Raised on a farm	Like it	Other
Iceland	1	7	7	4	6	13	0	16	0	3	15	4	0
Newfoundland	7	7	8	6	3	24	1	23	1	4	0	24	4

Source: Field research 1981.

may well be that alternative employment is much more readily available in Iceland.[1] The majority of the survey farmers, both in Iceland and Newfoundland, felt there was a good future in farming, citing shortage of food in the world to support that opinion. An interesting difference was revealed when the farmers were asked the open-ended question: Why are you farming? Most of the Icelanders replied that being raised on a farm was the main reason, while most of their Newfoundland counterparts said they were farming because they liked it, indicating yet again the great difference in farming tradition between the two areas.

The purpose of asking the questions listed in Table 17 was to examine whether the marked differences in the use of boglands could be explained by cultural and socio-cultural factors. While the responses do give some support for such an explanation it is clear that this difference in resource utilization cannot be explained by one set of factors; bogland reclamation is only a part of a much wider issue, agricultural production in general, and is therefore subject to a number of interrelated factors. But what meaning can this somewhat detailed section on the Mid-Mýrdalur farms have for the study of bogland farming in

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1 The unemployment rate in Iceland is extremely low, usually about 0.5 per cent, whereas it is extremely high in Newfoundland, about 15 per cent in recent years.

Newfoundland? First, it demonstrates that bogland farming in the area only took place as a part of farm expansion in general. This supports the stand taken earlier in the thesis that bogland promotion efforts should be concentrated on dairy farming in Newfoundland as that industry appears to be expanding. Second, most farmers cultivated all available mineral soil before they turned to the boglands, i.e. the farmers considered the boglands only as a second best choice. This was mostly due to the boglands being more expensive to reclaim, but in Newfoundland the situation is different; reclamation costs for mineral soil is usually very high. However, the field research in Newfoundland indicated that one of the reasons for the West Coast farmers abandoning their boglands in the 1960s was indeed that they also had good mineral soil available that could easily be reclaimed. The focus on dairy farming in the St. John's area where mineral soil is both scarce and expensive to reclaim is therefore further justified. Third, tunnel drains have been found to be crucial in making bogland farming in the Mid-Mýrdalur area successful, and are, for example, considered far superior to mole drains. Finally, the study revealed a number of recommended reclamation and management practices that will be discussed in the last chapter.

The next chapter examines some of the options available for promoting grassland bog farming in

Newfoundland, and also extends the study to other countries in search for drainage technology similar to the Icelandic tunnel drain ploughs.

CHAPTER VII

GRASSLAND BOG FARMING IN NEWFOUNDLAND: PROSPECTS AND APPROPRIATE TECHNOLOGY

7.1 Approaches for promoting grassland bog farming in Newfoundland

Broadly speaking there are three different approaches possible as regards bogland reclamation for grassland farming in Newfoundland. One is to curtail all efforts to reclaim boglands for this purpose, either because of better alternative uses for this particular resource or because of inherent difficulties in their use for grassland farming. Both of these will be dismissed as invalid. Admittedly there are a number of alternative uses for this resource including fuel utilization, peat moss production, afforestation, vegetable production, wildlife habitat, and recreation use; but as the resource in question is abundant all across the province and practically no use is made of it at present (except as wildlife habitat) the argument is unfounded. Furthermore, fuel utilization, peat moss production, and grassland farming can, theoretically at least, all proceed on the same plot; i.e. by first harvesting the uppermost peat moss layer, then harvest the more decomposed underlying peat for fuel, and the lowest stratum in the soil profile can subsequently be used for grassland farming. With regard to the suitability of the resource for bogland farming, that has already been demonstrated both experimentally, and commercially on a few farms, at least for hay experimentally, and commercially on a few farms, at least for hay production. Admittedly there are problems to be solved in various aspects of its use, and the long term economics of its use compared to those of mineral soil have not yet been worked out, but it is suggested that adopting the recommendations that will be presented later in this thesis will facilitate the solution of the remaining problems and make the economies of bogland farming favourable.

The second approach is to continue along the lines presently followed, i.e. the drainage aspect is more or less taken as given (and therefore implicitly as satisfactory) and the focus of attention is the development of special machinery that would mechanize all the different aspects of crop production on boglands (see e.g. Hergert, 1980). An attractive facet of this approach is its ecological implications; forage production under relatively high water tables minimizes subsidence, and it has been suggested that if the design and production of specialized machinery is successful Newfoundland could become an exporter of this technology to other parts of Canada and the rest of the world (Rayment, 1979). While the merits of this approach are recognized it has serious limitations for grassland farming.

First, the research efforts have focused mainly on vegetable production with little regard for application to grassland farming.

Second, drying of hay under prevailing Newfoundland conditions on a bog whose sod is more or less continuously wet, or transport of the relatively heavy crop of silage off the bog poses problems for efficient crop management which will probably be exceedingly difficult to solve economically.

Third, and perhaps most importantly, it is suggested that the development of such a line of machinery is hampered by the fact that there is not the feedback from farmers trying out this machinery in the field and without which such a development is unlikely to succeed. The farmers in the province have a perception of boglands that their agricultural utilization is unattractive because of machinery problems, and it is therefore not likely that such a feedback between researchers and farmers will develop in Newfoundland. The research into adapting and designing special bogland machinery has been undertaken in recent years by Agriculture Canada and the Engineering Department of Memorial University, but it appears that there has not been a coherent and serious effort made in this regard; instead separate short-term contracts have been awarded for the design of a few pieces of machinery, mainly for vegetable production. It seems therefore that not only is the problem, i.e. design of forage harvesting systems suited for bogs of minimal drainage, difficult to solve, but the efforts made so far in this regard have been insufficient, and due to problems encountered in previous bogland reclamation projects farmers are not likely to be interested in experimenting with such harvesting systems. Furthermore the Newfoundland Agriculture Branch has adopted a policy of not being involved in an operating function for agricultural production on boglands; instead it provides assistance _if_ there is an interest from farmers (Neilson _et.al._, 1979, 10). Grassland farming on boglands in Newfoundland can thus be considered to be in state of deadlock; the adaptive research into machinery design is not likely to succeed without farmers' involvement, the Newfoundland Agriculture Branch only provides assistance if interest from farmers is forthcoming, but under current drainage systems farmers are not interested in bogland farming.

The third approach, and the one recommended in this thesis, is to focus initial efforts on increasing drainage intensity and thereby reduce the machinery problems which in turn should make bogland farming more attractive to farmers. In this way the breaking of the deadlock just mentioned would be facilitated.

Admittedly there are negative aspects to this approach; reclamation costs increase and so do subsidence rates, but it is suggested that the benefits will outweigh the negative aspects. One of the main contributions that this thesis attempts to make is in fact that it is the identification of technology that keeps the increase in development costs just mentioned at a minimum. With regard to subsidence grassland farming tends to minimize subsidence rates, e.g. in comparison with vegetable farming, and adoption of certain reclamation practices, e.g. the spreading of reclamation operations over a number of years, also minimizes the problems associated with subsidence.

The benefits of intensive drainage are numerous; not only are the machinery problems minimized, management criteria for successfully farming the boglands would also be less stringent, and it is likely that yields would generally increase. Most important of these is the machinery factor as it is both a real cost factor for farmers, and widely perceived by farmers as the biggest stumbling block to their involvement in bogland farming.

It should be emphasized here, however, that the drainage approach is not mutually exclusive from that which emphasizes machinery development. As explained before drainage intensity is a relative concept, and focusing attention on increasing it does not mean that machinery problems will be solved once and for all; instead they will be less difficult to solve. It is suggested, for example, that tracked machinery would not be necessary for harvesting; instead wheeled machinery would suffice, either on flotation tires or dual wheels. The modifications of machinery would therefore be relatively minor and would not interfere with use of the same machinery on mineral soil.

7.2 Techniques for economically increasing drainage intensity

Having identified increased drainage intensity as a focus for efforts to encourage grassland bog farming in Newfoundland the next step is to determine how this should be done. One option would be to use the same drainage machinery as was used in the 1960s, i.e. the Healy ditcher, but deepen and/or decrease the spacing of ditches. However, this option is not realistic; deepening ditches has been found to be relatively ineffective in lowering water tables (Rayment and Cooper, 1968), and decreasing the already narrow ditch spacing would result in extreme difficulties in mechanized harvesting of fields. Subsurface drains are a preferred alternative as they combine an intensive system of drainage and large field sizes which allow for economical harvesting of a given acreage. One of the main potential advantages of farming boglands in Newfoundland compared to the mineral soil is the large and continuous acreage of nearly level and stone free farmland that would normally encourage economical mechanization of field operations, but so far this advantage has not been exploited due to machinery flotation problems. Intensive drainage by subsurface drains would allow that potential to be realized.

While the productivity of bogland soils under such a drainage system has not yet been demonstrated in Newfoundland it is suggested that the subsurface drainage techniques which have been employed in recent years for experimental purposes in Newfoundland, i.e. plastic pipes and Norwegian drains, are too expensive to justify their use in grassland farming in the province. Mole drains have been suggested as an alternative measure, but in Iceland tunnel drains have been found to be far superior to mole drains, both in terms of effectiveness and durability. In order to determine if alternate technologies existed elsewhere in the world that would achieve the same objective, i.e. provide cheap but efficient means of relatively intensive drainage, an extensive literature search was undertaken in addition to correspondence with a number of scientists in Europe, Asia, and South America. In order to steer away from the more expensive drains the search focused on nonmaterial mechanically installed subsurface drains. The research revealed that such techniques had been developed in West and East Germany, Norway, and Ireland.

In West Germany a technique ("Mecking Dranfrase") was developed back in 1952 which makes a rectangular drain 15cm wide and 20cm in height at a depth of 80-160cm, from which the soil material is excavated through an approximately 5cm wide slit up to the surface (Baden and Eggelsmann, 1961). The tool is attached to and operated from a specifically designed machine with an engine power of only 20-25hp, and the installation rate is 1.0-2.5km/day. More than 50,000km of such drains have been installed in

West Germany[1] and the technique has also been employed in Switzerland, Ireland, and Norway. In Finland a somewhat similar tool has been designed and used but its effectiveness appears to be limited (Menonen and Päivänen, 1979), possibly because the slit above the drain may cause soil material to fall into the drain and partially plug it. According to Eggelsmann (1972) the durability of the Mecking drains depends on the peat density, ranging from less than a year to more than eight years. Another slightly different technique ("Torfwerk Strenge") has also been developed and used in West Germany for the same purpose; a 10cm wide and up to 120cm deep slit is excavated but later another operation is needed to close the drains by cutting diagonally from the surface into one of the two walls of the drain so that a triangular chunk of soil slides down and closes the drain. The installation rate is about 120-180m/hour and the drain excavator is powered from a special machine with an engine power of 30-35hp. By 1961 over 1000km of such drains had been laid in West Germany.

In East Germany a special kind of a mole drain plough was developed in the mid-1960s (Scholz, 1967). Instead of forcing the bog radially outwards to make room for the mole drain (i.e. by pulling an egg-shaped metal

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1 Pers. Comm., Rudolf Eggelsmann, Niedersachsisches Landesamt fur Bodenforschung, 1982.

bullet through the soil) the East German plough cuts a cylindrical drain at a depth of up to 130cm and disposes of the corresponding spoil immediately below the drain. Thus, there is less tendency for the drain to cave in, and experiments have shown these drains to be superior to mole drains, both in terms of water outflow rates and durability. An added advantage is that less draught power is needed to install the drain: 1500–2000kg instead of 2000–2500kg. The installation rate is in the order of 300–400m/hour.

In Norway a tunnel drain plough, based on the same principle as the Reynir plough in Iceland (see Figure 14) was constructed in 1955 (Ödegaard, 1960). The rectangular drain produced was 11cm wide and 17cm in height and the working depth was about 60cm. The drains have been found to have little effect on forage yields (Halvorsen, 1974), and the plough has not been widely used; it did not work well on bog soils containing tree roots or fibrous material, and due to the shallow depth traffic of machinery tended to block the drains.[1]

In Ireland a tunnel drain plough was constructed in 1959 (Armstrong et.al., 1960). The plough extruded a soil ribbon 20cm wide and 38cm high up to the surface, leaving a rectangular drain of similar dimensions, but the top of the

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1 pers. comm., Einar Wold, Det Norske Jord- og Myrselskap, 1982.

drain was only 38cm from the surface. The plough was only usable on certain kinds of bog soils and interest in it declined. Recently, however, it has aroused renewed interest after it was discovered that tree plantations on fields drained by this technique had developed superior root systems compared to those on fields drained with conventional methods (Dillon et.al., 1976), and the top soil in these fields has also been found to develop certain particularly favourable physical characteristics (Burke, 1978). The design of the plough has since been modified (Grubb and Burke, 1979) and considerable acreage has recently been drained for the purpose of establishing tree plantations (O'Carroll et.al., 1981). Five such ploughs are now in use on afforestation projects but in spite of a lot of interest from grassland farmers the non-availability of ploughs for this purpose has hampered development in this regard.[1] On sites where tunnel drains are not effective due to variability in the peat gravel drains are employed in which a band of gravel is deposited on a layer of polethylene (Calvin, 1979), but in that case approximately 50 tons of gravel is needed per hectare making that drainage system considerably more expensive.

There are thus a number of techniques available that produce nonmaterial mechanically installed subsurface

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1 pers. comm., W. Burke, An Foras Taluntais, 1982.

drains. In Table 18 an attempt is made to compare the characteristics of the different types. The Norwegian plough has been found to be inefficient, the same appears to apply to the Finnish one, and the installation rate of the Torfwerk Strenge drains is low and another operation is needed to complete the drains. No up-to-date information has been found on the East German plough but initial performance was very promising. This leaves the Icelandic and Irish tunnel drain ploughs, and the German Mecking plough. These have all been extensively used reflecting their effectiveness under conditions in the countries concerned.

A drawback to the Mecking plough is the low installation rate, and the slit from the drain up to the surface which increases the danger of material falling down into the drain.

The drawback to the Icelandic ploughs is the heavy machinery needed to operate the ploughs. On the other hand ordinary bulldozers on flotation tracks are used for this purpose and would therefore have alternative uses, whereas most of the other ploughs are operated by special machinery. The Icelandic Eggert plough is the only one that leaves undisturbed peat all around the drain which theoretically should be reflected in increased stability of the drain. Furthermore, it can easily be disconnected when the draught machine hits a soft spot, and the plough can subsequently be pulled on wires to a drier area of the bog. The working depth of the Icelandic ploughs is also greater which serves to increase their effectiveness in lowering water tables and increasing the firmness of the surface layer.

A common drawback to the Icelandic, Irish, and East German ploughs is their sensitivity to fibrous roots in the soil as they rely on a cutting action. On the other hand, if mole drains can easily be installed on Newfoundland bogs by adding a serrated cutting disc to the plough, as was done at Colinet in the late 1950s, a similar modification might overcome this problem with the tunnel drain ploughs. All in all the Icelandic designs appear to possess a number of favourable qualities and their effectiveness under Icelandic conditions is unquestionable even if scientific measurements are not available. It should be noted, however, that in Ireland there is an ongoing research into the Irish plough which may yield a still superior design.

Drainage machinery for primary ditching also needs to be considered. If a subsurface drain depth of 1-1.3m is adopted the open ditches should be at least 10-20cm deeper which eliminates the use of Healy's spinning disc ditcher which was used on all the projects in the 1960s. The optimum spacing of open ditches in Newfoundland, when subsurface drains are used, is unknown, but in Iceland the ditch spacing is frequently 50-120m when tunnel drains are employed, so relatively little open ditching is necessary on a per acre basis. A backhoe excavator on flotation tracks has been used in Newfoundland for making perimeter ditches, etc., and should be adequate for initial projects assuming that it is not fully occupied on the maintenance of the regional pastures. A few alternatives exist; ordinary excavators on flotation tracks that can also be used for other purposes (the system presently used in Iceland), rotary ditchers similar in design to the "Dondi" ditcher already in use in Newfoundland (see Cahill, 1982), or specifically designed excavators. The Dondi design is an attractive choice as it produces a preferred trapezoidal shape of the ditch, and the design also facilitates easy maintenance, particularly as it relates to deepening of ditches.

So far in this thesis bogland farming in Newfoundland, and grassland farming in general, have been examined in some detail. Also, bogland farming in Iceland has been studied where it has special relevance to the Newfoundland case. Furthermore, the study has been extended to other countries in surveying a particular type of drainage technology. All of these have been considered within the context of diffusion of innovations. This sets the scene for reflections and conclusions on the study as a whole, and allows some recommendations to be made regarding the future for grassland farming on boglands in Newfoundland. This will be attempted in the concluding chapter of the thesis.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

The examination of bogland utilization in Newfoundland and Iceland has revealed enormous difference in scale; in Newfoundland only about 50ha (120ac) have been reclaimed and seeded and in use on farms while in Iceland ca. 70,000ha (173,000ac) are seeded and another ca. 30,000ha (74,000ac) are drained but unseeded. This huge difference in bogland use is in part a reflection of the difference between agricultural activity in general in the two areas. In Iceland there are roughly 800,000 winterfed sheep and some 60,000 cattle, but in Newfoundland the corresponding figures are 4,000 and 6,000. There are a number of inter-related reasons for this disparity including economic, political, and cultural factors, but notwithstanding these it would appear that the abundance of deep, nearly level, stonefree, and unforested boglands should be attractive farmland compared to the shallow, rocky, and tree-covered mineral soils in Newfoundland. Such has not been the case however. In their natural state most of the Newfoundland bogs support only sparse stands of vascular plants while mosses are dominant, and the farmers have accordingly regarded them as agricultural wasteland.

In Iceland, on the other hand, circumstances are different. Because of different physical characteristics that relate to volcanic activity the bogs had traditionally provided farmers with the bulk of the winter-feed they needed to carry the livestock through the winter. Accordingly, the distribution of boglands had been an influential factor in determining farm settlement location. However, when external circumstances made farm labour scarce and expensive, and productivity increased in other sectors of the economy, bogland farmers found themselves to be at a comparative disadvantage, particularly vis-a-vis other farmers which could more easily mechanize the expansion of their farms by cultivating mineral soil. The traditional system of exploiting boglands in their natural state was thus not competitive either with mineral soil farming or other occupations. There was thus a very real need for the farmers concerned to make a success of bogland farming by increasing drainage and cultivation that would both increase yields and allow for mechanization. This did in fact happen in Iceland, but in Newfoundland repeated efforts by authorities to promote boglands as an agricultural resource have met with little success. It is now time to reflect on the study of these developments, and, in particular, to examine the utility of the theoretical discussion in Chapter II for the study as a whole.

8.2 The bogland study and the theoretical context

In Chapter II it was pointed out that most diffusion studies focused on the adopter's characteristics whereas this study has been more concerned with the innovation itself, i.e. the innovation characteristics. It was also pointed out that the bulk of diffusion studies dealt with "successful" innovations, i.e. ones that had been widely adopted, whereas this study has examined an innovation that did not "make it". For the purpose of this thesis Rogers and Shoemaker's (1971) paradigm of the innovation decision process was found to be an improvement from previous models in that it accounted for the possibility of rejections and discontinuances. A further improvement in this regard was Klonglan and Coward's (1970) two-phase model of the adoption process where a distinction is made between symbolic adoption and use adoption. In Figure 21 the main features of both models are combined into a single model. Thus, it distinguishes between symbolic adoption and use adoption, and also between trial rejection and symbolic rejection. At the same time the main components of Rogers and Shoemaker's paradigm are included.

It has already been suggested that the critical breakdown in the Newfoundland bogland reclamation programme of the 1960s occurred at the trial stage. Figure 21 makes it quite clear that this stage should be considered as a

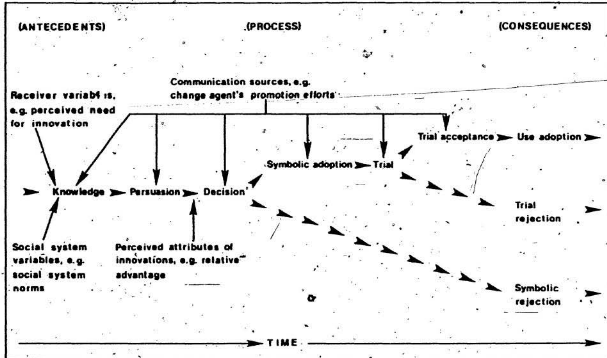

Figure 21 A suggested paradigm of the innovation decision process (Modified from Rogers and Shoemaker, Communication of Innovations, 1971; and Klonglan and Coward, Rural Sociology, 1970)

part of the "process" rather than the "consequences," and that the change agents' promotion efforts should therefore also be directed to this particular stage. But it appears that the bogland programme authorities focused their efforts on getting as many farmers as possible from the symbolic adoption stage to the trial stage. As it turned out trial rejection became widespread which in turn led more and more farmers to symbolic rejection and also, eventually, the agricultural authorities.

However, even if farmers had been carefully assisted during the trial stage there is, of course, no guarantee that the programme would have been a success. Two factors appear to be particularly important in this regard.

The first of these is the general decline experienced by most grassland farming sectors during the last few decades, i.e. the "antecedents" were unfavourable for an innovation like bogland farming that would have had the effect of increasing production.

Second, and perhaps more important, there is the machinery issue with all its implications. The study has revealed, without doubt, that this was by far the most critical characteristic of the innovation and the one perceived by Newfoundland farmers today as the biggest disadvantage of bogland farming. The machinery issue has been dealt with at some length before in this thesis and will therefore not be considered here in detail. However, it will be briefly examined how this particular issue relates to each of the five major categories of innovation characteristics identified by Rogers and Shoemaker (1971), i.e. relative advantage, compatibility, complexity, trialability; and observability.

The various modifications of machinery necessary for successful mechanization of operations increased the initial costs of engaging in bogland farming, and as farmers had no previous experience of bogland farming continuing costs, e.g. maintenance of ditches, were unknown and the risks inherent in investing in "flotation" machinery were accordingly perceived as considerable. These issues, initial and continuing costs, and perceived risk, are all considered to be different aspects of <u>relative advantage</u>, and have generally all been found to be negatively related to the rate of adoption. On the other hand, immediacy of reward, another subdimension of relative advantage, should have had the effect of increasing the adoption rate as the authorities bore most of the reclamation costs and the fields were handed over to the farmers when they were ready for full production.

The <u>compatibility</u> and <u>complexity</u> categories have only peripheral relevance for the machinery issue; it should be noted, however, that in the early 1960s mechanization was not characteristic of farming in Newfoundland so that the necessity to use modified machinery was hardly compatible with existing farming practices.

The <u>trialability</u> category is particularly relevant to the machinery issue. Normally some 10-20 acres were reclaimed for each farmer as it was considered uneconomical to transport the heavy reclamation unit to smaller plots. Small-scale trial of bogland farming was therefore hardly possible for the farmers, but the acreage was rather too small for the necessary investment in modified machinery, particularly as farmers found it difficult to get additional acreage reclaimed. What frequently happened was that farmers took a wait-and-see approach, but that approach was disastrous; if a fair stand of grass was not cut or pastured in a particular year the heavy mat of old grass in the following year usually led to abandonment, and if fertilizing was not carried out mosses and rushes, etc., quickly took over and the seeded grass species disappeared.

The <u>observability</u> concept is also important in the context of the machinery issue. The demonstration plots certainly had the effect of encouraging symbolic adoption among farmers in nearby areas, but in retrospect it appears that harvesting the same plots with the proper machinery should also have been demonstrated. In that way farmers would have become familiar with the necessary machinery modifications.

Finally, a sixth innovation characteristic will be suggested here, namely that of commitment. This concept has received scant attention in the literature, and only with regard to considerations of attitudinal and behavioral acceptance (Zaltman and Lin, 1971; Freedman and Frazer, 1966). In that context it is argued that the most favourable condition for adoption and diffusion is when at least a partial behavioral change precedes attitudinal change. In the context of the bogland study, however, the important thing is that since the Government was responsible for most or all of the reclamation work, usually undertaken on Crown land, the farmer had little or nothing to lose himself if he did not maintain and use the boglands. Thus, complete subsidization of bogland reclamation may actually be deterrent to successful adoption of bogland farming.

But how useful is the model (Figure 21) for explaining the development of bogland farming in Iceland? Again, it will be pointed out that not only were the physical characteristics of the Icelandic boglands different from the Newfoundland ones, and this probably made the symbolic adoption decision easier, but also that the "antecedents" in general were different. During the first half of this century Iceland was an agricultural society undergoing rapid change in both economic and political terms. Independence was achieved and decisions were made to be as self-sufficient in food production as possible. As a result a thriving grassland farm sector developed involving utilization of both mineral and bogland soils.

Another decisive difference between bogland development in the two countries is the machinery issue, which in turn is related to drainage intensity. The study has revealed that minimizing drainage intensity would have disastrous effects on yields in Iceland, opposite to what experiments have indicated in Newfoundland. It appears that the reason for these contrasting responses is a climatic one. Summer temperatures are much lower in Iceland than Newfoundland; the average temperatures in July-August are usually 9-11°C (49-52°F) in Iceland, but 15-16°C (59-61°F) in Newfoundland. Evaporation is therefore less in Iceland, and due to the large heat capacity of wet soils, soil temperature rises very slowly resulting in little grass growth. When considering the effect of temperature on crop response three cardinal points of activity are often distinguished; a minimum temperature below which no activity occurs, an optimum at which the highest activity takes place, and a maximum above which activity is zero again (Wesseling, 1974, 24). It seems that under the climatic conditions prevailing in Iceland maximizing bogland drainage intensity is necessary in order to stay clear of the minimum soil temperature and approach the optimum one as regards forage production. Increased drainage in turn has minimized machinery flotation problems.[1]

Finally, the time factor in Figure 21 should not be overlooked. In the Newfoundland case bogland reclamation has only been pursued seriously since the late 1950's whereas in Iceland it goes back to the first decades of this century, and even further if "Carex-farming" is included, In this context it should be remembered that during the 1920's and 1930's reclaiming boglands in Iceland developed slowly, and it was not until the 1950's when draining and harvesting operations had been successfully mechanized that large-scale bogland reclamation took place. The present state of affairs in Newfoundland can thus be perceived as only a temporary set back in the long term utilization of boglands for grassland farming.

8.3 Recommendations

8.3.1 Drainage

As explained before the main recommendation put forward in this thesis is to opt for more intensive drainage in bogland reclamation for grassland farming in Newfoundland. The low-cost drainage technology surveyed in Chapter VII has collectively been termed mechanically installed nonmaterial subsurface drains. The main advantage

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1 Where volcanic ash layers exist in the soil profile the capacity of the sod to support machinery is also increased.

of using this type of drain is their cheapness as no material is needed to support the drain; instead the drain is self-supporting.

The most common of these, the mole drain, has been tried in Newfoundland but due to minor technical problems and lack of concern for drainage intensity this technique has not been used in Newfoundland since 1961. In Europe a few other types of nonmaterial subsurface drains have been developed. These are generally more effective and durable than the mole drains, and of these the Icelandic and Irish tunnel drains seem to be the most advanced, particularly in terms of durability. Also, the East German design appears to be superior to ordinary mole drains. Further study is needed to examine and compare the machinery needed to operate the different kinds of drain ploughs, and their ability to work through fibrous layers. If none of these ploughs, that are based on a cutting action, is considered to be effective on fibrous peat two alternatives exist: to limit site selection of boglands for development to bogs without such layers, or to employ the West-German Mecking plough or the somewhat similar Finnish plough as they appear to be capable of making drains in fibrous bogland soils.

It is therefore recommended that the Newfoundland Agriculture Branch initiate a study tour to Iceland and Ireland, and preferably also to West and East Germany and Finland, to evaluate and compare the different techniques and their applicability for Newfoundland conditions. Attention in such a tour should also be given to machinery for primary ditching but as explained before the need for such machinery is less pressing.

It is also recommended that if drainage machinery is acquired from abroad experienced operators and/or designers of the machinery in question be hired, both to demonstrate proper operation of the machinery and to provide input into those adaptations of the machinery to Newfoundland conditions that may be necessary. Apart from being recognized as an important element in successful transfer of technology in general there are indications from the short history of bogland reclamation in Newfoundland that support this recommendation. First, if it had not been for Healy's experience and expertise in bogland engineering it is unlikely that the experimental programme in the 1950s would even have proceeded to a stage of commercial application. Second, about fifteen years ago a West German machine, the so-called Leichtraupe ditcher, was purchased at considerable expense to provide supplementary drainage.[1] From the outset there were difficulties experienced with its use in Newfoundland including slight manufactural defects and subsequent mishandling, but it is suggested that for an

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1 The slit drains produced were similar to those referred to in Chapter VII as "Torfwerk Strenge."

experienced operator the identification of the defects and the subsequent repairs would have been a relatively easy task and mishandling would have been avoided. Instead the problems persisted, interest in the machine declined, and it has in effect been idle since it was imported.

The initial expenses of examining drainage machinery in a number of countries with a view to acquiring the most suitable drainage technology, and the subsequent hiring of experienced operators and/or engineers might appear to be prohibitive for grassland farming, but spin-offs from such a project might well be considerable; already there are developments under way in Newfoundland for using peat for fuel, small-scale harvesting of peat moss, vegetable production on boglands, afforestation of boglands, and experimental work on sod production from boglands. Admittedly these operations are so far all of a relatively small-scale nature, but any expansion of these would require drainage, and efforts from all parties concerned should therefore be pooled in an effort to acquire the most suitable drainage technology available.

8.3.2 Utilization of reclaimed boglands

Once a drainage technology has been identified and acquired the question arises as to for what purpose the reclaimed bogland should be used. It has already been pointed out that continual grazing on boglands can be-problematic, both in Newfoundland and Iceland, whereas no problems are perceived with the quality of bogland hay. It is therefore recommended that hay and silage production be the focus for bogland reclamation, particularly for the dairy industry which has been identified as the most economically viable sector of the grassland farming industry. The dairy industry in the vicinity of St. John's is of particular interest in this regard as it is seriously short of grassland. A detailed study of bogs in the area is required to determine the feasibility of incorporating bogland farming into these operations including examination of location, size, surface and profile characteristics, depth and ownership, but generally speaking two alternatives may be perceived: on-farm bogland farming, or hay production on more distant bogs with the hay marketed in the St. John's area, or elsewhere in the province as demand warrants.[1] Producing hay for market has certain advantages compared with setting up bogland farms; investment is limited to land

1 Demand for hay in the province is substantial though the figures on the hay trade are somewhat inconclusive; according to the Newfoundland Statistical Agency 2440 tons were imported from other provinces by boat in 1979, and 1777 tons by rail for a total 5217 tons excluding truck traffic. On the other hand, according to the 1980 annual farm survey Newfoundland farmers purchased 1371 tons of hay from outside the province. It is not clear if the difference is accounted for by non-farmers, e.g. horse owners, or if the statistics are unreliable but in either case the provincial market demand for hay is substantial.

development and machinery as livestock expenditures would be eliminated and building requirements minimized.

In the long term, however, on-farm forage production on the dairy farms is to be preferred to purchasing hay as it allows for more efficient land and crop management, e.g. grazing of aftermath, and more efficient use of existing farm machinery. Furthermore, this would allow for the possibility of silage production from boglands which would appear to be the most appropriate harvesting system under prevailing climatic conditions in the region.

A preferred choice for a bogland farming project would be an innovative dairy farmer who would already have at least some of the harvesting machinery needed, who would have a real need for the extra forage, and who realized the merits of intensive land and crop management and on-farm forage production. The administrative structure already exists for financial and technical support from the public sector to farmers for adopting promising innovations (Newfoundland Agriculture Branch, 1981). The innovativeness is important in this regard; the existing production system in the area, i.e. heavy dependence on feed grain with feeding of forage minimized, is of a relatively long standing tradition and a certain amount of inertia is to be expected when it comes to promoting different management systems. An intensive effort is therefore needed to promote the merits of increased on-farm forage production.

Experimental work at the Agriculture Canada Research Sub-Station at Colinet should be expanded to include studies on the implications of increasing drainage intensity and the most economical way of achieving it, but it is also important that researchers be associated directly with the pilot projects. The direct involvement of Agriculture Canada with the projects is also particularly important because of the nature of the agricultural support system. In general, extension is a provincial responsibility while research is a federal domain. Moreover, the Federal Research Station in Newfoundland does not specifically concern itself with dairying; instead a Research Station in Nova Scotia is supposed to serve the Newfoundland dairy industry. This kind of arrangement is not conducive to the ideal system of feedback and dialogue between farmers, extension staff, and researchers, and it appears that a special effort is needed to pool the resources of all parties concerned to examine better land, crop, and livestock management systems. It is suggested that such an examination would serve to demonstrate the importance of extending the land base of the operations and thereby provide an outlet for reclamation of boglands.

In the event that experimental work proves to be successful but no interest in bogland farming is forthcoming from farmers, the Agriculture Branch should consider establishing a bogland farm for production of hay. In Iceland there are several production units successfully producing a total of over 10,000 tons of grass pellets annually that farmers substitute for imported feed grain. Most of the operations are managed on a Crown corporation basis and while production of grass pellets may not be economical in Newfoundland due to freight subsidy on imported feed grain the production of hay might well be economically viable, and if the private sector is not interested in such production the public sector, i.e. the Newfoundland Agriculture Branch, should seriously consider, through a demonstration project, the viability of such an enterprise.

Finally, in looking towards the long term development of the dairy industry in the St. John's region there is a real possibility that the industry will gradually be relocated. Not only is the present land base small but urban pressures already exist on that land. Admittedly, a land freeze is now in effect that designates certain areas within the St. John's region as agricultural land and prohibits alternate uses, but it is up to the politicians of the day to decide whether to lift that freeze or not. At present the long term continuation of the present operations is by no means secure, particularly in the coming years with the expectation of offshore oil development which can only be expected to increase land prices and pressure to lift the land freeze. If in the meantime grassland bog farming turns out to be successful the opportunity exists for an orderly development of the relocated industry on extensive boglands that would not likely be subject to urban pressures.

8.3.3 Recommended reclamation and management practices

It should be recognized that the reclamation of a particular area of bogland should preferably be spread over a number of years. At least a year should be allowed for settling after primary ditching of open ditches is undertaken. Then subsurface drains spaced relatively far apart, e.g. 15-20m, should be installed and time allowed for further settling, and a year later more closely spaced drains should be installed in between the older ones. Not only does this minimize eventual surface irregularities due to subsidence but it also results in a more effective de-watering system, and a more desirable drain depth. A year later rotovating, levelling, and liming should take place, and possibly seeding, but it may be beneficial to delay seeding to the following year to allow for better incorporation of limestone in the soil. Bringing a virgin bog into full production may therefore take 4-6 years. This time lag is definitely a handicap to the producer, but it is assumed that the bogland reclamation costs will be subsidized, as is the reclamation of mineral soil farm land, and it is suggested that that subsidy would at least cover the drainage costs, and in that way the direct financial costs of spreading the operations over a number of years would be borne by the Agriculture Branch, rather than the farmer concerned.

Particular care should be taken to level the fields to minimize danger of winterkill that may result from ice covered depressions. On very flat bogs cambering may be advisable to facilitate surface run-off and a more rapid lowering of water tables after rainy periods. The cost of cambering depends on the spacing of ditches; in Iceland the cost is considered excessive if the spacing is more than 50 metres. The benefits of cambering is one area where research is needed as it relates to the optimum spacing of open ditches. Many of the Newfoundland bogs have, however, a relatively generous slope and cambering may therefore not be worthwhile, and ditch spacing could be increased. Other topics for research include cultivation methods, e.g. optimum number of rotovations and alternate methods of filling, feasibility of growing special crops such as alfalfa and winter cereals, grass species composition and its interaction with intensity of use and susceptibility to winterkill. The bogland regional pastures presently require considerable maintenance which at least partly relates to the drainage system. It is therefore recommended that the effects of increased drainage intensity on the pastures be examined, both on maintenance requirements and forage yields in general.

When bogland reclamation was initiated in the 1950s, there were high expectations for the success of such a venture; the Premier was quoted as saying that,

> Newfoundland has wild grassland capable of supporting a million sheep and a quarter of million head of cattle...these bogs might well yield 20 tons of grass to the acre... And then perhaps Newfoundland, too, could have her rodeoes and her Calgary Stampede (Evening Telegram, 1955).

Not surprisingly this thesis does not share the kind of optimism expressed in the above quote. A number of problems involved in bogland utilization have been identified, but it is hoped that the identification of these and suggestions for solving of same will gradually lead to a modest scale of exploitation of this abundant Newfoundland resource.

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Appendix A

Questionnaire used for interviewing farmers in Newfoundland.

I. The Farmer

Name ______________

1. a) How long have you been farming? ______________

b) On this farm? ______________

c) How old are you? ______________

2. How long has the farm been in the family? ______________

3. a) Do you own the farm yourself? (i) No _____ (ii) Yes ____

b) (If no) Has not owning the farm had any effect on your farming operations? (i) No _____ (ii) Yes ____

Explain: ______________

____

4. a) Before you became a farmer had you worked on a farm? (i) Yes _____ (ii) No ____

b) (If yes) How long? ______________

5. a) Have you been to an agricultural school? (i) Yes _____ (ii) No ____

b) (If yes) Where and when? ______________

6. Who else works on the farm and at what time of the year?

i) Wife _____ ______________

ii) Children _____ ______________

iii) Other _____ ______________

7. Are you a member of any organizations associated with farming? (i) No _____ (ii) Yes _____

Specify: ______________

____

8. How do you market your products? ______________

____

9. Approximately how much feed grain did you purchase for your cattle and sheep in 1980?

____

____

II. Boglands

10. a) Have you ever used drained bogland for pasture or hay?
(i) No ______ (GO TO 11) (ii) Yes ______

b) Are you presently using bogland?
(i) No ______

c) How many acres did you use? ______	c) How many acres have you had in use? ______
d) When did you use it? ______	d) How long have you been using it? ______
e) What did you use it for? (i) Hay ______ (ii) Pasture ______	e) What do you use it for? (i) Hay ______ (ii) Pasture ______
f) Why did you stop using it? ______	f) Are there any particular problems in using bogland? ______

11. a) Have you ever applied to have bogland drained?
(i) No ______ (GO TO 14) , (ii) Yes ______

b) When? ______

c) What was the response to your application? ______

12. When you applied in ______ why did you do it?

i) Cheap ______ (ii) Only alternative for expansion ______

iii) Other ______ (Specify) ______

13. a) Had you seen any drained bogland before you applied?
(i) No ____ (GO TO 15) (ii) Yes ____

b) Where? (i) Other farms ____ (ii) Demonstration plots ____

(iii) Colinst ____ (iv) Elsewhere __5__

(Specify) ____________________

c) How important was this in your decision to cultivate bogland?
(i) None ____ (ii) Some ____ (iii) A lot ____ (iv) All ____

GO TO 15.

14. Why not?
(i) No bogland available ____ (ii) No need for expansion ____

(iii) Clearing mineral soil better alternative ____ (iv) Inferior hay from boglands ____ (v) Inferior pasture on boglands ____ (vi) Buying hay better alternative ____ (vii) Too expensive ____ (viii) Too risky ____ (ix) Other ____ (Specify) ____________________

____

____

15. Why do you think the bogland reclamation programme in the 1960s wasn't more successful? ____________________

____

____

16. If you were to compare drained bogland to mineral soil:

	Bog-Land	Min. Soil	About Same	Don't Know
a) Generally speaking, which is more productive?	____	____	____	____
b) Which is more expensive to bring into production?	____	____	____	____
c) Which needs more fertilizer?	____	____	____	____
d) Which gives more hay per acre?	____	✓	____	____
e) Which gives better hay	____	____	____	____
f) Which is better for grazing?	____	____	____	____

Does the livestock species matter in this respect?
(i) No ____ (ii) Yes ____ (Explain) ____________________

____

17. Are there any special animal health problems associated with boglands?
(i) Don't know ___ (ii) No ___ (iii) Yes ___ (Explain)

____

18. Can the same machinery be used in farming bogland as compared to mineral soil?
(i) Don't know ___ (ii) No ___ (Explain) ______________

(iii) Yes ___ (Any problems?) ______________

19. a) Do animals get stuck in the bog or in ditches?
(i) No ___ (ii) Don't know ___ (iii) Yes ___

b) (If yes) Is that a serious problem? (i) No ___
(ii) Don't know ___ (iii) Yes ___

20. a) Do you think that the government should be encouraging bogland cultivation?
(i) Don't know ___ (ii) No ___ (iii) Yes ___

b) (If yes or no) Why? ______________

____

Questions 21-24 for bogland farmers only.

21. a) Compared to mineral soil, do you think that drained boglands are:
(i) More ___ (ii) Less ___ or (iii) Equally ___ affected by climatic extremes (e.g. droughts, long wet or cold periods)?

____

b) Do you think that drained boglands are:
(i) Less ___ (ii) Equally ___ or (iii) More ___ affected by winterkill as compared to mineral soil?

____

22. a) Is your bogland drained by open ditches only?
(i) Yes ___ (ii) No ___ (Explain) ______________

b) How and when were the ditches dug? ______________

____

c) What is the spacing of the ditches? ______________

d) How deep were they? ______________

e) How deep are they now? ____________________

f) Have the ditches needed any maintenance? (i) No ___ Yes ___

g) (If yes) How have they been maintained? ____________________

____

____

23. Looking back on the draining and cultivation of your bogland, would you do it differently now if you were to do it again?
(i) No ___ (ii) Yes ___ (Explain) ____________________

____

24. a) If you were to expand the farm now and you had a choice between boglands and mineral soil, which would you choose?
(i) Boglands ___ (ii) Mineral soil ___

b) Why? ____________________

____

____

III. <u>Farming in general</u>

25. Do you think that governmental assistance to agriculture in Newfoundland is:
(i) Adequate ___ (ii) Less than adequate ___ or (iii) More than adequate ___

____

26. What do you think of credit available to farmers in Newfoundland?

____

____

27. What do you think of the future for farming in Newfoundland?

____

____

28. Do you think that Newfoundlanders in general consider farming to be:
(i) More ___ (ii) Less ___ or (iii) Equally ___ respectable as any other occupation?

____

29. If you had not gone into farming, do you think that you would be: (i) Better ___ or (ii) Worse ___ off financially or about the same ___? ______________________

30. Why are you farming? ______________________

____

31. a) Have you considered leaving farming? (i) No ___ (ii) Yes ___

b) (If yes) Why? ______________________

____

Appendix B

Questionnaire used for interviewing farmers in Iceland.

M.A. verkefni í Landafraedi vid Memorial University of Newfoundland

Nafn jardar ____________________

Nafn bónda ____________________

Aldur bónda ____________________

I. **Bóndinn:**

1. a) Hversu lengi hefur thú verid bóndi? ______

   b) Thar af á thessari jörd? ______

2. Hversu lengi hefur jördin verid innan fjölskyldunnar? ______

3. Hver er eigandi jardarinnar? ______

4. Ádur en thú gerdist bóndi hvad hafdir thú unnid vid sveitastörf? ______

5. Hefurdu farid í baendaskóla? Nei ___ Já ___ Hvanneyri ___ Hólar ___ hvenaer ______

6. Ert thú medlimur í
   a) Búnadarfélagi ___ Já ___ Nei ___
   b) Stéttarsambandi baenda ___ Já ___ Nei ___
   c) Kaupfélagi ___ Já ___ Nei ___
   d) Sláturfélagi Sudurlands ___ Já ___ Nei ___
   e) Einhverjum ödrum félagsskap tengdum landbúnadi? ___ Já ___ Nei ___

7. a) Stundardu önnur störf samhlida búskap? Nei ___ Já ___

   b) Hversu lengi á ári? ______

   c) Hlutur aukastarfa í nettótekjum? ______

II. **Jörd og áhöfn:**

8. Staerd (í hektörum):

	Alls	Thurrlendi	Mýrar	Annad (hvad?)
Alls				
Raektad				
Raektanlegt				
Framraest				

9. Vélaskrá:

Taeki fj.	Taeki fj.	Taeki fj.
Dráttarvélar	Baggavagn	Valtari
Heybindivélar	Baggatína	Skítadreifarar
Sjálfhleðsluvagnar	Faeriband	Áburdardreifarar
Sláttuthyrlur	Gnýblásarar	Haugsuga
Greiðusláttuvélar	Fastir blásarar	Ámoksturstaeki
Fjölfaetlur	Mótor vid blásara	Kerrur
Múgavélar	Jardtaetarar	Mjaltavélar (R)
Heyvagn	Herfi	Annad

Hestaflafjöldi dráttarvéla:

10. Landnotkun 1980:

			Áburdur		Beit								Heyuppsk.		
					Fé		Hross		Kýr		A.n.gr.				
Svaedi	Staerd	Magn	Gerd	Skítur	fj	Vikur	fj	Vikur	fj	Vikur	fj	Vikur	Thurrh	Voth.	Ástaedur voth.verk.

11. Framraesla sídan 1951:

Ár	Skurdir m	.	Raesi m	ha	Svaedi	Bil	Unnid af	Taeki	Hví gert	Ákv. á gerd	Breyt./Núv.notkun	Núv. ástand

12. Adrar jardraektarframkvaemdir sídan 1951:

Ár	ha	Svaedi	Hvad gert, hvernig, af hverjum	Hvers vegna	Hví thetta svaedi	Núv. notkun

13. Bupeningur sídan 1957:

Ár	Ábúandi	Eigandi	Saudfé	Kýr	Geldneyti	Hross	Haensn	Heyfengur	Aergildi	Heyfengur	Annad

III. Álit á mýrum:

14. Almennt talað, telur thú mýratun a) verri ___ b) betri ___ eda c) jafngód ___ thurrlendistúnum? ___

15. Er einhver munur a raektunarkostnadi mýra í samanburdi vid thurr - lendistún? a) Nei ___ b) Já ___ (útsk.) ___

16. Er munur á uppskeru? a) Nei ___ b) Já ___ (útsk.) ___

17. Er munur á áburdarthörf? a) Nei ___ b) Já ___ (útsk.) ___

18. Er munur á heygaedum? a) Nei ___ Já ___ (útsk.) ___

19. Telur thú mýratún vera a) betri ___ b) verri ___ eda c) jafngód ___ thurrlendistúnum til beitar? Ef a) eda b) útsk.

d) Skiptir í thessu sambandi máli um hvada búpening er ad raeda?

20. Telur thú framraest en óraektad mýrlendi a) verra __ b) betra __ eda c) jafngott __ óraektudu thurrlendi til beitar? Ef a) eda b) útsk. ___

d) Skiptir máli í thessu sambandi um hvada búpening er ad raeda?

21. Er einhver munur á vélavinnu vid raektun mýrlendis samanborid vid thurrlendi? a) Nei ___ b) Já ___ (útsk.) ___

22. Er einhver munur á vélavinnu vid notkun mýratuna í samanburdi vid thurrlendistún? a) Nei ___ b) Já ___ (útsk.) ___

23. Telurdu ad ríkid aetti ad a) auka ___ b) minnka ___ eda c) halda óbreyttum ___ hlut sínum í framraeslukostnadi mýra? Ef a) eda b) útsk. ___

24) a) Til thess ad framraesla mýra borgi sig fyrir bóndann, hverja telur thú vera lágmarkshlutdeild ríkisins í framraeslukostnadi?

b) Hvad med vidhald og endurnýjun? ___

25. Telurdu ad jardraektarstyrkurinn aetti ad a) haldast óbreyttur ___ b) haekka ___ eda c) laekka ___ Ef b) eda c) útsk. ___

26. Telurdu ad munurinn á jardraektarstyrk vegna raektunar mýrlendis annars vegar og thurrlendis hins vegar aetti ad a) aukast ___ b) haldast óbreyttur ___ eda c) minnka ___ Ef a) eda c) útsk.

27. Telur thú ad óvenjulegt vedurfar hafi a) minni ___ b) meiri ___ eda c) jafn mikil ___ áhrif á mýratun og thurrlendistún? Ef a) eda b) útsk. ___

d) Hvad um kal? ___

28. Hvers konar framraeslukerfi telur thú ad henti best á thinni jörd?

29. Eru einhverjir sjúkdómar í dýrum sem eru tengdir notkun mýrlendis sérstaklega? a) Nei ___ b) Já ___ (útsk.) ______________________

____

30. Hafur borid á thví ad dýr festist í mýri eda í skurdum?
a) Nei ___ b) Já ___ (útsk.) ______________________

____

31. Ef thú staedir frammi fyrir thví nú ad thurfa ad thurrka mýrarnar og raekta, myndir thú standa ödru vísi ad thví nú, en gert var?
a) Nei ___ b) Já ___ (útsk.) ______________________

____

____

____

32. Ef thú thyrftir ad auka vid raektun nú og gaetir valid á milli mýra og thurrlendis, hvort myndir thú kjosa?
a) Mýrar ___ b) Þurrlendi ___ (útsk.) ______________________

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Aukalínur
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IV. Álit á landbúnadi yfirleitt:

33. Telur thú ad studningur ríkisvaldsins vid landbúnadinn á Íslandi sé a) haefilegur ___ b) ónógur ___ eda c) of mikill? ___

Ef b) eda c) útsk. ___

34. Hvad vilt thú segja um framtíd landbúnadar á Íslandi? ___

35. Telurdu ad medal almennings njóti bóndastarfid a) meiri ___ b) sömu ___ eda c) minni ___ virdingar en önnur störf í thjódfélaginu? ___

36. Ef thú stundadir ekki búskap, heldurdu ad thú vaerir a) verr ___ b) eins ___ eda c) betur ___ settur fjárhagslega en thú ert nú?

37. Hvers vegna gerdist thú bóndi? ___

38. Hefurdu hugleitt ad haetta búskap? a) Já ___ b) Nei ___ c) Hvers ___ vegna (ekki)? ___

V. Nokkur atridi vardandi búskapinn 1980:

39. Á ad giska hversu mörg tonn keyptirdu í fyrra af a) fódurbaeti ___ b) graskögglum? ___

40. Hvernig skiptist thetta kjarnfódur á búpeninginn? a) kýr ________

________ b) kindur ________________ c) geldneyti ____________

d) annao ____

41. Hvert eru búsafurdir seldar? a) mjólk __________ b) nautgripakjöt

__________ c) kindakjöt __________ d) annad ________________

42. Vinnukraftur á búinu:

Hver (settingi?)	Tími árs	Aldur	Starf

43. Hvad viltu segja um thá lánafyrirgreidslu sem thú átt völ á?

____

44. Keyptirdu ada seldir hey á sídasta ári? a) Nei ___ b) Já ___

(útsk.) ____

45. Heildarbrúttótekjur búsins 1980: a) minna en 5m ___ b) 5-10m ___

c) 10-15m ___ d) 15-20m ___ e) 20-25m ___ f) 25-30m ___

g) 30-35m ___ h) 35-40m ___ i) 40-45m ___

Aukalínur

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Appendix C

A press release, dated January 29, 1960, announcing a policy of assistance in the reclamation of boglands for commercial agricultural purposes.

Similar assistance to that now being made available to farmers for the clearing of mineral soils will be made available in respect of bogland reclamation for commercial agriculture, according to the Honourable W.J. Keough, Minister of Mines and Resources.

At the moment a farmer who obtains the approval of the Department for the clearing of an acreage of mineral soil becomes eligible for a land clearing bonus of $125.00 per acre.

It is proposed to make a bonus available to farmers who wish to reclaim bogland for agricultural use at the maximum rate of $125.00 per acre.

The Minister explained that four years of experimental work in bogland reclamation at Colinet has resulted in the following conclusions:-

1. The average type of bogland in Newfoundland can be economically reclaimed for agricultural use.

2. Satisfactory crops of hay, pasture and vegetables can be produced.

3. Sheep and cattle can be successfully pastured on the reclaimed bogland.

The experimental work at Colinet has also resulted -

(i) In the development of an efficient and practical unit of equipment for drainage, tillage and other uses.

(ii) In the training of a unit of personnel in the techniques of bogland reclamation and cropping practice.

The Minister noted also that the Department of Agriculture of Canada has established an extensive research station at Colinet for long-term experimental work.

The experimental work in bogland reclamation carried on at Colinet arose out of the recommendations of our Royal Commission on Agriculture.

The preliminary investigations have now been concluded.

This bogland research programme has aroused considerable interest among farmers and farmer groups in bogland reclamation for commercial agricultural purposes.

Since there are large areas of suitable and accessible bogland available for reclamation in Newfoundland, and since there is an urgent need for farm expansion to maintain modern equipment and more efficient and economic production, the Executive Government felt that a policy of assistance in the reclamation of boglands for commercial agricultural purposes was desirable.

Consequently the Executive Government decided recently upon the following line of policy on a trial basis. Modifications will be made from time to time as they appear desirable:-

1. The Department of Mines and Resources is authorized to enter into a contract with any acceptable farmer or farmer group to reclaim an area of bogland for commercial agricultural use.

2. Such reclaimed boglands will become the subject of long-term conditional leases.

3. The total value of Departmental assistance in bogland reclamation will be limited to $6,000 to one farmer.

4. The total value of Departmental assistance to one farmer in any one year will be limited to $2,000.

5. Assistance at the maximum rate of $125.00 an acre will be made available for bogland reclamation as is the case in the clearing of mineral soil, but in the case of reclaimed boglands this assistance will cover the purchase and use of grass seeds, fertilizer for the initial seeding, the first year dressing and the initial application of agricultural limestone.

6. Until such time as custom equipment operators are prepared to enter the field and maintain the necessary machines and attachments to provide the essential drainage and tillage services, the Department will provide such machinery which will be charged to each project at cost in respect of services rendered.

7. Drainage of large bogland areas will be undertaken as a Departmental project and charged at cost to commercial farmers where it is found necessary to drain such large areas to provide for the orderly development of commercial bogland farms.

Appendix D

An agreement between prospective bogland farmers and the Newfoundland Department of Mines and Resources.

THIS AGREEMENT made this day of Anno Domini One thousand nine hundred and

BETWEEN farmer (hereinafter called "the Farmer") of the one part **AND** the Deputy Minister of Resources for the Province of Newfoundland for and on behalf of the Department of Mines and Resources (hereinafter called "the Department") of the other part;

WHEREAS the Farmer desires to lease from the Crown for commercial agricultural use the area of bogland hereinafter described;

AND WHEREAS the Department agrees subject to the terms and conditions of this agreement to reclaim either a part or the whole of the area of bogland hereinafter described in accordance with the policy of the Department of Mines and Resources for the reclamation of bogland for commercial farming purposes on the understanding that the Farmer will apply for and receive a Crown Lease of the said area of bogland;

NOW THIS AGREEMENT WITNESSETH

1. The Department will reclaim within a period of three years from the date of this agreement or as soon as practicable thereafter in accordance with the policy of the Department of Mines and Resources for the reclamation of boglands for commercial farming purposes that area of bogland situate and being located as follows, that is to say:

Bounded on the North by:

Bounded on the South by:

Bounded on the East by:

Bounded on the West by:

Diagram (not drawn to scale)

2. The Farmer agrees to apply for a lease from the Crown for commercial agricultural use of the foregoing described area of bogland;

3. The Farmer agrees to accept such lease for such term and subject to such conditions as may be prescribed in the lease;

4. The Farmer agrees to reimburse the Department for any expenses incurred by the Department in reclaiming the bogland hereinbefore described in excess of One hundred and twenty-five dollars ($125.00) an acre;

5. This Agreement shall be binding upon and shall inure to the benefit of the parties hereto.

IN WITNESS WHEREOF the parties hereto have hereunto their hands and seals subscribed and set the day and year first before written.

SIGNED SEALED AND DELIVERED

by the Farmer in the presence of:

Farmer

Witness

SIGNED SEALED AND DELIVERED

by the Deputy Minister of Resources for the Province of Newfoundland for and on behalf of the Department of Mines and Resources in the presence of:

Deputy Minister of Resources

Witness

Appendix E

Results of farmers' interviews carried out in Newfoundland 1981.

Two groups of farmers were interviewed in Newfoundland; farmers who have had boglands reclaimed, and a random sample of cattle, sheep and hay-selling farmers. The purpose of interviewing the former group was to examine their experiences in bogland farming, and particularly the reasons that led to the eventual abandonment of most of the projects. On the other hand, the reason for interviewing the random sample was to ascertain what perceptions the typical grassland farmer in Newfoundland has of boglands as an agricultural resource, but the identification of these may be critical if a future promotion of this resource among the farmers will be pursued.

There were eleven bogland farmers interviewed, and they were identified from files of the Agriculture Branch of the Newfoundland Department of Rural, Agricultural and Northern Development, and its predecessors, the Newfoundland Department of Forestry and Agriculture and before that the Agriculture Division of the Newfoundland Department of Mines, Agriculture and Resources, and still earlier the Newfoundland Department of Mines and Resources. The random sample of farmers was identified from the annual farm survey of the Newfoundland Agriculture Branch and the farm population from which the sample was drawn consisted of all farmers in the province, having annual sales of $2,000 or more, and, having five or more dairy or beef cows, five or more sheep, or selling hay in excess of ten tons in 1980. The sample was stratified according to type of farm, and it also turned out to represent proportionally the regional distribution of farms. There were exactly 200 farms in the population, a 15 per cent sample was drawn, i.e. 30 farms, and 22 of the 30 farmers were interviewed, as eight farmers were not at home when the interviewing took place. Instead, six alternative farmers were interviewed, in most cases on similar nearby farms.

The small number of farms in each sample stratum means that statistical inferences can rarely be made about the different population strata. In order to facilitate some statistical testing, however, the four types of farms were grouped to form two kinds of farms, dairy farms and other farms. This grouping of data is not entirely arbitrary, the dairy operations normally represent the sole occupation of the farmer whereas other types of grassland farming are more of a part-time nature, either along with non-farm activities, or with other kinds of farming, particularly vegetable farming which involves hay production as a part of a crop rotation. If a particular sub-type of other farms gives a markedly different response from the other two sub-types, this will be noted in the following analysis of the interviews. The responses from the random sample farmers are also tabulated according to regional distribution, and information on the bogland farmers, who are still farming, is also included for comparison.

Table A gives some information on the farmers, their background, and their farming operations. The farmers are typically in their late forties and have been farming for over twenty years. They own the farm themselves, most of them were raised on farms, but about half of them took the farm over from their parents. It should be noted

TABLE A. Some farm and farmer characteristics.

	N	Mean age	Mode Age-group	Years Farming	Own Their Farm	Same Farm Always	Raised on A Farm	Took Over Family Farm	Member of Farm. Org.	Private Marketing	Per Cent Income from Farming	Livestock in Sheep-Equivalent Units1	Acreage of Hayland	Acreage of Pasture	Number of Tractors	Gross Sales in $
Random Sample	28	46	41-50	21	28	26	25	13	20	20	71	497	32	17	16	30800
Dairy farmers	8	46	41-50	22	8	7	6	4	7	0***	87	1053	72	24	20	68400
Other farmers	20	47	41-50	20	20	19	19	9	13	20***	63	275	20	14	14	15800
Eastern farmers	14	47	41-50	22	14	12	13	8	10	8	71	577	28	14	13	39400
West./Centr. farmers	14	46	41-50	19	14	14	12	5	10	12	71	417	36	19	18	18300
Bogland farmers	6	49	41-50	29	6	5	5	2	5	1	75	550	29	14	18	18600

***Significant difference at 0.01 level of confidence.

1 Cattle two years or older equals 20 sheep-equivalent units, other cattle 10 sheep-equivalents units (based on the system used in Iceland).

Source: Field research 1981.
Unpublished data from 1980 annual farm survey, Newfoundland Agriculture Branch.

here that in a number of cases this referred to subsistence farming which the present farmers have since expanded into a semi-commercial or a fully commercial venture. About two thirds of the farmers are members of some farming organization and in this respect the dairy farmers have a considerably higher membership rate than the other farmers, but that difference is not statistically significant. Beef producers have a particularly low membership rate, one reason being that there is no beef producers association (similar to the Sheep Breeding Associations), and practically all the locally produced beef is sold directly to the consumer, i.e. the so-called freezer trade. The only statistically significant difference in Table A is in fact in regard to the marketing system. All the dairy producers sell their proudct on an organized basis which in part relates to health regulations on milk production and processing, while beef and sheep producers sell their products on an individual basis and usually without formal inspection or grading, but legislation is currently in preparation to enforce official inspection and grading of these products. All the remaining columns in Table A reflect the bigger scale of the dairy farms in comparison to the other grassland farms, and in fact the difference is even greater than the table indicates as large scale vegetable production on the hay-selling farms increases the averages for the other farms category. Thus, average annual gross sales of the seven sheep farms amount to only $5900.

Table B contains information on the farmer responses to many of the questions regarding boglands. One half of the random sample farmers have used boglands, most of them on the regional pastures, but only about 14 per cent are presently using boglands, reflecting considerable dissatisfaction with the bogland pastures, particularly by the sheep farmers. Of the six bogland farmers interviewed who had given up using boglands four cited leaving farming as the reason for giving up the bogs, one referred to machinery problems, and another could not get the ditches cleaned. Of the ten bogland farmers interviewed six had seen reclaimed bogs before they applied but most of these claimed that that in itself was not very important in deciding to apply. The majority of the farmers that applied to have boglands drained said they did so because it was the only alternative for expansion at the time but only two mentioned in this respect the inherent advantages of boglands over much of the mineral soil in the province, e.g. levelness and absence of stones. When the other random sample farmers were asked why they had not applied to have boglands reclaimed six farmers gave no bog available as a reason, six (five of them on the West Coast) said that enough mineral soil was available and thus indicating indirecty their preference for mineral soil, two argued that bogs were poor for pasture and hay, two mentioned machinery problems, and nine gave no specific reason. There were generally similar responses to the question on the reason for the lack of success of the reclamation for the reluctance of farmers to use boglands, but the absence of an active bogland policy has undoubtedly been a factor in recent years.

When it comes to specific comparative questions as to how the boglands stand up to mineral soil the overwhelming majority of the farmers declined to comment as they had not had any practical experience of using boglands on their farms. Statistically this trend is significant for all six such comparative questions at the 0.001 level of confidence

TABLE B. Bogland Information

	N	Bogland use ever	Bogland use now	Ever applied for bog recl.	More productive? Bogland	Min. Soil	Equal	Don't Know	More expensive to reclaim? Bogland	Min. Soil	Equal	Don't Know	Needs more fertilizer? Bogland	Min. Soil	Equal	Don't Know
Random sample	28	14	4	7	0	3	1	24	3	2	1	22	7	1	3	17
Dairy farmers	8	3	2	1	0	2	1	5	1	2	1	4	1	0	3	4
Other farmers	20	11	2	6	0	1	0	19	2	0	0	18	6	1	0	13
Eastern farmers	14	7	3	3	0	3	1	10	3	2	1	8	4	0	3	7
West./Centr. farmers	14	7	1	4	0	0	0	14	0	0	0	14	3	1	0	10
Bogland farmers	8	8	4	8	0	4	2	2	2	0	1	5	4	0	3	1

	Gives more hay? Bog-land	Min. Soil	Equal	Don't Know	Gives better hay? Bog-land	Min. Soil	Equal	Don't Know	Better for grazing? Bog-land	Min. Soil	Equal	Don't Know	Animal health affected? Yes	No	Don't Know
Random Sample	3	1	3	21	1	1	6	20	1	10	1	16	4	9	15
Dairy farmers	0	1	2	5	0	1	3	4	1	4	0	3	0	3	5
Other farmers	3	0	1	16	1	0	3	16	0	6	1	13	4	6	10
Eastern farmers	2	1	2	9	0	1	5	8	1	8	1	4**	3	4	7
West./Centr. farmers	1	0	1	12	1	0	1	12	0	2	0	12**	1	5	8
Bogland farmers	1	1	6	0	0	1	5	2	1	4	1	2	1	6	1

TABLE B. Bogland Information

Random sample	28	14	4	7	0	3	1	24	3	2	1	22	7	1	3	17
Dairy farmers	8	3	2	1	0	2	1	5	1	2	1	4	1	0	3	4
Other farmers	20	11	[illegible]	6	0	1	0	19	2	0	0	18	6	1	0	13
Eastern farmers	14	7	3	3	0	3	1	10	3	2	1	8	4	0	3	7
West./Centr. farmers	14	7	1	4	0	0	0	14	0	0	0	14	3	1	0	10
Bogland farmers	8	8	4	8	0	4	2	2	2	0	1	5	4	0	3	1

Random Sample	3	1	3	21	1	1	6	20	1	10	1	16	4	9	15
Dairy farmers	0	1	2	5	0	1	3	4	1	4	0	3	0	3	5
Other farmers	3	0	1	16	1	0	3	16	0	6	1	13	4	6	10
Eastern farmers	2	1	2	9	0	1	5	8	1	8	1	4**	3	4	7
West./Centr. farmers	1	0	1	12	1	0	1	12	0	2	0	12**	1	5	8
Bogland farmers	1	1	6	0	0	1	5	2	1	4	1	2	1	6	1

Random Sample	0	19	9	9	12	7	3	16	4	8
Dairy farmers	0	5	3	2	4	2	0	5	2	1
Other farmers	0	14	6	7	8	5	3	11	2	7
Eastern farmers	0	10	4	2	6	6	3	7	3	4
West./Centr. farmers	0	9	5	7	6	1	0	9	1	4
Bogland farmers	0	8	0	5	0	3	0	7	0	1

**Significant difference at 0.05 level of confidence.

Source: Field research 1981.

TABLE B. (cont'd)

	Same machinery usable?			Animals get stuck?				Should bogl. recl. be encouraged?		
	Yes	No	Don't Know	No	Don't Know	Yes	Serious?	Yes	No	Don't Know
Random Sample	0	19	9	9	12	7	3	16	4	8
Dairy farmers	0	5	3	2	4	2	0	5	2	1
Other farmers	0	14	6	7	8	5	3	11	2	7
Eastern farmers	0	10	4	2	6	6	3	7	3	4
West./Centr. farmers	0	9	5	7	6	1	0	9	1	4
Bogland farmers	0	8	0	5	0	3	0	7	0	1

**Significant difference at 0.05 level of confidence
Source: Field research 1981.

both within the overall random sample and the other farmers category, but due to the low numbers involved statistical tests such as the chi-square test are neither applicable for the dairy farmers' responses nor within each of the regional groups. As indicated in Table B there is in one instance a statistically significant difference in responses to those question between groups of farmers; the farmers in Eastern Newfoundland have more definite opinions of the value (or non-value) of boglands as pasture than their counterparts in Central and Western Newfoundland. This again reflects the bad experiences that some of the sheep farmers claim to have had of the regional pasture at Colinet. Overall the farmers have more definite opinions on some aspects of bogland farming than others; there is a feeling that the bogs need more fertilizer, are worse for grazing, and, particularly, that they need speical type of machinery. Slightly more than half of the random sample farmers feel that bogland reclamation should be encouraged.

The questions asked of the bogland farmers specifically yielded mixed responses. For instance, three farmers said they would prefer mineral soil if they were to expand their grassland farming operations while another three said they would prefer the boglands.

Table C provides an overview of the farmers' feelings towards governmental assistance, and farming as an occupation. About half of them feel that governmental assistance and availability of credit is adequate, but there is a feeling that society in general considers farming as an inferior occupation. Most farmers, however, have no intention of giving up farming, and indicate that they are farming because they like it. Finally, it is worth noting that some 63 per cent of the dairy farmers think they would be worse off financially if they were not farming, but only 15 per cent of other farmers feel that way. Admittedly, the number of dairy farmers in the sample is too small to allow for statistical inference to be drawn, but the figures do support the conclusion reached in section 4.5 of this thesis that only dairy farming appears to be an economically viable grassland industry in Newfoundland.