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THE SNOW HAZARD IN
MACKenzie COUNTY:
FARMERS' PERCEPTIONS AND ADJUSTMENTS

J. C. BRAY

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Bachelor of Arts with Honours in Geography,
at the University of Otago, Dunedin,
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CHAPTER ONE

1 : INTRODUCTION

Man's interaction with his environment involves facing risk and uncertainty in the form of environmental hazards. These threaten life and property, and the normal functioning of individuals and societies (an estimated 250,000 people die, and 25 billion dollars is directly lost each year, through disasters, the realization of hazards).

It is because much can be done to reduce the risk of these extreme events of nature, that a study of natural hazards is warranted.

This study concentrates on the affected population's perceptions of, and adjustments to, one particular hazard. The result is a picture of this part of the relationship between Man and his environment, and an indication of how it can be modified to be more in Man's favour.

The hazard of the study, is severe snows on farms in Mackenzie County.

These snows are rare events, but they have the potential to be very damaging. However, there are measures the farmer can take to reduce this risk.
The relationship between Man and his environment has always been a major concern of geographers. At the beginning of this century, when attempts were being made to define the subject, William Morris Davis wrote:

"It is essentially the factor of relationship of Earth and its inhabitants that characterises geography as a subject apart from other sciences, and gives an essential unity of content and discipline to all its varied parts (1909, p8)."

This was "the most definite, if not the only, unifying principle" he could find (p36).

Different geographers have placed emphasis on one or other side of the relationship. During the early development of the discipline, the study of environmental influences on Man and Man's adaptation to that environment were dominant. Davis, as the first president of the American Association of Geographers proclaimed in 1906, that:

"Any statement is of geographic quality, if it contains ... some relation between an element of inorganic control and organic response." (1906).

This deterministic approach that stressed the importance of environmental limitations and opportunities as determinants of human action (though never completely disregarding other influences) showed a decline in the 1920s. The reason for this decline can perhaps be found in Platt's definition of environmental determinism as:
"that ... approach which gives primary consideration to the natural environment as a causal factor, advocates its importance and looks particularly for evidence of its influence."

which creates a "prejudice in its favour". (1948, pp351, 355). The search for causal aspects to the relationship between Man and his environment was questioned, however because it was believed to preclude scientific objectivity.

From this reaction against environmental determinism, the possibilist philosophy of geography developed. This maintains that the environment acts to constrain or encourage mankind, but cannot be regarded as the principal initiating force of human activity (Tatham: 1951). This new approach emphasized the Man element of the Man-environment relationship.

An alternative was proposed by H.H. Barrows in 1923, who saw geography as the study of the mutual relations between Man and his natural environment, or "human ecology". With this definition, geographers could abandon their responsibility to conduct original research in physiography and climatology. As with the Probabilists' approach, Man and environment were given an equal weighting.

However, from the 1930s to the 1950s, human and physical geography drifted apart.

The conception of a geography as a bridge between the natural and social sciences was still proclaimed in some textbooks, but was seldom evident in research ... Between physical geography cultivated without reference to human activities, and human geography cultivated with only perfunctory reference to nature, there could be few
opportunities for collaboration, especially when both sides were influenced by a residual fear of environmentalism (i.e. environmental determinism) (Mikesell: 1974, p4).

The chorological approach that superseded those based on the environmentalist concept, emphasised areal differentiation and the search for regions dominated geographical study. Although the Man-environment relationship was seldom considered, the chorological approach did not necessarily preclude it. All the concept implies, is that the relationship does not define the field, and is important only insofar as it contributes to an understanding of areal differentiation. During this period, the existence of a perceptual environment as distinct from the real environment was brought to the attention of geographers. In 1947, Macleod proposed the study of "psychological geography" dealing with what appears to be there for the individual. Other writers took up the theme, including Wright in the same year, who proposed "geosophy" which would cover "geographical ideas, both true and false of all manner of people". Later, in 1952 and 1963, Kirk argued for a division in geography between the phenomenal and behavioural environments:

The former is defined as the world of physical facts, expanded to include those environments altered or even entirely changed by Man. The latter is a psycho-physical field in which phenomenal facts are arranged into patterns or structures (gestalten) and acquire values in a cultural context. (Downs: 1970, p130).

The rationality behind this approach is that decision-makers operating in an environment, base their decisions on the
environment as they perceive it, not as it is. Therefore, an understanding of environmental perception will help in the understanding of human behaviour in the environment. This approach to geography came into prominence after the "quantitative revolution" of the 1970s. During this period, a revival of interest in the Man-environment relationship was apparent, as concern about Man's adverse effects on the environment grew, and as mathematical techniques were increasingly used to describe relationships among natural phenomena and human phenomena, and between these two sets of phenomena.

A distinction between Man and Man's behaviour became more important; Man was regarded as a "black box", that is, as an unknown element between the environment and his behaviour. Explanation and prediction of human behaviour then, were limited. The "behavioural revolution" that followed, hoped to lighten the "box". As Downs points out, this meant that:

The basic scheme for analysis is no longer environment/spatial behaviour, but environment/man/spatial behaviour. (Man therefore, becomes an intervening variable, and in this behavioural formulation, is a significant if not crucial variable). (1970, p68).

Downs recognises three classes of approaches to perception research in geography:

The Structural Approach

This is concerned with "the identity and structure of geographic space perceptions" (p70). The questions that the approach concerns itself with are: What environmental information is stored in our minds? How is this stored information structured? What is the relationship between
the image (or stored information) and the real world from which the image is abstracted? What is the process of abstraction determined by? These questions have often been asked with regard to Man's orientation in the environment, which is necessary when implementing decisions in that environment, and is achieved and maintained by forming and holding images.

The Preference Approach

"The basic question is, given a set of spatially differentiated objects, how do people assess these on a scale of preference, with relation to some specified behavioural objective?" (p81). Research using this approach has concentrated on two areas: landscape preference and residential preference. It is recognised that the attractiveness of a landscape or place is determined by a person's perception of it, not only by the characteristics of the place or landscape.

The Evaluative Approach

"This is concerned with the evaluation of the environment via spatial images, and seeks to relate the evaluation to decision making and therefore to behaviour. An important assumption is that the perceived world is one of the fundamental criteria or bases used in making a decision which is then expressed as behaviour". (p80). In this approach, various perceived environmental states are assigned weightings according to their utility and probability of occurrence. Included in the work that follows this approach are natural hazard perception studies. These are attempts to understand an aspect of
Man's relationship with his environment - his response to extreme events - through an investigation of his perception of the extreme event and the various choices of response open to him.
A natural hazard consists primarily of an extreme event of nature. Such an event can be defined as any in the geophysical system displaying relatively high variance from the mean (White: 1974). The event in itself cannot be considered a hazard unless it impinges on the human use systems of the affected areas, to the extent that the normal buffering and adjusting capabilities of these systems are inadequate (Kates: 1971). It follows that the severity of a hazard is a function both of the characteristics of the natural event, and of its effects on human systems (Mitchel: 1974). The characteristics of the event include:

- **Magnitude** as a dimension, volume, or energy expression;
- **Frequency** expressed as a probability of occurrence in a unit of time or an average return or recurrence period of time;
- **Duration** expressed as temporal periods ranging from seconds to years; and **temporal spacing**, describing the patterned occurrence of the event in time - random, even (seasonal or regular periodic), or clustered (serially correlated). (White: 1974, p445).

The natural event can also be described in terms of areal extent, forecast capability, and warning time.

Mitchel illustrates the importance of the human effects element in a hazard's severity:

Few people are aware that the Bezymanny eruption of March 30, 1956 was the world's most powerful volcanic event of recent years. Since it took place in the almost uninhabited part of Kamchatka and caused no known casualties, the eruption was largely a scientific curiosity (Latter: 1965). In contrast, the extrusion of a small volume of lava from a secondary cone on the slopes of Tristan da
Cunha became a focus of global interest during October of 1961. By smothering a lobster processing plant and menacing the island's only settlement, the lava flow disrupted the economic system and compelled total evacuation of the three hundred residents to England. (1974, p311).

3.1 Origins of Natural Hazards Research

The original stimulus to natural hazards research came from the failure of a large-scale national programme designed to deal with the problem of flood losses in the U.S.A. Five billion dollars had been spent over twenty years on prevention and reduction of flood damage, when a 1956 investigation to assess the measures' effectiveness, concluded that over the period, the loss from floods had actually increased.

This finding generated research designed to discover why individuals and groups appeared not to behave in the expected manner. When estimating relative costs and benefits of the flood control schemes, it had been assumed that the decisions of people living on flood plains were guided by a desire to maximize productivity and utility, although it was accepted that this desire was accompanied by varying levels of knowledge on alternative courses of action and their consequences. Observations such as that which showed that people often returned to land that had been severely damaged by floods, aware of the disastrous consequences of a recurrence, made it clear that the "economic man" model of decision-making could not be applied to flood plain dwellers.
An alternative model, that of "bounded rationality" was proposed. This holds that Man, while being limited in his abilities to perceive and store information, to compute optimal solutions, and to predict the outcome of future events, is guided by multi-dimensional goals rather than a single profit goal (Wolpert: 1964). What followed was a period of inter-disciplinary study to find answers to a number of questions in different flood-prone areas:

What was the net impact of the protection work upon national efficiency and upon the life of the communities affected? Were there alternative ways of dealing with flood losses that might be more effective socially? What would be the human response to different sorts of incentives such as information programmes, improved warning systems and insurance systems? (White: 1974, pp3-4).

In 1967, the University of Chicago, Clark University, and the University of Toronto collaborated to apply the findings from the flood studies to other geophysical hazards in a variety of cultural and physical settings. The International Geographic Union's Commission on Man and Environment, responded in 1967 by supporting a programme for international collaboration in the study of problems of environmental hazards. The studies generated by the programme aimed to do the following:

(1) Estimate the extent of human occupancy in areas subject to extreme events in nature.
(2) Determine the range of possible adjustments by social groups to those extreme events.
(3) Examine how people perceive the extreme events and resultant hazard.
(4) Examine the process of choosing damage-reducing adjustments.
The basic hypotheses formulated for the studies were the following:

A. Human occupancy that persists in areas of recurrent hazard is justified in the view of the occupants for the following reasons:

(1) Superior economic opportunity;
(2) Lack of satisfying alternative opportunities;
(3) Short-term time horizons;
(4) High ratios of reserves to potential loss.

B. There are three types of response to natural hazards which may be characterized as:

(1) Folk, or preindustrial adjustments which involve a wide range of adjustments requiring more modifications in behaviour in harmony with nature than control of nature, are flexible and easily abandoned, are low in capital requirements, require action only by individuals or small groups, and can vary drastically over short distances.
(2) Modern technological, or industrial, adjustments which involve a more limited range of technological actions emphasizing control of nature, are inflexible and difficult to change, are high in capital requirements, require interlocking and interdependent social organisation, and tend to be uniform.
(3) Comprehensive, or postindustrial, adjustments which combine features of both earlier stages so as to involve a larger range of adjustments, greater flexibility and variety of capital and organizational requirements.

C. Variation in hazard perception and estimation can be accounted for by a combination of the following:

(1) Magnitude and frequency of the hazard;
(2) Recency and frequency of personal experience, with intermediate frequency generating the greatest variation in hazard interpretation and expectation;
(3) Importance of the hazard to income or locational interest;
(4) Personality factors such as risk-taking propensity, fate control and views of nature.
This variation is not related to common socioeconomic indicators such as ages, education and income.

D. For individuals, the choice of adjustment is a function of:

(1) Perception of the hazard;
(2) Perception of the choice open to them;
(3) Their command of technology;
(4) The relative economic efficiency of the alternatives;
(5) The perceived linkages with other people.

E. For individuals, the process of estimating economic efficiency is related to the perceived time horizon, the ratio of reserves to anticipated loss, and the degree to which choice is required.

F. For communities, the choice of adjustment is a function of perception of hazard, choice, and economic efficiency as influenced by the stability and the power structure of the government. (Natural Hazards Research Working Paper No. 16: 1970).

The basic tool for the programme's studies was an interview, described by White as:

"intended to elicit information about the social and economic status of the household, the conditions in which it is obliged to make decisions in the face of the specified hazards, and the precise types of adjustments which are perceived as being made by others. The factors entering into the choice of particular adjustments are probed. The interview contains several measures of personality traits, including a story in which the respondent selects what he regards as the most suitable outcome, and a sentence completion test which is coded for characteristics of external-internal control, traditionalism and modernism, and feelings towards hazards" (1974, p5).

It was later noted (Kates: 1971), that the choice of adjustment is dependent on four features of natural hazards: the frequency of occurrence, the magnitude of energy release, the suddenness of onset, and whether the hazard is intimately related to the occupance activity of the hazard site or not (as in drought to agriculture). The adjustments
chosen could be classified as the following (Burton, Kates, and White; 1968):

(1) Modification on the cause of the hazard (e.g. cloud-seeding to reduce the velocity of a hurricane).
(2) Modification of the hazard (e.g. the building of flood-control dams).
(3) Modification of loss potential (e.g. warning systems).
(4) Spreading of the losses (e.g. public compensation).
(5) Planning for losses (e.g. insurance).
(6) Bearing the losses.

3.2 Findings of Natural Hazard Studies

3.2.1. PERSISTENT AND INCREASING OCCUPANCE OF HAZARD ZONES

"One of the basic findings of recent geographic research is that intermittently hazardous zones are attracting human occupation at a more rapid rate than nominally 'safer' areas" (Mitchel: 1974, p322). This trend is clearly evident at least in areas subject to riverine floods and damage through coastal storms (White et al.: 1958; Burton: 1962; Kates: 1962; White: 1964; Sewell: 1965; Burton, Kates and Snead: 1969; White: 1974; Islam: 1971, 1972). White (1973) recognises that as well, more people are exposing themselves to risk from avalanches, landslides, forest fires and volcanoes. There are three possible reasons for this trend:

(1) With rapid population growth, particularly in the Third World, the ratio of resources to population is decreasing. Occupation of marginal land is therefore encouraged and abandonment after a hazard event is discouraged.
(2) The placing of too much faith in new hazard adjustments such as flood protection works and warning systems.
(3) An increasing availability of public relief in the event of a hazard.

A corollary is that the occurrence of a hazardous event does not seem to produce any significant outmigration from the affected areas. There are exceptions, such as the relocation of the town of Valdez, Alaska, after the 1964 earthquake, but these are rare and tend to be when the effects of a hazard event have made resettlement physically and/or economically impossible.

The hazard studies have gone some way to explaining the persistent occupation of hazard zones. Mitchel (1974) has mentioned the superior economic opportunities available to agriculturalists on alluvial and volcanic soils, and Nichols notes: "Seismic regions often combine the very best advantages of trade, communications and strategic location, with the very worst earthquake risks to life and property" (1974, p281).

A lack of satisfying alternative opportunities appears to explain much of the persistent occupation of cyclone-prone coastal Bangladesh. In Islam's 1974 study, half the respondents did not know how they would earn a living in places with fewer cyclones.

A high ratio of reserves to potential losses appears to be an important explanation, especially in developed countries where loss of life is less of a threat (because of generally more effective hazard adjustment) and property loss is the main concern. Where the risk to life is not perceived to be high, occupants of hazard zones may rely on private insurance for their property or upon various
public relief measures. Dependence upon the latter may not be in the best interests of society as a whole.

Kunreuther, with respect to the U.S.A., has concluded:

If victims of a disaster were forced to bear the costs themselves, it has been shown...that they would have a larger incentive to protect themselves against future catastrophes. Current federal policy encourages individuals not only to continue to ignore these events in future, but actually to take steps to profit from the next earthquake or flood (1974, p213).

Mitchel recognises this and other institutional and social factors:

Public relief and rehabilitation programs often impede attempts to reconstruct facilities in less hazardous locations (Islam: 1972, Kates: 1970). Pressures to "normalise" the post hazard economy encourage local officials to continue previous modes of operation and patterns of development (Bowden: 1970). In some cases, public agencies have even taken steps to recreate the psychological, social and physical characteristics of pre-disaster life in an effort to ensure that natural hazards will not effect any major socio-cultural changes (U.N. Technical Assistance Board: 1968). (1974, p323).

The overestimation of the effectiveness of a hazard adjustment made since the last occurrence of the hazard event, as mentioned above, may also encourage persistence of hazard zone occupancy (Beyer: 1974).

Personality factors may be involved. Ward, (1974) suggests an unwillingness to admit to a subservience to nature or a fondness for accepting a challenge as an ex-
planation for some people's persistence as citrus-growers in frost-prone areas of Florida, while it has also been demonstrated that social factors discourage movement from a hazard zone (Islam: 1974).

3.2.2. PERCEPTION OF HAZARD

Experience: That the accuracy of hazard perception is related to experience of the hazard, has generally been confirmed by research (Mitchel: 1974; Burton, Kates & White: 1978). However, there are exceptions. Erickson, (1974) found no relationship between expectation of future flooding in Opotiki and experience of floods; Mitchel's studies of coastal flooding, riverine flooding, and coastal erosion found 30, 27 and 20 per cent of residents who had experienced the local hazard, overlooked the prospect of a future event (Mitchel: 1973). Most residents of San Francisco who have experienced local earthquakes, appear to evaluate future risks as negligible (Jackson and Mukerjee: 1974).

Characteristics of the Natural Event: Several studies have confirmed that the magnitude and frequency of the event alter the perception of it. Burton and Kates (1964), Saarinen (1966), Heijnen and Kates (1974) and Hankins (1970) all report that perception of drought varies directly with aridity. Rowntree (1974) discovered the greatest level of individual understanding about frequency and magnitude of a coastal erosion hazard amongst those in the highest risk zone. Baker and Patton (1974) in a study of hurricane hazard, reported a significantly low expectancy of hazard
recurrence in their lowest risk zone. There is a marked increase in acknowledgement of the heavy snow hazard with greater magnitude and frequency of the event, in Ashburton County farmers (Paul: 1980).

This relationship is not universal, however. Respondents in Harding and Parker's (1974) high flood risk zones were just as unaware of the hazard and had the same low expectation as respondents in the medium and low risk zones.

Burton, Kates and White (1978) note that the regularity or periodicity of occurrence of the extreme event, enhances the relation between frequency, magnitude and awareness.

**Importance of the Hazard to Income or Locational Interest:**

Support for the view that perception of hazard is a function of resource use comes from studies that suggest that farmers in areas susceptible to drought, volcanic eruption, and frost, are more aware of the hazard than adjacent non-agriculturalists (Saarinen: 1966; Jackson: 1974; Ward: 1974; Murton and Shimabukuro: 1974).

Burton, Kates and White (1978), note that in urban settings, owners are more sensitive to hazard characteristics than tennants. In rural settings, however, the opposite seems to be true. This can probably be explained by the point that while the rural tenant has his livelihood endangered by the hazard, he does not have an investment in his land to fall back on and is still liable for rental payments.

**Personality Factors:** As Mitchel notes, "research on relationships between personality traits and perception of
hazard is still in an early stage" (1974, p329). Only a few studies have investigated this aspect (Baumann and Simms: 1974; Murton and Shimbu: 1974; Saarinen: 1966; Paul: 1980). Kates concludes that:

Of the many personality factors, fate control, differential views of nature, and tolerance of dissonance-creating information seem most relevant. Risk-taking propensity, which appeared logically relevant, has not been shown to be a consistent trait and has proved operationally difficult to measure (1971, p441).

Other Influences: As hypothesized, hazard perception appears not to be associated with socioeconomic indicators. However, Saarinen (1966) found in Great Plains farmers that acuity of perception of the extreme event probability increased with age up to some point in middle life, and then seemed to decline. Baumann and Simms (1974) found a disproportionate number of their respondents in the oldest age group in the low hurricane risk zone, gave the hazard a low evaluation. As income increased in that zone, the tendency to evaluate the hazard as low, also increased.

3.2.3. INDIVIDUAL MANAGERS' ADJUSTMENTS

Relatively little is known about the factors influencing the process of adjustment adoption (Mitchel: 1974). An exception is hazard perception which has been well studied. Ward (1974), Murton and Shimabukur (1974), Jackson and Mukerjee (1974), Earney and Knowles (1974), and Paul (1980), have all confirmed the relationship between perception of the hazard and the level of adjustment adoption. Islam (1974) and Baumann and Simms (1974),
could find no such association.

A strong direct association has been demonstrated between the frequency and magnitude of flood, frost, and drought and the level of adoption (Kates: 1962; Saarinen: 1966; Burton, Kates and Snead: 1969; Ward: 1974; Ramachandran and Thakur: 1974). Paul (1980) confirmed this finding for precautionary adjustments to the rural snow hazard, but for adjustments made after the snow was forecast, those who made the most adjustments were in the medium hazard zone. Heijnen and Kates (1972) had a similar finding in their drought study.

There is good reason to conclude that persons that have greater experience with floods and drought tend to perceive and adopt more adjustments (Kates: 1962; Burton: 1962; Burton, Kates and Snead: 1969; Sims and Baumann: 1972; Saarinen: 1966). This relationship was also found in Jackson and Mukerjee's San Francisco earthquake study (1974). Although this was also true for Baker and Patton's hurricane study (1974), Baumann and Sims concluded that past experience was not sufficient to produce effective cautionary action in response to the same hazard in a similar area (1974).

Economic considerations determine the adjustment level to some extent. According to Erickson (1974), a more effective flood control dam would have been constructed in Opotiki, had more resources been available. Fruit growers in a frost prone part of Florida have rejected the option of growing more frost-resistant crops because of the lower returns they give (Ward: 1974). Other factors such as
personality (Islam: 1974), a reliance on public relief (Ramachandran and Thakur: 1974; Kunreuther: 1974), literacy and income (Baker and Patton: 1974), and religious and philosophical considerations (Ward: 1974) have all been shown to have some bearing on hazard adjustment decisions.

3.2.4. PUBLIC ADJUSTMENTS

A trend in public hazard response of a progression from folk adjustments, through modern technological, to comprehensive adjustments has been recognised in the United States. Arey and Baumann (1971) noted that public policy on natural hazards in the U.S.A. has been dominated by centrally administered "technological fix" strategies during most of this century. A change in emphasis is recognised by Mitchel (1974) (an outcome of hazard research findings and a resurgent interest in resource conservation and environmental quality), and combinations of technological, social and legal adjustments are now being applied. White (1970) and Oya (1970) recognise the beginnings of such a change in emphasis in other countries, although most of the world's population relies on folk adjustments, while many depend on modern technological adjustments which are frequently misapplied (Farvar and Milton: 1972).
4 : THE SNOW HAZARD

4.1 Introduction

Until 1980, no hazard study had been conducted of snow in an agricultural setting. This state is a reflection of the view that "the adverse effects of snow are felt largely in the cities ..." (Visvader and Burton: 1974, p223). These adverse effects are mainly in the form of loss of mobility, and as Whittow points out:

The more dependent a society becomes on transport and mobility, the more catastrophic are the effects of any interference with that mobility. This is especially true in the urban areas, which have tended to become less and less self-sufficient, and therefore more vulnerable to the vagaries of nature (1980, p310).

The significance of the disruption snow causes in urban areas is reflected in the average annual costs of snow and ice removal (U.S.A. $500 million, Canada $125 million) as well as in loss of production. In Toronto, for example, it has been estimated that a typical winter's snowfall seriously affected 13% of its workforce, causing losses of $3.5 million (Whittow: 1980). The cost of an unusually severe snowfall is of course much greater. Such falls can cause loss of life (mainly from hypothermia) and damage to property.

Relatively little attention is paid to snow's impact on agriculture; Hewitt and Burton do not recognise it as a hazard except in "the more highly populated areas of the country, especially the cities. Elsewhere, it is a hindrance to transport" (1971, p118). However, virtually every
country prone to snow adjusts its farming activities in response to regular 'normal' snowfalls. Occasional severe falls can have disastrous consequences as in the January-February, 1978 British blizzard, where ten to fifteen percent of the livestock in Caithness and surrounding counties were killed, while some crofters lost virtually all their stock. In Southern England a government airlift was required to feed thousands of dairy cattle, but losses were still great. In 1947, crop production was severely hit, and 20% (4 million) of the nation's sheep were killed.

In New Zealand, because of the location of most of the population outside snow-prone areas, snow's greatest impact is on agriculture. Kidson (1936) notes that with respect to land utilization, activities are limited by it only in the central plateau of the North Island, and in the interior of the South Island, especially east of the main divide. The most notable response to the average winter snow, is the annual driving of livestock to lower and less snow-prone parts. Occasional severe snows, however, can extend to coastal areas, and cause great disruption to farming activities, and loss and damage to livestock and other farm property.

4.2 Effects of Snow in an Agricultural Situation

The main effects of such falls can be summarised as the following:

4.2.1. LIVESTOCK DEATHS

Most deaths are directly attributable to cold assoc-
iated with heavy snows. How prone livestock is to the effects of cold is, to a large extent, dependent on how well fed the animals are at the time:

Newly shorn sheep on full feed can stand temperatures down to \(-5^\circ C\) before they need to draw on body reserves in order to survive, but the temperature need only fall below \(20^\circ C\) for shorn sheep on a maintenance ration to have to draw on their reserves (Hughes: 1974, p70).

However, in a heavy snow situation, grazing is usually impossible, and the farmer's ability to provide feed is hampered by restricted mobility and difficulties in locating stock.

Other causes of death are:
(a) Dehydration.

This occurs where access to water is curtailed and the problem is especially acute where dry feed is given.
(b) Metabolic Disorders.

These are common in pregnant and suckling animals under additional stress from cold and the sudden withdrawal of greenfeed. A cure is possible with feeding and the use of various veterinary preparations.
(c) Infections.

Pneumonia is the most common.
(d) Abortions.

There may be a high rate among affected animals.
(e) A reduced milk supply from suckling animals, or a total withdrawal if the animal dies. These reduce the survival chances of young. Another reason for withdrawal of milk, is sunburned udders in some particularly susceptible breeds.
(f) The effects of eating wool, drowning, smothering (often
4.2.2. LOWERED PRODUCTION

Wool quality can be severely affected by the stress of situation, particularly in heavily pregnant ewes. A greater level of contamination of the clip from extended supplementary feeding, also lowers the quality.

4.2.3. DAMAGE TO TREES

This can be severe, particularly if the snow falls when the trees are in leaf, as a greater surface is available for snow to accumulate. The result can be broken limbs and a loss of commercial value.

4.2.4. DAMAGE TO CROPS

Crops can be flattened by the weight of snow, or be damaged by accompanying frost.

4.2.5. DAMAGE TO BUILDINGS

These may collapse under a snow loading in excess of the weight they are designed to bear.

4.2.6. DAMAGE TO FENCES

Fences can be swept away by avalanches, and the wires broken through ice and snow loading.

4.2.7. DAMAGE TO POWER AND TELEPHONE LINES

Snow and ice build-up on lines can result in breakage. Poles can also be damaged from the unbalanced strain imposed
on them by the broken lines.

4.2.8. DISRUPTION OF ROAD COMMUNICATIONS

Roads become impassable to normal traffic when covered by deep snow. Consequently, help is only accessible to farmers by air.

4.3 Factors Affecting the Hazardousness of Snow

Hewitt and Burton note that "the correlation between damage and depth of snow is in fact poor, except for extreme falls". (1971, p121). The present study is concerned primarily with falls of extreme depth, but in such falls, depth still interacts with a number of other variables to produce varying degrees of hazardousness in the agricultural situation.

The density of the snow is an important variable: a low density, 'dry' snow, because it is associated with low temperatures, will be immediately more stressful to livestock, but a 'wetter', more dense snow, associated with warmer temperatures, is a greater impediment to mobility. More dense snow has a greater likelihood of accumulating on power and telephone lines, fences and trees, and therefore of damaging them.

Associated weather conditions are also important. Clearly, cold temperatures both during and after a fall, will add to the stress on animals. A frozen cover of snow, however, will allow greater mobility, although it will be more difficult to clear.

Wind will compound the effects of cold temperatures,
and may create drifts that are obstacles to movement. It can bury stock and provide extra loading on structures.

The length of lie of a snow will have a bearing on how soon stock has access to greenfeed, and how long it is subject to the stress of cold. How great the damage to crops and to buildings, will also be in part determined by this.

An 'out-of-season' snowfall, will in general be more damaging, than a seasonal fall; farm operations are planned with the assumption that normal weather will prevail. An unusual weather event, then, can be disastrous.

The severity of damage to the following will vary with the time of year:
(a) Trees, for reasons given above.
(b) Crops, which are generally grown when snow is not expected.
(c) Livestock. The major metabolic diseases are problems only when the animal is in advanced pregnancy, or is suckling young. Newborn animals are particularly vulnerable in snow, so they are born at a time of relatively low snow risk. Pre-lamb shearing is undertaken at a time of year when snow is not uncommon. Shorn sheep are at greater risk in cold, unless a high level of feeding is maintained. Sheep, however, are more mobile in snow without their fleeces.

When the fall occurs will have a bearing on associated weather conditions, which will affect the hazardousness of the snow.

A snow falling during the day will hinder the farmer's
attempts to save his stock, as the animals will probably be spread out in a grazing pattern, rather than in a more manageable concentration.

Livestock in poor condition, possibly as a result of a shortage of feed at some time before the snow falls, will be less able to withstand the stress of a snow.

4.4. Severe Snowfalls in Mackenzie County

Snow falls in Mackenzie county on average, between five and twenty-one days a year (New Zealand Meteorological Service: 1973). Occasionally falls, or a series of falls are of unusually great depth. Unpredictability is an important feature: "They always result from an unusual combination of meteorological events, which can be difficult to predict individually, and even more difficult in combination" (Tomlinson and Edie: 1976, p16). Such falls have been documented for over a hundred years. Records have tended to be vague and chiefly qualitative, but it is probably safe to say that there have been around twenty such falls over the period (Burrows: 1976).

The damage to farm economies has frequently been severe, particularly in earlier times. In the 1895 snow, for example, there were several cases of a farm's entire flock being killed. The greater impact was a reflection of the fact that relatively little could be done to save livestock at that time.

There is some evidence to suggest that the meteorological conditions favouring a severe snow have become less frequent. Burrows (1976) notes that this probably
results from a northerly shift of the sub-Antartic low pressure belt. Salinger and Gunn (1975) have concluded that there has been a climatic warming in New Zealand since around 1935. Comments of long-time residents of the study area, support this.

The most recent severe falls came after a 32 year break, in 1967 and 1973. Because of their recency, and as illustrations of the type of snow and its effects, descriptions follow of both.

4.4.1. THE SNOW OF NOVEMBER, 1967

This snow was unusual and particularly hazardous for two reasons:

(1) The unusual depth of the fall: depths of 25 to 100cm were common, but five feet were reported in some areas.
(2) The unseasonableness of the event: most falls in the affected area occur in June, July and August, and a fall of any significant depth in November is extremely rare.

The complex conditions giving rise to this fall are described by Tomlinson (1970). The snow was notable at lower altitudes for its high density and consequent heavi-ness, which gave rise to widespread damage to tree branches and buildings. At higher altitudes, the snow was less dense, but deeper so damage was as severe, if not worse (Hughes: 1969). The period of lie was short: most snow had melted within about three days. This rapid thaw can be accounted for by the relatively high November soil and

1. There was a heavy fall in 1965, but in terms of its effects, it was relatively insignificant.
air temperatures, and the rain that followed. The snow seriously disrupted road and telephone communications and the electricity supply was cut in many places for up to two weeks. Damage to crops was widespread, particularly on low altitude farms, and severe damage was caused to trees that were just coming into leaf. Many buildings collapsed. The worst effects of the snow were on livestock: between 60 and 70,000 sheep and lambs, and 300 and 500 cattle and calves died. Lambing and calving had not long taken place, or were still in progress and this explains most of the deaths.

4.4.2. THE SNOW OF AUGUST, 1973

The most distinguishing features of this fall were the following:

(1) The unusual depth of the fall: depths of up to five feet were recorded, and unlike the 1967 snow, the accompanying winds in places, produced drifts - up to six metres in depth.

(2) The density of the snow: remarkably large amounts of precipitation were recorded (within two days, some places received precipitation totals with an estimated fifty year return period (Hughes: 1976) which again meant a heavier and more damaging snow.

(3) The duration of the lie: unlike the 1967 fall, the thaw was very slow, taking up to six weeks for snow to clear in places. This was a very important contributing factor to the high death rate amongst livestock.

Again, the damage to trees was considerable, but this
time, it was mainly confined to exotic species. Damage to buildings was widespread: the Earthquake and War Damages Commission received claims involving 600 farm buildings. Road and telephone communications were severely disrupted (some were without telephone links for up to three weeks), as was electricity supply (3-4 weeks passed before all services were restored). Damage to fences was very common.

Again, the worst effects were on livestock; at least 133,193 sheep and 4,137 cattle died as a direct result of the fall (In Mackenzie County, the corresponding figures were 20,743 and 543). Two additional factors contributed to the high death rate:

(1) Because of an unusually dry summer and autumn, livestock generally went into the winter in poorer than usual condition, and feed reserves were low.

(2) Pre-lamb shearing was taking place on many of the lower properties, and many had inadequate post-shearing feed because of the poor autumn growth. Lambing and calving had also begun on many of these properties.

4.5 Adjustments to the Hazard

To reduce the risk from severe snowfalls, the farmer can make a number of adjustments to his farming practice. The following are the most fundamental and widely adopted of these.

(1) The holding of feed reserves at a recommended level of 25% above anticipated normal requirements. (Ward-Smith: 1976). Experience has shown that concentrates are best in a heavy snow situation, followed by grain and then high
quality hay. Livestock should be accustomed to eating such feed.

(2) The maintenance of good condition in livestock throughout the year, especially on going into winter.

(3) The keeping of livestock, at times when snow is relatively common, in accessible parts of the farm, where shelter is available (e.g. plantations) and snow clears fast. Particularly vulnerable animals (e.g. shorn sheep, calves, lambs), should of course be given priority.

(4) The immediate moving of livestock, at the time of a fall, if possible and if necessary, to accessible, sheltered, and fast-clearing areas.

(5) The feeding of livestock as soon as possible in the event of a heavy fall. Experience has demonstrated that because of varying tolerances of the conditions, cattle should be fed first, and wethers last (Donaldson: 1974).

(6) Snowraking of livestock. This involves digging out buried animals and gathering them on a cleared area. To accomplish this, snow-clearing equipment is required. A snowplough, used with a crawler or four-wheel-drive tractor, is the most effective, followed by an angle-blade dozer, and then a bulldozer (Donaldson: 1974). Other equipment is generally ineffective in very deep snow. If a helicopter is available, animals can be fed where they stand, and snowraked later (a helicopter is also valuable as a transporter of snowrakers).

(7) The holding of reserves of veterinary supplies to treat affected stock for metabolic diseases and pneumonia. Because differential diagnosis is difficult, it is
recommended that an affected animal be treated for all of pregnancy toxemia (sleepy sickness), milk fever, and pneumonia (Baker: 1974).

(8) The evacuation of stock to areas less or not affected by a snow. This is highly desirable, but difficult to achieve.

(9) The shearing of sheep with blades, or if by machine, with a snow comb. Both of these methods leave more wool on the sheep, making it less vulnerable in cold weather.

(10) The maintenance of stores of food and fuel to sustain the household during a period of relative isolation.

Other adjustments include:

(1) Having some form of two-way radio to enable communication when telephone links are cut.

(2) Growing choumoellier with swedes and turnips (the height of the plant means that some greenfeed is available in a moderately deep snow).

(3) Certain management practices designed to ensure that stock is concentrated in the event of a snowfall. These include subdividing wintering blocks, and managing lambing by set-stocking, (rather than shedding-out whereby the flock is repeatedly divided to keep yet-to-lamb ewes separate).

(4) Farming breeds of sheep and cattle that are less susceptible to udder-burn.

(5) Insuring stud stock (it is impractical to insure non-stud stock).
In an extreme snow situation, there is much scope for help to farmers from outside sources. In both the 1967 and 1973 snows, various public bodies, particularly the Ministry of Agriculture and Fisheries, played very important roles. Their main work was in the following areas:

1. Obtaining helicopters to transport snow-rakers and hay.
2. Arranging the deployment of snow-clearing equipment for farms that did not have their own.
3. Obtaining supplementary feed for those farms that had insufficient of their own.
4. Arranging the evacuation of livestock.
5. Obtaining extra supplies of stock medicines.
6. Organizing voluntary help from people outside the disaster area.
7. Arranging dead stock disposal.

Disaster Relief Committees, comprising representatives of farmer organizations, local bodies, and government departments associated with relief work were formed in 1967 and 1973, for various sub-areas of the disaster zone. Their chief function was to negotiate with the government for relief payments for some of the costs of the measures taken after the storm, and for assistance for the economic recovery of affected farms. After the 1967 snow, the following relief was secured:

1. Payment of some freight costs of hay that was brought into the area, and payment of the hiring and transporting costs of bulldozers used to clear snow, and of veterinary
and sundry labour costs.

(2) Government guarantees of some farmers' overdrafts.

(3) Some tax relief for those with reduced income and where livestock had to be replaced.

(4) The opportunity for the farmer to contribute to a Farm Income Equalization Scheme, if he anticipated reduced income in future years.

Other public relief that farmers could apply for through established provisions were:

(1) Assistance for repair of fences with soil conservation functions.

(2) Remission of County and Rabbit Board rates.

(3) Payments for damaged buildings under the provisions of the Earthquake and War Damages Commission.

(4) Silvicultural treatment for damaged trees under the provisions of the Farm Forestry Scheme.

In 1973, government relief payments were secured for:

(1) Freight costs of evacuation of stock.

(2) 50% of the costs of burying livestock, except where the farmer's own equipment was used.

(3) Some of the freight costs of hay.

(4) Some of the costs of stock rescue, including those incurred by the army and air force.

Also available, were loans from the State Advances Corporation, and an additional suspensory loan. If the above two were inadequate, Government was prepared to consider requests for Government guaranteed bank overdrafts.

Paul (1980), concluded that the adjustments made to the snow hazard in Ashburton County, could be described as
folk or pre-industrial, as they involved modification of behaviour rather than the event, and were mainly modifications of normal farm practices. The same could be said of the adjustments made in Mackenzie County. However, at least in this area, there are some which have characteristics of technological or industrial adjustments. In the 1967 and 1973 snows, the livestock rescue programme which involved large numbers of off-farm individuals and organizations, the negotiations for government relief, and the actual relief given, have characteristics of this type; they were high in capital requirements and required interlocking and interdependent social organization.

Most of the adjustments listed, are of the modification of loss potential type. Some planning for losses is evident, in that where practical, insurance may be taken out.

A report of the 1967 snow published by the Tussock Grasslands and Mountain Lands Institute, included a list of 'Suggestions for the Future'. This made recommendations on individual farmer action, and suggested that a pre-arranged plan of action be prepared by the various organizations involved in relief work, for use in future snow emergencies. Hughes (1976), however, in his similar report of the 1973 snow, noted that few of these recommendations were put into practice. Although in 1973, most had some sort of disaster plan that was implemented, a lack of coordination and cooperation was apparent among the various bodies involved, which restricted the effectiveness of relief operations. After this snow, various organizations
met individually and in some cases, collectively, to discuss ways to improve their efficiency in future snows. This involved mainly the defining and clarifying of responsibilities and priorities. Despite this planning, it was Hughes' opinion that the degree of cooperation among the various organizations involved was (and presumably, still is) inadequate (1976).
CHAPTER TWO

1. AIMS AND HYPOTHESES

1.1 Aims

The study aimed to:

(1) Describe the snow hazard to farming in Mackenzie County.

(2) Investigate the nature and determinants of farmers' perceptions of the hazard.

(3) Investigate the nature and determinants of the farmers' adjustments to the hazard.

1.2 Hypotheses

Hypotheses were formulated after consideration of the following:

(1) The aims of the study;

(2) The nature of the hazard and of the farmers;

(3) The restrictions imposed by the research method;

(4) The findings of past studies.

The hypotheses were:

(1) Variation in snow hazard perception can be accounted for by variations in a combination of the following:

(a) Magnitude and frequency of snowfalls;

(b) Recency of experience of severe snowfalls;

(c) Frequency of experience of severe snowfalls;

(d) Past loss and damage from severe snowfalls;

(e) Age of the farmer;

(f) Significance of the hazard as a threat to income.
2.1 Physical

Mackenzie County can be divided into two distinct regions (figure 2). The first of these is within what is commonly known as the Mackenzie Country. This region consists of an intermontane basin, covered with extensive glacial moraine, and the surrounding hill and mountain country. The basin is relatively flat, with a height above sea level of between 360m and 760m, although rising from it are occasional hills and down country of low elevation. The surrounding high country varies in altitude from 3766m to the northwest, to around 1200m to the south and east. The southern third of the Mackenzie Country lies within the Waitaki County and so is not included in the area of study.

The second region is to the east of the first. Norton (1952) has designated this area the Eastern Range and the Flats and Downs country. The Flats and Downs country consists of gently rounded low hills sloping down to the valleys of the numerous small streams that flow between them. Two small alluvial plains have been formed in the northern part of the region by the main rivers. Surrounding the flats and downs to the west, north and northeast, are the ranges which reach heights of up to 2319m. To the west, these form the barrier between the Mackenzie Country and the Flats and Downs country.

The position and shape of the Mackenzie Country give its climate some continental features. During the summer,
FIGURE 1
LOCATION OF THE STUDY AREA
FIGURE 2
MACKENZIE COUNTY SUB-REGIONS
temperatures are often high, as are sunshine hours, and humidity is low. Temperatures in winter are consistently low, and frosts are frequent. Precipitation is variable through the region: the east and southeast part of the basin is relatively dry, and high summer evaporation rates reduce the efficiency of rainfall. Most precipitation here comes with the relatively infrequent southerly winds. Rainfall in the southeast is estimated to be about 381mm. The slopes of the western ranges receive a high rainfall from the prevailing northwest winds. Further east, the northwest rain declines appreciably, resulting in an average rainfall of between 960 and 1100mm. Snow generally falls in winter and spring and comes mainly from the south. Occasional falls from the northwest, however, may affect the high altitude western country.

In the Eastern Range and the Flats and Downs country, the prevailing winds come from the west to southeast and the northeast, although there are occasional northeasterlies. Precipitation varies considerably, from 1092mm in the western range country, to 635mm in the east. The latter area is sheltered from southerly winds and less prone to northwest winds. Most snow falls in the western range country, but frequently comes to lower levels. The one temperature recording station in the area (at Fairlie) records a similar temperature range to that of the Mackenzie Country, but sunshine hours are lower and frosts less frequent.
2.2 Agriculture in Mackenzie County

Coxhead (1951) recognized three types of farming in Mackenzie County. Based mainly on his field observations, he delimited regions characterized by each type of farming (figure 3).

Extensive Sheep Farming: The carrying capacity of these farms is low and consequently, holdings are large; wool is the main product, with store sheep of some importance in the east. This type of farming dominates in the Mackenzie Country and the eastern ranges. The distinctive feature of extensive sheep farming is the seasonal mustering; during summer, sheep are grazed in south-facing and higher altitude country, and for winter they are moved to the warmer north-facing slopes and low-lying areas. Some cattle may be carried for beef production, but these are of minor importance compared with sheep.

Store Sheep Farming: This type is distinguished from the latter by higher carrying capacities and the consequently smaller size of holdings, a lower proportion of native grasses, and a higher proportion of each holding in crops (chiefly fodder crops). Ewe lambs are sent to the plains and downlands as replacement stock and old ewes are either sold for fattening, or fattened on the farm. Again, cattle are often carried, but sheep remain dominant. Store sheep farms in the County are marginal to extensive sheep farms, being located mainly on the foothill of the eastern ranges.

Commercial Livestock and Crop Farming: This type of farming is distinguished from the other two by higher
FIGURE 3
DISTRIBUTION OF FARMING TYPES

- Extensive Sheep Farming
- Store Sheep Farming
- Commercial Livestock and Crop Farming
carrying capacities and smaller holdings, and the greater proportion of land in cash and fodder crops. At least ten per cent of each holding is used for the production of supplementary feed, and another five per cent at least for the production of cash crops, mainly grains. These relative areas vary in response to market prices. Such farming is practised in the Eastern Flats and Downs country.

2.3 Snow Risk

There is considerable variation in snow risk throughout the county. In order to fulfil the aims of the study, it was necessary to make an assessment of the snow risk of each individual farm in the county. As a result, figure 4, which designates high, medium, low and negligible risk areas, was produced. The assessment of snow risk was based on a combination of the following:

(1) A small scale map produced by Tomlinson and Edie (1976), showing the maximum snow depths to be expected once in fifty years for all New Zealand. This was based on snowfall records from 1867 to 1973 inclusive.

(2) The relative snow risks of the various parts of the county as assessed by Coxhead (1951) and Norton (1951), both of whom made studies of the agriculture of the area.

(3) Comments made by farmers in the questionnaire on the snow risk of their properties.


By coincidence, there were equal numbers of farms in the low, medium and high risk groups.
FIGURE 4
SNOW RISK
3: METHODS

3.1 The Survey

A self-administered questionnaire was sent to all the farmers in the county, apart from those in the 'negligible snow risk' region. It was appreciated that this was not the ideal survey method for this type of study, but taking into consideration time and budget constraints, it was the most appropriate. The source of names and addresses was the Fairlie Ministry of Agriculture and Fisheries mailing list, which listed farmers as distinct from owners.

The questionnaires were delivered in late January, 1981. A stamped, addressed envelope was included and the farmers were asked to return the completed questionnaires within a week.

3.2 The Questionnaire

The questionnaire of the Collaborative Programme on natural hazard research that was discussed above, provided the basis for the design. Modifications were made to suit the particular hazard, and to allow the questionnaire to be self-administered. The scope was more limited than the basic questionnaire's because of time constraints on the study, and because of the need to keep a self-administered questionnaire as brief as possible (Dixon and Leach: No date).

The first five questions were designed to discover how the farmers perceived both the natural event itself, and the hazardousness of the event. Their experience of the
hazard was sought in the next four questions. A block of 17 questions followed on individual adjustments to the hazard. Questions 28-30 sought general attitudes on snow hazard adjustment. The purpose of questions 31 and 32 was to enable classification of the survey farms by location and economic base, and questions 33-35 asked about the farming experience of the farmers. The last three questions - on age, farm ownership, and economic dependence on livestock - were included to discover whether these variables had any bearing on hazard perception and adjustment. Finally, the farmers were invited to make any comments they wished.

Three questions were open-ended as they asked for reasons for answers to the previous question. The farmers were asked to name any adjustments they made to the hazard, that were not covered by previous questions.

3.3 Data Analysis

A computer package (FREQUENCY) was employed for a frequency count and for cross-tabulations of responses to test for associations. It was necessary to repeat the chi-squared tests of association after some modifications had been made to the data; because many of the classes of responses had calculated expected frequencies less than one, and therefore contributed disproportionately to the chi-squared value, it was necessary to either exclude them from the calculation, or to combine them with other classes (as recommended by Snedecor and Cochran: 1967). In order to retain as much of the test's sensitivity as possible,
eliminations of classes were only made where the numbers in them were so small as to be insignificant. Classes were combined only if one or more was similarly insignificant, and another class was available such that the combination would be meaningful.
CHAPTER THREE

1: THE RESPONSE

The initial response rate to the questionnaire was 72.7%. Approximately one month after sending the questionnaires, reminders were posted to those who had not replied. Of these, 34.7% responded, which brought the overall response rate to 81.2%. This is high for a mail survey (Moser: 1969), so the assumption can be made that the responses obtained are representative of the entire population. Those who did not reply were not concentrated in any one snow risk group: 40% were on high risk properties, 26% on medium, and 33% on low.

The questionnaire was generally well received by those who replied. Many gave answers and comments with considerable detail, and 23% of the respondents (after being invited to) asked for a summary of the survey's results.
The response to the questionnaire allowed a profile of the farmers and their farms to be built up.

Most farmers were aged between 30 and 60: only 25% were outside this range (Table 1).

Table 1

<table>
<thead>
<tr>
<th>Age</th>
<th>%</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>60+</td>
<td>20</td>
<td>13.1</td>
</tr>
<tr>
<td>51 - 60</td>
<td>33</td>
<td>21.7</td>
</tr>
<tr>
<td>41 - 50</td>
<td>36</td>
<td>23.6</td>
</tr>
<tr>
<td>31 - 40</td>
<td>45</td>
<td>29.6</td>
</tr>
<tr>
<td>21 - 30</td>
<td>16</td>
<td>10.5</td>
</tr>
<tr>
<td>0 - 20</td>
<td>2</td>
<td>1.3</td>
</tr>
</tbody>
</table>

In general, the respondents were very experienced farmers: nearly 70% had farmed for more than 20 years; only one had less than six years' experience (Table 2).
Table 2

Farming Experience

<table>
<thead>
<tr>
<th>Years</th>
<th>%</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>6 - 10</td>
<td>9</td>
<td>6.5</td>
</tr>
<tr>
<td>11 - 20</td>
<td>37</td>
<td>31.0</td>
</tr>
<tr>
<td>21 - 30</td>
<td>54</td>
<td>66.7</td>
</tr>
<tr>
<td>30+</td>
<td>50</td>
<td>99.8</td>
</tr>
</tbody>
</table>

151 100

Not all of this time had been spent as a major decision-maker on a farm, but 74% had at least 11 years of such experience (Table 3).

Table 3

Time as a Major Decision-Maker on a Farm

<table>
<thead>
<tr>
<th>Years</th>
<th>%</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>16</td>
<td>10.5</td>
</tr>
<tr>
<td>6 - 10</td>
<td>23</td>
<td>25.6</td>
</tr>
<tr>
<td>11 - 20</td>
<td>49</td>
<td>57.8</td>
</tr>
<tr>
<td>21 - 30</td>
<td>39</td>
<td>83.4</td>
</tr>
<tr>
<td>30+</td>
<td>25</td>
<td>99.8</td>
</tr>
</tbody>
</table>

152 100
All had spent at least one winter on their present farms, and most had spent a substantial period there (Table 4).

Table 4

<table>
<thead>
<tr>
<th>Years</th>
<th>%</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 0.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.5 - 5</td>
<td>17</td>
<td>11.2</td>
</tr>
<tr>
<td>6 - 10</td>
<td>23</td>
<td>15.2</td>
</tr>
<tr>
<td>11 - 15</td>
<td>24</td>
<td>15.8</td>
</tr>
<tr>
<td>16 - 20</td>
<td>9</td>
<td>5.9</td>
</tr>
<tr>
<td>21 - 30</td>
<td>29</td>
<td>19.2</td>
</tr>
<tr>
<td>30+</td>
<td>49</td>
<td>32.4</td>
</tr>
</tbody>
</table>

151 100

Forty two per cent had farmed elsewhere; of these, only 16% assessed the snow risk of their last places as greater than that of their present farms (Table 5).
Table 5

Snow Risk of Last Place Farmed

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much Greater</td>
<td>5</td>
</tr>
<tr>
<td>Rather Greater</td>
<td>6</td>
</tr>
<tr>
<td>Same</td>
<td>6</td>
</tr>
<tr>
<td>Rather Less</td>
<td>10</td>
</tr>
<tr>
<td>Much Less</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>67</td>
</tr>
</tbody>
</table>

Only six per cent were farm managers; the remainder were either part owners and/or leaseholders (30%), or full owners and/or leaseholders (63%).

Livestock was the main income generator: 84% of the farmers derived at least 90% of their incomes from this source (Table 6).
### Table 6

<table>
<thead>
<tr>
<th>Proportion of Income from Livestock</th>
<th>%</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 - 100%</td>
<td>127</td>
<td>84.6</td>
</tr>
<tr>
<td>75 - 89%</td>
<td>13</td>
<td>8.6</td>
</tr>
<tr>
<td>50 - 74%</td>
<td>7</td>
<td>4.6</td>
</tr>
<tr>
<td>25 - 49%</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>0 - 24%</td>
<td>2</td>
<td>1.3</td>
</tr>
</tbody>
</table>

| 150 | 100 |

Twenty per cent of the respondents' farms were located in the Mackenzie Country, with the remainder in the eastern districts. The greatest concentration was in the Fairlie Basin (Table 7, Figure 2).

### Table 7

<table>
<thead>
<tr>
<th>Location of Farm</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>District</td>
<td></td>
</tr>
<tr>
<td>Mackenzie Country ) Mackenzie Basin</td>
<td>20</td>
</tr>
<tr>
<td>Country ) Gorge Country</td>
<td>11</td>
</tr>
<tr>
<td>Eastern Foothills</td>
<td>34</td>
</tr>
<tr>
<td>Fairlie Basin</td>
<td>78</td>
</tr>
<tr>
<td>Cattle Valley )</td>
<td></td>
</tr>
<tr>
<td>Middle Valley )</td>
<td>5</td>
</tr>
<tr>
<td>Raincliff )</td>
<td></td>
</tr>
<tr>
<td>Orari Basin</td>
<td>4</td>
</tr>
</tbody>
</table>

| 152 | 100 |
The farmers were asked to indicate whether they had experienced the falls of 1967, 1973 and any others. Because of a relatively high proportion of non-responses to the question on 'other falls' (14%), this, and subsequent related questions will be disregarded. Almost all farmers had experienced a severe snowfall: only six per cent had experienced neither the 1967 nor the 1973 fall. It is improbable that any of this group had experienced any other fall. Seventy three per cent had experienced both of the two most recent falls (Table 8).

Table 8

<table>
<thead>
<tr>
<th>Experience of Severe Snowfalls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
</tr>
<tr>
<td>1967, but not 1973</td>
</tr>
<tr>
<td>1973, but not 1967</td>
</tr>
<tr>
<td>1967 + 1973</td>
</tr>
<tr>
<td>Neither</td>
</tr>
</tbody>
</table>


151 100

Similar levels of loss and damage were reported for the 1967 and 1973 snows: most farmers' ranged from none to moderate. An exception was trees in 1967: a relatively high proportion of farmers reported a heavy level of loss and damage (Tables 9 and 10).
### Table 9

**1967 Loss and Damage**

<table>
<thead>
<tr>
<th>Levels</th>
<th>Buildings %</th>
<th>Fences %</th>
<th>Crops %</th>
<th>Trees %</th>
<th>Other %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Response</td>
<td>47</td>
<td>30</td>
<td>55</td>
<td>36</td>
<td>81</td>
</tr>
<tr>
<td>Slight</td>
<td>67</td>
<td>44</td>
<td>67</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>Moderate</td>
<td>27</td>
<td>18</td>
<td>27</td>
<td>18</td>
<td>13</td>
</tr>
<tr>
<td>Heavy</td>
<td>12</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>

153 100 153 100 153 100 153 100 153 100

### Table 10

**1973 Loss and Damage**

<table>
<thead>
<tr>
<th>Levels</th>
<th>Buildings %</th>
<th>Fences %</th>
<th>Crops %</th>
<th>Trees %</th>
<th>Other %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Response</td>
<td>40</td>
<td>26</td>
<td>45</td>
<td>29</td>
<td>89</td>
</tr>
<tr>
<td>Slight</td>
<td>83</td>
<td>54</td>
<td>77</td>
<td>50</td>
<td>57</td>
</tr>
<tr>
<td>Moderate</td>
<td>20</td>
<td>13</td>
<td>23</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Heavy</td>
<td>10</td>
<td>7</td>
<td>8</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

153 100 153 100 153 100 153 100 153 100
To gain an impression of the economic loss the farmers had sustained from heavy snowfalls, the reported loss and damage to livestock (the main source of income for most farmers), in the two most recent falls were examined together. A score of one to three was assigned according to whether no, slight, moderate, or heavy loss and damage were reported. The scores for both years were combined, which gave a range from one to six. There is a fairly even spread through the six categories, with a peak at 3 and a low at 6. This suggests that the economic impact of past falls has been quite variable among farms (Figure 5).

Figure 5  Livestock Loss and Damage, 1967 and 1973
The observations of the 1967 and 1973 snows, by a number of people, suggest that the farmers' perception of the hazard was frequently unrealistic. For example, the farm advisory officer of the adjacent Geraldine County reported that in the 1973 fall: "Only a few farmers assessed the situation correctly and took action immediately after the storm." (Crump: 1976). The Mackenzie farm advisor observed that many farmers were at first too optimistic about the effects of the 1973 fall, (Donaldson: 1974). Hughes' report of the 1967 snow records that: "The whole atmosphere at the time on the runs and farms was one of unreality. Many farmers (particularly at lower altitudes), were mentally unprepared for deep snow at this time of year." (1969, p62). The Mackenzie farm advisor supported this view, and commented on the implications of such perception:

Two predominant farmer reactions stand out most clearly in my mind at this time. The first was the stunned disbelief that it could happen and had happened, and an almost complete inability to grasp the immensity of the problem that was facing them, particularly as far as organization and using any assistance was concerned. The second point was that once the initial reaction was overcome, the immediate reaction was: 'it's late spring, this will be gone within a day.' These two factors meant that at least three good days were lost in organizing and directing assistance to those localities that needed it most. (Reynolds: unpublished, p183).

An attempt has been made here, to describe farmers' perceptions of the hazard, seven years since the last event, and to identify those factors that influence these per-
The majority of farmers agreed that snowfalls were a problem of farming in their area: only 17% disagreed, while six per cent were uncertain (Table 11).

Table 11

<table>
<thead>
<tr>
<th>Response to Statement: &quot;Heavy Snowfalls are a Problem of Farming Here&quot;</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>23</td>
</tr>
<tr>
<td>Agree</td>
<td>92</td>
</tr>
<tr>
<td>Uncertain</td>
<td>9</td>
</tr>
<tr>
<td>Disagree</td>
<td>25</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There have been approximately fourteen severe snowfalls affecting the County area in the last hundred years (Burrows: 1976; Tomlinson: 1970). Such falls were defined by Burrows as those causing disruption of communications and/or damage to property and severe stock losses. Only 13% of the respondents estimated correctly that there were between 11 and 20 such falls in this period; 75% estimated that there were fewer (Table 12).
Table 12

Estimates of Number of Severe Snowfalls in Past 100 Years

<table>
<thead>
<tr>
<th>Number of Falls</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td>3 - 5</td>
<td>37.8</td>
</tr>
<tr>
<td>6 - 10</td>
<td>37.1</td>
</tr>
<tr>
<td>11 - 20</td>
<td>13.5</td>
</tr>
<tr>
<td>21 - 30</td>
<td>2.0</td>
</tr>
<tr>
<td>Don't Know</td>
<td>8.1</td>
</tr>
<tr>
<td></td>
<td>148</td>
</tr>
</tbody>
</table>

This almost universal underestimation of the past occurrence of heavy snowfalls can perhaps be explained by the remoteness of most of these falls; before 1965, there had not been such a snow since 1945, and at that time, 64% of the respondents were under 16 years of age (Table 1). In view of this result, it is surprising that 31% expected another fall within five years, and 73% within ten years (Table 13).
Table 13
Perception of Future Occurrence of Severe Snowfalls

<table>
<thead>
<tr>
<th>Likely to Occur</th>
<th>%</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>This year</td>
<td>3</td>
<td>2.1</td>
</tr>
<tr>
<td>Within 5 Years</td>
<td>42</td>
<td>29.5</td>
</tr>
<tr>
<td>Within 10 Years</td>
<td>60</td>
<td>42.2</td>
</tr>
<tr>
<td>Within 20 Years</td>
<td>29</td>
<td>20.4</td>
</tr>
<tr>
<td>Within 50 Years</td>
<td>7</td>
<td>4.9</td>
</tr>
<tr>
<td>Within 100 Years</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Never</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>142</td>
<td>100</td>
</tr>
</tbody>
</table>

This suggests that there is a belief that the likelihood of such falls is increasing. The small amount of time that elapsed between the last three falls (1965, 1967, 1973), compared with the third and fourth most recent (1945, 1965), may account for this. That the likelihood is increasing, is indicated by Burrows who notes: "That New Zealand seems to be subject to more influxes of sub-polar air than in the previous two decades, might be indicative of a greater likelihood of the occurrence of such storms ... " (1976, p46).

Some farmers' comments suggest that a pattern of occurrence is perceived:

"Most big snows and floods etc. come after drought".
"Present observation is that it is likely to occur in dry seasons".

BUT: "In the past, good falls have always followed a series of good seasons growth-wise".

"Perhaps snowfalls occur close towards the end of the century".

"Winters are generally getting warmer; with less snow on the hills each year".

"Farm stats do not support the likelihood of heavy snowfalls occurring more frequently than once every fifty years".

That a clear distinction is perceived by farmers between a 'seasonal' and an 'unseasonal' fall in terms of their effects, is suggested by comments like the following from the questionnaire:

"You cannot compare 1973 and 1967".

"The worst snowfall is one that comes early when there has been no snow previously to put stock on the sunny side of the hill".

"The worst feature of the 1967 snow, was its being unseasonal".

"Seasonal falls do not cause too much harm. Unseasonal is very bad to prepare for".

This conclusion is supported by farmers' expected losses from both types of fall (Table 14): 92% anticipated very slight to moderate loss and damage from a seasonal fall, but for an unseasonal fall, this figure was only 64%; eighty seven per cent anticipated at least moderate loss and damage from an unseasonal fall, but for a seasonal fall, this figure nearly halved (45%).
Table 14

Expected Loss and Damage from Heavy Snowfalls

<table>
<thead>
<tr>
<th></th>
<th>Seasonal</th>
<th>Cumulative %</th>
<th>Unseasonal</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Slight</td>
<td>20</td>
<td>13.2</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>Slight</td>
<td>62</td>
<td>41.0</td>
<td>16</td>
<td>10.8</td>
</tr>
<tr>
<td>Moderate</td>
<td>58</td>
<td>38.4</td>
<td>77</td>
<td>52.0</td>
</tr>
<tr>
<td>Severe</td>
<td>9</td>
<td>5.9</td>
<td>40</td>
<td>27.0</td>
</tr>
<tr>
<td>Very Severe</td>
<td>2</td>
<td>1.3</td>
<td>12</td>
<td>8.1</td>
</tr>
</tbody>
</table>

151 100

148 100

The definition farmers gave to a 'heavy snowfall' gives some suggestion of the reason for making this distinction: factors other than depth are considered significant (Table 15).
Table 15
Respondents' Definitions of a 'Heavy Snowfall'

<table>
<thead>
<tr>
<th>1. Mentioned Depth Only:</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.5m</td>
<td>51</td>
</tr>
<tr>
<td>0.6 - 1 m</td>
<td>66</td>
</tr>
<tr>
<td>1.1 - 1.5m</td>
<td>4</td>
</tr>
<tr>
<td>1.5m +</td>
<td>4</td>
</tr>
</tbody>
</table>

| 2. Mentioned Effect on Mobility and/or Grazing: | 5 | 3.5 |

| 3. Mentioned Length of Lie and/or Freezing: | 9 | 6.3 |

| 4. Mentioned Both 2 and 3: | 3 | 2.1 |

| 142 | 100 |

Farmers' comments suggest that the term 'heavy snowfall is not ideal, as it connotes mainly great depth. 'Severe' or 'extreme' would have been more appropriate, as they allow for those other features of a snowfall that determine its hazardousness. Had these alternative terms been used, the farmers would probably have put less emphasis on depth. The writer's impression from comments of the respondents, is that other factors, particularly the length of lie, and the time of the fall, are perceived to be of at least as great importance as depth.

3.1 The Hypotheses

As hypothesised, farmers' perception of the hazard varied with the magnitude and frequency of snow on their
farms. To test this hypothesis, responses to Question One, in which the farmers were asked to indicate their agreement with the statement: "Heavy snowfalls are a problem of farming here", were cross-tabulated with the snow risk of the respondents' farms. This relationship proved significant at the 0.001 confidence level: the higher the snow risk to his farm, the more likely the farmer was to agree with the statement.

No significant relationship was found between past loss and damage and present perception of snow. The livestock loss and damage from the 1967 and 1973 falls combined, were selected for cross-tabulation with responses to the "Heavy snowfalls are a problem of farming here" statement. There was an apparent tendency to agree with this statement as loss and damage increased, although this was not statistically significant.

The responses to the same statement were selected again for testing of the hypothesis that recency and frequency of experience influenced perception. These responses were cross tabulated firstly with experience of the 1973 fall, and then with the combined experience of the 1967 and 1973 falls. No relationship was evident.

To test for a relationship between age and perception of the hazard, the farmers' assessments of the likelihood of future heavy snows was considered. This 'future perception' was selected because it was the opinion of a number of farmers spoken to before the commencement of the study, that younger farmers have a greater expectation of severe snows. Although a
A statistically significant relationship was not confirmed, but a declining expectation of future heavy snowfalls was clearly evident. A possible reason for the existence of this relationship could lie in the fact that older farmers would have probably experienced a greater number of consecutive years without such falls; younger farmers may have their perception distorted by the occurrence of three severe falls within eight years, without having experienced a long clear period.

Because there was so little variation in the significance of the hazard as a threat to income (inferred from the respondents' dependence on income from livestock, and whether they owned their farm or not), the hypothesis that perception was affected by this variable was not tested.
4 : ADJUSTMENT TO THE HAZARD

The minimizing of harm to livestock is mainly a matter of action at, or close to, the time of the snowfall. The questionnaire did not ask farmers about their responses in the snow situation, but concentrated on precautionary adjustments. Questions on their responses in the snow situation would have been valuable, but were not included because this did not become apparent until the completed questionnaires were studied, and farmers' comments indicated the importance of prompt action at, or near the time of a fall. However, by concentrating on precautionary adjustments, a valid impression of farmers' adjustment behaviour should be no less possible, as the effectiveness of these actions is greatly dependent on precautionary adjustments: there is little point in moving livestock close to the haybarn at the first suggestion of a heavy snowfall if the barn is empty.

The farmers' attitudes to snow hazard adjustment in general, was gauged by their responses to two questions on the personality variables, risk-taking propensity and fate control.

Attitudes to the idea of preparing each winter for a disaster-type snowfall (Question 29) indicate a generally low risk-taking propensity (Table 16).
Table 16

Responses to Question 29: "Do you think a farmer that was hit badly by the 1967 and 1973 snows, should prepare for each winter as though there was going to be another such fall?"

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitely</td>
<td>83</td>
</tr>
<tr>
<td>Probably</td>
<td>42</td>
</tr>
<tr>
<td>Don't Know</td>
<td>1</td>
</tr>
<tr>
<td>Probably Not</td>
<td>13</td>
</tr>
<tr>
<td>Definitely Not</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>147</td>
</tr>
</tbody>
</table>

Only 14% thought a farmer should not make such preparations. The reason given for this stand was, in almost every case, that the infrequent occurrence of such falls did not warrant such preparations.

The responses to question 28, which asked how much loss and damage from snow the farmers thought they could avoid, indicated considerable variation in what was taken to be fate control (Table 17). Fifty eight per cent felt at least 50% of the potential loss and damage was within their control, including 13% who felt that 100% was. The remainder considered most of the effects of a snowfall were beyond their control; 18% felt they could avoid less than 10%.
Table 17

Responses to Question 28: "In the case of a heavy snowfall, what do you consider to be the maximum amount of loss and damage that could be avoided by your own actions, (including help from others)?"

<table>
<thead>
<tr>
<th>%</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>19</td>
</tr>
<tr>
<td>75%</td>
<td>50</td>
</tr>
<tr>
<td>50%</td>
<td>17</td>
</tr>
<tr>
<td>25%</td>
<td>13</td>
</tr>
<tr>
<td>10%</td>
<td>15</td>
</tr>
<tr>
<td>Less than 10%</td>
<td>27</td>
</tr>
<tr>
<td>Don't Know</td>
<td>4</td>
</tr>
</tbody>
</table>

145 100

Despite the value of radios as means of communication when road and telephone links are cut, eight per cent of the farmers were without a transistor radio, and only thirteen per cent owned a two-way radio.

A few months before the survey, the Ministry of Agriculture and Fisheries sent a card to farmers in the County with instructions on actions to take in a snowfall, particularly where life is at risk. Despite the instruction to keep it "by the telephone", 30% were unable to say where their card was.

Farmers who wintered livestock on hill country, were asked whether their wintering blocks had been subdivided by
aspect; 43% said theirs were. However, of these, only 24% mentioned snow as a reason for doing so, that is, 10% of the farmers who wintered on hill country.

A second question with a similar theme, asked about lambing method. Sixty eight per cent set-stocked (the method that keeps the flock concentrated). However, none of these practised the method for the reason that it has advantages in a severe snow situation. That it involved less work and caused less mismothering, were the most common reasons given for set-stocking.

A high proportion of the farmers had no snow-clearing equipment (table 18).

Table 18

<table>
<thead>
<tr>
<th>Snow-Clearing Equipment</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most Effective</td>
<td></td>
</tr>
<tr>
<td>Snowplough + Angle-blade</td>
<td>12 8.0</td>
</tr>
<tr>
<td>Dozer + Bulldozer</td>
<td></td>
</tr>
<tr>
<td>Snowplough + Angle-blade</td>
<td>3  2.0</td>
</tr>
<tr>
<td>Dozer</td>
<td></td>
</tr>
<tr>
<td>Snowplough + Bulldozer</td>
<td>2  1.3</td>
</tr>
<tr>
<td>Snowplough</td>
<td>12 8.0</td>
</tr>
<tr>
<td>Angle-blade Dozer and</td>
<td></td>
</tr>
<tr>
<td>Bulldozer</td>
<td>12 8.0</td>
</tr>
<tr>
<td>Angle-blade Dozer</td>
<td>19 12.6</td>
</tr>
<tr>
<td>Bulldozer</td>
<td>6  4</td>
</tr>
<tr>
<td>Least Effective</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>84 56.0</td>
</tr>
<tr>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>

However, 19% owned the most effective means of
clearing snow, the snowplough; 11% in combination with a bulldozer and/or an angle-blade dozer. Twenty four per cent owned an angle-blade dozer, a bulldozer, or both. Forty eight per cent of the snow ploughs, 38% of the angle-blade dozers, and 20% of the bulldozers were bought within two years of a recorded severe snowfall. That fewer of the dozers were bought seemingly as a reaction to a particular fall, suggests that their other uses in many cases may have been the motivation to buy the machines.

Only five per cent carried no supplementary feed "in case of a heavy snowfall", Hay was the most commonly stored feed: 40% kept only hay and 51% kept it with grain and/or sheepnuts (Table 19).

Table 19

<table>
<thead>
<tr>
<th>Supplementary Feed</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Best Combination</strong></td>
<td></td>
</tr>
<tr>
<td>Nuts + Grain + Hay</td>
<td>11</td>
</tr>
<tr>
<td>Nuts + Grain</td>
<td>0</td>
</tr>
<tr>
<td>Nuts + Hay</td>
<td>4</td>
</tr>
<tr>
<td>Grain + Hay</td>
<td>64</td>
</tr>
<tr>
<td>Nuts</td>
<td>0</td>
</tr>
<tr>
<td>Grain</td>
<td>3</td>
</tr>
<tr>
<td>Hay</td>
<td>61</td>
</tr>
<tr>
<td><strong>Worst Combination</strong></td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>151</td>
</tr>
</tbody>
</table>
Sheep nuts and grain were less popular than hay despite their being more suitable feed in a severe snow. Three factors may encourage farmers to rely on hay:

(1) Sheep nuts are very much more expensive than either hay or grain.

(2) Nuts and grain are more easily lost in snow than hay. Wastage can be considerable.

(3) Most of the land in the study area is unsuitable for good grain production, so grain would have to be bought.

Despite the fact that a great proportion of livestock deaths can be prevented with medicines, 47% carried no extra supplies (Table 20).

Table 20

Livestock Medicines

<table>
<thead>
<tr>
<th>The Number of Conditions for which Medicines were Held</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>0</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>150</td>
</tr>
</tbody>
</table>

Baker (1974) recommended that any 'dopey' ewe be treated for milk fever, sleepy sickness, and infections, but only 20% kept supplies for all three.
The 103 farmers who grew swedes or turnips as supplementary feed, were almost equally divided between those who grew choumoellier with them (50), and those who did not (53). Choumoellier is unlikely to be grown in the study area for reasons other than that it supplies greenfeed in a moderately deep snow.

The farmers were asked to name any other special measures taken. Two types were frequently mentioned:

(1) Controlling livestock to keep them concentrated and off avalanche prone, and slow-clearing parts. Thirteen of the 53 (24%) who listed other adjustments, mentioned this.

(2) Mustering livestock when a snow is suspected, to concentrate the animals in accessible, fast-clearing, and sheltered areas. Again, 13 farmers mentioned this type of action.

Other measures that were mentioned less often, included keeping tracks cleared as snow falls, keeping snow-clearing equipment well maintained, not stocking for a good year, having prior arrangements with helicopter and snow-clearing equipment owners, growing shelter belts, marrying an understanding wife, praying, and keeping in a good supply of gin.

4.1 The Hypothesis

Little support was found in this study for the hypothesis that variation in farmers' adjustment to the hazard can be accounted for by variation in their perception. The farmers' responses to the statement: "Snowfalls are a problem of farming here" were cross
tabulated with their responses to the question on supplementary feed supplies (probably the most fundamental adjustment to the hazard). Although no significant relationship was evident, there was a slight tendency to have better supplementary feed with agreement that snowfalls were a problem (Table 21).

Table 21

| "Heavy Snowfalls are a problem of farming here". | Hay, Nuts + Grain | Hay + Grain Only | Nuts Only | Hay Only | Nothing
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>obs. 5</td>
<td>10</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>exp. 1.63</td>
<td>10.40</td>
<td>8.91</td>
<td>1.04</td>
</tr>
<tr>
<td>Agree</td>
<td>obs. 4</td>
<td>45</td>
<td>38</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>exp. 6.76</td>
<td>43</td>
<td>36.80</td>
<td>4.30</td>
</tr>
<tr>
<td>Uncertain</td>
<td>obs. 1</td>
<td>5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>exp. 0.66</td>
<td>4.25</td>
<td>3.64</td>
<td>0.42</td>
</tr>
<tr>
<td>Disagree, strongly disagree</td>
<td>obs. 1</td>
<td>10</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>exp. 1.93</td>
<td>12.20</td>
<td>10.50</td>
<td>1.22</td>
</tr>
</tbody>
</table>

A further test of the hypothesis was made by cross-tabulating the farmers' assessment of the future likelihood of heavy snowfalls with their responses to the question on stock medicine supplies, another fundamental preparation. No relationship could be observed (Table 22).
Table 22

<table>
<thead>
<tr>
<th>Number of Conditions for which Stock Medicines Held.</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within obs. 5 years? exp.</td>
<td>7</td>
<td>9</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>Within obs. 10 years? exp.</td>
<td>13</td>
<td>11</td>
<td>9</td>
<td>27</td>
</tr>
<tr>
<td>Within obs. 20 years or more? exp.</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>17</td>
</tr>
</tbody>
</table>

"Do you think it is likely that there will be such a heavy snowfall on your farm?".
The farmers in general, had the opportunity to develop an accurate perception of the snow hazard and the various mitigating actions that may be taken. The majority had considerable experience of farming, most having lived on their farms for several years, and nearly all had experienced a heavy snowfall. Burton et al.'s observation that "the farmer is keenly aware of the details of hazard risk." (1978, p101) is in fact, supported by this study. The not inconsiderable proportion that did not agree that snowfalls were a problem, may comprise mainly those whose farms are in a marginally hazardous part of the county.

That this perception does vary directly with the snow risk of an area was confirmed. This is in accord with the findings of previous studies (Paul: 1980; Baker and Patton: 1974; Saarinen: 1966; Burton and Kates: 1964; Heijnen and Kates: 1974; Hankins: 1970). One finding, however, was unlike that of most studies (Mitchel: 1974; Burton, Kates and White: 1978): an association between experience of the hazard and perception of it was not found. Because of the generally high awareness of the hazard, it is more likely that this lack of association reflects a non-reliance on experience to form a perception, than an inability to learn from experience, as appeared to be the case with San Francisco residents' perception of earthquake hazard (Jackson and Mukerjee: 1972). The spectacular nature of
the hazard event, and its effects, the consequent wide publicity an event receives, and the presence of a large number in the district who had experienced a severe fall, would all help to ensure that a newcomer was well aware of the hazard. Burton and Kates questioned the belief that perception would be heightened by personal experience: "Newcomers often take on the shared or dominant perception of the community." (1964, p429). Although Paul (1980) in his study of the same hazard, found an association between perception and experience, he observed that newcomers perceived the hazard and were well aware of its effects.

The economic impact of past severe falls varied greatly among the farms. This did not appear to produce a corresponding great variety in perception of the hazard, although some relationship between the two was apparent.

An interesting result was that while the occurrence of past falls tended to be underestimated, expectation of future falls was high. The possible influence of the temporal spacing of severe falls on these perceptions has already been discussed. As Burton et al. note: "The greater the periodicity, the more acute the awareness." (1978, p102). Recent falls had high periodicity, while those in the past did not.

Like Baumann and Sims (1974) and Saarinen (1966), but unlike most, this study found some relationship between age and hazard perception, in that the estimated likelihood of future falls declined with age. As implied
earlier, this may not be a function of age per se, but rather, of the ratio of years lived in which a severe fall occurred, to years lived without such falls.

That farmers perceive an unseasonal severe fall as more hazardous than a similar seasonal fall can be inferred from a comparison of estimates of expected loss and damage from both types of fall. This shows the importance of elements of the fall other than its depth, and highlights the distinction between an extreme event and a hazard: the latter term takes account of the threat to human systems.

The multiple purposes of some adjustments complicate the assessment of the adequacy of farmers' adjustment behaviour. To overcome this difficulty, where an adjustment had another possible purpose, the question was usually worded so that the main motivation for making the adjustment could be known. This way, it was made clear that the purpose of most hill subdivision was not to keep stock concentrated in case of a heavy snowfall, and even though a majority set-stocked, none did so for that reason.

That there were other motivating factors in the decision to purchase some snow-clearing equipment, could be inferred by comparing the number who bought snowploughs (which have only one use) soon after a severe fall, with the corresponding numbers for bulldozers and angle-blade dozers.

The significance of some other considerations in adjustment decisions was not explored, and this too, makes the assessment of the adequacy of farmers' adjust-
ment behaviour more difficult. The most significant are probably the farmer's perception of the choices open to him, the relative economic efficiency of alternatives, and his linkages with other people.

The latter is likely to be particularly significant when deciding whether or not to purchase snow-clearing equipment. In the 1973 snow, an estimated forty bulldozers were made available to farmers whose own equipment was inadequate. The 56% who had none of the most effective equipment were, presumably, relying on help from outside (having one's own equipment is, of course, preferable to sharing with several others).

The farmer, when making a decision on snow-clearing equipment, will of course be concerned with the relative economic efficiency of the alternatives. Dozers may be more expensive and less effective than snow-ploughs for clearing snow, but they have other uses.

As mentioned above, choices of supplementary feed, are likely to be dependent on relative costs.

The importance of the farmer's perception of the choices open to him, may help to explain the small proportion who kept supplies of the recommended three types of stock medicines. It is quite possible that Baker's article in the New Zealand Journal of Agriculture, in which he made the recommendations, did not come to the attention of all farmers, and that this was the only source of such information. It is also conceivable that some farmers were aware of the recommendations, but did not agree with them.
Bearing of losses appears to be an important type of adjustment as suggested by the numbers who failed to make alternative adjustments. However, it is difficult to say how much the farmers relied on outside help instead of taking their own actions; that 56% had no snow-clearing equipment of their own is probably not an indication that over half the respondents will make no attempt to save their livestock, and will instead 'bear the losses'. This view is supported by the fact that only five per cent carry no supplementary feeding for use in a heavy snow. The farmers' attitudes to the idea of preparing each winter for such a fall also support this.

That there was very little support for the hypothesis that adjustment behaviour is influenced by perception of the hazard, is surprising considering how often this association has been found by other studies, and that by intuition it seems that such a relationship should exist.
CHAPTER FOUR
CONCLUSION

A better understanding of Mackenzie farmers' perceptions of the snow hazard, and of the way they adjust to it, would no doubt have been possible had they been personally interviewed. The self-administered questionnaire is an inferior method because of the need to keep it brief, which restricts its scope, but more importantly, because its inflexibility means that the respondents are more bound by the researcher's preconceptions. Despite these limitations, a number of conclusions can be drawn from this study.

The farmers in general, are aware of the snow hazard and of its effects. They appreciate that there are measures that can be taken to mitigate the effects of snow, and they feel that some such adjustment should be made. However, the preparations made are not sufficient to ensure that as much as possible of the potential loss and damage from a snowfall is prevented. This observation does not justify the conclusion that Mackenzie County farmers are poor managers. Considering the expense of making the optimum in adjustments, it may be in the farmers' best policy to gamble on there not being a heavy snowfall, and on receiving sufficient outside help when it is most needed. The infrequency of the events, the availability of outside help, the possibility of Government relief for loss, and the likelihood that they will act quickly and effectively at
the time of a severe fall, support the conclusion that the farmers are adequately adjusted to the hazard. An accurate assessment of the farmers' adjustment behaviour, however, would require an economic study of the hazard.

Another direction that future research could take is in a comparison of perceptions and adjustment behaviour at some other time in relation to a severe snow. This study found no significant relationship between perception and experience, but it is intuitively likely that as the memory of a severe snow fades, the farmer's perception of the hazard will alter. The observations of some reporters of the 1967 and 1973 falls, give some indication of perceptions at the time of the hazard events (the impression given, is that farmers' perceptions are more in accord with reality now than then), but more objective data, such as this study provides, are needed. That there will be an opportunity to collect such data soon after another severe snow is, of course, probable.
BIBLIOGRAPHY


White, G.F., 1964, Choice of Adjustment to Floods, University of Chicago, Department of Geography Research Paper, No. 93.


APPENDIX

THE QUESTIONNAIRE
QUESTIONNAIRE

PERCEPTION OF SNOWFALL

1. "HEAVY SNOWFALLS ARE A PROBLEM OF FARMING HERE."
   DO YOU:
   □ STRONGLY AGREE?
   □ AGREE?
   □ UNCERTAIN
   □ DISAGREE?
   □ STRONGLY DISAGREE?

   □ 2
   □ 3 - 5
   □ 6 - 10
   □ 11 - 20
   □ 21 - 30
   □ 31 - 40
   □ MORE THAN 40

3. DO YOU THINK IT IS LIKELY THAT THERE WILL BE SUCH A HEAVY SNOWFALL ON YOUR FARM.....
   □ THIS YEAR?
   □ WITHIN THE NEXT 5 YEARS?
   □ WITHIN THE NEXT 10 YEARS?
   □ WITHIN THE NEXT 20 YEARS?
   □ WITHIN THE NEXT 50 YEARS?
   □ WITHIN THE NEXT 100 YEARS?
   □ NEVER?
4. IF THERE WAS A HEAVY SNOWFALL ON YOUR FARM THIS YEAR, HOW SEVERE DO YOU THINK THE LOSS AND DAMAGE TO YOUR FARM WOULD BE, IF IT WAS....

(a) A HEAVY SEASONAL SNOWFALL?
   □ VERY SLIGHT
   □ SLIGHT
   □ MODERATE
   □ SEVERE
   □ VERY SEVERE

(b) A HEAVY UNSEASONAL SNOWFALL?
   □ VERY SLIGHT
   □ SLIGHT
   □ MODERATE
   □ SEVERE
   □ VERY SEVERE

5. WHAT KIND OF SNOWFALL ON YOUR FARM WOULD YOU DESCRIBE AS A HEAVY SNOWFALL?
EXPERIENCE OF HEAVY SNOWFALLS

6. WERE YOU ON YOUR FARM OR SOMEWHERE ELSE THAT EXPERIENCED HEAVY SNOWFALLS IN....

(a) NOVEMBER, 1967? □ YES □ NO
(b) AUGUST, 1973? □ YES □ NO
(c) SOME OTHER TIME(S)? (PLEASE SPECIFY) □ YES □ NO

7. IF YOU DID EXPERIENCE ANY OF THESE HEAVY SNOWFALLS, AND WERE INVOLVED WITH FARMING AT THE TIME, HOW GREAT WAS THE DAMAGE AND LOSS ON THE FARM YOU WERE ON?

(a) 1967 SNOWFALL

BUILDINGS □ HEAVY □ MODERATE □ SLIGHT
FENCES □ □ □
LIVESTOCK □ □ □
CROPS □ □ □
TREES □ □ □
OTHER □ □ □

(PLEASE SPECIFY)

________________________________________
________________________________________
________________________________________
(b) **1973 SNOWFALL**

<table>
<thead>
<tr>
<th></th>
<th>HEAVY</th>
<th>MODERATE</th>
<th>SLIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUILDINGS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FENCES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIVESTOCK</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CROPS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TREES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(PLEASE SPECIFY)

(c) **ANOTHER HEAVY SNOWFALL YOU HAVE EXPERIENCED**

<table>
<thead>
<tr>
<th></th>
<th>HEAVY</th>
<th>MODERATE</th>
<th>SLIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUILDINGS</td>
<td></td>
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<td>FENCES</td>
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<tr>
<td>LIVESTOCK</td>
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<td>CROPS</td>
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<tr>
<td>OTHER</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

(PLEASE SPECIFY)

---

IF YOU HAVE NOT BEEN INVOLVED WITH FARMING ANYWHERE ELSE, PLEASE GO TO QUESTION 10.
8. WHERE WAS THE LAST PLACE BEFORE HERE THAT YOU WERE INVOLVED WITH FARMING?

9. HOW WOULD YOU COMPARE THE SNOW RISK OF THAT PLACE WITH THE SNOW RISK OF YOUR PRESENT FARM?

   AT THE LAST PLACE THE SNOW RISK WAS....
   □ MUCH GREATER
   □ RATHER GREATER
   □ ABOUT THE SAME
   □ RATHER LESS
   □ MUCH LESS

DAMAGE AND LOSS AVOIDANCE

10. DO YOU HAVE A TRANSISTOR RADIO IN WORKING ORDER, IN YOUR HOUSE?

    □ YES
    □ NO

11. DO YOU HAVE SOME KIND OF TWO-WAY RADIO SYSTEM, SUCH AS RADIO TELEPHONES OR A CITIZEN BAND RADIO?

    □ YES
    □ NO

(IF YOU WERE NOT ON THIS FARM LAST WINTER, PLEASE MOVE TO QUESTION 14)
12. IF, LAST WINTER, YOUR FARM HAD BEEN CUT OFF FROM THE OUTSIDE, WITHOUT ELECTRICITY, WOULD YOU HAVE HAD SUFFICIENT OF THE FOLLOWING TO LAST, SAY, 3 DAYS?

- **FOOD**
  - [ ] YES
  - [ ] NO

- **FUEL**
  - [ ] YES
  - [ ] NO

- **COOKING FACILITIES**
  - [ ] YES
  - [ ] NO

- **LIGHTING**
  - [ ] YES
  - [ ] NO

13. LAST WINTER THE MINISTRY OF AGRICULTURE SENT YOUR FARM A CARD ON WHAT TO DO IN A SNOWFALL. DO YOU KNOW EXACTLY WHERE IT IS, RIGHT NOW?

- [ ] YES
- [ ] NO

(IF YOU DO NOT WINTER STOCK ON HILL COUNTRY, PLEASE GO TO QUESTION 19)

**ACCESS**

14. DOES YOUR FARM HAVE ANY TRACKS CONSTRUCTED, AT LEAST PARTLY, TO MAKE ACCESS EASIER IN A HEAVY SNOWFALL?

- [ ] YES
- [ ] NO

(IF NOT SURE) PLEASE GO TO QUESTION 16

15. WHEN WAS THE TRACK(S) MADE?
16. **ON YOUR WINTERING BLOCKS, HAVE THE SHADY FACES BEEN FENCED OFF FROM THE SUNNY FACES?**

   □ YES
   □ NO  (PLEASE MOVE TO QUESTION 19)

17. **WHAT WAS THE REASON, OR REASONS, FOR DOING THIS FENCING?**

18. **WHEN WAS THE FENCING DONE?**

19. **DOES YOUR FARM HAVE:**

   (a) **A SNOWPLOUGH?**

      □ YES  WHEN WAS IT ACQUIRED?_____  
      □ NO

   (b) **AN ANGLE - BLADE DOZER?**

      □ YES  WHEN WAS IT ACQUIRED?_____  
      □ NO
(c) A BULLDOZER?

☐ YES WHEN WAS IT ACQUIRED? 

☐ NO

(d) A HIGH VEHICLE, SUCH AS A FOUR WHEEL DRIVE ARMY TRUCK, THAT IS RELATIVELY MOBILE IN DEEP SNOW?

☐ YES WHEN WAS IT ACQUIRED? 

☐ NO

(IF YOU DO NOT FARM SHEEP, PLEASE MOVE TO QUESTION 24)

20. DURING LAMBING, DO YOU:

☐ ROTATIONALLY GRAZE AND SHED OUT?

(please go to question 22)

OR ☐ SET STOCK?

21. WHY HAS SET STOCKING BEEN ADOPTED IN PREFERENCE TO THE OTHER SYSTEM?

(IF YOU FARM NEITHER SHEEP NOR DEER, PLEASE MOVE TO QUESTION 23).
STOCK HEALTH

22. IN CASE OF HEAVY SNOW, DO YOU KEEP EXTRA SUPPLIES OF:
   (a) SHEEP NUTS?
       □ YES
       □ NO
   (b) GRAIN?
       □ YES
       □ NO

23. IN CASE OF HEAVY SNOW, DO YOU KEEP EXTRA SUPPLIES OF HAY?
       □ YES
       □ NO

(IF YOU DO NOT GROW SWEDES OR TURNIPS AS SUPPLEMENTARY FEED, PLEASE MOVE TO QUESTION 25).

24. DO YOU GROW CHOUMOELLIER (MARROW STEM KALE) WITH YOUR SWEDES OR TURNIPS?
       □ YES
       □ NO
25. **IN CASE OF A HEAVY SNOWFALL, DO YOU KEEP EXTRA VETERINARY SUPPLIES TO TREAT:**

(a) **SLEEPY SICKNESS?**

☐ YES
☐ NO

(b) **MILK FEVER?**

☐ YES
☐ NO

(c) **INFECTIONS, SUCH AS PNEUMONIA?**

☐ YES
☐ NO

26. **IS YOUR LIVESTOCK COVERED BY SOME FORM OF INSURANCE AGAINST LOSS THROUGH HEAVY SNOW?**

☐ YES
☐ NO

27. **ARE THERE ANY OTHER SPECIAL MEASURES THAT YOU TAKE TO REDUCE LOSS AND DAMAGE THROUGH HEAVY SNOWFALLS?**
28. IN THE CASE OF A HEAVY SNOWFALL, WHAT DO YOU CONSIDER TO BE THE MAXIMUM AMOUNT OF LOSS AND DAMAGE THAT COULD BE AVOIDED BY YOUR OWN ACTIONS (INCLUDING HELP FROM OTHERS)?

☐ 100%
☐ 75%
☐ 50%
☐ 25%
☐ 10%
☐ LESS THAN 10%

29. DO YOU THINK A FARMER ON A PROPERTY THAT WAS HIT BADLY BY THE 1967 AND 1973 SNOWS, SHOULD PREPARE FOR EACH WINTER AS THOUGH THERE WAS GOING TO BE ANOTHER SUCH FALL?

☐ DEFINITELY
☐ PROBABLY
☐ DON'T KNOW
☐ PROBABLY NOT
☐ DEFINITELY NOT

30. WHAT IS THE REASON FOR YOUR ANSWER?
THE FOLLOWING QUESTIONS ARE FOR STATISTICAL PURPOSES ONLY. YOU WILL NOT BE IDENTIFIED IN ANY WAY.

31. How would you classify your farm?

☐ Extensive Sheep
☐ Store Sheep
☐ Intensive Sheep and Cash Crop
☐ Other (Please Specify)__________________________

32. In what part of Mackenzie County is your farm?

☐ The Mackenzie Basin
☐ The Gorge Country
☐ The Eastern Foothills
☐ The Fairlie Basin
☐ Other (Please Specify)__________________________

33. How long have you lived on your farm?

☐ Less than six months
☐ 6 months - 5 years
☐ 6 - 10 years
☐ 11 - 15 years
☐ 16 - 20 years
☐ 21 - 30 years
☐ More than 30 years
34. WHAT IS THE TOTAL NUMBER OF YEARS' FARMING EXPERIENCE THAT YOU HAVE HAD?

- [ ] 0 - 5 YEARS
- [ ] 6 - 10 YEARS
- [ ] 11 - 20 YEARS
- [ ] 21 - 30 YEARS
- [ ] MORE THAN THIRTY YEARS

35. HOW MUCH OF THIS TIME HAVE YOU BEEN A MAJOR DECISION-MAKER ON A FARM?

- [ ] 0 - 5 YEARS
- [ ] 6 - 10 YEARS
- [ ] 11 - 20 YEARS
- [ ] 21 - 30 YEARS
- [ ] MORE THAN THIRTY YEARS

36. IN WHICH GROUP DOES YOUR AGE LIE?

- [ ] MORE THAN 60
- [ ] 51 - 60
- [ ] 41 - 50
- [ ] 31 - 40
- [ ] 21 - 30
- [ ] 0 - 20
37. ARE YOU:

- [ ] FULL OWNER AND/OR LEASEHOLDER
- [ ] PART OWNER AND/OR LEASEHOLDER
- [ ] MANAGER

OF YOUR FARM?

38. PLEASE INDICATE WHAT PROPORTION OF YOUR HOUSEHOLD INCOME COMES DIRECTLY FROM SHEEP, CATTLE, GOATS AND DEER.

- [ ] 90 - 100%
- [ ] 75 - 89%
- [ ] 50 - 74%
- [ ] 25 - 49%
- [ ] 0 - 24%

ANY COMMENTS?

THANK YOU FOR YOUR COOPERATION IN THIS SURVEY.