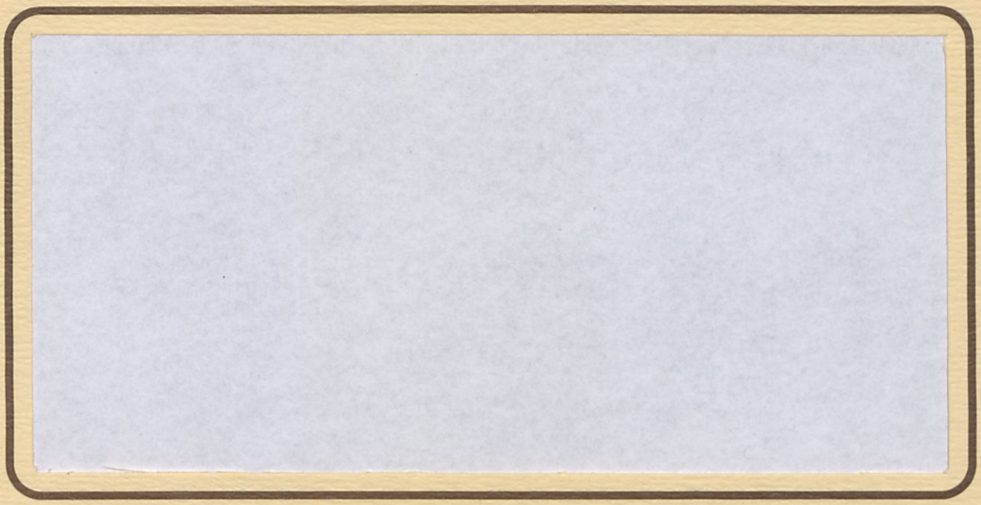
RURAL ECONOMY



PROJECT REPORT

Department of Rural Economy
Faculty of Agriculture and Forestry
University of Alberta
Edmonton, Canada

PRIVATE LANDOWNER WILDLIFE HABITAT IN ALBERTA: AN ECONOMIC ANALYSIS OF RETENTION AND DEVELOPMENT[1]

Project Report 91-04

Ted J. Haney, William E. Phillips,
and Wiktor L. Adamowicz[2]

---

[1]This project is the outgrowth of a larger study entitled "Wildlife Habitat on Alberta Private Lands: An Analysis of Land Use Trade-offs." Funding was provided by the Alberta Recreation Parks and Wildlife Foundation and the Alberta Fish and Wildlife Division. The particular efforts of Ernie Ewaschuk and Ron Weatherill are gratefully acknowledged.

[2]The authors are respectively: Senior Development Officer, Agri-Food Development Branch, Agriculture Canada, Edmonton; Professor and Chair, Department of Rural Economy, University of Alberta, and; Associate Professor, Department of Rural Economy, University of Alberta.

PRIVATE LANDOWNER WILDLIFE HABITAT IN ALBERTA: AN ECONOMIC ANALYSIS OF RETENTION AND DEVELOPMENT

ABSTRACT

There is a conflict between private landowners' rights and public wildlife rights in Alberta. This conflict is expressed in the reduction or removal of wildlife habitat for agricultural purposes on private lands in Alberta. The landowners' decisions to alter habitat may not reflect society's value on the displaced wildlife.

Factors that affect habitat change on private lands within the agricultural regions of Alberta were investigated. Survey respondents chose more often to alter wildlife habitat that was situated on irrigated cultivation than wildlife habitat that was situated on dryland cultivation. Survey respondents chose more often to preserve voluntarily a woodlot than a slough, without enroling in any preservation program. Survey respondents' age, proportion of land enroled in a preservation program, land use interaction beliefs, net household income, economic outlook, personal value of wildlife, belief in the effectiveness of compensation, risk acceptance, and belief in the economic value of wildlife all significantly affect either their decision to alter or preserve wildlife habitat or their choice of wildlife habitat preservation program.

The survey results were, in part, analyzed using a random utility model applied through the use of a multi-nomial logit analysis. The above factors were analyzed and incentive compatible mechanisms that are, or may be, used to attain social welfare wildlife goals were investigated. The two most acceptable land use options for dryland cultivation were lease for wildlife management and contract for joint agriculture-wildlife management. The two most acceptable land use options for irrigated cultivation were contract for joint agriculture-wildlife management and alter wildlife habitat for agricultural purposes. The two least acceptable land use options for private land were sale and donation for wildlife management.

The combination of landowner attributes, current and potential land use, and wildlife habitat preservation program attributes will determine the success of preservation efforts. Landowners must believe that they would be no worse off by preserving their land for wildlife habitat. This belief may be affected by the availability of both financial and non-financial incentives to preserve wildlife habitat.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

There is a conflict between private landowners rights and public wildlife rights in Alberta. This conflict is expressed in the reduction or removal of wildlife habitat for agricultural purposes on private lands in Alberta. The landowners' decisions to alter habitat may not reflect society's value on the displaced wildlife. The purpose of this study is to investigate the factors that affect habitat change on private lands within the agricultural regions of Alberta. An analysis of these factors, and an investigation of program prescriptions that are, or may be, used to attain social welfare goals, is included.

Research Objectives

Wildlife property rights are held by the public and the resource is protected from direct depletion through public regulation. Habitat is not protected on privately owned land, as Fee Simple property rights are held by the landowners. Public wildlife and private habitat property rights are in conflict. The central issue remains to identify and assess alternate program prescriptions to offset this property rights imbalance.

There is an array of policy instruments that can be used to solve the property rights imbalance. These instruments include such options as expropriation, zoning (i.e., conservation reserves), taxation, and other regulatory instruments. None of these are considered in this study. Current real property rights entitlements are assumed to remain intact, and emphasis is on voluntary compliance with various incentive compatible mechanisms. This study is intended to identify mechanisms which are acceptable to landowners, cost effective (in some fashion), and may balance public wildlife rights and private real property rights. A compensation mechanism must be found where private land owners would be "no worse off", in the long term, for maintaining habitat. The eventual compensation mechanism must be flexible enough to allow the public to express, in monetary and non-monetary terms, its willingness to have specific habitat preserved. The policy mechanism must also allow private landowners to alter this same habitat if the proposed compensation is insufficient to make them "no worse off." The problem is to identify mechanisms within the present institutional framework which exist or may be developed that will control the removal of habitat that is critical to wildlife within the agricultural regions of Alberta. Once the property rights have been balanced, the private costs of maintaining wildlife habitat will be paid by governments on the public's behalf. In this way the costs and benefits of wildlife use and conservation may be closely associated.

To fulfil the purpose of this study, three interrelated objectives must be met. These objectives are:

1. To evaluate likely landowner behavioral responses to alternate program prescriptions;

2. To identify and determine the effect of those landowner characteristics which are significantly related to wildlife habitat preservation decisions, and;

3. To merge the results of objectives 1 and 2 to assess wildlife potential and program effectiveness on privately owned agricultural land.

Investigation of alternate program activities designed to encourage those landowners currently not preserving habitat to preserve or enhance habitat will be completed. Further investigation of landowner knowledge levels with respect to the compatibility of agricultural and wildlife habitat retention activities will be completed. This additional information will be used to further investigate the decision-making process used by landowners when preserving or developing wildlife habitat. Landowner motivations will be studied in order to better understand the effects of alternate program activities.

Background

The emergence of vocal environmental organizations has increased public awareness of and concern for the protection and preservation of wildlife in Alberta. It is presently uncertain whether the development of environmental awareness will lead to a balancing of public and private property rights, or instead will cause the rights imbalance to increase (Ciriacy - Wantrup, 1968).

Various wildlife and habitat management approaches are currently pursued in Canada (Environment Council of Alberta, Renewable Resources Sub-Committee, 1989) (Haney, et al, 1991). The government of Alberta has funded two pilot projects to test the effectiveness of alternate incentive compatible programs designed to encourage private landowners to preserve or enhance wildlife habitat. The Landowner Habitat Project (LHP), a pilot project of the Alberta Fish and Wildlife Division, has attempted to internalize private landowners' wildlife habitat externality.

The Red Deer County Habitat Retention on Private Land Program was initiated as a three year pilot project in 1978 by Alberta Fish and Wildlife Division (Ewaschuk and D.A. Westworth, 1983). Financial incentives were offered to private landowners who enroled in one of five program options. The program options are presented in Table 1.

Table 1. Red Deer County Habitat Retention on Private Land Program Options

Option	Parcel Size	Term	Fence Requirement	Agricultural Practices	Annual Payment ($/Ac.)
1	> 40 Ac.	15 Years	Yes	Limited	Negotiated
2	< 40 Ac.	15 Years	Yes	None	$5.00
3	< 40 Ac.	3 Years	No	None	$5.00
4	> 40 Ac.	3 Years	No	Limited	Negotiated
5	20 Acres	3 Years	Yes	Pheasant Rearing	Cost Share and Negotiated

Note: Option 5 required landowners to initiate a pheasant captive breeding and release program with cost sharing in year one.
A negotiated annual "Habitat Recognition Payment" was offered in the second and third years.

A total of 83 landowners participated in this program with over 11,000 total enroled acres. An evaluation of this project suggested that insufficient financial incentives were offered, and that important wildlife habitat, from a biological perspective, was not targeted. Partially as a result of these problems, the majority of enroled lands were either non-arable, or were marginally arable.
The Landowner Habitat Project (LHP) was initiated as a three year pilot project in 1986 by Alberta Fish and Wildlife Division (D.A. Westworth, 1990). Financial and recognition incentives within a flexible structure were offered to landowners in three regions of Alberta. Land leases and joint management contracts were available to private landowners who met management criteria. High quality project signs were erected at the building sites of LHP participants. Only lands with a high wildlife habitat potential were accepted into the project. All land lease rates were based on 80% of existing local cash lease rates. Compensation for modifying agricultural activities, for the benefit of wildlife, was based on 80% of the cooperators' reduced net income. Technical assistance was offered to all cooperating landowners in the form of wildlife habitat development plans. An evaluation of this project was completed in 1990. The basis of this evaluation was a survey comprised of 82 randomly selected non-participants of the LHP and 89 LHP participants (94% of total participants).

Landowners were asked questions related to socioeconomic classification, wildlife and habitat knowledge and attitude, farming operation and practices, LHP program awareness and satisfaction, and wildlife recreation. This study suggested that the flexible nature and level of financial compensation was appealing to LHP participants. It was suggested that the LHP should be promoted to wildlife user groups in order to increase awareness of landowners' view of recreationists. It was suggested that highly motivated landowners should be encouraged to cooperate on a volunteer or purely recognition basis. In summation, this evaluation found the LHP to be a successful pilot project, and recommended a province-wide expansion.

While both of these pilot projects provided vital information as to the acceptability of several wildlife habitat program alternatives, major questions remain unanswered. Of primary concern to this study, was the lack of landowner motivation and decision making process description and analysis. What are the reasons that landowners choose to participate, renew agreements, withdraw from the program, or not cooperate?

Problem Situation

Society values the preservation of wildlife. The costs of maintaining habitat are primarily incurred by private landowners. The problematic situation is that an imbalance of property rights has led to the destruction of wildlife habitat on Alberta farms.

The primary symptom of this rights imbalance is that habitat is being removed from private lands within the agricultural regions of Alberta. The public has become increasingly aware that this habitat removal may have negative effects on wildlife, and therefore on social welfare. A further possible symptom may be the development of mutual distrust between wildlife preservation advocates and private landowners.

Landowners, hunters, wildlife observers, public policy makers, and the general public are all affected by this problem. Public demand for private habitat preservation may primarily affect landowners who possess critical habitat.

The desired situation may exist when the public is satisfied that social welfare is being maintained through the survival of wildlife and the private landowners are compensated for the opportunity costs which they incur in the maintenance of habitat necessary for the survival of wildlife. Application of economic theory can provide guidelines toward the solution of the original problem situation.

Theoretical Basis

Private landowners may choose to alter wildlife habitat for agricultural purposes. The landowners are entitled to remove habitat by the legal fee title real property rights they hold. The public's welfare, or utility, is adversely affected by the private landowners' actions through a resultant reduction in publicly owned and valued wildlife. There currently exists no mechanism that internalizes societies costs of reduced wildlife in the cost functions of private landowners. This situation is typical of an ownership externality. A solution to this externality will link the private and public costs and benefits associated with wildlife habitat preservation and enhancement on private lands.

Economic institutions are "collective conventions and rules that establish acceptable standards of individual and group behaviour." (Bromley, 1982: 12). These institutions are defined both "by legal and jurisdictional rules and in part by social conventions, mores, and habits." (Adamowicz, et al, 1985: 2). Resource use conflicts may occur where legal entitlements and social expectations are not closely associated. Legal and social definitions of a particular institution may diverge over time. Conflict may also occur where two or more institutions are interrelated and allow conflicting actions.

While private landowners are entitled to alter wildlife habitat for agricultural purposes, societies preservation expectations are not satisfied. If rules are enacted that restrict the landowners' rights to alter wildlife habitat, either the original entitlements must be changed, or the landowners must be willing to "sell" those entitlements (Adamowicz, 1990). The social cost of changing fee simple real property entitlements through revoking rights and privileges may possibly be higher than the benefit of preserving wildlife habitat. The public may "purchase" certain real property rights from private landowners in order to protect publicly owned wildlife assets. Through fee simple acquisition of private lands, all real property rights are purchased. Selected strands of the rights may be acquired through land leases, management contract, and conservation easements.

Economic theory guides the empirical analysis which follows. The decision criteria used by landowners when preserving or altering wildlife habitat are assumed to conform with utility and production theory. Society's willingness to pay landowners to modify agricultural practices is assumed to conform with utility (welfare) and institutional theory. The analytical models employed to describe these relationships also conform to the above theories.

RESEARCH METHODS AND SURVEY DESIGN

The purpose of this section is to present the research methods used in the collection and analysis of data gathered in a landowner survey. A decision criteria model and support for its selection as well as a rigorous analysis of the model will be presented. The development and application of an original survey instrument will be described. Finally, a description of the data used in this study, and the results of collinearity analysis will be presented.

Utility and Revealed Preferences

The application of theory must allow the investigation of the decision-making process used by landowners when considering wildlife habitat preservation and alteration options. In order to do this, a set of discrete land use choices will be used to elicit landowner perceptions for various wildlife habitat program options. Landowners will not be asked to rate or describe the utility attributes of discrete land use options. Since direct measures of utility derived from options are normally unavailable, option selection criteria must be based on selected landowner attributes. Landowner attributes can be used to provide an indirect reflection of the respondents' utility functions. These attributes and associated factors that affect landowners' utility are listed in Table 2.

Table 2. Land Owner Attributes and Factors Affecting Landowner Utility

ATTRIBUTES	FACTORS
Study Region	Regional
Total Acreage	Scale
Owned/Leased Land	Tenure
Percent Land LHP Enroled	Prior Experience
Age	Life Stage
Education	Knowledge and Exposure
Household Size	Family Structure
Personal Wildlife Value	Wildlife Perception
Economic Future	Prosperity
Risk	Risk
Wildlife Economic Value	Wildlife Compatibility
Financial Compensation Effectiveness	Financial Incentive
Land Use Compatibility	Compatibility
Primary Enterprise	Agricultural
Net Income	Financial
Interviewer	Interviewer Bias

These landowner attributes provide the basis for empirical analysis. These attributes will be used to indirectly measure the effect of respondents' utility functions on the selection of land use options. Through a greater understanding of the effects of these attributes on the actions of private landowners, programs and policies directed toward preserving wildlife habitat on private land may be adjusted to increase the probability of success.

The objective of analysis is to identify those landowner attributes that affect the choice of land use alternatives described in the three scenario sections of the survey. The purpose of this understanding is to analyze alternative program prescriptions to the rights imbalance problem described in previous sections. Existing programs may be altered or new programs may be developed which satisfy the requirements of landowners for the preservation of wildlife habitat on private lands.

Frequencies of responses from land owners and valid percent of responses will be determined. These frequencies and percentages will allow a qualitative review of the data. General response rates, and attitudes held by landowners will be examined at this stage of analysis. Crosstabs will be calculated to give response frequencies for selected questions by study region and by landowner status. Qualitative analyses will be completed, at a cursory level, to understand differences in response patterns between landowners in different geographical locations and participation groups. Breakdowns will be calculated to give response value means, standard deviations, and frequencies by location and by participation status. Comparisons will be made between the rankings of selected responses and between socioeconomic profiles. These comparisons will allow the identification of those characteristics which, after aggregation, vary between respondent groups.

The methods used must provide indications of how and why landowners chose particular wildlife habitat preservation or alteration options. This approach allowed an indirect investigation of those components of the landowners' utility functions that affect land use decisions.

> In the random utility model the utility to a consumer of an alternative is specified as a linear function of the characteristics of the consumer and the attributes of the alternative, plus an error term. The probability that a particular consumer will choose a particular alternative is given by the probability that the utility of that alternative to that consumer is greater than the utility to that consumer from all other available alternatives (Kennedy, 1985: 191-192).

Utility can be gained from tangible (financial) and intangible (recognition) sources. The utility that individual i obtains from land use choice j, can be represented as follows:

$$U_{ij}=V(\pi_{ij};\epsilon_{ij}),$$

where π_{ij} and ϵ_{ij} are the observable and random components of the utility function. It is assumed that an option will be chosen if it has the highest utility among the available options. The decision criteria is therefore based on the relative utility gained from one option over another. In order to proceed empirically, a linear form of the random utility function may be written as:

$$U_{ij} = \alpha_j + \beta_j X_i,$$

for the i^{th} individual and the j^{th} land use option. The variable X_i represents the attributes of the i^{th} individual.

The probability of option j being chosen over all other available options may be written as:

$$Pr\ \{U_{ij} > U_{ik}\ \forall_j \in K\}$$

Let

$$Uij = \alpha_j + \beta_j X_i + \varepsilon_j$$

Then

$$\begin{aligned} Pr\{j\ chosen\} &= Pr\ \{\alpha_j + \beta_j X_i + \varepsilon_j > \alpha_k + \beta_k X_i\}\ \forall_K \\ &= Pr\ \{\varepsilon_j - \varepsilon_k > \alpha_k - \alpha_j + \beta_k X_i - \beta_j X_i\}\ \forall\ K \\ &= Pr\ \{\varepsilon_k - \varepsilon_j \leq (\alpha_j - \alpha_k) + (\beta_j - \beta_k) X_i\}\ \forall\ K \end{aligned}$$

The probability of discrete option j being chosen over all other options contained in the choice set K is therefore based on the difference in option specific constants ($\alpha_j - \alpha_k$) and the difference in the parameters of X_i ($\beta_j - \beta_k$). In order to estimate the final probability, the model must be normalized on one α and one β. It is the distribution on the error terms ($\epsilon_k - \epsilon_j$) that is assumed to conform to a logistic distribution.

To gain further information as to the probabilistic relationships between landowner attributes and land use choices, universal multi-nomial logit analyses will be completed. These analyses will lead to estimated probabilities of landowners choosing individual land use options in the scenario section. The probability function of this model employs a logistic distribution (Amemiya, 1981). This distribution function has the superior quality of constraining probabilities between 0 and 1. The random utility errors are assumed to be independently and identically distributed in a Weibull (extreme-value) distribution (Kennedy, 1985).

$$P_{ij} = \frac{\exp(\beta'_{ij}\, x_i)}{1 + \sum_{k=1}^{m-1} \exp(\beta'_{ik}\, x_i)}$$

where: P_{ij} = probability of individual i choosing option j, and
i = (1, 2, ..., n) individuals, and
j,k = (1, 2, ..., m) options, and
x_i = vector of characteristics of individual i, and
ßij = matrix of parameters (Maddala, 1983).

The probability of individual i choosing option j is consistent with utility theory and is based upon the respondents' perceived marginal utility difference of choice alternatives.

Model performance is based primarily upon maximum likelihood ratios, calculated on the base of the fully restricted model (all non-constant coefficients set to zero). An initial OLS estimate of the coefficients was fit into the following likelihood function:

$$L = \prod_{i=1}^{n} P_{i1}^{y_{i1}} P_{i2}^{y_{i2}} \ldots P_{im}^{y_{im}}$$

where: $y_{i1} = 1$ if individual i chooses option 1, and
$y_{i1} = 0$ otherwise

or

$$\ln(L) = \sum_{i=1}^{n} \sum_{j=1}^{m} y_{ij} \, lnP_{ij}$$

The equation to solve for obtaining the ML estimates is:

$$\frac{\partial \ln(L)}{\partial B_k} = 0$$

where: k = 1, 2, ... , m-1 (Maddala, 1983)

Since the logistic probability function is highly nonlinear in $ß_{ij}$, the maximum likelihood does not have a closed form solution. The Newton-Raphson iterative procedure was used to estimate this nonlinear function. The $(t+1)^{st}$ round estimate of $ß_{ij}$ is estimated by:

$$\beta_{t+1} = \beta_t - \frac{\left(\frac{\partial \ln(L)}{\partial \beta} \Big|_{\beta_t} \right)}{\left(\frac{\partial^2 \ln(L)}{\partial B \, \partial B'} \Big|_{B_t} \right)}$$

"The properties of the log-likelihood function for both the normal and the logistic c.d.f.'s guarantee that this method will converge to the global maximum based on any set of starting values $ß_0$. Furthermore, we know that the maximum likelihood estimators are consistent, asymptotically efficient, and asymptotically normally distributed." (Judge, et al, 1988: 792).

It is this empirical model that produces the probabilities of behaviour, given selected choices among alternate land uses and selected land owner attributes. A survey of landowners includes questions designed to elicit responses suitable for the use of this model, from which insights into landowner utility and behaviour responses can form the basis for wildlife habitat program formulation and analysis.

A number of performance criteria may be applied to the above described model. The application of these performance tests form part of the study results.

Goodness of fit tests are restricted primarily to likelihood ratio tests and to the percent of decisions correctly predicted. Maddala's pseudo R^2 is calculated as follows:

$$Maddala's\ R^2 = 1 - \left(\frac{L_0}{L_{ML}}\right)^{2/n}$$

where: $\ln(L_0)$ is the ln(L) subject to the constraint that all the regression coefficients, except for the constant, are restricted to zero, and

$\ln(L_{ML})$ is the ln(L) of the specified model at the maximum likelihood parameter estimates.

Maddala's pseudo R^2 is a form of likelihood ratio test where the maximum likelihood value of the fully restricted model is divided by the likelihood value of the tested specification. This proportion is then raised to the power 2/n, and the result is then subtracted from one. This statistic is therefore adjusted for the number of observations.

McFadden's pseudo R^2 is calculated as follows:

$$McFadden's\ R^2 = 1 - \frac{\ln(L_{ML})}{\ln(L_0)}$$

where: $\ln(L_0)$ is the ln(L) subject to the constraint that all the regression coefficients, except for the constant, are restricted to zero, and

$\ln(L_{ML})$ is the ln(L) of the specified model.

McFadden's pseudo R^2 is a form of likelihood ratio test where the maximum log likelihood value of the tested specification is divided by the log likelihood value of the fully restricted model. This proportion is then subtracted from one.

Craig and Uhler's pseudo R^2 is calculated as follows:

$$Craig\ \&\ Uhler's\ R^2 = \frac{L_{ML}^{2/n} - L_0^{2/n}}{1 - L_0^{2/n}}$$

where: $\ln(L_0)$ is the ln(L) subject to the constraint that all the regression coefficients, except for the constant, are restricted to zero, and

$\ln(L_{ML})$ is the maximum ln(L) of the specified model.

Craig and Uhler's pseudo R^2 is calculated by subtracting the maximum log likelihood value of the fully restricted model, raised to the power 2/n, from the maximum log likelihood value of the tested specification, raised to the power 2/n. This difference is then divided by 1 minus the maximum log likelihood value of the fully restricted model, raised to the power 2/n. This statistic is therefore adjusted for the number of observations.

Theory suggests that explanatory variables should be linearly independent in the MNL model. When collinear relationships exist between explanatory variables, the resulting parameter estimates may be inefficient. The estimation of choice probabilities will be correct, but the variance of coefficient estimates will be high. The MNL model is, at least partially, unable to distinguish between the effect of related explanatory variables.

The MNL model will estimate the probability of each respondent choosing particular land use options. The options which will be calculated to have the highest probability of being chosen will be treated as the predicted option. Predictions will then be compared to respondents' actual choices and the percentage of correct predictions will be calculated.

Three specifications of the model will be used. Unrestricted, choice restricted, and fully restricted specifications will be investigated. The unrestricted model will result in estimates of the $ß_{ij}$ parameters for all choice options, using all selected explanatory variables. The choice restricted model will result in estimates of the $ß_{ij}$ parameters for the two most popular choice options, using all selected explanatory variables. The fully restricted model will result in estimates of the $ß_{ij}$ parameters for the two most popular choice options, using the two selected "best" explanatory variables.

The inclusion of selected land owner attributes may cause the multi-nomial logit model not to converge and to subsequently fail. These specific attributes will be excluded. All observations with missing values will be removed from the sample data to ensure that remaining observations contain complete explanatory variable sets.

This model may violate the assumption of independence-of-irrelevant-alternatives, as "the relative probability of choosing two existing alternatives is unaffected by the presence of additional alternatives." (Kennedy, 1985: 192). This problem is limited if the landowners are able to identify each option clearly as a separate choice.

Previous Study Sample Design

A master list of 180 respondents for a previous Landowner Habitat Project (LHP) study by D.A. Westworth & Associates Ltd. (1990), completed for the preparation of the report entitled "An Evaluation of the Landowner Habitat Program" was used as the master landowner contact list for this study. Included were 9 names of landowners who were not interviewed by the project consultants. The consultant's master landowner contact list was prepared in two stages. Of the 95 landowners participating in the Landowner Habitat Project (LHP), 89 (94%) participants cooperated in the completion of the previous survey. A total of 82 non-participating landowners were randomly selected and surveyed. Landowners were surveyed in three study areas between 1 November, 1988 and 31 January 1989 (D.A. Westworth & Associates, 1990).

Current Study Sample Design

A survey instrument was developed in June, 1990 and field tested in July, 1990 on four out-of-sample respondents. Adjustments were made to the survey instrument, and the final version was prepared in August, 1990.

Attempts were made to survey, in person, all of the 180 landowners on the compiled master landowner contact list. A total of 32 landowners could not be contacted, were unable to cooperate, or were unwilling to cooperate in completing a survey for this study. A total of 148 landowners were surveyed, including 80 participants in the LHP, and 68 non-participants. The distribution of respondents between study regions was: 47 (32%) in the county of Minburn (East-central Alberta); 66 (44%) in the County of Red Deer (Central Alberta), and; 35 (24%) in the Eastern and Bow River

Irrigation Districts (Southern Alberta). The in-person surveys were completed between 15 August, 1990 and 31 October, 1990.

Certain answers given by respondents on the previous LHP survey were appended to their responses to the current survey to produce a complete data set. Those 9 landowners not originally surveyed by the project consultants were asked questions, to be used in this study, in follow-up telephone interviews. These telephone surveys were completed between 15 January, 1991 and 31 January, 1991. All landowners were classified by individual identification number, participation status, and study region.

Survey Questionnaire Design

The survey questionnaire used in this study had seven main sections (Appendix I). The following describes the content of each section.

Section One

The first section contained six questions. The first five likert scaled questions related to the landowners' relative value of wildlife and profit, relative value of non-monetary awards and profit, economic future, and perception of farming as a business. Landowners were asked to rate each statement with a five-point likert scale response of either strongly agree, agree, neutral, disagree, or strongly disagree. The last question in this section required a yes/no response as to whether respondents accepted a risky versus a risk free investment option which produced an equal financial return.

Section Two

The second section of the survey questionnaire contained three wildlife habitat-agriculture land use scenarios. The first scenario described a hypothetical 10-acre slough in the corner of a dryland cultivated 160-acre field. Respondents were given the option of either: subdividing and selling the slough and surrounding 30 acres of cultivation at market en bloc value for wildlife habitat preservation; subdividing and donating the slough and surrounding 30 acres of cultivation in return for an income tax exemption equal to the market value of the land (en bloc value) for wildlife habitat preservation; leasing the slough and surrounding 30 acres of cultivation at 80% of the local cash lease rate for similar land (en bloc value) for wildlife habitat preservation; contracting for five years to seed the 30 acres of cultivation to dense nesting cover (hay or grass), maintain the slough, and not to undertake any agricultural operations within the parcel before July 15 each year in return for compensation equal to 80% of expected decreased net profit; drain the slough and cultivate the entire field, or; continue farming without any changes and without any wildlife habitat programs. Follow-up questions investigated landowners preference in dealing with public or private organizations, receiving non-financial incentives, length of land leases, form and timing of compensation payments, reasons for draining the slough, and reasons for continuing without any changes.

The second scenario described a hypothetical 10-acre slough in the corner of an irrigated and cultivated 160-acre field. The same options for selling, donating, leasing, contracting, draining, or maintaining the property were available to the landowners as in the previous scenario. This second scenario was presented only to landowners within the irrigated study region.

The third scenario described a hypothetical 40-acre woodlot in the corner of a dryland cultivated 160-acre field. The same options for selling, donating, leasing, draining, or maintaining the property were available to the landowners as in the previous scenarios. The option to contract for joint agriculture-wildlife management was not offered in this third scenario.

Remaining Sections

The third section contained four questions related to the landowners' acceptance of four non-financial incentives. Landowners were asked whether they would require more, less, or the same level of financial compensation if they were also: publicly presented with a certificate of recognition; given free lifetime hunting/fishing licenses; given free honourary lifetime memberships to a conservation organization, or; given project signs for public posting.

The fourth section contained nine questions. These were five-point likert scale questions which related to; landowners' public responsibility for wildlife habitat protection; governments' public responsibility for wildlife habitat protection on private lands; direct economic effect of wildlife populations; landowners' value of wildlife, and; landowners' perceptions of the effectiveness of financial incentives in maintaining wildlife habitat on private lands. The landowners were asked to rate each statement with a likert scale response of either: strongly agree; agree; neutral; disagree, or; strongly disagree.

The fifth section contained three questions. Three land use compatibility matrices were constructed by matching four agricultural land uses with five wildlife habitat land uses. Four agricultural land uses consisted of dryland cultivation, irrigated cultivation, dryland pasture, and irrigated pasture. Five wildlife habitat land uses consisted of shelter belts, ditch/fence cover, grassed waterways, sloughs and grassed uplands, and woodlots. Respondents were asked to rate each interaction on a five point likert scale of strongly compatible, compatible, neutral, competitive, or strongly competitive. Respondents were asked to rank all land use interactions in terms of agricultural profitability, wildlife preservation and production, and control of water and wind erosion.

The sixth section contained three socio-economic questions related to the landowners': primary farming operation; changes in landbase since the previous LHP study, and; net household income.

The seventh section contained three open ended summation questions allowing landowners to answer: how they would decide to participate in a government habitat retention program; if and why it is important to maintain wildlife habitat, and; if they have any further comments.

Other Information

A small subset of responses to selected questions contained in the previous LHP survey were added to the above survey in order to complete the data set. Responses regarding total land base, age of landowner, education level of landowner, number of individuals in the household, length of time enroled in LHP (participants only), and number of acres in LHP (participants only) were used.

Data

Information collected for this study was entered into an electronic database. A small subset of data from the previous LHP study's data set was also entered in this database. A working database containing twenty-seven variables was constructed. The variable listing is contained in Table 3.

Table 3: Variable List From Survey Questionnaire

#	VARIABLE	DEFINITION	LHP SURVEY
1	ID	Identification Number of Respondent	Previous and Current
2	S	Participation Status (LHP or Non-LHP)	Previous and Current
3	R	Study Region	Previous and Current
4	TAO	Total Acres Owned	Previous
5	TAL	Total Acres Leased	Previous
6	LHPL	Percent Acres in LHP	Previous and Current
7	AGE	Age	Previous
8	EDUC	Highest Education	Previous
9	SO	People Over 18 Years	Previous
10	SU	People Under 18 Years	Previous
11	CONSID	Importance of Wildlife	Current
12	ECONFUT	Economic Future Bright	Current
13	RISK	Choose Risky Investment	Current
14	DSLOUGH	Dryland Slough Choice	Current
15	ISLOUGH	Irrigated Slough Choice	Current
16	WOODLOT	Dryland Woodlot Choice	Current
17	VALUE	Farmers Value Wildlife	Current
18	MV	Economic Value of Wildlife	Current
19	ALTER	Compensation Effectiveness	Current
20	PCOMP	Profit-Habitat Compatibility	Current
21	WCOMP	Wildlife-Habitat Compatibility	Current
22	ECOMP	Erosion-Habitat Compatibility	Current

Table 3: Variable List From Survey Questionnaire

#	VARIABLE	DEFINITION	LHP SURVEY
23	ENT	Primary Farming Enterprise	Current
24	INC	Net Household Income	Current
25	OAC	Owned Acres Changed	Current
26	LAC	Leased Acres Changed	Current
27	INT	Interviewer	Current

Variable ID consisted of survey respondents' identification numbers. A numerical code identifying the respondents' participation status in the Landowner Habitat Program (LHP) constituted variable S. Variable R reflected a classification code identifying each of the three study regions in which respondents were located.

The summation of all acres owned by each respondent generated variable TAO. The summation of all acres leased by each respondent formed variable TAL. Variable LHPL reflected the proportion of all acres (TAO - OAC + TAL - LAC) enroled in the LHP. Variable age consisted of the respondents' age. In order to normalize variable age near 1, all responses were divided by 80.

A numerical code reflecting the respondents' education achievement constituted variable EDUC. The total number of people over the age of 18 years living in the respondents' households made variable SO. Variable SU consisted of the total number of people under the age of 18 years living in the respondents' households.

Respondents' ratings (1=Strongly Agree; 2=Agree; 3=Neutral; 4=Disagree; 5=Strongly Disagree) of the statement "Farmers must consider wildlife when seeking to maximize profits" constituted variable CONSID. The respondents' ratings (1=Strongly Agree; 2=Agree; 3=Neutral; 4=Disagree; 5=Strongly Disagree) of the statement "My economic future on this present farm is bright" generated variable ECONFUT. Variable RISK consisted of the respondents' response (1=Accept Risk; 0=Reject Risk) to a return-neutral investment option involving one risky and one risk free investment.

Variable DSLOUGH consisted of the respondents' responses to land use options regarding the hypothetical dryland slough scenario. The respondents' responses to land use options regarding the hypothetical irrigated slough scenario generated variable ISLOUGH. Variable WOODLOT reflected the respondents' responses to land use options regarding the hypothetical dryland woodlot scenario.

The respondents' ratings (1=Strongly Agree; 2=Agree; 3=Neutral; 4=Disagree; 5=Strongly Disagree) of the statement "Farmers, in general, value wildlife habitat on their farms" generated variable VALUE. Variable MV was formed by respondents' ratings (1=Strongly Agree; 2=Agree; 3=Neutral; 4=Disagree; 5=Strongly Disagree) of the statement: "Increased wildlife populations on a farm increases its market value." The respondents' ratings (1=Strongly Agree; 2=Agree; 3=Neutral; 4=Disagree; 5=Strongly Disagree) of the statement "My neighbours will alter less habitat in the future if they are compensated to maintain it" made variable ALTER.

Variable PCOMP consisted of the respondents' mean of ratings to the agricultural profitability-wildlife habitat land use interaction matrix. The respondents' mean of ratings to the wildlife preservation and production-wildlife habitat land use interaction matrix constituted variable WCOMP. Variable ECOMP reflected the respondents' mean of ratings to the control of water and/or wind erosion-wildlife habitat land use interaction matrix.

The respondents' responses (1=grain; 2=cattle; 3=hogs; 4=poultry; 5=dairy; 6=forage; 7=other) to the question "Which of the following is the primary operation on your farm?" generated variable ENT. Variable INC was formed by the respondents' responses to the question: "Which category best represents your net household (farm and non-farm) income?." The respondents were able to indicate which of eleven income cohorts best represented their situation. The midpoint of each cohort, divided by 100,000 was used as the variable value for analysis.

The summation of all owned acreage changes since the previous LHP survey for each respondent made variable OAC. Variable LAC consisted of the summation of all leased acreage changes since the previous survey for each respondent. Variable INT consisted of a numerical code identifying the interviewer of each respondent.

From the above list of variables, the following twelve variables were selected for further data analyses. The three dependent variables investigated included: DSLOUGH, ISLOUGH, and WOODLOT. Each of these variables consisted of responses indicating the preferred mechanism for either preserving or altering wildlife habitat.

The nine explanatory variables selected for the Dryland Slough scenario data analysis included: LHPL, AGE, ECOMP, INC, ECONFUT, VALUE, ALTER, RISK, and MV. Certain explanatory variables were eliminated from the Irrigated Slough and Dryland Woodlot data analyses as these variables caused the multi-nomial logit (MNL) procedure not to converge and to subsequently fail. The five explanatory variables selected for the Irrigated Slough scenario data analysis included: AGE, INC, VALUE, ALTER, and MV. The eight explanatory variables selected for the Dryland Woodlot scenario data analysis included: LHPL, AGE, ECOMP, INC, ECONFUT, VALUE, ALTER, and MV.

The purpose of LHPL was to identify the effects of degree of involvement with the Landowner Habitat Project. AGE was used to identify the effects of age on the preferred mechanism. The purpose of ECOMP was to identify the effects of perceived wildlife habitat erosion control benefits on the preferred mechanism. INC was used to identify the effects of net income on the preferred mechanism. The purpose of ECONFUT was to identify the effects of perceived economic future on the preferred mechanism. VALUE was used to identify the effect of personal value of wildlife on the preferred mechanism. The purpose of ALTER was to identify effect of perceived effectiveness of compensation on the preferred mechanism. RISK was used to identify the effect of riskiness on the preferred mechanism. The purpose of MV was to identify the effect of perceived financial effect of wildlife on the preferred mechanism.

All observations with missing observations were excluded from the analyses. A total of 123 observations were used for the "unrestricted" specification Dryland Slough MNL analysis. A total of 92 observations were used for the "restricted" specification Dryland Slough MNL analysis.

A total of 30 observations were used for the "unrestricted" specification Irrigated Slough MNL analysis. A total of 20 observations were used for the "restricted" specification Irrigated Slough MNL analysis.

A total of 122 observations were used for the "unrestricted" specification Dryland Woodlot MNL analysis. A total of 102 observations were used for the "restricted" specification.

RESULTS

The purpose of this chapter is to present the empirical results arising from the data analysis. The qualitative results presented below identify the proportion of survey responses to the questions contained in the survey questionnaire (Appendix I). The random utility model application and multinomial logit analysis results follow the qualitative results section.

Qualitative Survey Results

While 79% of the surveyed LHP participants either strongly agreed or agreed that farmers must consider wildlife when seeking to maximize profits, only 57% of the surveyed non-participants responded similarly. This indicated that LHP participants viewed private land stewardship responsibilities more favourably than non-participants.

A total of 90% of surveyed LHP participants, and 88% of non-participants chose to either lease or contract the dryland slough in order to preserve habitat. Contracting for joint habitat preservation and agricultural uses was most popular in both groups.

While 53% of surveyed LHP participants chose to either lease or contract the irrigated slough for habitat preservation, 19% of the non-participants responded similarly. While 21% of surveyed LHP participants chose to drain the irrigated slough, 56% of the non-participants responded similarly. This indicated that non-participants in the irrigated study region viewed agricultural land uses as more valuable than did participants. LHP participants may have had their attitudes toward habitat preservation altered by virtue of their experience.

A total of 68% of the surveyed LHP participants and 58% of the non-participants chose to either sell, donate, or lease the dryland woodlot for habitat preservation. The lease option was the most popular choice for participants and non-participants.

Over 80% of surveyed LHP participants and non-participants indicated that they would require the same lease compensation whether or not non-financial incentives (certificates of recognition, free hunting/fishing licenses, free memberships, or project signs) were offered.

Over 80% of surveyed LHP participants and non-participants either strongly agreed or agreed that farmers are responsible, to all those now living and to future generations, to maintain wildlife habitat in order protect wildlife populations.

A total of 41% of surveyed LHP participants and 35% of surveyed non-participants either strongly agreed or agreed that the government had the responsibility to enforce wildlife habitat preservation on private land in Alberta while 84% of surveyed LHP participants and non-participants either strongly agreed or agreed that the government had the responsibility to compensate farmers for their costs of maintaining wildlife habitat on their farms. These responses indicated that private landowners prefer to have their wildlife habitat management entitlements purchased or leased rather than confiscated. This also indicates that landowner resistance may develop to a restrictive regulation approach to wildlife habitat preservation.

While 63% of surveyed LHP participants either strongly agreed or agreed with the statement that farmers, in general, value wildlife on their farms, 74% of surveyed non-participants responded similarly. While 100% of surveyed LHP participants either strongly agreed or agreed with the statement that they value wildlife on their farms, 94% of surveyed non-participants responded similarly. This indicated that LHP participants believed they personally valued wildlife slightly more than farmers in general.

A total of 34% of surveyed LHP participants either strongly agreed or agreed with the statement that increased wildlife populations on a farm increases its market value while 16% of surveyed non-participants responded similarly. This indicated that non-participants viewed wildlife as more highly competitive with agricultural activities than did surveyed participants. Wildlife depredation was the most common reason given for increased wildlife populations causing decreased farm market values.

While 81% of surveyed LHP participants either strongly agreed or agreed with the statement that they would alter less habitat in the future if they were compensated to maintain it, 75% of surveyed non-participants responded similarly. While 62% of surveyed LHP participants either strongly agreed or agreed with the statement that their neighbours would alter less habitat in the future if they were compensated to maintain it, 52% of surveyed non-participants responded similarly. While both groups agreed that compensation was an effective method of encouraging wildlife habitat preservation on private lands, LHP participants believed compensation to be more effective than did non-participants.

Respondents were asked to rate land use interactions on a five point likert scale of: 1=Strongly Compatible; 2=Compatible; 3=Neutral; 4=Competitive, and; 5=Strongly Competitive. All land use interactions in terms of effect on wildlife and erosion control were rated, in aggregate, to be neutral or compatible by respondents across participation status and survey region. The majority of land use interactions in terms of agricultural profitability were also rated, in aggregate, to be neutral or compatible. Those land use interactions that received more competitive and strongly competitive ratings than compatible and strongly compatible ratings may be viewed as sources of potential conflict. These interactions are highlighted in Table 4.

All land use interactions that received more competitive and strongly competitive ratings than compatible and strongly compatible ratings are listed in Table 4. The primary sources of expected land use conflict existed between sloughs & uplands and woodlots, and dryland cultivation, irrigated cultivation, and irrigated pasture. The primary study regions where land use conflict may exist are the County of Red Deer and the irrigated study region. Both LHP participants and non-participants viewed specific land use interactions as more competitive than compatible. This indicates that the primary focus of land use modification programs should be directed toward preserving sloughs & uplands and woodlots on dryland cultivation, irrigated cultivation, and irrigated pasture.

Table 4: Competitive Land Use Interactions Between Agricultural and Wildlife Land Uses

Agriculture Land Use	Wildlife Habitat Land Use	Study Region	LHP Status
Sloughs & Uplands	Dryland Cult.	Red Deer	Participant
Sloughs & Uplands	Dryland Cult.	Red Deer	Non-Part.
Woodlots	Dryland Cult.	Red Deer	Participant
Woodlots	Dryland Cult.	Red Deer	Non-Part.
Sloughs & Uplands	Irrigated Cult.	Red Deer	Participant
Sloughs & Uplands	Irrigated Cult.	Irrigated	Participant
Sloughs & Uplands	Irrigated Cult.	Red Deer	Non-Part.
Woodlots	Irrigated Cult.	Minburn	Participant
Woodlots	Irrigated Cult.	Red Deer	Participant
Woodlots	Irrigated Cult.	Irrigated	Participant
Woodlots	Irrigated Cult.	Red Deer	Non-Part.
Sloughs & Uplands	Irrigated Past.	Red Deer	Non-Part.

Note: The land use pairings in Table 4 represent those interactions that respondents rated as competitive more often than complementary by the survey respondents.

A total of 43% of surveyed LHP participants responded that grain was their primary operation, while 53% of surveyed non-participants responded similarly. A total of 43% of surveyed LHP participants responded that cattle was their primary operation, while 29% of surveyed non-participants responded similarly. All other surveyed LHP participants and non-participants responded that hogs, forage, dairy, or some other enterprise was their primary operation.

The mean household net income was reported higher for surveyed non-participants ($46,885.00 calculated as cohort mid-points) than for surveyed LHP participants ($39,872.00 calculated as cohort mid-points). The highest household net income was reported for surveyed non-participants in the irrigated study region ($65,625.00 calculated as cohort mid-points). The lowest household net income was reported for surveyed LHP participants in the County of Minburn ($24,400.00 calculated as cohort mid-points).

The three most common Other Benefits requested by respondents with the three scenario questions were increased compensation, more access control to project lands, and more capital improvements on project lands. Respondents indicated that they expected or experienced more trespass interference and property damage with publicly posted LHP projects. Commonly requested capital improvements included improved water facilities (i.e., dugouts and wells) and shelterbelt improvement (i.e., tree planting).

Many landowners were sensitive to the perception that wildlife habitat was being preserved, at least partially, at the expense of rural land owners for the benefit of Canadian and American urban hunters (i.e., doctors and lawyers). This concern suggested that many landowners believe that the entire cost of wildlife habitat preservation should be paid by the public.

The results of the qualitative analysis indicated that many differences existed, after aggregation, between respondents from different study regions and from different participation groups. These identified differences provided clues as to how and why specific landowners decided to choose specific land use options in the hypothetical scenarios. These potential explanations were investigated further with quantitative analysis.

Model Performance and Specification Results

The utility and probability models described in the previous section were used to attain further results. They are presented below, but preceded by model performance and independence results that have a direct bearing on survey results and analyses.

Three specifications were estimated for the three land use scenarios. The unrestricted specification used all available explanatory variables to estimate the probability of respondents choosing each of the land use options. The choice restricted specification used all available explanatory variables to estimate the probability of respondents choosing between the two land use options that were selected the highest number of times. Those respondents indicating other land use alternatives were removed from the analysis. The choice and explanatory variable restricted specification used only AGE and INC as explanatory variables to estimate the probability of respondents choosing between the two land use options that were selected the highest number of times.

Tests of Multi-Nomial Logit Model Performance

The four Goodness of Fit statistics that were calculated for each of the nine MNL model specifications are given in Table 5. The first statistic calculated was the Percent Correctly Predicted. The other three statistics were pseudo R^2 measures, and were formally described in the previous section.

Table 5: Goodness of Fit Measures

Specification	Percent Correctly Predicted	Maddala's pseudo RSq.	McFadden's pseudo RSq.	Craig & Uhler's pseudo RSq.
Dryland Slough:				
Unrestricted	65.04	0.4684	0.2443	0.0717
Choice Restricted	81.52	0.2090	0.1969	0.1154
Choice & Explan. Var. Restricted	76.09	0.1248	0.1119	0.0623
Irrigated Slough:				
Unrestricted	53.33	0.4337	0.1868	0.0383
Choice Restricted	75.00	0.2887	0.2475	0.1371
Choice & Explan. Var. Restricted	70.00	0.1700	0.1354	0.0692
Dryland Woodlot:				
Unrestricted	58.20	0.2347	0.1153	0.0335
Choice Restricted	68.63	0.0605	0.0477	0.0238
Choice & Explan. Var. Restricted	67.65	0.0325	0.0252	0.0124

A wide variation of model performance was achieved. It may be noted that the predictive power and the goodness of fit measures for the dryland slough scenario was superior to the other two scenarios.

Explanatory Variable Dependency

A correlation matrix was constructed with the explanatory variables in each of the nine regression specifications. The purpose of this estimation was to identify possible relationships between explanatory variables.

Correlation coefficients above .300 indicate that explanatory variables are relatively strongly linearly correlated and may produce inefficient parameter estimations. All correlation estimates above .300 are reported.

Unrestricted Specification

The results of the correlation estimation of the Dryland Slough unrestricted explanatory variable set produced the relationships (Corr. > .300) presented in Table 6.

Table 6: Dryland Slough Unrestricted Correlation Results

#	First Explanatory Variable	Second Explanatory Variable	Correlation
1	INC	ECONFUT	.321
2	AGE	RISK	-.413
3	ALTER	MV	.373

The results of the correlation estimation of the Irrigated Slough unrestricted explanatory variable set produced the significant relationships (Corr. > .300) presented in Table 7.

Table 7: Irrigated Slough Unrestricted Correlation Results

#	First Explanatory Variable	Second Explanatory Variable	Correlation
1	LHPL	ECOMP	.358
2	AGE	ECOMP	.307
3	INC	ECONFUT	.392
4	INC	ALTER	-.355
5	ECONFUT	RISK	.381
6	ALTER	MV	.369

The results of the correlation estimation of the Dryland Woodlot unrestricted explanatory variable set produced the significant relationships (Corr. > .300) presented in Table 8.

Table 8: Dryland Woodlot Unrestricted Correlation Results

#	First Explanatory Variable	Second Explanatory Variable	Correlation
1	INC	ECONFUT	.368
2	AGE	RISK	-.412
3	ALTER	MV	.356

The above relationships indicated the existence of certain correlations. As household net income increased, respondents also believed that their economic future was brighter. As age increased, respondents were more risk averse. As compensation was believed to have been more effective, respondents also tended to believe that wildlife populations increase farm market value. As the percentage of land enroled in the LHP increased, respondents also believed that habitat preservation techniques were more effective at controlling erosion. As age increased, respondents also believed that habitat preservation techniques were more effective at controlling erosion. As household net income increased, respondents also believed that compensation was less effective in inducing landowners to preserve wildlife habitat. As economic future was perceived to be brighter, respondents were less risk averse. As household net income increased, respondents also believed that habitat preservation techniques were more effective at controlling erosion. As the percentage of land enroled in the LHP increased, respondents also believed that compensation was less effective in inducing landowners to preserve wildlife habitat. As the personal value of wildlife increased, respondents were more risk averse. As economic future was perceived to be brighter, respondents also tended to believe that increased wildlife populations increase farm market value.

Restricted Specifications

The results of the correlation estimation of the Dryland Slough restricted explanatory variable set produced the significant relationships (Corr. > .300) presented in Table 9.

Table 9: Dryland Slough Restricted Correlation Results

#	First Explanatory Variable	Second Explanatory Variable	Correlation
1	AGE	RISK	-.367
2	ALTER	MV	.447

The results of the correlation estimation of the Irrigated Slough restricted explanatory variable set produced the significant relationships (Corr. > .300) presented in Table 10.

Table 10: Irrigated Slough Restricted Correlation Results

#	First Explanatory Variable	Second Explanatory Variable	Correlation
1	LHPL	ECOMP	.318
2	INC	ECOMP	.413
3	LHPL	ALTER	-.339
4	AGE	RISK	-.325
5	ECONFUT	RISK	.382
6	VALUE	RISK	-.348

Table 10: Irrigated Slough Restricted Correlation Results			
#	First Explanatory Variable	Second Explanatory Variable	Correlation
7	ECONFUT	MV	.425
8	ALTER	MV	.409

The results of the correlation estimation of the Dryland Woodlot restricted explanatory variable set produced the significant relationships (Corr. > .300) presented in Table 11.

Table 11: Dryland Woodlot Restricted Correlation Results			
#	First Explanatory Variable	Second Explanatory Variable	Correlation
1	INC	ECONFUT	.337
2	AGE	RISK	-.371
3	MV	ALTER	.320

The above relationships indicated the existence of certain correlations. As household net income increased, respondents also believed that their economic future was brighter. As age increased, respondents were more risk averse. As compensation was believed to have been more effective, respondents also tended to believe that wildlife populations increase farm market value. As the percentage of land enroled in the LHP increased, respondents also believed that habitat preservation techniques were more effective at controlling erosion. As age increased, respondents also believed that habitat preservation techniques were more effective at controlling erosion. As household net income increased, respondents also believed that compensation was less effective in inducing landowners to preserve wildlife habitat. As economic future was perceived to be brighter, respondents were less risk averse. As household net income increased, respondents also believed that habitat preservation techniques were more effective at controlling erosion. As the percentage of land enroled in the LHP increased, respondents also believed that compensation was less effective in inducing landowners to preserve wildlife habitat. As the personal value of wildlife increased, respondents were more risk averse. As economic future was perceived to be brighter, respondents also tended to believe that increased wildlife populations increase farm market value.

Multi-Nomial Logit Analysis Results

The land use choice alternatives for the dryland and irrigated slough scenarios included sell (1), donate (2), lease (3), contract (4), drain (5), and continue without any changes (6). The land use choice alternatives for the dryland woodlot scenario included sell (1), donate (2), lease (3), clear (4), and continue without any changes (5). The one unrestricted model specification and the two restricted model specifications were used to obtain estimates for each of the three scenarios.

Unrestricted Specification

The unrestricted model specification was estimated first. The probability of all choice alternatives were estimated with all the possible explanatory variables.

Dryland Slough Scenario

The results of the estimation of the Dryland Slough unrestricted MNL model[3] produced the significant relationships presented in Table 12.

Table 12: Dryland Slough Unrestricted Results

#	Variable	Choice over Choice	Coefficient	P > |t|
1	Constant	Contract over Sell	19.08	.052
2	Constant	Contract over Donate	16.65	.057
3	Constant	Contract over Lease	6.664	.032
4	Constant	Contract over No Change	6.195	.058
5	Constant	Drain over Sell	29.93	.035
6	Constant	Drain over Donate	27.5	.041
7	Constant	Drain over Lease	17.52	.100
8	Constant	Drain over No Change	17.05	.112
9	LHPL	Donate over Sell	21.76	.110
10	LHPL	Lease over Sell	22.75	.089
11	LHPL	Contract over Sell	22.10	.098
12	LHPL	No Change over Sell	21.02	.117
13	AGE	Lease over Sell	9.843	.060
14	AGE	Lease over Donate	7.249	.138
15	AGE	Lease over Contract	6.234	.002
16	AGE	Lease over No Change	3.643	.135

[3]An additional MNL analysis was completed with PCOMP used in place of ECOMP. PCOMP proved to be a significant explanatory variable in describing respondents' choices of leasing over donating, contracting over donating, and leasing over continuing without change.

An additional MNL analysis was completed with the addition of the dummy variable INT, where INT=1 for those respondents interviewed by Ted Haney and INT=0 otherwise. INT proved to be a significant explanatory variable in describing respondents' choices of contracting or selling over continuing without change. This result suggested the presence of interviewer bias.

Table 12: Dryland Slough Unrestricted Results

#	Variable	Choice over Choice	Coefficient	P > |t|
17	AGE	No Change over Contract	2.591	.187
18	ECOMP *	Sell over Donate	4.157	.197
19	ECOMP *	Sell over Lease	7.134	.009
20	ECOMP *	Sell over Contract	7.131	.008
21	ECOMP *	Sell over Drain	8.350	.015
22	ECOMP *	Sell over No Change	6.642	.015
23	ECOMP *	Donate over Lease	2.977	.115
24	ECOMP *	Donate over Contract	2.974	.110
25	ECOMP *	Donate over Drain	4.193	.139
26	ECOMP *	Donate over No Change	2.486	.193
27	INC	Donate over Sell	7.331	.121
28	INC	Lease over Sell	7.595	.089
29	INC	Contract over Sell	6.520	.138
30	INC	Drain over Sell	10.16	.058
31	INC	No Change over Sell	6.554	.142
32	ECONFUT *	No Change over Sell	0.9951	.182
33	VALUE *	Donate over Drain	1.664	.086
34	VALUE *	Lease over Drain	1.270	.104
35	VALUE *	Contract over Drain	1.332	.079
36	VALUE *	No Change over Sell	1.086	.186
37	VALUE *	No Change over Drain	1.525	.055
38	ALTER *	Contract over Sell	1.428	.082
39	ALTER *	Contract over Lease	0.4642	.195
40	ALTER *	No Change over Sell	1.565	.072
41	ALTER *	No Change over Donate	1.045	.178
42	ALTER *	No Change over Lease	0.6014	.197
43	RISK	Lease over Sell	2.688	.108
44	RISK	Lease over Contract	0.8853	.151

Table 12: Dryland Slough Unrestricted Results

#	Variable	Choice over Choice	Coefficient	P > |t|
45	RISK	Lease over No Change	1.149	.130
46	MV *	Lease over Contract	0.6341	.027
47	MV *	Lease over No Change	0.8313	.024

Note: * - Likert scale: 1=Strongly Disagree to 5=Strongly Agree.

The coefficients in Table 12 were estimated by the MNL analysis. The coefficients are multiplied by the value of explanatory variables (xß) for use in the Logit.

The p value in Table 12 estimates the probability that the coefficients (ß) are not different from zero. The existence of p values less than 0.10 suggest strong behavioral responses. The existence of p values more than 0.10 but less than 0.20 suggest weak behavioral responses. Relationships with p values over 0.20 were not reported.

The significant relationships in Table 12 indicated the existence of certain behavioral responses. Independent of all other factors in the model, respondents would rather contract the dryland slough for joint habitat preservation and agricultural uses than sell, donate, or lease the slough for habitat preservation, or continue with no change. Independent of all other factors in the model, respondents would rather drain the dryland slough rather than sell, donate, or lease the slough for habitat preservation, or continuing with no change.

Increased percentage of land enroled in LHP increased the probability of a respondent donating or leasing the dryland slough for habitat preservation, contracting the slough for joint habitat preservation and agricultural uses, or continuing without any change rather than selling the slough for habitat preservation.

Older respondents tended to lease the dryland slough for habitat preservation rather than selling or donating the slough for the same purpose, contracting the slough for joint habitat preservation and agricultural uses, or continuing without any change. Increased age also increased the probability of a respondent continuing without any change rather than contracting the slough for joint habitat preservation and agricultural uses.

As a respondent believed more strongly that wildlife habitat preservation effectively controlled erosion, the probability of selling the dryland slough for habitat preservation rather than donating or leasing the slough for habitat preservation, contracting the slough for joint habitat preservation and agricultural uses, draining the slough, or continuing without any change also increased. Increased belief in the effectiveness of wildlife habitat preservation controlling erosion increased the probability of a respondent donating the dryland slough for habitat preservation rather than leasing the slough for habitat preservation, contracting the slough for joint habitat preservation and agricultural uses, draining the slough, or continuing without any change.

Respondents with higher net income tended to donate or lease the slough for habitat preservation, contract the slough for joint habitat preservation and agricultural uses, drain the slough, or continue without any change rather than selling the slough for habitat preservation. By not selling, landowners chose to maintain future land use options.

Increased perception of a bright economic future increased the probability of a respondent continuing without any change rather than selling the dryland slough for habitat preservation. By not selling, landowners chose to maintain future land use options.

Increased personal value of wildlife caused the probability of a respondent donating or leasing the dryland slough for habitat preservation, or contracting the slough for joint habitat preservation and agricultural uses rather than draining the slough to increase. Increased personal value of wildlife increased the probability of a respondent continuing without any change rather than selling the slough for habitat preservation, or draining the dryland slough.

As a respondent believed more strongly that compensation would cause less habitat alteration in the future, the probability of a respondent contracting the dryland slough for joint habitat preservation and agricultural uses rather than selling or leasing the slough for habitat preservation increased. Increased belief in the effectiveness of compensation also increased the probability of a respondent continuing without any change rather than, donating, or leasing the dryland slough for habitat preservation.

If a respondent chose the risky investment option, the probability of that respondent leasing the dryland slough for habitat preservation rather than selling the slough for the same purpose, contracting the slough for joint habitat preservation and agricultural uses, or continuing without any change increased.

Increased belief that wildlife populations increase farm market value increased the probability of a respondent leasing the dryland slough for habitat preservation rather than contracting the slough for joint habitat preservation and agricultural uses, or continuing without any change.

The above results indicate that respondents who were older, who believed in the effectiveness of wildlife habitat preservation in controlling erosion, who had smaller net household incomes, and who personally valued wildlife, had the highest probability of preserving and enhancing a slough on their dryland cultivation.

Irrigated Slough Scenario

The results of the estimation of the Irrigated Slough unrestricted MNL model produced the significant relationships presented in Table 13.

Table 13: Irrigated Slough Unrestricted Results

#	Variable	Choice over Choice	Coefficient	P > |t|
1	AGE	No Change over Drain	6.925	.190
2	INC	Drain over Sell	16.29	.186
2	INC	Drain over Contract	3.667	.101
4	ALTER *	Drain over Sell	2.577	.158
5	MV *	Sell over Drain	2.153	.163
6	MV *	Contract over Drain	.9866	.151

Note: * - Likert scale: 1=Strongly Disagree to 5=Strongly Agree.

The coefficients in Table 13 were estimated by the MNL analysis. The coefficients are multiplied by the value of explanatory variables (xß) for use in the Logit.

The p value in Table 13 estimates the probability that the coefficients (ß) are not different from zero. The existence of p values less than 0.10 suggest strong behavioral responses. The existence of p values more than 0.10 but less than 0.20 suggest weak behavioral responses. Relationships with p values over 0.20 were not reported.

The older the respondent, the higher the probability of that respondent continuing without any change rather than draining the slough.

Respondents were more likely to drain the irrigated slough rather than selling the slough for wildlife preservation or contracting the slough for joint habitat preservation and agricultural uses if they had high net income.

Increased belief in the effectiveness of compensation increased the probability of a respondent draining the dryland slough rather than selling the slough for habitat preservation.

As respondents believed more strongly that wildlife populations increase farm market value the probability of those respondents selling the dryland slough for habitat preservation or contracting the slough for joint habitat preservation and agricultural uses rather than draining the slough increased.

The above results indicate that respondents who were older, who had smaller net household incomes, who did not believe in the effectiveness of compensation, and who believed in the economic value of wildlife, had the highest probability of preserving and enhancing a slough on their irrigated cultivation.

Dryland Woodlot Scenario

The results of the estimation of the Dryland Woodlot unrestricted MNL model produced the significant relationships presented in Table 14.

Table 14: Dryland Woodlot Unrestricted Results

#	Variable	Choice over Choice	Coefficient	P > |t|
1	Constant	Sell over Donate	21.69	.092
2	Constant	Lease over Donate	18.34	.138
3	Constant	Clear over Donate	21.00	.100
4	Constant	No Change over Donate	18.15	.144
5	AGE	Donate over Clear	9.073	.124
6	AGE	Lease over Clear	6.618	.054
7	AGE	No Change over Clear	6.590	.044
8	ECOMP *	Donate over Sell	3.918	.129
9	ECOMP *	Donate over Lease	3.523	.157
10	ECOMP *	Donate over Clear	3.621	.162
11	ECOMP *	Donate over No Change	3.607	.148
12	ECONFUT *	No Change over Sell	0.5187	.172
13	ALTER *	Lease over Sell	0.6290	.173
14	MV *	Sell over Lease	0.6197	.155
15	MV *	Sell over Clear	0.9352	.107
16	MV *	Sell over No Change	0.7301	.104

Note: * - Likert scale: 1=Strongly Disagree to 5=Strongly Agree.

The coefficients in Table 14 were estimated by the MNL analysis. The coefficients are multiplied by the value of explanatory variables (xß) for use in the Logit.

The p value in Table 14 estimates the probability that the coefficients (ß) are not different from zero. The existence of p values less than 0.10 suggest strong behavioral responses. The existence of p values more than 0.10 but less than 0.20 suggest weak behavioral responses. Relationships with p values over 0.20 were not reported.

Independent of all other factors in the model, respondents would rather sell or lease the woodlot for preservation purposes, clear the woodlot, or continue without any change rather than donate the woodlot for preservation purposes.

Increasing age increased the probability of a respondent donating or leasing the dryland woodlot for habitat preservation, or continuing without any change rather than clearing the woodlot.

As a respondent believed that wildlife habitat preservation effectively controlled erosion, the probability of that respondent donating the woodlot for habitat preservation rather than selling or leasing the woodlot for habitat preservation, draining the woodlot, or continuing without any change increased.

Respondents believing they had a bright economic future were more likely to continue without any change rather than selling the woodlot for habitat preservation.

As respondents believed that compensation effectively encourages landowners to preserve wildlife habitat, they tended to lease the woodlot for habitat preservation rather than selling the woodlot for the same purpose.

Increased belief that wildlife populations increase farm market value increased the probability of a respondent selling the woodlot for habitat preservation rather than leasing the woodlot for habitat preservation, clearing the woodlot, or continuing without any change.

The above results indicate that respondents who were older, who believed in the effectiveness of wildlife habitat preservation in controlling erosion, and who believed in the economic value of wildlife, had the highest probability of preserving and enhancing a woodlot on their dryland cultivation.

Choice Restricted Specification

The second specification tested was choice restricted. The probability of the two most common choices were selected from the entire choice set. All those responses reflecting less popular options were excluded. This specification was estimated with the entire explanatory variable set.

Dryland Slough Scenario

The results of the estimation of the Dryland Slough choice restricted MNL model produced the significant relationships presented in Table 15.

Table 15: Dryland Slough Choice Restricted Results				
#	Variable	Choice over Choice	Coefficient	P > |t|
1	Constant	Contract over Lease	5.287	.079
2	AGE	Lease over Contract	6.197	.002
3	ALTER *	Contract over Lease	0.6307	.084
4	RISK	Lease over Contract	0.9269	.147
5	MV *	Lease over Contract	0.7600	.017

Note: * - Likert scale: 1=Strongly Disagree to 5=Strongly Agree.

The coefficients in Table 15 were estimated by the MNL analysis. The coefficients are multiplied by the value of explanatory variables (xß) for use in the Logit.

The p value in Table 15 estimates the probability that the coefficients (ß) are not different from zero. The existence of p values less than 0.10 suggest strong behavioral responses. The existence of p values more than 0.10 but less than 0.20 suggest weak behavioral responses. Relationships with p values over 0.20 were not reported.

Independent of all other factors in the model, respondents would rather contract the dryland slough for joint habitat preservation and agricultural uses than lease the slough for habitat preservation.

Older respondents were more likely to lease the dryland slough for habitat preservation rather than contracting the slough for joint habitat preservation and agricultural uses.

Increased belief in the effectiveness of compensation increased the probability of a respondent contracting the dryland slough for joint habitat preservation and agricultural uses rather than leasing the slough for habitat preservation.

A landowner selecting the risky investment was more likely to lease the dryland slough for habitat preservation rather than to contract the slough for joint habitat preservation and agricultural uses.

Respondents were more likely to lease the dryland slough for habitat preservation rather than contracting the slough for joint habitat preservation and agricultural uses if they believed that wildlife populations increase farm market value.

The above results indicate that respondents who were younger, who believed in the effectiveness of compensation, who were risk averse, and who did not believe in the economic value of wildlife, were more likely to contract to manage a slough on their dryland cultivation for joint agriculture-wildlife purposes than to lease the slough for wildlife management.

Irrigated Slough Scenario

The results of the estimation of the Irrigated Slough choice restricted MNL model produced the significant relationships presented in Table 16.

Table 16: Irrigated Slough Choice Restricted Results+

#	Variable	Choice over Choice	Coefficient	P > |t|
1	AGE	Contract over Drain	5.383	.199
2	INC	Drain over Contract	3.025	.127
3	ALTER *	Drain over Contract	0.9294	.187
4	MV *	Contract over Drain	0.9497	.144

Note: * - Likert scale: 1=Strongly Disagree to 5=Strongly Agree.

+ - No Significant Relationships to the 90% Level of Confidence.

The coefficients in Table 16 were estimated by the MNL analysis. The coefficients are multiplied by the value of explanatory variables (xß) for use in the Logit.

The p value in Table 16 estimates the probability that the coefficients (ß) are not different from zero. The existence of p values less than 0.10 suggest strong behavioral responses. The existence of p values more than 0.10 but less than 0.20 suggest weak behavioral responses. Relationships with p values over 0.20 were not reported.

The probability of respondents contracting the irrigated slough for joint habitat preservation and agricultural uses rather than draining the slough was higher for older respondents.

High net income respondents were more likely to drain the irrigated slough rather than contracting the slough for joint habitat preservation and agricultural uses.

Increased belief in the effectiveness of compensation increased the probability of a respondent draining the irrigated slough rather than contracting the slough for joint habitat preservation and agricultural uses.

Respondents believing that wildlife populations increase farm market value were more likely to contract the irrigated slough for joint habitat preservation and agricultural uses rather than draining the slough.

The above results indicate that respondents who were older, who had lower household net income, who did not believe in the effectiveness of compensation, and who believed in the economic value of wildlife, were more likely to contract to manage a slough on their irrigated cultivation for joint agriculture-wildlife purposes than to drain the slough.

Dryland Woodlot Scenario

The results of the estimation of the Dryland Woodlot choice restricted MNL model produced the significant relationships presented in Table 17.

Table 17: Dryland Woodlot Choice Restricted Results

	ariable	Choice over Choice	Coefficient	P > |t|
1	INC	No Change over Lease	1.251	.170

Note: * - Likert scale: 1=Strongly Disagree to 5=Strongly Agree.

The coefficient in Table 17 was estimated by the MNL analysis. The coefficient is multiplied by the value of explanatory variables (xß) for use in the Logit.

The p value in Table 17 estimates the probability that the coefficient (ß) is not different from zero. The existence of p values less than 0.10 suggest strong behavioral responses. The existence of p values more than 0.10 but less than 0.20 suggest weak behavioral responses. Relationships with p values over 0.20 were not reported.

Increased net income increased the probability of a respondent continuing without any change rather than leasing the dryland woodlot for habitat preservation.

Choice and Explanatory Variable Restricted Specification

The third specification tested was choice and explanatory variable restricted. The probability of the two most common choices were estimated with AGE and INC explanatory variables.

Dryland Slough Scenario

The results of the estimation of the Dryland Slough choice and explanatory variable restricted MNL model produced the significant relationships presented in Table 18.

Table 18: Dryland Slough Choice and Explanatory Variable Restricted Results

#	Variable	Choice over Choice	Coefficient	P > |t|
1	AGE	Lease over Contract	5.091	.003
2	INC	Lease over Contract	1.565	.089

Note: * - Likert scale: 1=Strongly Disagree to 5=Strongly Agree.

The coefficients in Table 18 were estimated by the MNL analysis. The coefficients are multiplied by the value of explanatory variables (xß) for use in the Logit.

The p values in Table 18 estimate the probability that the coefficients (ß) are not different from zero. The existence of p values less than 0.10 suggest strong behavioral responses. The existence of p values more than 0.10 but less than 0.20 suggest weak behavioral responses. Relationships with p values over 0.20 were not reported.

The probability of a respondent leasing the dryland slough for habitat preservation rather than contracting the slough for joint habitat preservation and agricultural uses increased with age.

High net income respondents were more likely to lease the dryland slough for habitat preservation rather than contracting the slough for joint habitat preservation and agricultural uses.

The above results indicate that respondents who were younger, and who had lower household net income, were more likely to contract to manage a slough on their dryland cultivation for joint agriculture-wildlife purposes than to lease the slough for wildlife management.

Irrigated Slough Scenario

The results of the estimation of the Irrigated Slough choice and explanatory variable restricted MNL model produced the significant relationship presented in Table 19.

Table 19: Irrigated Slough Choice and Explanatory Variable Restricted Results+

#	Variable	Choice over Choice	Coefficient	P > |t|
1	AGE	Contract over Drain	5.495	.150

Note: * - Likert scale: 1=Strongly Disagree to 5=Strongly Agree.

+ - No Significant Relationships to the 90% Level of Confidence.

The coefficient in Table 19 was estimated by the MNL analysis. The coefficient is multiplied by the value of explanatory variables (xß) for use in the Logit.

The p value in Table 19 estimates the probability that the coefficient (ß) is not different from zero. The existence of p values less than 0.10 suggest strong behavioral responses. The existence of p values more than 0.10 but less than 0.20 suggest weak behavioral responses. Relationships with p values over 0.20 were not reported.

Increased age increased the probability of a respondent contracting the irrigated slough for joint habitat preservation and agricultural uses rather than draining the slough.

Dryland Woodlot Scenario

The results of the estimation of the Dryland Woodlot choice and explanatory variable restricted MNL model produced the significant relationships presented in Table 20.

TABLE 20: Dryland Woodlot Choice and Explanatory Variable Restricted Results

#	Variable	Choice over Choice	Coefficient	P > |t|
1	Constant	Lease over No Change	1.489	.143
2	INC	No Change over Lease	1.449	.071

Note: * - Likert scale: 1=Strongly Disagree to 5=Strongly Agree.

The coefficient in Table 20 was estimated by the MNL analysis. The coefficient is multiplied by the value of explanatory variables (xß) for use in the Logit.

The p value in Table 20 estimates the probability that the coefficient (ß) is not different from zero. The existence of p values less than 0.10 suggest strong behavioral responses. The existence of p values more than 0.10 but less than 0.20 suggest weak behavioral responses. Relationships with p values over 0.20 were not reported.

Independent of all other factors in the model, respondents would rather lease the dryland woodlot for habitat preservation uses than continue without any change.

Increased net income increased the probability of a respondent continuing without any change rather than leasing the dryland woodlot for habitat preservation.

DISCUSSION

Potential land use conflicts were identified between sloughs and woodlots (wildlife land uses), and cultivation and irrigated pasture (agricultural land uses). These potential conflicts exist, as the presence of sloughs or woodlots exclude cultivation or adversely affect the ability to irrigate pasture. These are the land use conflicts that must be resolved in order to attain social welfare wildlife goals.

Certain landowner attributes affected the choice of land use options in the dryland slough scenario. Increased participation in the present landowner habitat program and increased net household income caused landowners not to choose the subdivide and sell option. Increased age caused landowners to choose the lease option. Increased belief in the ability of wildlife habitat land uses to control erosion caused landowners to choose the subdivide and sell option. Increased risk acceptance and increased belief in the economic value of wildlife caused landowners to choose the lease option.

The choice of land use options in the irrigated slough scenario were affected by the following land owner attributes. Increasing age and belief in the economic value of wildlife caused landowners not to choose the drain option. Increased net household income and belief in the effectiveness of compensation caused landowners to choose the drain option.

The following landowner attributes affected the choice of land use options in the dryland woodlot scenario. Independent of all other factors in the model, landowners did not want to choose the subdivide and donate option. Older landowners chose not to clear the woodlot. Increased belief in the ability of wildlife habitat to control erosion caused landowners to choose the subdivide and donate

option. The perception of a bright economic future and effectiveness of compensation caused landowners not to choose the subdivide and sell option. Landowners tended to choose the subdivide and sell option if they believed in the economic value of wildlife.

Based on the above analysis, older landowners who have lower household net incomes, who personally value wildlife, who believe wildlife habitat land uses control erosion, who believe in the economic value of wildlife, and who do not believe in the effectiveness of compensation, are most likely either to voluntarily preserve wildlife habitat or enrol in a wildlife habitat preservation program like the Landowner Habitat Project

Further analysis of these results may suggest adjustments to existing programs, or may suggest new programs that would be more effective in balancing private wildlife habitat rights and public wildlife rights. The new program options would be more effective, as landowner requirements would be more fully reflected in their design.

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Summary and Conclusions

A rights imbalance exists between privately owned wildlife habitat and publicly owned wildlife. In the pursuit of agricultural activities, landowners are altering wildlife habitat at the expense of wildlife carrying capacity. There currently exists no market in which society can express the public cost of decreasing wildlife populations to private landowners. The institutions of real property ownership and the wildlife are therefore not balanced.

The purpose of this study was to identify incentive compatible mechanisms by which society may cause private landowners to internalize the public value of wildlife. A total of 148 landowners were surveyed for this study. Socioeconomic, and wildlife attitude questions were asked in order to understand the landowners' motivations. Three scenarios were presented to the landowners where they were asked to select land use options that either preserved or enhanced wildlife habitat, or altered it for agricultural purposes. The land use options involving the preservation and enhancement of wildlife habitat represented incentive compatible mechanisms that may be used to correct the persistent rights imbalance.

A data set was constructed with responses to the current LHP survey, and a small subset of responses to the previous LHP survey. A multi-nomial logit analysis was completed in an attempt to explain the probability of landowners choosing specific land use options by their socioeconomic and wildlife attitude responses. The purpose of this analysis was to identify those factors that, when incorporated, would increase the efficiency of future wildlife habitat preservation programs.

The results suggested the existence of relationships between survey responses and the land use options chosen in three scenario sections. Factors affecting land use option selection included involvement in current preservation programs, landowner age, belief in the ability of wildlife habitat land uses to control erosion, net household income, economic future, personal value of wildlife, belief in the effectiveness of compensation, landowner risk acceptance, and belief in the economic value of wildlife. These revealed preferences are to be interpreted as indirect reflections of the respondents' utility functions. Through the study of these relationships, specific incentive compatible mechanisms can be developed which may provide the respondents with substitutes for agricultural land in their production functions.

Limitations

Two primary limitations of this research were identified. Landowner interviews were completed within one time frame and within three geographical regions of Alberta. The findings of this study will only remain valid for a period of time. Public attitudes, commodity and land prices, and other social and economic forces all affect the decision making process (parameters) of landowners. As these forces change over time, so may the response of landowners to wildlife habitat preservation programs. In order to remain valid over time, this study must be periodically repeated.

The application of the study findings to landowners outside the geographical study regions must be approached with caution. If landowners in other regions possess the same utility (parameters) as landowners in the three study regions, the findings may be applied. It is not clear that landowners in other regions will react the same to land use choices. In order to remain valid in other regions, landowners in the new regions must also be studied.

Program Implications

The success or failure of any program with the purpose of changing the actions of a target group is constrained by the behavioral responses of the individuals within that target group. In the present case, the purpose of the Landowner Habitat Project, and any permanent program that may grow from the project, is to encourage landowners to modify their present behaviour of altering wildlife habitat on their private lands. The incentives or regulations contained in such a program will be most successful if they are compatible with the behavioral responses of the landowners.

The above analysis indicated that landowners who did not consider habitat preservation a good erosion control mechanism, or who had high net incomes, or who did not personally value wildlife were most likely to alter and remove dryland slough wildlife habitat. This information allows public agencies to specifically target these groups. The dryland slough leasing and contracting options were picked with the highest frequency. Respondents who were older, or more risk accepting, or believed that wildlife increased farm market values tended to select the lease option. Respondents who believed in the effectiveness of compensation tended to select the contract option.

The marketing and promotion of preservation programs could highlight the advantages of habitat preservation with respect to erosion control. The financial incentives of the program must be marketed strongly to the high income landowners, as farming is their primary business in many cases and lifestyle concerns are less important. Respondents also felt strongly that it is the government's responsibility to compensate private landowners for their costs of maintaining wildlife habitat on their private lands. General promotion of wildlife value may increase landowners' awareness and acceptance of preservation programs. Specific attention must be taken to address the perception that wildlife is being protected at the private cost of rural landowners for the primary benefit of urban hunters and wildlife viewers. Compensation programs to offset the perception that wildlife depredation causes decreased farm market values must be either developed or promoted to encourage landowners to preserve habitat.

The analysis indicated that respondents who were younger, or who had higher net incomes, or who believed in the effectiveness of compensation in preserving wildlife habitat, or who did not believe that wildlife increased farm market values were most likely to alter and remove irrigated slough wildlife habitat. This information allows public agencies to specifically target these groups. The irrigated slough contracting and draining options were picked with the highest frequency. Respondents who were older, or who believed that wildlife increased farm market values tended to select the contract option. Respondents who had higher net incomes, or who believed in the effectiveness of compensation tended to select the drain option.

Although the age of landowners cannot be changed, more study of younger landowners may indicate what incentives will encourage this group to preserve wildlife habitat. The financial incentives of the program must be marketed strongly to the high income landowners, as farming is their primary business in many cases and lifestyle concerns are less important. General promotion of wildlife value may increase landowners' awareness and acceptance of preservation programs. The only other benefit requested by respondents was increased compensation. The two most common reasons given for draining irrigated sloughs were interference with irrigation, and use for crop production. These conflicts must be resolved in order to increase habitat preservation within irrigated regions.

The above analysis indicated that respondents who were younger, or who did not believe that wildlife habitat was a good mechanism for controlling erosion, or who did not believe that wildlife increased farm market values were most likely to alter and remove dryland woodlot wildlife habitat. This information allows public agencies to specifically target these groups. Continuing without change and

leasing dryland woodlot options were picked with the highest frequency. Respondents who had higher net incomes tended to select the continuing without change option.

Although the age of landowners cannot be changed, more study of younger landowners may indicate what incentives will encourage this group to preserve wildlife habitat. General promotion of wildlife value may increase landowners' awareness and acceptance of preservation programs. The marketing and promotion of preservation programs could highlight the advantages of habitat preservation with respect to erosion control. The three most common other benefits requested by respondents were increased compensation, access control to project lands, and shorter lease terms. The two most common reasons given for clearing dryland woodlots were use for crop production, and adverse financial effect. These conflicts must be resolved in order to increase habitat preservation within wooded regions.

Further research is required to monitor the development, promotion, and acceptance of an expanded Landowner Habitat Project. The development of the expanded program should reflect the requirements of targeted landowners. The promotion of the program should target those landowners who possess attributes that may increase their probability of enroling. An analysis of those landowners participating and not participating in the expanded program is required to confirm whether the landowner attributes identified in this study continue to successfully estimate the probability of program enrolment.

REFERENCES

Adamowicz, W. 1990. Pers. Comm. Unpublished Course Lecture. Edmonton, Alberta.

Adamowicz, Wiktor L.; T. W. Manning; and W. E. Phillips. 1985. Research Methodology and Property Rights. Unpublished.

Amemiya, T. 1981. "Qualitative Response Models: A Survey". in Journal of Economic Literature. Vol. XIX (December 1981), pp. 1483-1536.

Beattie, B. R., and C. R. Taylor. 1985. The Economics of Production. John Wiley & Sons. Toronto, Ontario.

Bromley, D. W. 1982. "Land and Water Problems: An Institutional Perspective." American Journal of Agricultural Economics. 64(December): 834-844.

Caws, Peter. 1969. The Structure of Discovery. Science. 166:
1375-80.

Ciriacy-Wantrup, S. V. 1968. Resource Conservation: Economics and Policies. University of California Press. Berkeley, California.

Cohen, Morris R. and Ernest Nagel. 1934. An Introduction to Logic and Scientific Method. Harcourt, Brace & World. New York, New York.

D.A. Westworth & Associates. 1990. An Evaluation of the Landowner Habitat Project. Alberta Fish and Wildlife Division, Habitat Branch. Edmonton, Alberta.

Deaton, A., and J. Muellbauer. 1980. Economics and Consumer Behaviour. Cambridge University Press. New York, New York.

Environment Council of Alberta, Renewable Resources Sub-Committee. 1989. A Place for Wildlife. ECA89-PA/CS-S12. Environment Council of Alberta. Edmonton, Alberta.

Ewaschuk, E., and D.A. Westworth & Associates. 1983. An Evaluation of the Red Deer County Habitat Retention on Private Land Program. Alberta Fish and Wildlife Division. Edmonton, Alberta.

Haney, T., E. Ewaschuk, W.E. Phillips, and W. Adamowicz. 1991. Retention and Development of Wildlife on Private Lands: An Annotated Bibliography. Staff Paper 91-04, Department of Rural Economy, University of Alberta, Edmonton, Alberta.

Haney, T., W.E. Phillips, and W. Adamowicz. 1991. Wildlife Habitat on Private Lands: An Analysis of Land Use Trade-Offs. Unpublished Masters Thesis, Department of Rural Economy, University of Alberta, Edmonton, Alberta.

Haney, T., W.E. Phillips, and W. Adamowicz. 1991. Wildlife Habitat Preservation Programs on Private Lands: A Selected Survey of Provicnes, States, and Territories of Canada and the United States. Project Report 91-02, Department of Rural Economy, University of Alberta, Edmonton, Alberta.

Judge, G. G., R. C. Hill, W. E. Griffiths, H. Lutkepohl, and T-C Lee. 1988. Introduction to the Theory and Practice of Econometrics. Second Edition. John Wiley & Sons. Toronto, Ontario.

Kennedy, P. 1985. A Guide to Econometrics. Second Edition. The MIT Press. Cambridge, Mass.

Maddala, G. S. 1983. Limited Dependent and Qualitative Variables in Econometrics. Cambridge University Press. New York, New York.

Manning, Travis W. 1988. "Methods in Economics". In Canadian Journal of Agricultural Economics. 36(1988): 775-787.

Russel, R. R., and M. Wilkinson. 1979. Microeconomics: A Synthesis of Modern and Neoclassical Theory. John Wiley & Sons. Toronto, Ontario.

APPENDIX I.
SURVEY LETTER, QUESTIONNAIRE, AND SUPPLEMENTAL QUESTIONNAIRE

WILDLIFE HABITAT PRESERVATION ON PRIVATE LANDS

Dear Landowner:

Your participation in the Landowner Habitat Project study of 1988/89 was greatly appreciated. We would like to present you, at the end of this interview, with a summary of that study and also with statistics from Alberta Fish and Wildlife Division regarding current LHP enrolment.

The Department of Rural Economy of the University of Alberta, in conjunction with Alberta Fish and Wildlife Division, The Recreation Parks and Wildlife Foundation, and Wildlife Habitat Canada, is studying alternate wildlife habitat preservation programs. The present survey is being administered to participants of the recent project completed by D.A. Westworth and Associates project in which the Landowner Habitat Project was reviewed. The Westworth study answered many questions, but also posed new questions. The process by which farmers decide to preserve or alter habitat, and the acceptability of various program alternatives are among those questions.

The questions which follow are not limited solely to the Landowner Habitat Project, but are concerned with all wildlife habitat on privately owned lands in Alberta. This survey will only take about 25 minutes to complete. The purpose of this survey is to better understand the decision making process used by landowners when preserving or alter wildlife habitat on their own land. This knowledge will be used to design wildlife habitat program alternatives within the LHP framework.

We would like to again request your cooperation in participating in the following questionnaire. To ensure that your individual responses to the questions will be held in strict confidence, they will be combined with those of other interview participants.

Thank you for your participation.

WILDLIFE HABITAT PRESERVATION ON PRIVATE LANDS CODE:

(NOTE TO INTERVIEWER: USE NUMERIC CODE 99 FOR NO RESPONSE)

I. WILDLIFE KNOWLEDGE/ATTITUDES

On a scale of: 1 Strongly Agree; 2 Agree; 3 Neutral; 4 Disagree; 5 Strongly Disagree (circle appropriate answer), please rate the following five statements.

1. Farmers must consider wildlife when seeking to maximize profits. 1 2 3 4 5

2. Receiving a non-monetary award for outstanding wildlife habitat preservation is worth a great deal and can compensate for lower profits. 1 2 3 4 5

3. Maximizing profits is more important than insuring wildlife populations for generations yet to come. 1 2 3 4 5

4. My economic future on this present farm is bright. 1 2 3 4 5

5. Farming is just like any other business. 1 2 3 4 5

Please answer the following questions as indicated (circle appropriate answer).

6. PLEASE CONSIDER THE FOLLOWING HYPOTHETICAL SITUATION:

Suppose that you have $50,000.00 available for investment purposes, and that you could purchase a 1 year guaranteed investment certificate and it would earn 10% interest. Would you instead invest it in a specific 1 year farm venture if in 7 chances in 10 you would recover your investment plus 15% and in 3 chances in 10 you would only recover your original investment.

_____ YES _____ NO

7. DRYLAND SLOUGH AREA:

This section of the questionnaire is part of an experiment designed to provide an indication of program acceptability. The details which follow relate to a hypothetical situation to give you a reference point for your answers, and DO NOT reflect any specific plans on behalf of the Government.

Suppose You own a particular 160 acre field with average soil quality. Area average yields are produced on 150 acres of dryland cultivation. There is a 10 acre semi-permanent slough area in one corner (see map). This slough area can be seeded and harvested 1 year out of 4. The slough area is wet and can not be farmed 3 years out of 4. The presence of the slough alters the field's cultivation pattern on wet years. It is possible to drain the slough area by mechanically contouring the land. If drained, this slough would be converted into dryland cultivation of similar quality to the rest of the field. On wet years, this slough supports migratory bird (ie. ducks) and upland (ie. pheasant) bird nesting and cover. In order to provide high quality habitat, 30 acres of dryland cultivation surrounding the 10 acre slough would have to be seeded to dense nesting cover (hay or grass). This would produce a 40 acre parcel of high quality wildlife habitat.

Given the background information and the following options, which would you choose?

A. Subdivide and sell in fee simple the 40 acre parcel, for 100% of appraised market value, for habitat preservation (if chosen go to A-1), or;

B. Subdivide and donate in fee simple the 40 acre parcel, in exchange for a 100% of land value income tax exemption, for habitat preservation (if chosen go to B-1), or;

C. Lease out the 30 acres of dryland cultivation for 80% of local cash rental rates, and receive compensation for 80% of expected decreased net profit in return for not farming the 10 acre slough during the 1 dry year in 4 (if chosen go to C-1), or;

D. Seed the 30 acres of dryland cultivation to hay, and sign a five year contract to receive compensation for 80% of expected decreased net profit in return for agreeing not to undertake any farming practices within the 40 acre parcel before July 15 each year (if chosen go to D-1), or;

E. Drain the slough (if chosen go to E-1), or;

F. Continue without any changes (if chosen go to F-1).

A-1. Would you rather sell the slough to:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Duck's Unlimited)?
_ No preference

A-2. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Duck's Unlimited)?

A-3. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 8)

B-1. Would you rather donate the slough to:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Duck's Unlimited)?
_ No preference

B-2. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Duck's Unlimited)?

B-3. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 8)

C-1. Would you rather lease the slough to:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Duck's Unlimited)?
_ No preference

C-2. Would you rather lease the slough:
_ For 10 years with no grantee of renewal, or
_ For 20 years with no grantee of renewal, or
_ In perpetuity with a caveat being registered on the title that would remain if the land was sold.

C-3. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Duck's Unlimited)?

C-4. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 8)

D-1. Would you rather sign the contract with:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Duck's Unlimited)?
_ No preference

D-2. Would you rather receive compensation:
_ In annual cash payments, or
_ In annual Provincial Income Tax rebates, or
_ In a one-time up-front cash payment equal to the present value of expected future payments?

D-3. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Duck's Unlimited)?

D-4. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 8)

E-1. What are your reasons for choosing this option rather than any of the others?

Would an increase in compensation levels change your mind? (Proceed to Question 8)

F-1. What are your reasons for choosing this option rather than any of the others?

Would an increase in compensation levels change your mind? (Proceed to Question 8)

8. IRRIGATED SLOUGH AREA:

This section of the questionnaire is part of an experiment designed to provide an indication of program acceptability. The details which follow relate to a hypothetical situation to give you a reference point for your answers, and DO NOT reflect any specific plans on behalf of the Government.

Suppose You own a particular 160 acre field with average soil quality. Area average yields are produced on 150 acres of irrigated cultivation. The field is irrigated with a side-roll wheel move system. There is a 10 acre semi-permanent slough area in one corner (see map), which is not the irrigation water source. This slough area can be seeded and harvested 1 year out of 4. The slough area is wet and can not be farmed 3 years out of 4. The presence of the slough alters the field's cultivation pattern on wet years. It is possible to drain the slough area by mechanically contouring the land. If drained, this slough would be converted into irrigated cultivation of similar quality to the rest of the field. On wet years, this slough supports migratory bird (ie. ducks) and upland (ie. pheasant) bird nesting and cover. In order to provide high quality habitat, 30 acres of irrigated cultivation surrounding the 10 acre slough would have to be seeded to dense nesting cover (hay or grass), and would not have to be irrigated. This would produce a 40 acre parcel of high quality wildlife habitat.

Given the background information and the following options, which would you choose?

A. Subdivide and sell in fee simple the 40 acre parcel, for 100% of appraised market value, for habitat preservation (if chosen go to A-1), or;

B. Subdivide and donate in fee simple the 40 acre parcel, in exchange for a 100% of land value income tax exemption, for habitat preservation (if chosen go to B-1), or;

C. Lease out the 30 acres of irrigated cultivation for 80% of local cash rental rates, and receive compensation for 80% of expected decreased net profit in return for not farming the 10 acre slough during the 1 dry year in 4 (if chosen go to C-1), or;

D. Seed the 30 acres of irrigated cultivation to hay, and sign a five year contract to receive compensation for 80% of expected decreased net profit in return for agreeing not to undertake any farming practices within the 40 acre parcel before July 15 each year (if chosen go to D-1), or;

E. Drain the slough (if chosen go to E-1), or;

F. Continue without any changes (if chosen go to F-1).

A-1. Would you rather sell the slough to:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Duck's Unlimited)?
_ No preference

A-2. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Duck's Unlimited)?

A-3. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 9)

B-1. Would you rather donate the slough to:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Duck's Unlimited)?
_ No preference

B-2. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Duck's Unlimited)?

B-3. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 9)

C-1. Would you rather lease the slough to:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Duck's Unlimited)?
_ No preference

C-2. Would you rather lease the slough:
_ For 10 years with no grantee of renewal, or
_ For 20 years with no grantee of renewal, or
_ In perpetuity with a caveat being registered on the title that would remain if the land was sold.

C-3. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Duck's Unlimited)?

C-4. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 9)

D-1. Would you rather sign the contract with:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Duck's Unlimited)?
_ No preference

D-2. Would you rather receive compensation:
_ In annual cash payments, or
_ In annual Provincial Income Tax rebates, or
_ In a one-time up-front cash payment equal to the present value of expected future payments?

D-3. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Duck's Unlimited)?

D-4. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 9)

E-1. What are your reasons for choosing this option rather than any of the others?

Would an increase in compensation levels change your mind? (Proceed to Question 9)

F-1. What are your reasons for choosing this option rather than any of the others?

Would an increase in compensation levels change your mind? (Proceed to Question 9)

9. DRYLAND WOODLOT AREA:

This section of the questionnaire is part of an experiment designed to provide an indication of program acceptability. The details which follow relate to a hypothetical situation to give you a reference point for your answers, and DO NOT reflect any specific plans on behalf of the Government.

Suppose You own a particular 160 acre field with average soil quality. Area average yields are produced on 120 acres of dryland cultivation. There is a 40 acre woodlot in one corner (see map). This woodlot is of no commercial logging value. It is possible to clear the woodlot. If cleared, this woodlot would be converted into dryland cultivation of similar quality to the rest of the field. This woodlot supports bird nesting cover and permanent deer shelter.

Given the background information and the following options, which would you choose?

A. Subdivide and sell the woodlot, for 100% of appraised market value, for habitat preservation (if chosen go to A-1), or;

B. Subdivide and donate in fee simple the woodlot, in exchange for a 100% of land value income tax exemption, for habitat preservation (if chosen go to B-1), or;

C. Lease the woodlot for 80% of local cash rental rates for similar woodlots (ie. grazing rates), for habitat preservation (if chosen go to C-1), or;

D. Clear the woodlot (if chosen go to D-1), or;

E. Continue without any changes (if chosen go to E-1).

A-1. Would you rather sell the woodlot to:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Nature Conservancy)?
_ No preference

A-2. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Nature Conservancy)?

A-3. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 10)

B-1. Would you rather donate the woodlot to:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Nature Conservancy)?
_ No preference

B-2. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Nature Conservancy)?

B-3. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 10)

C-1. Would you rather lease the woodlot to:
_ The Government (ie. Fish and Wildlife Division),or to
_ A private Wildlife Habitat organization (ie. Nature Conservancy)?
_ No preference

C-2. Would you rather lease the woodlot:
_ For 10 years with no grantee of renewal, or
_ For 20 years with no grantee of renewal, or
_ In perpetuity with a caveat being registered on the title that would remain if the land was sold.

C-3. Would you prefer to either:
_ Receive no other benefits, or
_ Be given public recognition by having your land posted, or
_ Be given free lifetime hunting/fishing licenses, or
_ Be given an honourary lifetime membership in a private conservation organisation (ie. Nature Conservancy)?

C-4. Are there any other benefits that would make this option more attractive to you (specify)?

(Proceed to Question 10)

D-1. What are your reasons for choosing this option rather than any of the others?

Would an increase in compensation levels change your mind?
(Proceed to Question 10)

E-1. What are your reasons for choosing this option rather than any of the others?

Would an increase in compensation levels change your mind?
(Proceed to Question 10)

Please answer the following questions as indicated

10. Suppose you were originally satisfied with a particular lease compensation level with no other benefits, for each of the following INDIVIDUAL options would you require more, less, or the same compensation:

A. If You were publicly presented with a Certificate of Recognition: _____

B. If You were given free lifetime hunting/fishing licenses: _____

C. If You were given a lifetime membership in a conservation organisation: _____

D. If Your land was publicly posted with Project signs: _____

On a scale of: 1 Strongly Agree; 2 Agree; 3 Neutral; 4 Disagree; 5 Strongly Disagree (circle appropriate answer), please rate the following nine statements.

11. Farmers have a responsibility toward all those now living to maintain wildlife habitat so as to protect wildlife populations. 1 2 3 4 5

12. Farmers have a responsibility toward future generations to maintain wildlife habitat so as to protect wildlife populations. 1 2 3 4 5

13. The government has the responsibility to enforce wildlife habitat preservation on private lands in Alberta. 1 2 3 4 5

14. The government has the responsibility to compensate farmers for their costs of maintaining wildlife habitat on their farms. 1 2 3 4 5

15. Farmers, in general, value wildlife habitat on their farms. 1 2 3 4 5

16. I value wildlife habitat on my farm. 1 2 3 4 5

17. Increased wildlife populations on a farm increases its market value. 1 2 3 4 5

18. I will alter less habitat in the future if I am compensated to maintain it. 1 2 3 4 5

19. My neighbours will alter less habitat in the future if they are compensated to maintain it. 1 2 3 4 5

II. Land Use Compatibility

This section of the questionnaire is part of an experiment designed to provide an indication of land use compatibility. In each of the following three questions, four separate agricultural land uses are compared with five separate wildlife habitat land uses. You are asked to rate the level of compatibility between land uses.

20. Please rate the following land use interactions for agricultural profitability on a scale of:

1 Strongly Compatible; 2 Compatible; 3 Neutral; 4 Competitive; 5 Strongly Competitive

INTERACTION MATRIX	SHELTER BELTS	MAINTAIN DITCH/ FENCE COVER	GRASSED WATERWAYS	MAINTAIN SLOUGHS/ GRASSED UPLANDS	MAINTAIN WOODLOTS
DRYLAND CULT.					
IRRIGATED CULT.					
DRYLAND PASTURE			XXXXXXXXX		
IRRIGATED PASTURE			XXXXXXXXX		

21. Please rate the following land use interactions for wildlife preservation and production on a scale of:

1 Strongly Compatible; 2 Compatible; 3 Neutral; 4 Competitive; 5 Strongly Competitive

INTERACTION MATRIX	SHELTER BELTS	MAINTAIN DITCH/ FENCE COVER	GRASSED WATERWAYS	MAINTAIN SLOUGHS/ GRASSED UPLANDS	MAINTAIN WOODLOTS
DRYLAND CULT.					
IRRIGATED CULT.					
DRYLAND PASTURE			XXXXXXXXX		
IRRIGATED PASTURE			XXXXXXXXX		

22. Please rate the following land use interactions for control of water and/or wind erosion on a scale of:

1 Strongly Compatible; 2 Compatible; 3 Neutral; 4 Competitive; 5 Strongly Competitive

INTERACTION MATRIX	SHELTER BELTS	MAINTAIN DITCH/ FENCE COVER	GRASSED WATERWAYS	MAINTAIN SLOUGHS/ GRASSED UPLANDS	MAINTAIN WOODLOTS
DRYLAND CULT.					
IRRIGATED CULT.					
DRYLAND PASTURE			XXXXXXXXX		
IRRIGATED PASTURE			XXXXXXXXX		

(NOTE TO INTERVIEWER: PRESENT LHP SUMMARY TO LANDOWNER NOW)

III. FARMING OPERATIONS/PRACTICES

23. Which of the following is the primary operation on your farm? (circle appropriate response)

a) grain
b) cattle
c) hogs
d) poultry
e) dairy
f) forage
g) other (specify)

24. If your landbase changed since the last survey, please specify which changes occurred.

LAND TYPE		ACRES OWNED	ACRES LEASED	RENTAL/LEASE RATE ($/ACRE)
Cultivated:	dry			
	irrig			
Hay:	dry			
	irrig			
Pasture:	dry			
	irrig			
Range:	dry			
	irrig			
Summerfallow:	dry			
	irrig			
Sloughs/Ponds:				
Woodlots:				
Idle Grassland:				
Other(specify):				

25. Which category best represents your net household (farm and non-farm) income (please circle appropriate category):

a. under $10,000
b. $10,000 - $19,999
c. $20,000 - $29,999
d. $30,000 - $39,999
e. $40,000 - $49,999
f. $50,000 - $59,999
g. $60,000 - $69,999
h. $70,000 - $79,999
i. $80,000 - $89,999
j. $90,000 - $99,999
k. $100,000 and over

Please answer the following questions in point form.

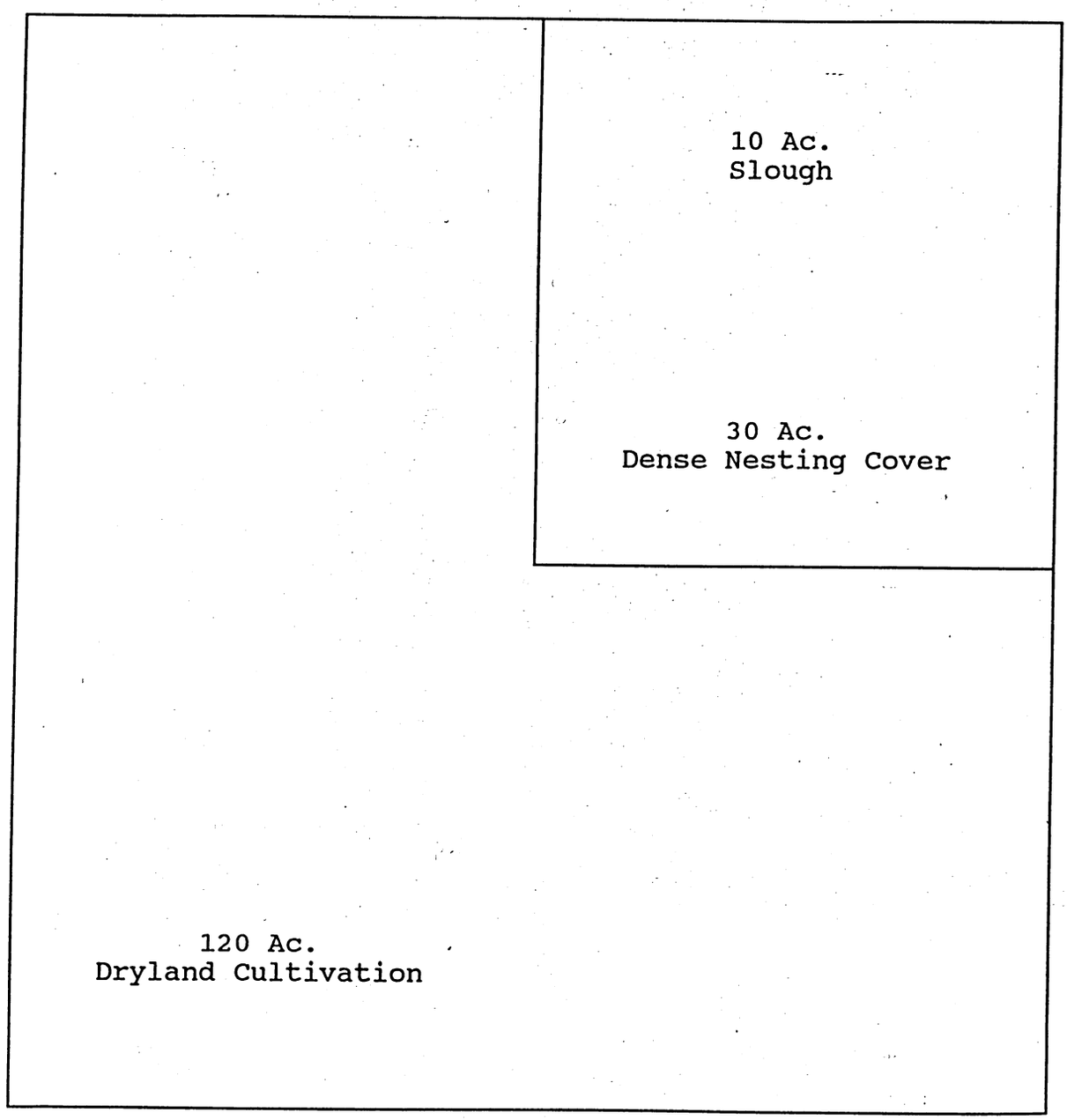
26. How would you decide whether or not to participate in a Government Habitat Retention Program?

27. Do you think it's important to maintain wildlife habitat?

Why?

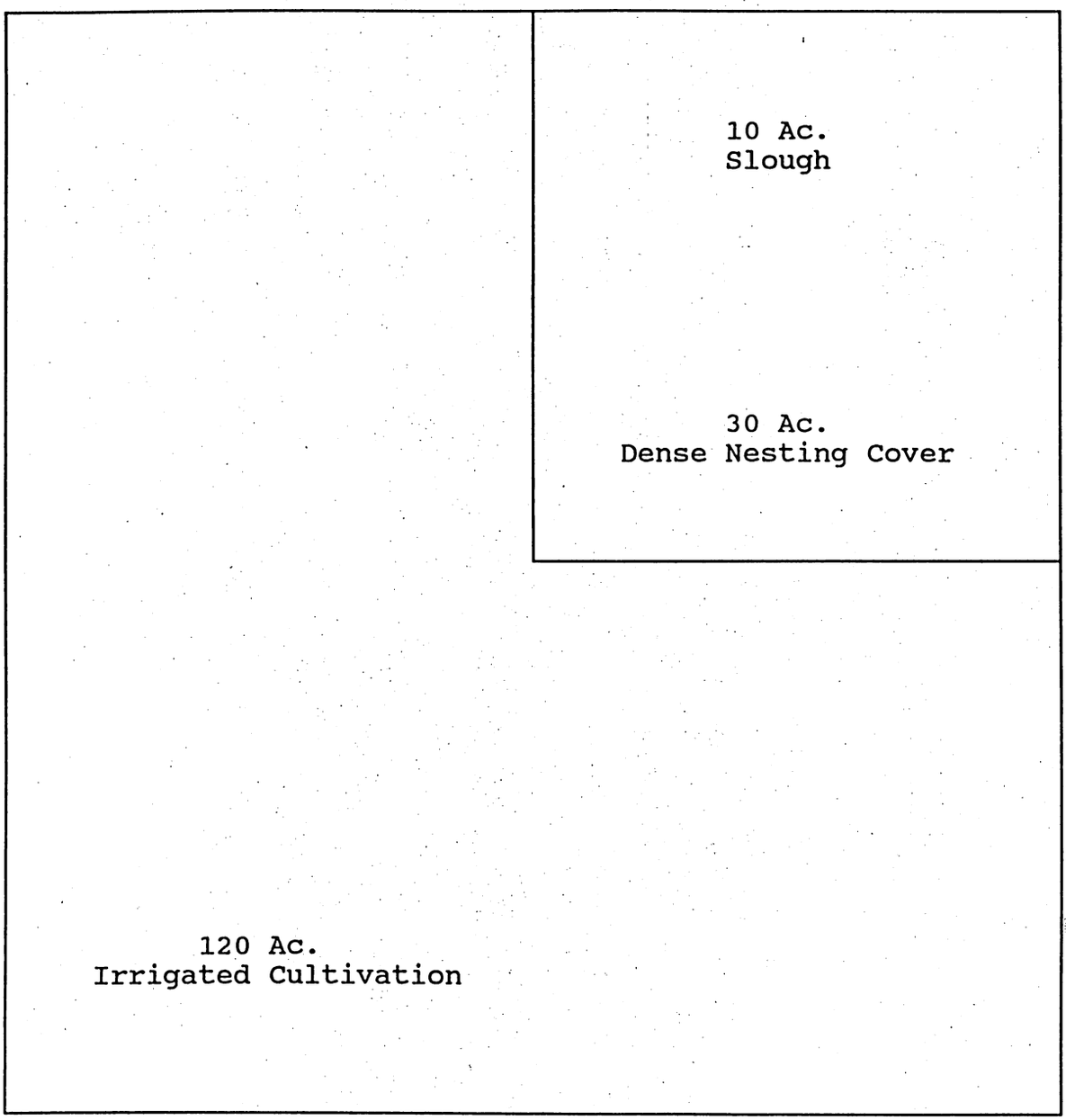
28. Do you have any further comments?

7. DRYLAND SLOUGH AREA MAP



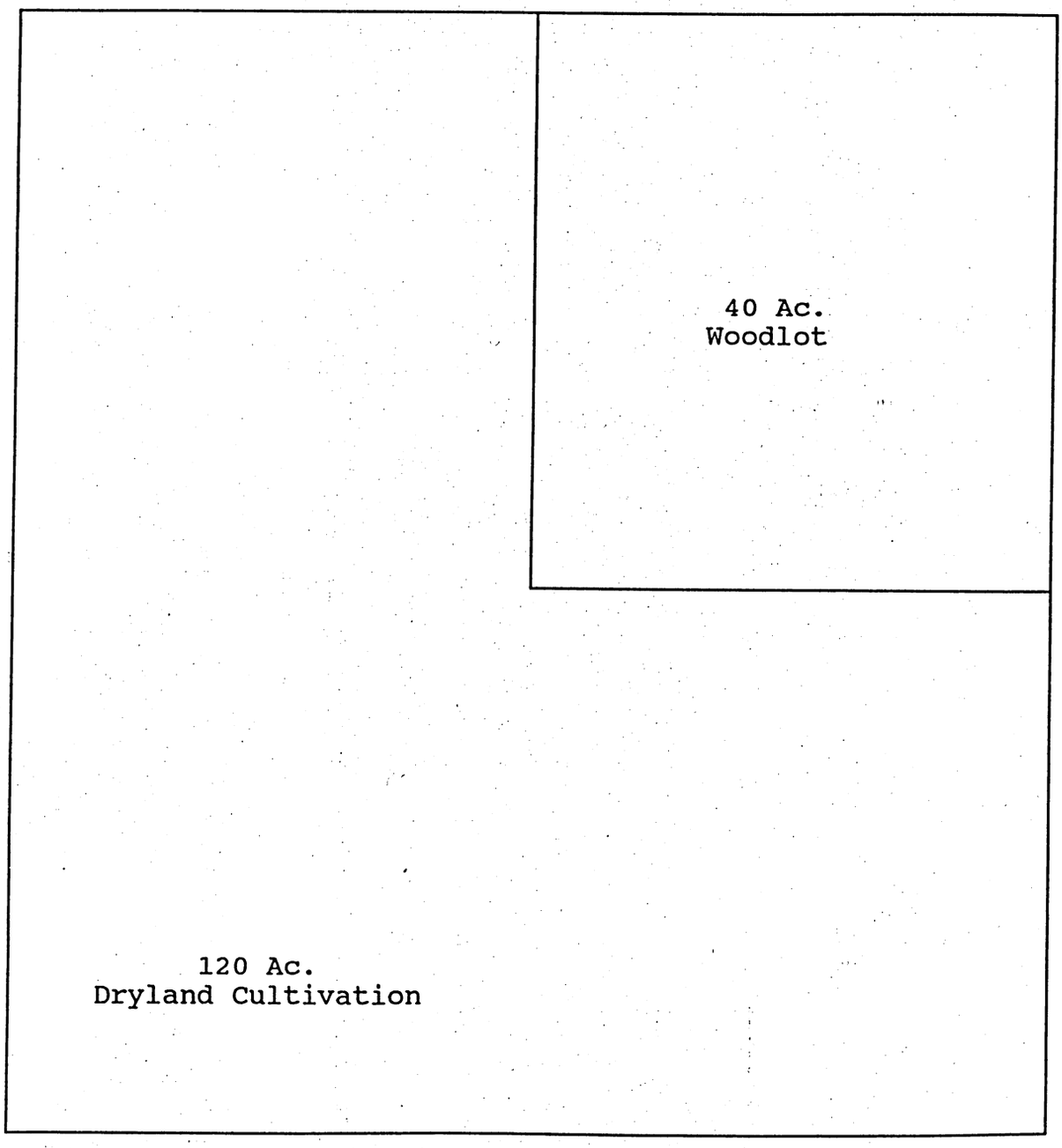
160 ACRE TOTAL FIELD SIZE

8. IRRIGATED SLOUGH AREA MAP



160 ACRE TOTAL FIELD SIZE

9. WOODLOT AREA MAP



160 ACRE TOTAL FIELD SIZE

WILDLIFE HABITAT PRESERVATION ON PRIVATE ALBERTA LANDS
SUPPLEMENTAL TELEPHONE INTERVIEW

NAME: CODE:
STATUS:
REGION:

1. AS OF DECEMBER 31, 1988, HOW MANY ACRES OF YOUR FARM WERE:

LAND TYPE		ACRES OWNED	ACRES LEASED	RENTAL/LEASE RATE ($/ACRE)
Cultivated:	dry			
	irrig			
Hay:	dry			
	irrig			
Pasture:	dry			
	irrig			
Range:	dry			
	irrig			
Summerfallow:	dry			
	irrig			
Sloughs/Ponds:				
Woodlots:				
Idle Grassland:				
Other(specify):				

2. AGE OF LANDOWNER: _____ YEARS

3. EDUCATION: _____ YEARS
HIGHEST LEVEL ATTAINED: _____

4. NUMBER IN HOUSEHOLD (INCL. SELF):
OVER 18 YEARS: _____
UNDER 18 YEARS: _____

5. DATE OF LHP ENROLMENT: _____ = _____ MOS.

6. ACRES IN LHP: _____ ACRES

APPENDIX II.
PREVIOUS LHP SURVEY RESULTS

The following material is a summary taken directly from the unpublished report by D. A. Westworth and Associates (1990), and was provided to all survey participants of the current LHP study with the permission of the authors.

In 1986, the Alberta Fish and Wildlife Division initiated a three year pilot project designed to encourage habitat retention practices among landowners in agricultural areas of the province. The Landowner Habitat Project (LHP), through various incentive mechanisms, promotes land use practices that benefit both the landowner and the wildlife resource the land supports. A study was initiated in 1988 to evaluate the effectiveness of the project in achieving its goals, to assess various funding scenarios, and to identify requirements for province-wide expansion.

The study was conducted in three areas of the province and included the Counties of Minburn and Red Deer and the Eastern and Bow River Irrigation Districts. Of the 95 landowners participating in the LHP, 93% (88) were interviewed using a detailed questionnaire designed to assess landowners' general wildlife knowledge and attitudes towards wildlife habitat, farming operations, demographic characteristics, and perceptions of the LHP. In addition to the participant interviews, a total random sample of 82 non-participating landowners was also made in the study regions.

Demographic comparisons of landowner status and study regions indicated that the majority of landowners interviewed had spent a large proportion of their life on the farm. Participants in the LHP tended to attain a higher education level, and reported higher income levels that non-participants. The majority of the landowners in each of the three study regions were engaged in mixed farming operations. Average farm sizes ranged from 261 ha to 541 ha.

When asked about changes to their landbase, only 13% of the participants interviewed indicated that some changes had occurred over the past 10 years. By comparison, 23% of non-participants had drained or backsloped their lands. Land-clearing (brushing, woodlot removal) accounted for 65% of the land base changes for participants and 85% for non-participants.

The majority of the landowners interviewed valued the presence of wildlife on their land and were aware of the importance of various types of habitat to wildlife. When queried about the condition of wildlife on their land, 44% of the participants rated it as excellent, 51% rated it as good, and just 3% of

the participants rated it as poor. Non-participants, however, tended to rate lower the condition of wildlife habitats on their lands. The majority of both participants and non-participants gave much lower ratings when asked what they thought the condition of wildlife habitat was on areas around their lands. The perception by both participants and non-participants that the condition of wildlife habitat is much better on their lands than on lands owned by others is significant in that it may influence their tendency to manage their land in ways that are beneficial to wildlife or their willingness to become involved in habitat preservation programs.
Almost two-thirds of the landowners (participants and non-participants) felt that the amount of wildlife habitat available on their land was stable. Again the majority of landowners interviewed saw the situation as being much less favourable on neighbouring lands. Recent exposure to crop depredation by wildlife did not appear to be a significant factor in the landowners' attitudes toward wildlife or to their willingness to become involved in the LHP.

A majority of participants interviewed indicated that they were very satisfied or satisfied with the LHP. In addition, financial incentives offered by the LHP were considered adequate by most of the participants. However, participants tended to consider incentives offered and soil and water quality/conservation concerns significantly less important than non-participants. By comparison, wildlife-related concerns of issues are significantly more important to participants than to non-participants.

The report includes a discussion on issues and concerns that will ultimately influence the success of the LHP in Alberta. Non-participants indicated that incentives offered, soil quality/conservation concerns, and water quality/conservation concerns are LHP features that may influence program participation, significantly more than participants did. Participants indicated that personal interest in wildlife and wildlife habitat, habitat recognition/promotion (awards, signs), increase families awareness for wildlife, and increase families awareness of wildlife habitat are LHP features that may influence program participation, significantly more than non-participants did. Those surveyed in the County of Minburn (participants and non-participants) indicated that soil quality/conservation concerns are LHP features that may influence program participation, significantly more than those surveyed in other areas did.

Participation in the LHP reached the following levels during the past 2 years.

1989

LOCATION	AGREEMENTS	ACRES
Irrigation Districts	26	1,690
Red Deer	62	10,823
Minburn	35	5,918
Total	123	18,431

1990

LOCATION	AGREEMENTS	ACRES
Irrigation Districts	58	5,062
Red Deer	126	18,926
Minburn	89	14,770
Total	273	38,758

Overall the LHP appears to be a cost-effective method of retaining wildlife habitat in Alberta. The project itself was widely accepted by participants and non-participants interviewed during the study and it is likely to receive widespread support once the project is expanded throughout the province. However, agricultural programs and other economic, political, and social forces promoting the intensification of farming activities in existing agricultural areas and the expansion of agriculture into northern regions may offset any potential gains and benefits the LHP may have for wildlife habitat. To some extent, this has already happened in the White Area of the province where the population goals established by Fish and Wildlife Division for the white-tailed deer are being reduce considerably. A province-wide expansion of the LHP will also require a considerable amount of funding and to this end, a number of funding alternatives are identified and evaluated.

Table 33
Forecast Selective Investment Strategy And MSE
Feeder Cattle Or T-Bills
Without Hedging And Without NTSP

Year	Net Revenue Mean Per Lot Dec. 1989 $	Net Returns Mean % Annual	MSE Net Returns
1980-89[1]	3362.61	9.20	743.8
1980-Mar86	3979.37	11.40	1192.8
Apr1986-89	2334.68	5.53	5.5

1. The MSE for the cattle investment which occurs 44 times is 2058.3 with an actual real rate of return of 11.2%. Other selective investment strategies have very similar patterns and numbers of cattle investment.

Table 34
Forecast Selective Investment Strategy And MSE
Feeder Cattle Or T-Bills
Without Hedging And With NTSP

Year	Net Revenue Mean Per Lot Dec. 1989 $	Net Returns Mean Per Lot % Annual	MSE Net Returns
1980-89	3405.75	9.44	770.1
1980-Mar86	3979.37	11.40	1192.8
Apr1986-89	2449.71	6.16	76.8

Table 35
Forecast Selective Investment Strategy And MSE
Feeder Cattle Or T-Bills
With Hedging And Without NTSP

Year	Net Revenue Mean Per Lot Dec. 1989 $	Net Returns Mean Real % Annual	MSE Net Returns
1980-89	2396.20	8.89	165.5
1980-Mar86	3048.38	10.95	239.9
Apr1986-89	1309.22	5.46	44.2

Table 36
Forecast Selective Investment Strategy And MSE
Feeder Cattle Or T-Bills
With Hedging And With NTSP

Year	Net Revenue Mean Per Lot Dec. 1989 $	Net Returns Mean Real % Annual	MSE Net Returns
1980-89	2448.52	9.11	179.2
1980-Mar86	3048.38	10.95	239.9
Apr1986-89	1448.76	6.05	81.1

The net returns for the selective investment in feeder cattle or T-Bills are greater than for any other strategy. The standard deviation of these net returns are lower than for the other comparable investment strategies. The selective strategies in general increase mean income over the base simulation with 100% hedging and with NTSP.

TABLE. III-4: Non-Monetary Award Valuable		
Rank	FREQUENCY	VALID PERCENT
Strongly Agree	15	10.1%
Agree	51	34.5%
Neutral	39	26.4%
Disagree	33	22.3%
Strongly Disagree	10	6.8%

Note: Results of this frequency table relate to question 2 of the survey questionnaire in Appendix I.

TABLE. III-5: Maximizing Profit More Important		
Rank	FREQUENCY	VALID PERCENT
Strongly Agree	7	4.8%
Agree	22	15.0%
Neutral	20	13.6%
Disagree	65	44.2%
Strongly Disagree	33	22.4%

Note: Results of this frequency table relate to question 3 of the survey questionnaire in Appendix I.

TABLE. III-6: Economic Future Bright		
Rank	FREQUENCY	VALID PERCENT
Strongly Agree	13	9.2%
Agree	54	38.0%
Neutral	28	19.7%
Disagree	33	23.2%
Strongly Disagree	14	9.9%

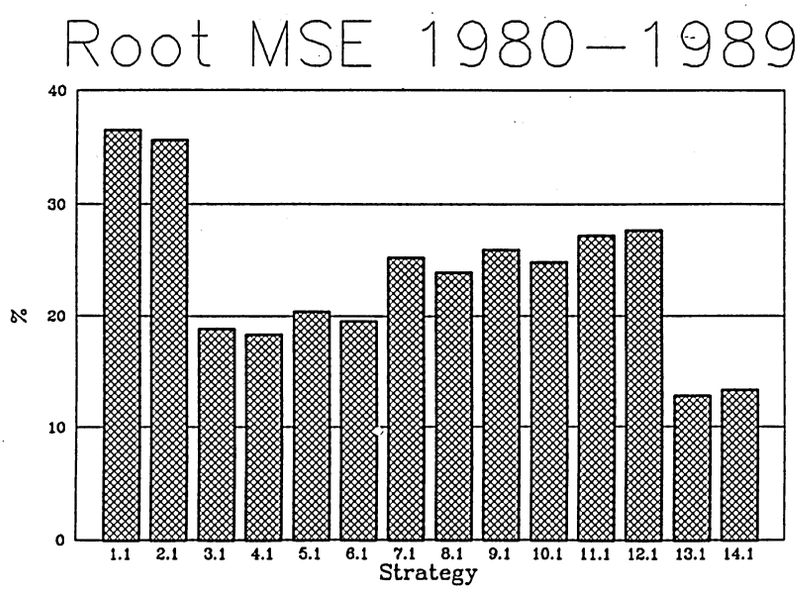
Note: Results of this frequency table relate to question 4 of the survey questionnaire in Appendix I.

Table 37
Root Mean Square Error Of Cattle Investment Strategies

Time Period & Strategies	No Hedging No NTSP	No Hedging With NTSP	Hedging No NTSP	Hedging With NTSP
100% Hedge				
1980-89	36.55	35.66	18.88	18.41
80-Mar86	39.53	39.53	18.59	18.59
Apr86-89	31.37	28.47	19.56	18.32
Optimal Hedge				
1980-89			20.44	19.60
80-Mar86			20.58	20.58
Apr86-89			20.44	18.07
Selective Hedge 5%				
1980-89			25.33	24.00
80-Mar86			23.20	23.20
Apr86-89			28.80	25.53
Selective HedgeT-Bill				
1980-89			26.00	24.90
80-Mar86			24.56	24.56
Apr86-89			28.51	25.73
Selective Investment				
1980-89[1]	27.27	27.75	12.86	13.39
80-Mar86	34.54	34.54	15.49	15.49
Apr86-89	2.35	8.76	6.65	9.01

1. The root MSE for the cattle investment only, (44 feeding periods) with no NTSP and no hedging is 45.4. Other scenarios in this selective investment strategy have very similar cattle feeding investments.

Figure 8



Strategy Legend
1. Base Model - No Hedging, No NTSP.
2. Base Model - No Hedging, With NTSP.
3. 100% Hedging, No NTSP.
4. 100% Hedging, With NTSP.
5. Optimal Hedging, NO NTSP.
6. Optimal Hedging, With NTSP.
7. 5% Selective Hedge, No NTSP.
8. 5% Selective Hedge, With NTSP.
9. T-Bill Selective Hedge, No NTSP.
10. T-Bill Selective Hedge, With NTSP.
11. Selective Investment - Steers or T-Bills, No NTSP.
12. Selective Investment - Steers or T-Bills, With NTSP.
13. Selective Investment - Steers or T-Bills, With Hedging, No NTSP.
14. Selective Investment - Steers or T-Bills, With Hedging, With NTSP.

The decimals represent time period.
.1 = 1980 to 1989.
.2 = 1980 to March 1986 (NO NTSP).
.3 = April 1986 to 1989 (NTSP Available).

Figure 9

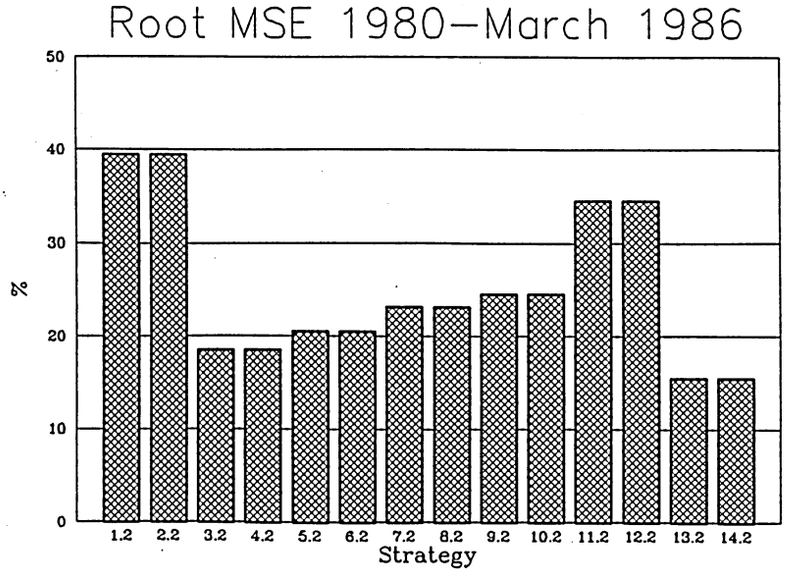
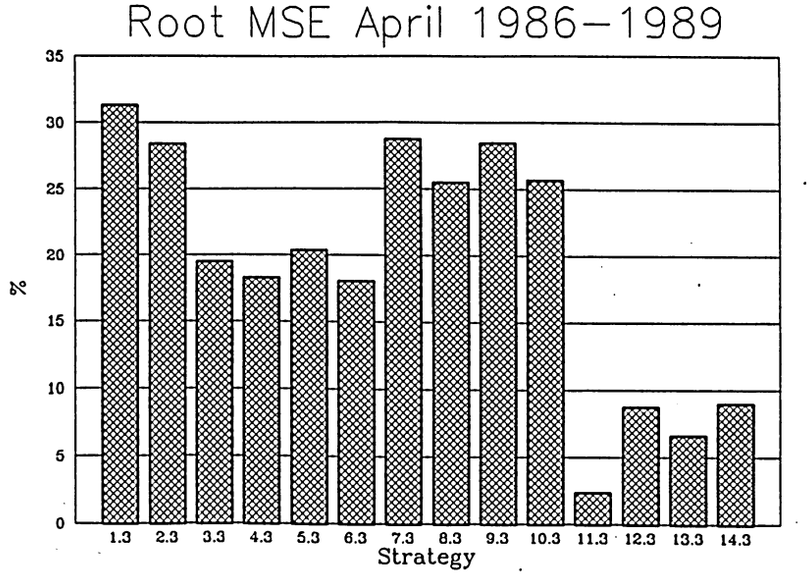


Figure 10



The no hedging with NTSP, strategy 2, for April 1986 to 1989 in Figure 10 reduces risk slightly over the base model of no hedging and no NTSP, strategy 1. The optimal hedge strategies 5 and 6 in Figure 8 reduce risk almost as much as the 100% hedge strategies 3 and 4. The selective hedging strategies 7, 8, 9 and 10 in Figure 9 reduce risk for the period 1980 to March 1986 compared to the base strategies 1 and 2. The selective hedge strategies are less effective in reducing risk for April 1986 to 1989 when relatively fewer hedges are placed. Participation in the NTSP does not appear to reduce the effectiveness of hedging as a risk management strategy.

Selected MSEs on net returns are tested for significant differences using the test of Ashley et al. (1980) to help determine the superior risk strategies. The alternative MSEs in Tables 9 and 10 using the forecast from the mean of net returns are not tested. The test description and detailed test results are in Appendix F. Some general conclusions on these tests follow.

The MSE error of participating in the NTSP is not significantly different from no NTSP.
The 100% hedge strategy MSE is significantly smaller than no hedging.
The selective hedge and selective investment strategies MSEs are significantly smaller than the no hedging strategies.
The 100% hedge strategy MSE is smaller than the selective hedge strategy.
The optimal hedge strategy MSE is smaller than the selective hedge strategy.
The selective investment strategy MSE is smaller than the optimal hedge or selective hedge strategies.

These tests of significance confirm what the graphs on root MSE show. The exception to this is the optimal hedge versus the 100% hedge. This test suggests that the optimal hedge MSE is smaller despite the fact that the MSE for the 100% hedge in absolute terms is smaller.[37]

This leads the discussion back to several hypotheses stated in chapter 3. The NTSP has slightly reduced cattle feeding risk in Alberta however this reduction in risk is not significant. Therefore this may lead to the rejection of the hypothesis in section 3.2 that the NTSP has reduced cattle feeding risk. The hypothesis in section 3.3.3 that the 100% hedge strategy reduces risk over the no hedging strategy is not rejected. The hypothesis in section 3.3.5 that the optimal hedge strategy reduces risk over the no hedging strategy is not rejected.

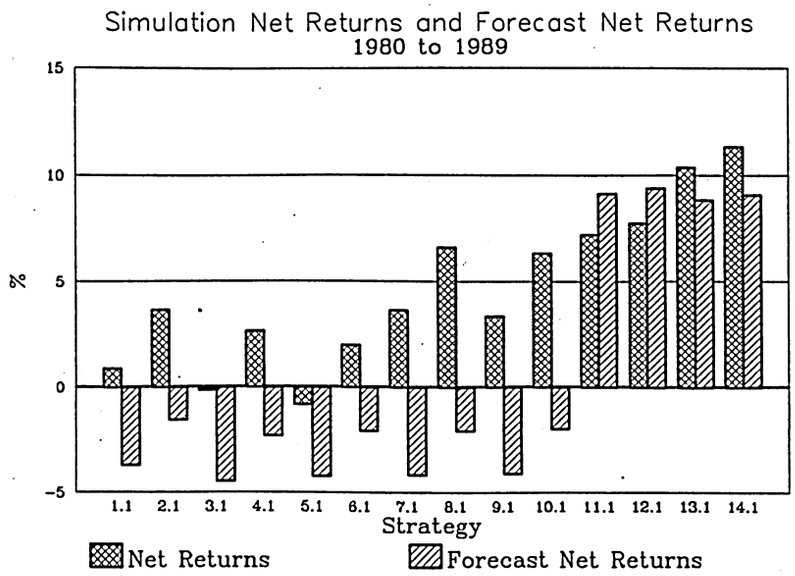
The Alberta cattle feeder investor can reduce risk slightly by participating in a public program, the NTSP, although this risk reduction may not be significant. A different net returns forecast such as the mean of historical net returns MSE shown in Tables 9 and 10 may lead to a different conclusion. The Alberta cattle investor can significantly reduce risk by hedging. The optimal hedge results suggest that 100% hedging of heavy feeders is not required to get most of the benefits of risk reduction by hedging. Hedging about 60% of the feeder cattle gives similar reductions in risk. Selective hedging strategies lead to variable results in risk reduction depending on the time period and whether the strategy gives any hedge signals. The selective investment strategy in feeder cattle or T-Bills reduces risk however it may not be a viable option since it appears to favour one investment or the other investment for several years at a time. Cattle are fed only about 38% of the time with selective investment strategies and most of the cattle feeding occurred in 1980 to 1986. Another problem with the selective investment strategy is the difficulty in forecasting NTSP pay outs. The forecast often indicates not to feed but the final result with NTSP is that the cattle investor should have fed cattle.

The net returns and the forecast net returns for the fourteen different strategies are compared in Figures 11, 12 and 13. The highest net returns in Figure 11 occur with the selective hedging and selective investment strategies over the period 1980 to 1989. Forecast net returns tend to underestimate the actual returns for the period 1980 to 1989 for most of the investment strategies. The forecasts are more accurate during 1980 to March 1986. The NTSP forecasts are not accurate and the period April 1986 to 1989 has relatively inaccurate net returns forecasts. All strategies have positive net returns for the period 1980 to March 1986. Only the selective investment strategies and some of the strategies with NTSP have positive net returns for the period April 1986 to 1989.

---

37 See Appendix F for a complete explanation on this result. The likely reason for this apparent contradiction is the way the MSE test is set up combined with the correction for autocorrelation.

Figure 11



Strategy Legend
1. Base Model - No Hedging, No NTSP.
2. Base Model - No Hedging, With NTSP.
3. 100% Hedging, No NTSP.
4. 100% Hedging, With NTSP.
5. Optimal Hedging, NO NTSP.
6. Optimal Hedging, With NTSP.
7. 5% Selective Hedge, No NTSP.
8. 5% Selective Hedge, With NTSP.
9. T-Bill Selective Hedge, No NTSP.
10. T-Bill Selective Hedge, With NTSP.
11. Selective Investment - Steers or T-Bills, No NTSP.
12. Selective Investment - Steers or T-Bills, With NTSP.
13. Selective Investment - Steers or T-Bills, With Hedging, No NTSP.
14. Selective Investment - Steers or T-Bills, With Hedging, With NTSP.

The decimals represent time period.
.1 = 1980 to 1989.
.2 = 1980 to March 1986 (NO NTSP).
.3 = April 1986 to 1989 (NTSP Available).

Figure 15

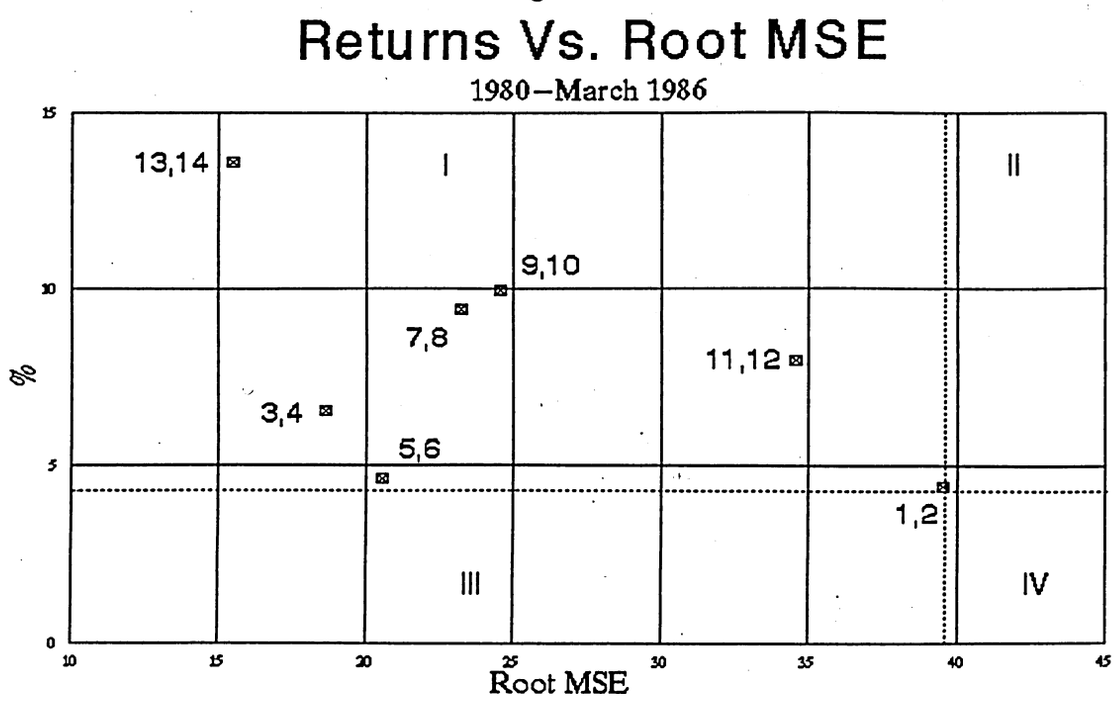
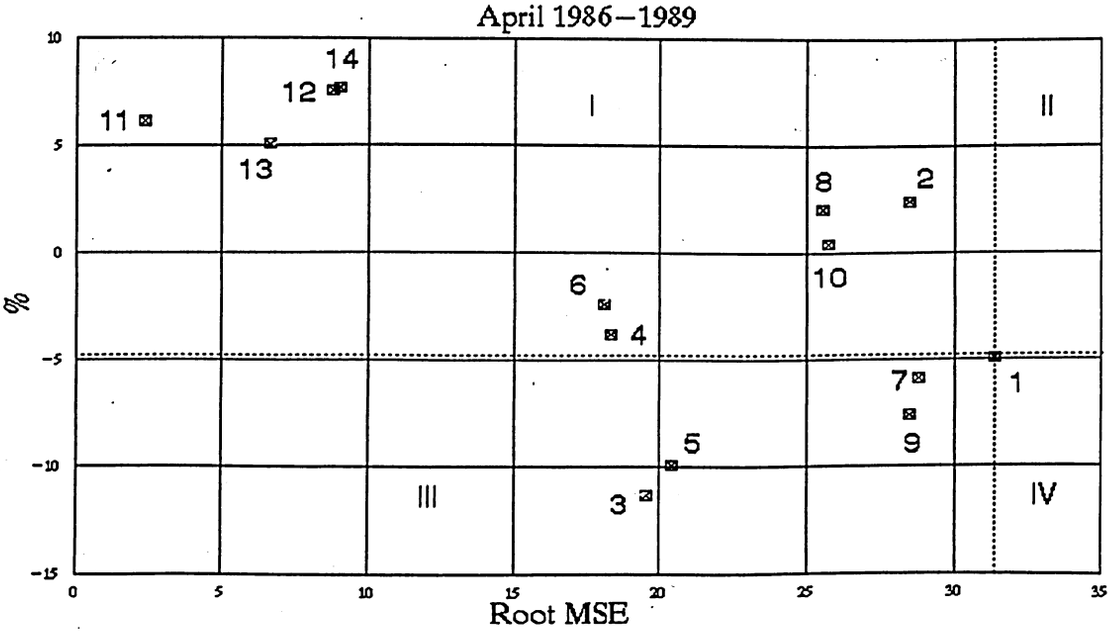


Figure 16



All strategy combinations in Figure 14 for the period 1980 to 1989 dominate the base model of no hedging and no NTSP (strategy 1) except for 100% hedging with no NTSP strategy 3 and optimal hedging with no NTSP strategy 5. Strategies 3 and 5 are in quadrant III. These two strategies have lower risk than strategy 1 but they also have lower returns. A risk averse individual may or may not prefer strategies 3 or 5 in quadrant III over strategy 1.

Figures 14, 15 and 16 compare the different strategies to each other. For example, the selective investment strategies 13 and 14 in Figure 14 dominate all the other strategies[38]. Any strategies that are to the left and above another strategy dominates that strategy. The strategies with NTSP usually dominate the strategies with no NTSP in Figure 16 for the period April 1986 to 1989. The hedging strategies reduce risk over the base model of no hedging in all strategies. The hedging strategies do not always dominate the no hedge strategy.

This brings up the question, is it worth while to use the 100% or the optimal hedge strategies? Figure 3 in chapter 2 shows there was a major upward trend in nominal slaughter prices over the period 1977 to 1979. All hedging research that used this period (Caldwell et al. (1982), Carter and Loyns (1985), Gaston and Martin (1984), Gillis et al. (1989)) reported that the hedge and hold strategies for slaughter cattle performed poorly. Most hedges (selling contracts) placed during this time period will lose money on the futures market and some of these hedges could lose very large amounts of money[39]. The cost of 100% hedging over 10 years, 1980 to 1989, drops the net returns on cattle feeding by about 1% which is not a high cost. The years 1986 to 1989 in Figure 3 show a another possible rising trend in nominal slaughter prices. This period also shows larger losses from futures hedging transactions[40]. The successful 100% hedge strategy requires financial resources and a long term commitment that will span both the up trends and the down trends in price. Over an extended time period the cost of the strategy is not high. Shorter time periods of three to four years may show high costs or high returns to this strategy. Some cattle investors may not be willing to endure several years of losses on the futures market following a 100% hedge strategy. The selective hedging strategies are an alternative which increase income but do not reduce risk as much as the 100% hedge strategy.

The CAPM beta's for each of the investment strategies are calculated and reported in Tables 38 to 43. The CAPM compares the cattle feeding investment to the market portfolio. The TSE 300 is used as the market portfolio for reasons explained in chapter 3. Appendix G explains the calculation of the real TSE 300 returns to match the cattle returns calculation used in the research. The beta calculation uses equation 6 in chapter 3. The CAPM investment beta's for most of the cattle feeding period 1980 to 1989 are under 0.20[41]. This is different from Coles's (1989) reported beta of 0.64 for cattle feeding in Alberta for the period 1973 to 1985. Brown (1989) reported a beta of -0.182 for cattle feeding in Saskatchewan for the period 1971 to 1987 which may be closer to the betas calculated in this study. The period 1976 to 1979 has a Beta of 1.00. The results of Coles (1989), Brown (1989) and this study may indicate that the value of any beta from the CAPM is dependent on the time period used in the calculation.

The systematic and the non systematic portion of the MSE risk is calculated using equations 7 and 8 in chapter 3 and results are reported in Tables 38 to 43. The majority of the risk in these strategies is non systematic because the correlations between the net returns on cattle feeding and the TSE 300 are close to 0.

---

38 The selective investment in cattle only (44 lots) is not included in the graphs. The selective investment in cattle with no hedging and no NTSP has net returns of 11.2% and root MSE of 45.4. This would put this strategy in quadrant II in Figure 14.

39 Hedge results for 1976 to 1979 are in Appendix C.

40 See Appendix C.

41 Beta is not tested for significance since there is autocorrelation in the estimating equation. It is the authors' opinion that these Beta's are probably not much different from 0.

Table 38
Net Returns, CAPM Betas, Root MSE, Systematic Risk and Non Systematic Risk
Base Models - No Hedging

Strat. & Date	Net Returns %	Beta	Corr[1]	Root MSE	Sys. Risk	Non Sys. Risk
No NTSP						
76-89	6.02	0.111	0.093	--	--	--
76-79	19.69	1.000	0.358	--	--	--
80-89	0.89	0.018	0.022	36.55	0.80	35.75
80-Mar86	4.39	-0.023	-0.029	39.53	-1.15	40.68
Apr86-89	-4.94	0.161	0.201	31.37	6.31	25.06
NTSP						
76-89	8.01	0.099	0.084	--	--	--
76-79	19.69	1.000	0.358	--	--	--
80-89	3.63	0.0037	0.005	35.66	0.18	35.48
80-Mar86	4.39	-0.023	-0.029	39.53	-1.15	40.68
Apr86-89	2.37	0.102	0.139	28.47	3.96	24.51

1. This is the correlation between the cattle net returns and the TSE 300 net returns.

Table 39
Net Returns, CAPM Betas, Root MSE, Systematic Risk and Non Systematic Risk
100% Hedging

Strat. & Date	Net Returns %	Beta	Corr	Root MSE	Sys. Risk	Non Sys. Risk
No NTSP						
80-89	-0.15	0.130	0.219	18.88	4.13	14.75
80-Mar86	6.54	0.123	0.228	18.59	4.24	14.35
Apr86-89	-11.30	0.133	0.214	19.56	4.19	15.38
NTSP						
80-89	2.66	0.117	0.202	18.41	3.72	14.69
80-Mar86	6.54	0.123	0.228	18.59	4.24	14.35
Apr86-89	-3.82	0.079	0.122	18.32	2.24	16.08

Table 40
Net Returns, CAPM Betas, Root MSE, Systematic Risk and Non Systematic Risk
Optimal Hedging

Strat. & Date	Net Returns %	Beta	Corr	Root MSE	Sys. Risk	Non Sys. Risk
No NTSP						
80-89	-0.82	0.096	0.173	20.44	3.54	16.90
80-Mar86	4.62	0.079	0.153	20.58	3.15	17.43
Apr86-89	-9.89	0.142	0.242	20.44	4.95	15.49
NTSP						
80-89	1.96	0.082	0.154	19.60	3.02	16.58
80-Mar86	4.62	0.079	0.153	20.58	3.15	17.43
Apr86-89	-2.46	0.086	0.151	18.07	2.73	15.34

Table 41
Net Returns, CAPM Betas, Root MSE, Systematic Risk and Non Systematic Risk
5% Selective Hedging[1]

Strat. & Date	Net Returns %	Beta	Corr	Root MSE	Sys. Risk	Non Sys. Risk
No NTSP						
80-89	3.66	0.149	0.240	25.33	6.08	19.25
80-Mar86	9.40	0.127	0.232	23.20	5.38	17.82
Apr86-89	-5.90	0.210	0.283	28.80	8.15	20.65
NTSP						
80-89	6.63	0.133	0.232	24.00	5.57	18.43
80-Mar86	9.40	0.127	0.232	23.20	5.38	17.82
Apr86-89	2.02	0.146	0.229	25.53	5.85	19.68

1. The selective hedge with NTSP had 13 one month hedges, 13 two month hedges and 50 three month hedges. 75% of the hedges (57 hedges) are placed from 1980 to March 1986. Other selective hedge strategies have similar hedging numbers.

Table 42
Net Returns, CAPM Betas, Root MSE, Systematic Risk and Non Systematic Risk
T-Bill Selective Hedging

Strat. & Date	Net Returns %	Beta	Corr	Root MSE	Sys. Risk	Non Sys. Risk
No NTSP						
80-89	3.38	0.127	0.202	26.00	5.25	20.75
80-Mar86	9.97	0.109	0.193	24.56	4.74	19.82
Apr86-89	-7.60	0.174	0.243	28.51	6.93	21.58
NTSP						
80-89	6.37	0.114	0.194	24.90	4.83	20.07
80-Mar86	9.97	0.107	0.193	24.56	4.74	19.82
Apr86-89	0.36	0.122	0.191	25.73	4.91	20.82

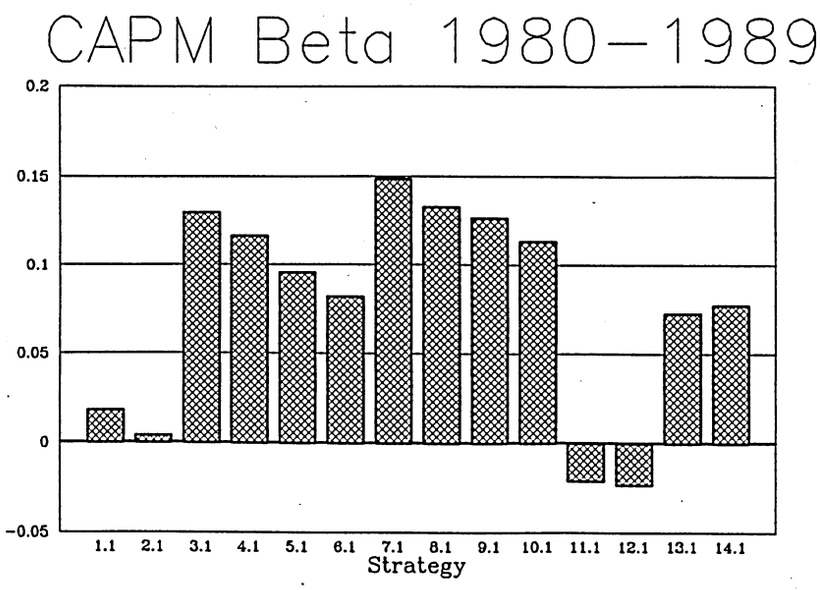
The CAPM Betas are compared in Figures 17, 18 and 19. These graphs show low Betas for the period 1980 to 1989. The CAPM betas and the non systematic risk measures show that cattle investors in heavy feeders can diversify most of their risk by investing in the TSE. The cattle investment is not closely linked to the parts of the economy that affect risk in the TSE 300. This would agree with results commented on by Hirshleifer (1988) that returns in stocks and commodities have low negative correlations.

Table 43
Net Returns, CAPM Betas, Root MSE, Systematic Risk and Non Systematic Risk
Selective Investment in Feeder Cattle or T-Bills[1]

Strat. & Date	Net Returns %	Beta	Corr	Root MSE	Sys. Risk	Non Sys. Risk
No Hedge No NTSP						
80-89	7.26	-0.021	-0.033	27.27	-.90	28.17
80-Mar86	7.97	-0.031	-0.044	34.54	-1.52	36.06
Apr86-89	6.09	0.015	0.085	2.35	.20	2.15
No Hedge NTSP						
80-89	7.80	-0.023	-0.035	27.75	-0.97	28.72
80-Mar86	7.97	-0.031	-0.044	34.54	-1.52	36.06
Apr86-89	7.52	0.008	0.020	8.76	0.17	8.58
Hedge No NTSP						
80-89	10.40	0.074	0.194	12.86	2.49	10.37
80-Mar86	13.61	0.088	0.221	15.49	3.42	12.07
Apr86-89	5.04	0.011	0.047	6.65	0.31	6.34
Hedge NTSP						
80-89	11.37	0.078	0.200	13.39	2.68	10.71
80-Mar86	13.61	0.087	0.221	15.49	3.42	12.07
Apr86-89	7.65	0.035	0.101	9.01	0.91	8.10

1. Cattle are fed 45 times in the selective investment with hedging and NTSP. 89% of the cattle feeding (40 lots) is during 1980 to March 1986. The other strategies have similar results.

Figure 17



Strategy Legend
1. Base Model - No Hedging, No NTSP.
2. Base Model - No Hedging, With NTSP.
3. 100% Hedging, No NTSP.
4. 100% Hedging, With NTSP.
5. Optimal Hedging, NO NTSP.
6. Optimal Hedging, With NTSP.
7. 5% Selective Hedge, No NTSP.
8. 5% Selective Hedge, With NTSP.
9. T-Bill Selective Hedge, No NTSP.
10. T-Bill Selective Hedge, With NTSP.
11. Selective Investment - Steers or T-Bills, No NTSP.
12. Selective Investment - Steers or T-Bills, With NTSP.
13. Selective Investment - Steers or T-Bills, With Hedging, No NTSP.
14. Selective Investment - Steers or T-Bills, With Hedging, With NTSP.

The decimals represent time period.
.1 = 1980 to 1989.
.2 = 1980 to March 1986 (NO NTSP).
.3 = April 1986 to 1989 (NTSP Available).

Figure 18

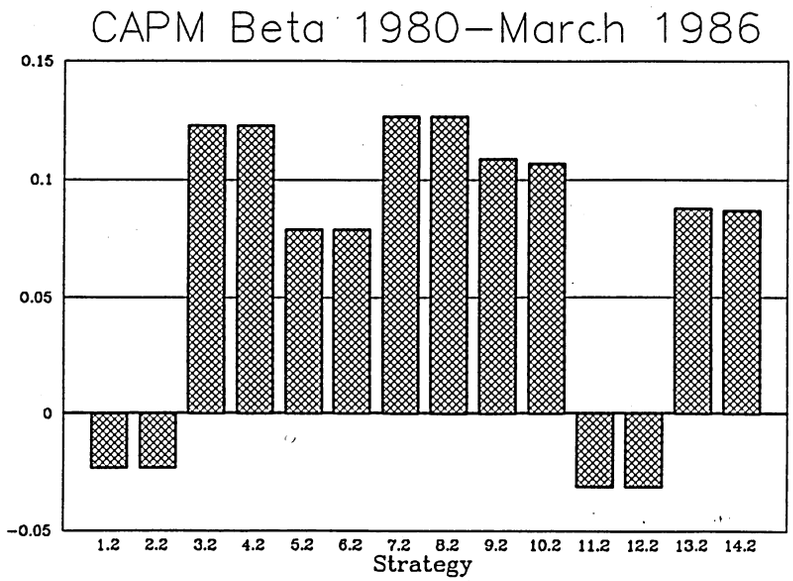
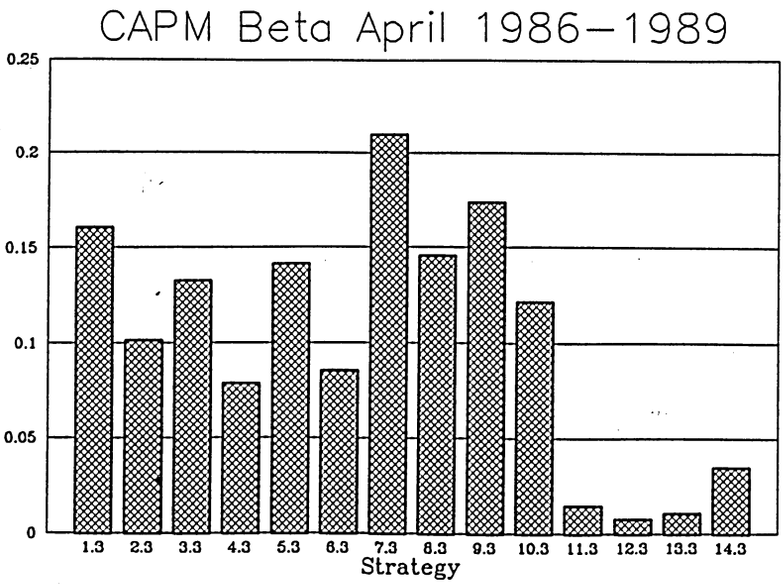


Figure 19



This section compared the risk and returns of the different Alberta cattle feeding investment strategies. The selective investment strategies and the hedging strategies reduce the risk of cattle feeding over no hedging and no participation in government programs. The hedging results in this study conflict with prior Canadian research and this is investigated further in the next section. The NTSP increases income and decreases risk slightly. Not all these strategies are preferred by a risk averse investor when the mean-variance efficiency criterion is used. The beta from the CAPM suggests that non agricultural investors can reduce systematic risk by investing in heavy feeder steers in Alberta. Alternatively investors in heavy feeder cattle can reduce most of their risk by investing in the TSE 300. Final comments on the use of these strategies by cattle investors are in chapter 6.

5.9 Issues in Risk Measures and Other Research Conclusions

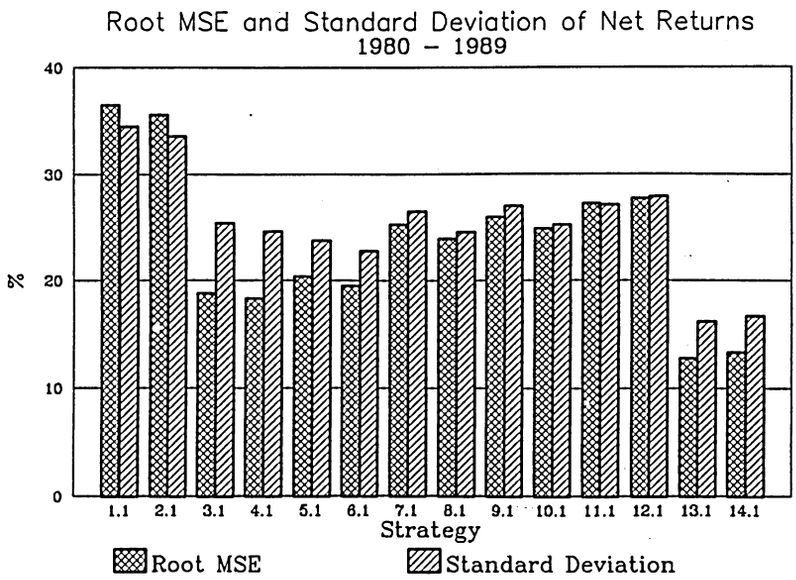
Chapter 3 reported conflicting results in the literature on the use of different risk management strategies, especially the strategy using 100 % hedging. The MSE and the standard deviation from this study are briefly compared to determine if these lead to different conclusions. Canadian studies also concluded that basis is too variable to use hedging for managing risk. Currency exchange rate risks were cited as reasons for variable basis. The hedging results in this study may contradict the conclusions of these studies. Hedging is a risk reducing strategy that can be used by Alberta cattle feeder investors. One reason for this may be reduced basis risk. Exchange rate risk is a part of basis risk. This section further investigates hedging risk and compares the Alberta basis to the Omaha basis and tests basis variability during the past 10 years. A less variable basis implies less risk[42]. A comparison of exchange rate risk is also included.

The main risk measure used in this study is the MSE of net returns. The rational investor uses current as well as historical information to make investment decisions and measure risk. Standard deviation is an alternative risk measure used by other studies (Caldwell et al. (1982), Carter and Loyns (1985)). It was suggested earlier that the conflicting risk results reported in the literature may be from different risk measures. The MSE and the standard deviations risk measures are compared in Figures 20, 21 and 22.

---

42 Recall the results from the last section comparing the square root of MSE and standard deviations of net returns. The change in direction for standard deviations followed the same direction for MSE risk measures for different strategies.

Figure 20



Strategy Legend for Net Returns and Root MSE
1. Base Model - No Hedging, No NTSP.
2. Base Model - No Hedging, With NTSP.
3. 100% Hedging, No NTSP.
4. 100% Hedging, With NTSP.
5. Optimal Hedging, NO NTSP.
6. Optimal Hedging, With NTSP.
7. 5% Selective Hedge, No NTSP.
8. 5% Selective Hedge, With NTSP.
9. T-Bill Selective Hedge, No NTSP.
10. T-Bill Selective Hedge, With NTSP.
11. Selective Investment - Steers or T-Bills, No NTSP.
12. Selective Investment - Steers or T-Bills, With NTSP.
13. Selective Investment - Steers or T-Bills, With Hedging, No NTSP.
14. Selective Investment - Steers or T-Bills, With Hedging, With NTSP.

The decimals represent time period.
.1 = 1980 to 1989.
.2 = 1980 to March 1986 (NO NTSP).
.3 = April 1986 to 1989 (NTSP Available).

Figure 21

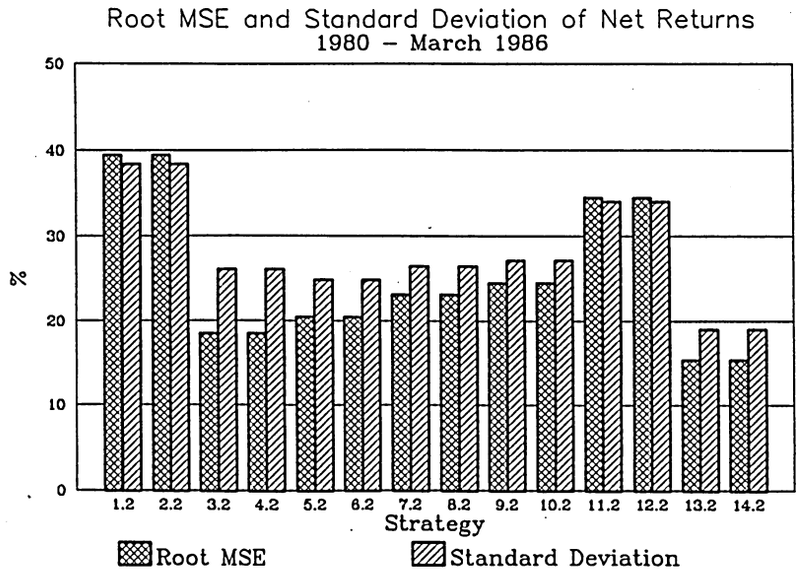
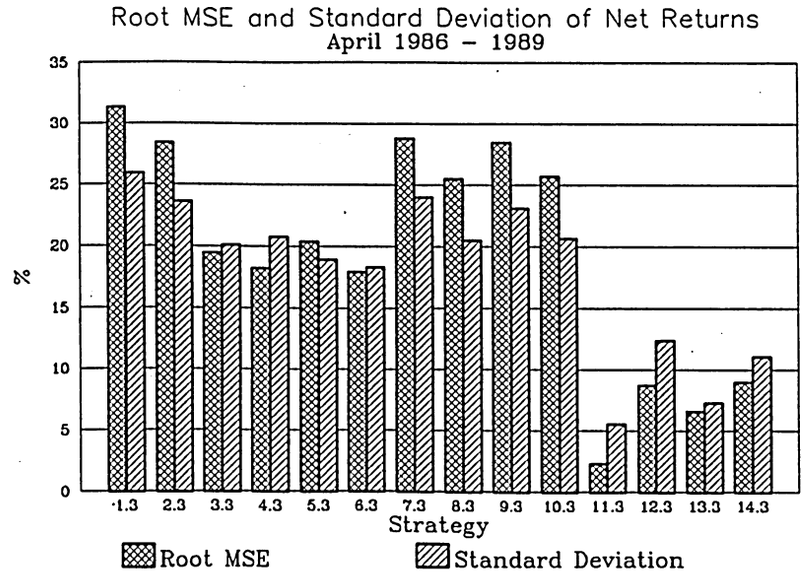


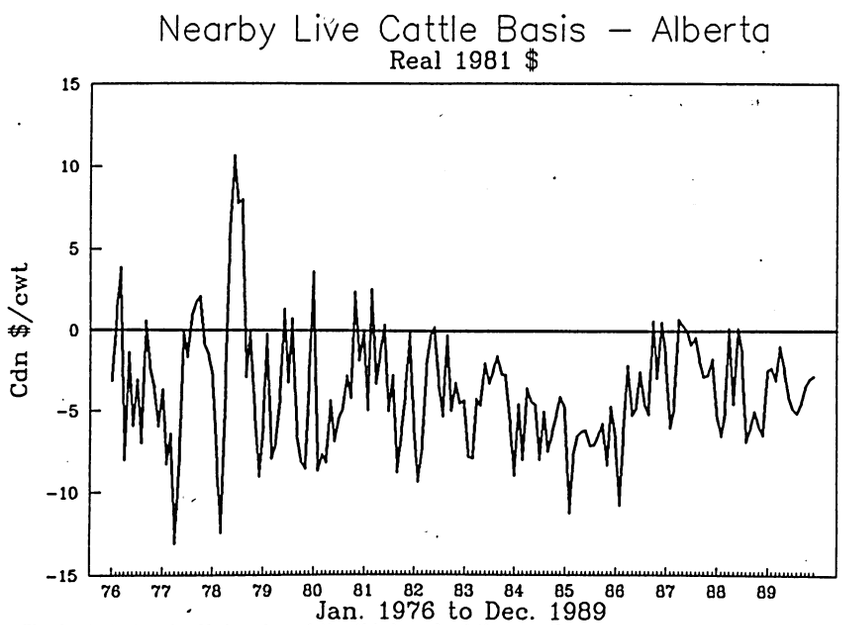
Figure 22



The MSE and standard deviation of net returns show similar changes in the direction of risk for the different investment strategies. The standard deviation would give similar rankings to the different strategies as the MSE risk measure when combined with net returns in a mean-variance efficiency criterion. The MSE is a better measure of risk for the reasons outlined in chapter 3. The standard deviation consistently underestimates the amount of the change in risk. Better price forecasts and NTSP pay out forecast would improve the MSE risk measure. The different results on the hedging reported by Caldwell et al. (1980) and by Carter and Loyns (1985) are probably caused by different time periods and different data. This study shows that different time periods give different answers about the best price forecasting models, best investment strategies or CAPM betas.

Alberta nearby basis is the difference between the Alberta slaughter cash price and the CME live cattle futures contract adjusted to Canadian dollars. Basis variability is tested here. Figure 23 is Alberta nearby basis in June 1981 dollars for the Wednesday of the third week of the months for 1976 to 1989. Figure 23 shows that Alberta basis is less variable in the period 1985 to 1989.

Figure 23



Sample means and sample standard deviations for basis for different time periods for Alberta and Omaha are in Tables 44, 45 and 46. The time periods 1976 to 1980 and 1985 to 1989 are used to compare two time periods of equal length. Thompson and Bond (1985) suggested that it is perceived basis variance that is important when comparing a United States hedger to an offshore hedger. The standard deviations for 1985 to 1989 for Alberta basis and Omaha basis (in Canadian dollars) are 2.72 and 3.51 respectively. Omaha basis is not less variable than Alberta basis for this time period.

Table 44
Alberta Nearby Basis in real Canadian June 1981 Dollars

Time Period	Mean	Std. Dev. Sample
1976-89	-3.73	3.64
1976-1979	-2.87	5.07
1976-1980	-3.11	4.85
1980-1989	-4.07	2.83
1980-Mar. 86	-4.68	3.01
1985-1989	-4.04	2.72
Apr. 86-89	-3.05	2.20

Table 45
Omaha Nearby Basis in real U.S. January 1982 Dollars

Time Period	Mean	Std. Dev. Sample
1976-89	-0.955	2.87
1976-1979	-1.35	3.47
1976-1980	-1.42	3.27
1980-1989	-0.79	2.58
1980-Mar. 86	-1.06	2.57
1985-1989	-0.96	2.70
Apr. 86-89	-0.345	2.58

Table 46
Omaha Nearby Basis in real 1982 Dollars Changed to Canadian Dollars

Time Period	Mean	Std. Dev. Sample
1976-89	-1.12	3.40
1976-1979	-1.41	3.72
1976-1980	-1.52	3.55
1980-1989	-1.01	3.28
1980-Mar. 86	-1.36	3.27
1985-1989	-1.26	3.51
Apr. 86-89	-.041	3.23

The hypothesis in chapter 3, section 3.3.4 that Alberta basis is less variable in the period 1985 to 1989 than 1976 to 1980 is tested. The test uses a null hypothesis that the variance for 1976 to 1980 equals the variance for 1985 to 1989. The alternative hypothesis is that the variance for 1976 to 1980 is greater. The F statistic is 3.18 for the ratio of the variances. At the 5% level of significance the null hypothesis is rejected. Alberta basis is less variable for the period 1985 to 1989. The same test for Omaha (in U.S. dollars) has an F statistic of 1.48. At the 5% level of significance the null hypothesis is not rejected. These tests suggests the Alberta basis is less variable now than 10 years ago and the Omaha basis is not less variable now than 10 years ago[43]. The Alberta basis may be less variable because of increased cattle exports and because the exchange rate is less variable.

The exchange rate is not formally tested, however the standard deviation of the exchange rate for the period 1976 to 1981 is 6.5 and for the period 1986 to 1989 it is 5.0. The exchange rate risk component in the MSE of net returns may not be that large. A simple test is to replace the forecast exchange rate in the slaughter price forecasts in equation 36 with the actual exchange rate that will occur. The investor has perfect knowledge of exchange rates. Compare the MSE with the forecast exchange rate to the MSE with the perfect knowledge exchange rate. This shows the change in total risk from exchange rates. The MSE on net returns with no hedging and no NTSP for 1980 to 1989

43 The Alberta and Omaha basis have autocorrelation. Correcting for the autocorrelation does not change the conclusions of the F test. This is explained in Appendix I.

with perfect knowledge of exchange rates is 1292.7. The MSE on net returns for the same strategy in Table 9 using a forecast exchange rate is 1335.7. Risk drops marginally when exchange rate risk on the forecast price is removed. Exchange rate risk in this comparison is low.

Alberta basis variability is compared to Omaha basis variability to answer the question are Alberta cattle investors at a disadvantage in using the CME for risk management? It has been an implicit assumption of some Canadian studies that United States cattle investors are better able to use the futures market. The Alberta basis and the Omaha basis are not independent since they are both calculated from the same futures contract and the market for cattle is a North American market. A standard F test to compare the variances is not appropriate. It is the unpredictable portion of basis that is relevant to the cattle investor. Therefore, test the basis MSE between two similar forecast models for Alberta basis and Omaha basis using the test of Ashley et al. (1980) explained in Appendix F. Use this test as a proxy for comparing the variances.

The test proceeds as follows. The null hypothesis is that the unpredictable portion of Alberta basis and the Omaha basis are the same for 1980 to 1989. The Alberta basis (already in real 1981 $) is converted to U.S. dollars so the MSE have the same measure. It is the relative basis variability that is important. The forecast model used for both Alberta basis and Omaha basis is the historical average updated each month and used as the three month ahead basis forecast[44]. The alternate hypothesis is the Omaha basis has lower MSE than the Alberta basis. The null hypothesis is not rejected if the coefficients are both positive and not significantly different from 0 or neither coefficient is significantly positive. The results after adjusting for first order autocorrelation using ML are in Table 47. The last coefficient, auto, is the estimated autocorrelation coefficient.

Table 47
MSE Test Between Alberta Basis and Omaha Basis

Var	Coef	Std. Error	T-Ratio	P-Value
const.	0.21	0.60	0.36	0.72
X1	-0.63	0.15	-4.13	0.00
auto	0.37	0.08	4.38	0.00

OLS DW=1.24 Chi-Squared=17.2 P-Value Chi=0.00
Mean Prediction Errors AB Basis = -0.47(US $), Omaha Basis=0.19
(Alberta basis error vector multiplied by -1)

The test results are mixed. The constant is positive and not significant at the 5% level. The X1 coefficient is negative and significant. The asymptotic Chi-Squared test for the coefficients equal to zero cannot be used in the Ashley et al. (1980) test because of the opposite signs on the coefficients. The coefficients are not significantly positive so do not reject the hypothesis that the two MSE for the basis are the same. The conclusion is that the mean square error of the basis for Omaha is not smaller than the basis for Alberta. The 3 month basis forecast risk using the basis average forecast model during the period 1980 to 1989 was not greater for Alberta investors. This test indirectly rejects the hypothesis in chapter 3, section 3.3.4, that Alberta live cattle basis is more variable than the Omaha live cattle basis. The Ashley et al. (1980) test is weak and should be interpreted with caution.

Alberta basis variability has decreased during the past 10 years and Alberta basis is not more unpredictable than the Omaha basis. Alberta basis contains an exchange rate component that Omaha basis does not have. The exchange rate may not be a major factor in basis movement and in slaughter

44 See Appendix I for further information on Omaha basis, and Omaha slaughter steer price forecasts. The basis average forecast model is chosen since it is calculated the same way in both locations, it is neither the worst nor the best basis forecast, and it is easy to calculate.

price variability in Alberta for 1980 to 1989 although this conclusion needs more.[45] The use of MSE and standard deviations as risk measures should lead to the same qualitative conclusions. This again suggests that the different risk findings of other studies are related to data and time periods studied.

5.10 Using Put Options

The use of put options with a cattle feeding investment is simulated. The simulation with options covers the period November 1984 to December 1989. Results are also reported for the period April 1986 to December 1989 to match the reported results in the rest of the study. All numbers are adjusted with the Canada-U.S exchange rate to convert option values to Canadian dollars.

Three similar uses of put options are simulated. The first two strategies use puts as insurance against a drop in slaughter cattle price. These two strategies are to purchase puts just out of the money and just in the money when the feeder cattle are purchased. The net costs of puts are calculated on a net profit (loss) per cwt on the options alone and include brokerage fees. Costs are adjusted to June 1981 Canadian dollars to allow comparison between the different time periods. The put option net profits (losses) are calculated on each lot of cattle and added to the net returns on each lot of cattle sold. This gives total returns in the simulation on feeding cattle using puts. Cattle feeding risk is measured using MSE.

The third strategy using options calculates net profits for put options just in the money in a delta neutral strategy. This should give a similar risk response as hedging. Only the net costs per cwt for options is calculated with this strategy. It is not added to the cattle feeding returns part of the simulation.

The put insurance strategies are simulated as follows. Put options on the CME live cattle futures contract that expires after the expected cattle sale date are purchased on the same date the feeder cattle are purchased. The first purchase is on the Wednesday in the third week of November 1984. The expected cattle sale date is the Wednesday in the third week in February, 1985. The put options are assumed infinitely divisible so that put option purchases can exactly match the expected quantity of cattle sold in each lot. Brokerage fees are included in the costs.

The put option is held by the cattle investor until the sale of the lot of cattle. On the cattle sale date the put option value is tested and one of three things happens. The option expires worthless, the option is sold or the option is exercised. The option is assumed to expire worthless if the value of the option premium is less than the brokerage option fee to sell the put.[46] The option is either sold or exercised if the option premium is greater than the brokerage option fee. The option is tested to determine whether selling the put option or exercising the put option is more profitable. The most profitable choice is taken.

This strategy is repeated for each lot of cattle purchased each month. The time period covered is cattle sales from February 1985 to December 1989. The insurance strategy is repeated with put options just out of the money and with put options just in the money. The net profit on the options only is calculated and reported in Tables 48 and 49. The net returns in the cattle simulation with options as insurance is also calculated and reported in Table 50.

The MSE risk measure on net returns in the cattle simulation with the use of options as insurance is calculated. This requires that the simulation cattle feeding net returns with options be forecast. The Alberta slaughter steer price forecast used is the futures contract model with ARIMA basis forecast described in the study.

The net profits (losses) for put options are forecast in two different ways. The first is a naive forecast that the option is worthless at the time of the cattle sale. The forecast on the cost of put options is the initial brokerage fee to purchase the option and the purchase option premium paid by the cattle investor. These figures are then used to forecast the net returns on cattle feeding using put options. The actual calculations are similar to the hedge and hold calculations in the study.

---

45 Here is more supporting evidence on exchange rates and basis for 1980 to 1989. The correlation between the Alberta slaughter steer price (in Cdn $) and the CME nearby live cattle futures contract (in U.S..$) is 0.91. When the futures price is converted to Cdn. $ this correlation is 0.96. The Omaha slaughter steer price has a correlation of 0.94 with the nearby futures contract. The correlation of the Alberta nearby basis (in Cdn $) with the Omaha basis (in Cdn $) is 0.52. The correlation of the Alberta basis with the exchange rate is 0.14. The Omaha slaughter price (in U.S. $) correlation with the exchange rate, 0.69, is greater than the Alberta slaughter price (in Cdn $) correlation, 0.43. These data series are adjusted with the appropriate Canadian CPI or U.S. GNP.

46 The option value is also checked to make sure it is not worthwhile to exercise the option.

The net costs of the option strategy are forecast using a second method. This assumes that the rational investor checks the value of the put option at the time of each cattle sale. The net value of the put option at cattle sale time, put option premium less the brokerage fee, is recorded if this value is greater than zero. The investor records this data each month as either zero or the ending net option value. The average of this data is used as the forecast put option value on the cattle purchase. This average is updated each month adding the new information available. This option average forecast and associated MSE risk measure are reported for the period of cattle sales from April 1986 to December 1989.

The delta neutral strategy is an attempt to use options in a way similar to the 100% hedge. Option premiums do not change by the same amount as the underlying change in the futures contract value. This change in the option value with respect to the futures value is measured by the option delta. A delta neutral strategy uses the delta to determine the ratio of options to purchase so that there is an exact correspondence between the change in the futures contract price and the change in the total value of the option premium. The delta changes with time and the value of the underlying futures contract. This implies that the delta neutral strategy must be adjusted with time. The delta neutral strategy is not added to the net returns in the cattle feeding simulation for reasons explained later in this section.

The delta neutral net returns on the put options is simulated as follows. Put options just in the money, with strike price K, are purchased on the date the feeder cattle are purchased. The amount of put options purchased are adjusted by the inverse ratio of the CME reported delta (1/delta). The ratio of put options with strike price K to one underlying futures contract are equal to the inverse delta ratio.

Two months before the date of sale of the cattle the delta is checked again to maintain delta neutrality. If the delta for the K strike price options has increased (1/delta has decreased), K strike options are sold until the ratio of options contracts to one futures contracts again matches the new inverse delta ratio. If the delta for the K strike price option has decreased (1/delta has increased), K strike price options are purchased until the ratio of option contracts to one futures contract again equals the new inverse delta ratio. The delta ratio is again checked at one month prior to the sale of the cattle. Options with K strike price are purchased or sold to maintain a delta neutral strategy.

The value of the options in the delta neutral strategy are evaluated at the slaughter cattle sale date. The put options are allowed to expire, sold or exercised in the same way as in the insurance strategies. The net profits (losses) on the options including the brokerage fees are calculated in 1981 Canadian dollars per cwt.

The results of these options strategies follow. The first results are the net profit (losses) reported in Table 48 for the three different option strategies. The 100% hedge and hold strategy is included for comparison for April 1986 to December 1989 in Table 49.

Table 48
Put Option Strategies
Net Profit (Loss) Of Buying Put Options With Brokerage Fee Included
Three Month Holding Period Before Selling
Feb. 1985 To Dec. 1989

Put Just Out Of The Money $/cwt Mean[1]	Put Just Out Of The Money Std. Dev.	Put Just In The Money $/cwt Mean	Put Just In The Money Std. Dev.	Delta Put Just In The Money Mean	Delta Put Just In The Money Std. Dev.
-0.66	1.89	-0.81	2.50	-2.42	6.40

1. This is for put options only and does not include the simulation cattle feeding returns. It is reported in June 1981 Canadian dollars.

Table 49
Put Options Strategies
Net Profit (Loss) Of Buying Put Options With Brokerage Fee Included
Three Month Holding Period Before Selling
April 1986 To Dec. 1989

Put Out Of The Money $/cwt Mean[1]	Put Out Of The Money Std. Dev.	Put In The Money $/cwt Mean	Put In The Money Std. Dev.	Delta Put In The Money Mean	Delta Put In The Money Std. Dev.	Hedge 100 % $/cwt Mean[2]	Hedge 100% $/cwt Std. Dev.
-1.21	1.30	-1.55	1.79	-3.81	6.14	-1.21	3.37

1. This is for put options only and does not include the simulation cattle feeding returns. Reported in June 1981 Canadian dollars.
2. The 100% hedge and hold includes brokerage fees but no margin costs.

The average net cost of the insurance option strategy is lower for the put just out of the money at -$1.21 per cwt, than for the put just in the money at -$1.55 for the period April 1986 to December 1989 in Table 49. The delta neutral strategy cost -$3.81 per cwt. The 100% hedge and hold strategy has an average cost of -$1.21 and this is lower than the delta neutral strategy simulated here.

The delta neutral strategy is expensive when the delta for the particular option starts to approach zero. This decrease in delta occurs when the live cattle futures price increases. A delta neutral strategy using the same option with the same strike price, when the delta approaches zero, requires the purchase of many options contracts to match one futures contract. This increases the brokerage fees paid per cwt and the time value paid for the options. This makes the delta neutral strategy used in this simulation very unrealistic. For example, there is one month (this monthly data is not reported) where the cost of the delta neutral strategy exceeds $32.00 per cwt in 1981 dollars. The underlying price rise in the futures market is approximately $6.50 per cwt. The net cost of the 100% hedge and hold in this same month would not exceed $7.00 per cwt. The cost of the put just out of the money insurance strategy for this same month is $1.84. No further analysis of the delta neutral strategy as used in this study is done because of these results. A different delta neutral strategy that updates the option position using option contracts always just in the money may be more effective. This strategy is not explored here.

The delta neutral strategy should be expected to cost more than the 100% hedging strategy. The writer of the put option has to maintain margin on the options similar to the underlying futures contract. The writer of the option is paid for the time value of the option which is really the risk that the option loses money for the writer. Therefore an investor using a delta neutral strategy must consider that there is a payment of risk premium to the option writer that covers the writer's potential margin calls, potential interest costs and desired returns on investment. These costs are paid for in the option premium. The delta neutral option hedging strategy cost should exceed the 100% hedge strategy cost over longer time periods.

The cattle simulation net returns are reported for the option insurance strategies. Option and cattle returns are combined. The cattle returns do not include the NTSP. Forecast returns are also included in Table 50.

Table 50
Put Options As Insurance
Net Returns In Cattle Simulation With Options
April 1986 To Dec. 1989

	Put Just Out Of The Money Net Return	Put Just In The Money Net Return	Net Returns[2] No NTSP No Hedging Or Options	Net Returns[2] No NTSP 100% Hedge
Actual Mean %	-13.04	-15.16	-4.94	-11.30
Std. Dev	20.15	18.09	25.93	20.14
Forecast Naive[1] Mean %	-27.93	-32.19	-17.98	-18.69
Forecast Average Mean %	-17.90	-16.94		

1. Naive is the forecast using the assumption that options are worthless when cattle are sold. The forecast average is the forecast that uses the mean of previous ending options values at cattle sale time to forecast the ending value.
2. These are two strategies from the study presented for comparison to the option strategy.

The average net returns using the options insurance strategies are lower than the net returns with no options or no hedging. The forecast net returns is more accurate when the average ending value of the put options is used in the forecast. The information on the MSE of the option insurance strategies on the cattle feeding simulation are in Table 51.

Table 51
Mean Square Error Of Net Returns
Put Options As Insurance
Cattle Simulation With Options
April 1986 To Dec. 1989

Option Forecast	Put Just Out Of The Money	Put Just In The Money	No NTSP[2] No Hedging Or Options	No NTSP[2] 100% Hedge
Naive[1]	746.5	715.0	984.1	382.4
Average	479.8	342.9		

1. Naive is the forecast using the assumption that options are worthless when cattle are sold. The forecast average is the forecast that uses the mean of previous ending options values at cattle sale time to forecast the value of the put options.
2. These are two strategies from the study presented for comparison to the option strategy.

Put options used as insurance reduce price risk. The use of puts just in the money reduces the MSE risk from 984.1 with no options to 342.9 with options. The risk measure with 100% hedging is 382.4. Using the mean-variance efficiency criteria, none of the option strategies dominate the feeding of cattle with no options. The 100% hedging dominates the puts just out of the money. This is shown in Figure 24, a graph of returns versus square root MSE.

The number of times the options are allowed to expire, are sold or are exercised are in Table 52. The put options are allowed to expire less than 40% of the time when purchasing options just out of the money. Very rarely does it pay to exercise the option at the time of the cattle sale. The time value of the option makes it worth while to sell the put rather than exercise the option.

Figure 24

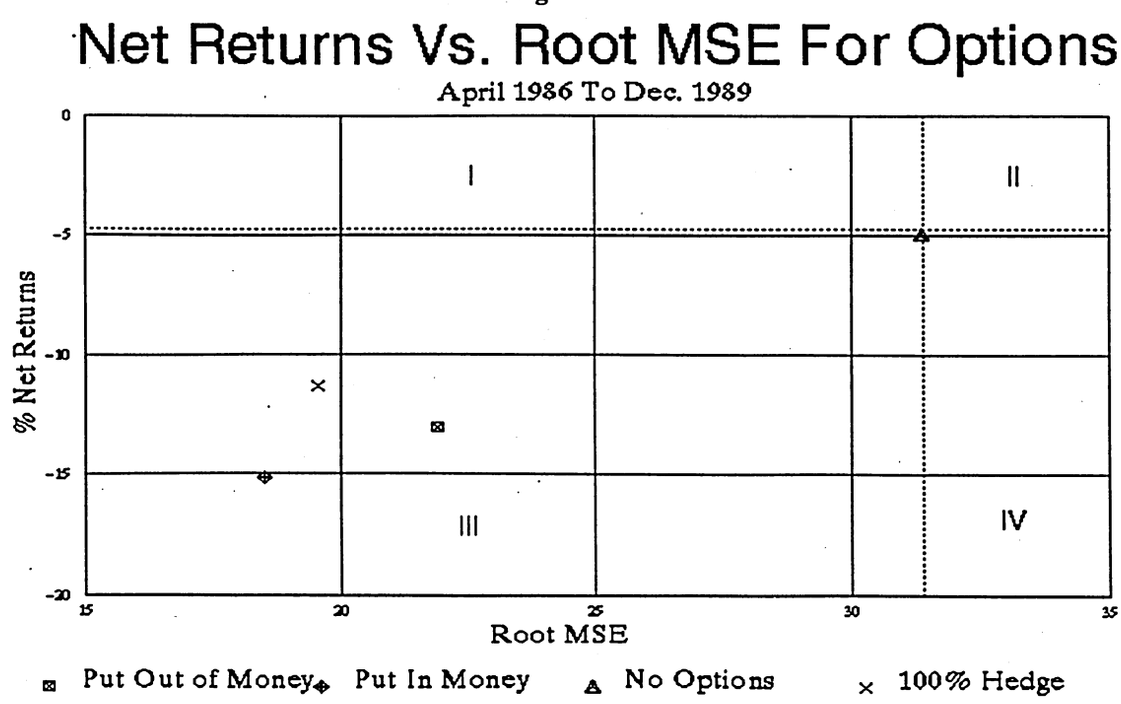


Table 52
Number of Times Options Sold Or Exercised
At Cattle Sale Time

Time Period & Action	Put Just Out Of The Money	Put Just In The Money
Feb. 85-89		
Expires	19	13
Sold	39	46
Exercised	1	0
Apr86-89		
Expires	18	12
Sold	26	33
Exercised	1	0

This completes the cattle feeding simulation using put options. Put options used as insurance reduce the risk in cattle feeding. The option strategy does not dominate a no option strategy. Therefore a risk averse individual may or may not choose to use puts for risk management. The net cost of using put options just out of the money is approximately equivalent to 100% hedging. However 100% hedging reduces risk as measured by MSE more than does the use of put options just out of the money. The advantage of the put option is there are no margin calls.

MSE as defined and forecast here may not be the appropriate risk measure when using put options as insurance. The implicit assumption in using puts as insurance is that it reduces the down side risk in net returns while still leaving upside potential. This upside potential (or the truncation of only the lower part of the distribution of returns) is not accounted for in the MSE forecasts. A different type of forecast, conditional on the use of puts as insurance may be a better measure to use in MSE. This is not done in this study.

It may not be possible to use put options well out of the money for insurance since very little trading occurs with these options. The use of delta neutral put option strategies may be more expensive than using direct hedging of the futures market. Different delta neutral option strategies need to be simulated before a more definite conclusion on this comparison of the costs of hedging to the costs of a delta neutral option strategy can be stated.

This option simulation used simple option strategies. It also did not have data on the option expiry value. It is possible that options that were considered valueless on the date of sale of the slaughter cattle had some value on the date of expiration. This could be checked in future simulations. The net returns forecasting with put options could be improved. The forecast should account for the truncation of the lower part of the returns distribution. This should improve the forecasts and reduce risk when using options.

5.11 Summary

This chapter reviewed the historical simulation and analysis of different cattle feeding management strategies. Different slaughter price forecasting models were compared as part of the gathering information risk management strategy. The CME live cattle futures contract and a basis forecast model were chosen for the simulation. Two efficiency tests did not reject the hypothesis that the CME live cattle futures contract is efficient. The futures market should be a good price forecast model and the variance minimizing hedge ratio is the optimal hedge ratio. Different investment strategies were compared. The selective hedging strategies and the selective investment strategies reduced the cattle feeding risk and increased returns. The 100% hedging strategies and the optimal hedging strategies lowered risk but they may have also lowered net returns. Participation in the government program, NTSP, increased income and reduced risk but the risk reduction was insignificant. The risk averse investor may choose different investment strategies for different time periods based on a mean-variance efficiency criterion. Alberta basis, a part of hedge risk and price forecast risk, is less variable now than ten years ago. The risk reduction from 100% hedging or using put options as insurance are similar. Further comments regarding this study on cattle feeding risk in Alberta are in the next chapter.

Chapter 6 Conclusions

Chapter 1 listed ten objectives for this research. This concluding chapter reviews these objectives and the results presented in Chapters 2 through 5. This is followed with a discussion of the uses for these results, their limitations and possible further research.

The literature review identified some of the major sources of risk in investing in heavy feeder steers in Alberta. Slaughter steer price was identified as the major source of risk in finishing heavy feeder steers after the feeder purchase decision is made. Slaughter price risk was the main research focus.

Realized net returns from cattle feeding were measured and compared to forecast net returns. Several different strategies or combinations of strategies were measured. Selective investment strategies had the highest returns. The selective investment and the 100% hedging strategies had the lowest risk. This objective of measuring risk is tied quite closely to other objectives discussed later.

Beef cattle investments were compared to alternative investments using the CAPM. The cattle investment had low systematic risk for the period 1980 to 1989. There was a low correlation between the returns on finishing heavy feeders and the TSE 300. A large portion of risk in cattle feeding can be diversified by investment in the TSE 300. This conclusion may be time period dependent since other studies, such as Coles (1989), show the cattle investment with higher systematic risk.

Different slaughter steer price forecasting models were compared as part of the information gathering risk management strategy. This research did not reject the hypothesis that the CME live cattle futures contract adjusted for basis is an unbiased forecast of Alberta slaughter prices. Other models, such as econometric models, ARIMA cash price models and lagged cash prices did not forecast better than the futures price for the period 1980 to 1989. Over different time periods, different forecasting models perform better than other models.

The Alberta live cattle nearby basis is less variable now than it was ten years ago. This should improve risk reduction from hedging and price forecasting using the futures market. Increased cattle exports to the United States and lower exchange rate variability were proposed as possible reasons for less basis risk in 1986 to 1989. The Alberta basis does not appear to be more variable than the basis at Omaha and Alberta investors and Omaha investors have the same relative basis risk. Alberta basis is not too variable to use the CME live cattle futures contract in risk management strategies and this conclusion is different from the conclusions of other Canadian studies.

Other studies used different measures. The MSE and the standard deviation risk measures indicated different amounts of risk, but in general showed the same change in risk for different strategies. The conflicting results in other studies using standard deviations to measure risk may be more related to the time period and the data used.

The National Tripartite Stabilization Program was included in the investment strategies. The NTSP increased net returns over not participating in the program. Risk, as measured by MSE, was reduced slightly with NTSP. The forecasting of NTSP caused difficulties. Improved forecasts would increase the risk reduction of NTSP for the Alberta cattle investor. The risk averse and the risk neutral cattle investor benefited from participation in the NTSP.

Hedging using the CME live cattle futures market was included with several investment strategies. The 100% hedge and hold strategies significantly reduced risk and reduced annualized net returns slightly. It is not possible to state whether a risk averse person prefers this strategy to not hedging. Most of the risk reduction from hedging can be obtained by optimally hedging about 60% to 70% of the cattle on feed. The long term cost of hedging excluding brokerage fees should be close to 0 since the CME live cattle futures market is unbiased. There may be periods of several years where hedge profits are positive or negative. Therefore over a short time period, the hedging strategy may appear to be increasing income or decreasing income and this may be unattractive to some cattle investors. The hedging conclusions from Freeze et al. (1990) and other researchers may not apply in different time periods or over longer time periods.

Selective investment strategies were compared. These included hedging if a target profit was forecast and investing in T-Bills if the forecast return on cattle feeding was less than the T-Bill rate of return. These strategies reduce risk. The net returns from these selective strategies are higher than the simple cattle investment. These strategies may give signals that for several years lead to little use of hedging or very little investment in feeder cattle. The forecasts tended to underestimate returns, especially with NTSP. It may not be possible to selectively invest in cattle for a time period and then not invest in cattle for a long time period. This makes these selective strategies less useful.

Put options used as insurance, decrease risk and lower net returns. The delta neutral strategy that always uses the same put option strike price is too expensive. There are many different option strategies available.

The Alberta investor in heavy feeder steers can use the research results in the following way. Three month price forecasting can be done using the CME futures market adjusted with an Alberta basis forecast. The basis forecast can be an ARIMA model but other basis estimates such as short term rolling averages may be suitable. Different models may be better price forecasters for different lengths of time and for different time periods. One price forecast should not be used exclusively for long periods of time and should be continually tested against competing models.

Participation in the NTSP, a public risk management program, from 1986 to 1989 benefited the risk neutral and risk averse cattle investor. Cattle investors could improve risk management with better forecasts of NTSP pay outs. The effect of the NTSP on feeder cattle prices or supply responses by cattle feeders were not studied.

Hedging, a private risk management strategy, reduces risk . Only a portion of the value of the cattle needs to be hedged to get most of the benefit of risk reduction. A hedge and hold strategy is expected to provide zero profits over the long run. Selective hedging when a forecast target profit can be locked in reduces risk and increases income. There may be several years where this strategy of selective hedging is used very little. Individual investors have to evaluate their level of risk aversion in choosing these strategies. The Alberta cattle investor does not appear to be at a disadvantage relative to an investor at Omaha in terms of using the CME futures market for risk management.

Options can reduce cattle feeding risk similar to the risk reduction from using 100% hedging. Options used continuously also reduce the net returns on the cattle feeding investment. The net costs are similar to 100% hedging. The cattle investor would benefit the most from the use of puts as insurance when the cattle investor considers the futures price an upward biased forecast of the futures price in the future. However, the results in this study provide no evidence that the futures market is biased. The cattle investor can use the Black model to compare the market's estimate and the investor's estimate of the futures price variance. An investor with higher expected variance than the market's estimate might consider using options.

One limitation in this study is the production function which purchases heavy feeder steers each month and assumes zero production risk. This limits the flexibility a cattle investor has in choosing different types and sizes of cattle. The results may not apply to lighter feeder cattle where there may be more production risk or where a cattle investor feeds cattle only during certain times of the year. The econometric price forecasting models are weak and could be improved upon. The tests for significance on mean square error of Ashley et al. (1980) are weak and should be interpreted with caution. The level of net returns reported in this study should not be considered typical of any particular feedlot or cattle feeder. A change of only $0.01 to $0.02 per lb in costs or selling price would make a big difference in the actual level of net returns reported.

Future research directions could include the following:

1. Do similar research including different weights of cattle and types of cattle to extend the results to other cattle investors.
2. Alberta basis could be compared to several locations in the United States to confirm or reject the comparisons to Omaha done in this study. The factors that impact on basis risk could be measured and tested. The optimal hedge calculations for these different locations could be estimated and compared.
3. Alternative optimal hedge estimating models using ARCH or GARCH could be tested.
4. There is no information in the literature on the actual use of the futures market by cattle investors. This information would be very useful in determining future research directions. It could be used to test whether such factors as debt levels, length of feeding period and size of cattle investment impact on the use of hedging or other alternatives such as options or forward contracting. These results could indirectly support or reject the investor's perception regarding bias in the futures market.
5. Slaughter price forecasts and NTSP forecasts could be improved. The ARIMA models forecasting basis might be improved by adding other information such as cattle slaughter and cattle on feed numbers. Improved forecasting models and using different models in different periods may reduce risk and make the selective hedging and selective investment strategies more useful. The decision rules developed to change forecast models may help signal the price trend or level of price risk in the market.
6. There are many options strategies that could be investigated. Further research on options could explore the use of delta neutral strategies. The writing of options for reducing risk is also another source of research. If futures markets are efficient, then the writer of options should on average expect to make money. The use of implied variance from the Black option formula could be researched and how the cattle investor can use this implied variance to evaluate slaughter steer price risk. For example, the implied variance could be used to develop confidence intervals on the price forecast.

This research shows cattle investors in heavy feeders can reduce risk using different strategies. Some of these strategies may not decrease income. Further research could extend these results to different classes of cattle.

Bibliography

Agriculture Canada and Alberta Agriculture. 1989. *National Tripartite Stabilization Program for Red Meats: Cattle Models.* Edmonton, Alberta.

Alberta Agriculture. 1969-1989. *Agricultural Statistics Year Book.* Edmonton, Alberta.

Alexander, V.J., Musser, W.N. and Mason, G. 1986. "Futures Markets and Firm Decisions Under Price, Production, and Financial Uncertainty." *Southern Journal of Agricultural Economics.* 18: 39-49.

Anderson, R.W. and Danthine, J.P. 1981. "Cross Hedging." *Journal of Political Economy.* 89: 1182-1196.

Ashley, R., Granger, C.W. and Schmalensee, R. 1980. "Advertising and Aggregate Consumption: An Analysis of Causality." *Econometrica.* 48: 1149-1167.

Baillie, R.T. and Myers, R.J. 1989. *Modeling Commodity Price Distributions and Estimating the Optimal Futures Hedge.* Working Paper Series CSFM #201, Michigan State University.

Bank of Canada. *Bank of Canada Review.* Ottawa.

Barry, P.J. 1980. "Capital Asset Pricing and Farm Real Estate." *American Journal of Agricultural Economics.* 62: 549-553.

Barry, P.J. and Baker, C.B. 1984. "Financial Responses To Risk In Agriculture." In *Risk Management in Agriculture.* P.J. Barry (editor). Iowa State University Press, Iowa.

Benninga, S., Eldor, R. and Zilcha, I. 1984. "The Optimal Hedge Ratio In Unbiased Futures Markets." *Journal of Futures Markets.* 4: 155-159.

Berck, P. 1981. "Portfolio Theory and the Demand for Futures: The Case of California Cotton." *American Journal of Agricultural Economics.* 63: 466-474.

Black, F. 1976. "The Pricing of Commodity Contracts." *Journal of Financial Economics.* 3: 167-179.

Blank, S.C. 1989. "Research on Futures Markets: Issues, Approaches, and Empirical Findings." *Western Journal of Agricultural Economics.* 14(1): 126-139.

Bond, E.B., Thompson, S.R. and Lee, B.M.S. 1987. "Application of a Simplified Hedging Rule." *Journal of Futures Markets.* 7(1): 65-72.

Bond, E.B. and Thompson, S.R. 1985. "Risk Aversion and the Recommended Hedging Ratio." *American Journal of Agricultural Economics.* 67: 870-872.

Bond, E.B. and Thompson, S.R. 1986. "Optimal Commodity Hedging within the Capital Asset Pricing Model." *The Journal of Futures Markets.* 6 (3): 421-432.

Boothe, P. and Longworth, D. 1986. "Foreign Exchange Market Efficiency Tests: Implications of Recent Empirical Findings." *Journal of International Money and Finance.* 5: 135-152.

Braga, F.S. 1990. *On the Relation Between Adjusted Basis and Hedge Results.* Working Paper WP90/06, Department of Agricultural Economics and Business, University of Guelph, Ontario.

Brandt, J.A. 1985. "Forecasting and Hedging: An Illustration of Risk Reduction In the Hog Industry." *American Journal of Agricultural Economics.* 67: 24-31.

Brealey, R., Myers, S., Sick, G., and Whaley, R. 1986. *Principles of Corporate Finance.* McGraw-Hill Ryerson Ltd., Toronto.

Brown, S.L. 1985. "A Reformulation of the Portfolio Model of Hedging." *American Journal of Agricultural Economics.* 67: 508-512.

Brown, W.J. 1989. *The Review of the Economies of Farm Enterprise Size and Implications for Farm Diversification.* Discussion Paper No. 360. Economic Council of Canada, Ottawa.

Buccola, S.T. 1989. "Pricing Efficiency in Agricultural Markets: Issues, Methods, and Results. *Western Journal of Agricultural Economics.* 14(1): 111-121.

Caldwell, J., Copeland, J., and Hawkins, M. 1982. "Alternative Hedging Strategies for an Alberta Feedlot Operator." *Canadian Journal of Agricultural Economics.* 30: 257-72.

Carter, C.A., Rausser, G.C. and Schmitz, A. 1983. "Efficient Asset Portfolios and the Theory of Normal Backwardation." *Journal of Political Economy.* 91(21): 319-331.

Carter, C.A. and Loyns, R.M.A. 1985. "Hedging Feedlot Cattle: A Canadian Perspective." *American Journal of Agricultural Economics.* 67: 32-39.

Cecchetti, S.G., Cumby, R.E. and Figlewski, S. 1988. "Estimation of the Optimal Futures Hedge." *Review of Economics and Statistics.* 70: 623-630.

Chavas, J.P. and Pope, R. 1982. "Hedging and Production Decisions Under a Linear Mean-Variance Preference Function." *Western Journal of Agricultural Economics.* 7: 99-110.

Chicago Mercantile Exchange. 1976-1987. *Statistical Yearbook.* Chicago Mercantile Exchange, Chicago, Illinois.

Chrystal, K.A. and Thornton, D.L. 1988. "On The Informational Content of Spot and Forward Exchange Rates." *Journal of International Money and Finance.* 7: 321-330.

Coles, H. 1989. "Risk And Returns Analysis of Beef Feedlot Investments In Alberta." Masters of Science Thesis, Department of Rural Economy, University of Alberta, Edmonton, Alberta.

Collins, R.A. 1985. "Expected Utility, Debt-Equity Structure, and Risk Balancing." *American Journal of Agricultural Economics.* 67: 627-629.

Collins, R.A. and Barry, P.J. 1986. "Risk Analysis with Single-Index Portfolio Models: An Application to Farm Planning." *American Journal of Agricultural Economics.* 68: 152-161.

Cox, J.C. and Rubinstein, M. 1985. *Options Markets.* Prentice-Hall Canada Inc., Toronto.

Danthine, J.P. 1977. "Martingale, Market Efficiency and Commodity Prices." *European Economic Review.* 10: 1-17.

Ehrhardt, M., Jordan, J. and Walkling, R. 1987. "An Application of Arbitrage Pricing Theory to Futures Markets: Tests of Normal Backwardation." *Journal of Futures Markets.* 7: 21-24

Fackler, P.L. and King, R.P. 1990. "Calibration of Option-Based Probability Assessments in Agricultural Commodity Markets." *American Journal of Agricultural Economics.* 72: 73-83.

Featherstone, A.M., Moss, C.B., Baker, T.G. and Preckel, P.V. 1988. "The Theoretical Effects of Farm Policies on Optimal Leverage and the Probability of Equity Losses." *American Journal of Agricultural Economics.* 70: 572-579.

Feder, G., Just, R.E., and Schmitz, A. 1980. "Futures Markets and the Theory of the Firm Under Price Uncertainty." *Quarterly Journal of Economics.* 94: 317-328.

Fishburn, P.C. 1977. "Mean-Risk Analysis With Risk Associated With Below-Target Return." *American Economic Review.* 67: 116-126.

Freeze, B.S., Nelson A.B., Musser W.N. and Hironaka, R. 1990. "Feeding and Marketing Portfolio Effects of Cattle Feeding in Alberta." *Canadian Journal of Agricultural Economics.* 38: 233-252.

Gabriel, S.C. and Baker, C.B. 1980. "Concepts of Business and Financial Risk." *American Journal of Agricultural Economics.* 62: 560-564.

Garcia, P., Leuthold, R.M., Fortenbery, R. and Sarassoro, G.F. 1988. "Pricing Efficiency in the Live Cattle Futures Market: Further Interpretation and Measurement." *American Journal of Agricultural Economics.* 70: 162-169.

Garcia, P., Leuthold, R.M. and Sarharn, M.E. 1984. "Basis Risk: Measurement and Analysis fo Basis Fluctuations for Selected Livestock Markets." *American Journal of Agricultural Economics.* 66: 499-504.

Gaston, C.W. and Martin, L. 1984. *Hedging Strategies to Protect The Financial Position Of Canadian Beef Feedlot Operators.* School of Agricultural Economics and Extension Education, University of Guelph, Guelph, Ontario.

Gillis, K.G., Jameson, K., and Kerr, W.A. 1989. *Hedging in International Markets: The Ramifications for Management of Beef Feedlots in Western Canada.* Discussion Paper 117, Department of Economics, University of Calgary.

Hauser, R.J. and Neff, D. 1985. "Pricing Options on Agricultural Futures: Departures from Traditional Theory." *Journal of Futures Markets.* 5: 539-577.

Hauser,R.J. and Eales, J.S. 1987. "Option Hedging Strategies." *North Central Journal of Agricultural Economics.* 9:123-134.

Hauser R.J. and Andersen, D.K. 1987. "Hedging with Options under Variance Uncertainty: An Illustration of Pricing New-Crop Soybeans." *American Journal of Agricultural Economics.* 69: 38-45.

Heifner, R.G. 1972. "Optimal Hedging Levels and Hedging Effectiveness in Cattle Feeding." *Agricultural Economics Research.* 24(2): 25-36.

Hill, J. and Schneeweis, T. 1982. " A Note on the Hedging Effectiveness of Foreign Currency Futures." *Journal of Futures of Markets.* 1: 659-664.

Hirshleifer, D. 1988. "Residual Risk, Trading Costs, and Commodity Risk Premia." *Review of Financial Studies.* 1(2): 173-193.

Holthausen, D.M. 1979. "Hedging and the Competitive Firm under Price Uncertainty." *American Economic Review.* 69: 989-995.

Holthausen, D.M. 1981. "Risk Return Model with Risk and Return Measured as Deviations from a Target Return." *American Economic Review.* 71: 182-188.

Hull, J. 1989. *Options, Futures And Other Derivative Securities.* Prentice-Hall Canada Inc., Toronto.

Johnson L.L. 1960. "The Theory of Hedging and Speculation in Commodity Futures." *Review of Economic Studies.* 27: 139-151. Reprinted in *Selected Writings on Futures Markets*, Vol 2. A.E. Peck (editor) Chicago Board of Trade. 209-222.

Judge, G.G., Griffiths,W.E., Hill R.C., Lutkepohl, H. and Lee, T. 1985. *The Theory and Practice Of Econometrics. 2nd Edition.* John Wiley and Sons, Toronto.

Judge, G.G., Griffiths,W.E., Hill R.C., Lutkepohl, H. and Lee, T. 1988. *Introduction To The Theory and Practice Of Econometrics. 2nd Edition.* John Wiley and Sons, Toronto.

Just, R.E. and Rausser, C.R. 1981. "Commodity Price Forecasting with Large Scale Econometric Models and the Futures Market." *American Journal of Agricultural Economics.* 63: 97-208.

Kahl, K.H. 1983. "Determination of the Recommended Hedge Ratio." *American Journal of Agricultural Economics.* 65: 603-605.
Kahl, K.H. and Tomek W.G. 1986. "Forward Pricing Models For Futures Markets: Some Statistical and Interpretative Issues." *Food Research Institute Studies.* 20(1): 71-85.
Kamara, A. 1982. "Issues in Futures Markets: A Survey." *Journal of Futures Markets.* 2: 261-294.
Kenyon, D. and Clay, John. 1987. "Analysis of Profit Margin Hedging Strategies for Hog Producers." *Journal of Futures Markets.* 7(2): 183-202.
King, R.P. and Robison, L.J. 1984. "Risk Efficiency Models." In *Risk Management in Agriculture.* P.J. Barry (editor). Iowa State University Press, Iowa.
Kmenta, J. 1971. *Elements of Econometrics.* Macmillan Publishing Co. Inc., New York.
Leuthhold, R.M., Garcia, P., Adam, B.D., and Park, W.I. 1989. "An Examination Of The Necessary And Sufficient Conditions For Market Efficiency: The Case of Hogs." *Applied Economics.* 21: 193-204.
Leuthold, R.M., Junkus, J.C., and Cordier, J.E. 1989. *Theory and Practice of Futures Markets.* Lexington Books, Toronto.
Leuthold, R.M. 1974. "The Price Performance on the Futures Market of a Nonstorable Commodity: Live Beef Cattle." *American Journal of Agricultural Economics.* 56: 271-279. Reprinted in *Selected Writings on Futures Markets.* 1977. Vol 2. A.E. Peck (editor) Chicago Board of Trade: 375-385.
Leuthold, R.M. 1979. "An Analysis of the Futures-Cash Price Basis For Live Beef Cattle." *North Central Journal of Agricultural Economics.* 1: 47-52.
Leuthold, R.M. and Hartmann, P.A. 1981. "An Evaluation of the Forward-pricing Efficiency of Livestock Futures Markets." *North Central Journal of Agricultural Economics.* 3: 71-80.
Leuthold, R.M. and Tomek, W.G. 1980. "Developments in the Livestock Futures Literature." In *Livestock Futures Research Symposium*, Leuthold, R.M. and Dixon, P. (editors). Chicago Mercantile Exchange.
Lindahl, M. 1989. "Measuring Hedging Effectiveness With R^2: A Note." *Journal of Futures Markets.* 9(5): 469-475.
Lintner, J. 1965. "The Valuation of Risk Assets and Selection of Risky Investments in Stock Protfolios and Capital Budgets." *Review of Economics and Statistics.* 47: 13-37.
Longworth, D., Boothe, P. and Clinton, K. 1983. *A Study of the Efficiency of Foreign Exchange Markets.* Bank of Canada.
Marcus, A.J. 1984. "Efficient Asset Portfolios and the Theory of Normal Backwardation: A Comment." *Journal of Political Economy.* 92(1): 162-164.
Markowitz, H. 1952. "Portfolio Selection." *Journal of Finance.* 7: 77-91.
Martin, L. and Garcia, P. 1981. "The Price-Forecasting Performance of Futures Markets For Live Cattle and Hogs: A Disaggregated Analysis." *American Journal of Agricultural Economics.* 63: 209-215.
Myers, R.J. and Thompson, S.R. 1989. "Generalized Optimal Hedge Ratio Estimation." *American Journal of Agricultural Economics.* 71: 858-868.
Newbery, D.M.G. and Stiglitz, J.E. 1981. *The Theory of Commodity Price Stabilization A Study in the Economics of Risk.* Oxford University Press, New York.
Peck, A.E. (editor) 1977. *Selected Writings on Futures Markets. Volume 2.* Chicago Board of Trade.
Peck, A.E. 1975. "Hedging and Income Stability: Concepts, Implications, and an Example." *American Journal of Agricultural Economics.* 57: 419-410.
Peterson, P.E. and Leuthold, R.M. 1987. "A Portfolio Approach to Optimal Hedging for a Commercial Cattle Feedlot." *Journal of Futures Market.* 7: 443-457.
Price, R.V., Morgan, T.H., Dayton, A.D. and McCoy, J.H. 1979. "Basis Variability of Live Cattle Futures At Selected Kansas Markets." *North Central Journal of Agricultural Economics.* 1: 133-139.
Ritchken, P. 1987. *Options Theory, Strategy, and Applications.* Scott, Foresman and Company, Glenview, Illinois.
Robison, L.J. and Barry, P.J. 1987. *The Competitive Firm's Response to Risk.* Macmillan Publishing Company, New York.
Rolfo, J. 1980. "Optimal Hedging Under Price and Quantity Uncertainty: The Case of a Cocoa Producer." *Journal Of Political Economy.* 88: 100-116.
Ross, S.A. and Westerfield, R.W. 1988. *Corporate Finance.* Times Mirror/Mosby College Publishing, Toronto.
Selley, R. 1984. "Decision Rules in Risk Analysis." In *Risk Management in Agriculture.* P.J. Barry (editor). Iowa State University Press, Iowa.
Shapiro B.I. and Brorsen B.W. 1988. "Factors Affecting Farmers' Hedging Decisions." *North Central Journal of Agricultural Economics.* 10(2): 145-153.

Sharpe, W.F. 1964. "Capital Asset Prices: A Theory Of Market Equilibrium Under Conditions Of Risk." *Journal of Finance*. 19: 425-42.

Shonkwiler, J.S. 1986. "Are Livestock Futures Prices Rational Forecasts?" *Western Journal of Agricultural Economics*. 11(2); 123-128.

Statistics Canada. *CANSIM*.

Stein, J.L. 1961. "The Simultaneous Determination of Spot and Futures Prices." *American Economic Review*. 51: 1012-1025. Reprinted in *Selected Writings on Futures Markets*, Vol 2. A.E. Peck (editor) Chicago Board of Trade. 223-235.

Thompson S.R. and Bond, G.E. 1985. "Basis and Exchange Rate Risk in Offshore Futures Trading." *American Journal of Agricultural Economics*. 67: 980-985.

Thompson S.R. and Bond, G.E. 1987. "Offshore Commodity Hedging Under Floating Exchange Rates." *American Journal of Agricultural Economics*. 69: 46-55.

Turvey, C.G. 1989. "The Relationship Between Hedging with Futures and the Financing Function of Farm Management." *Canadian Journal of Agricultural Economics*. 37: 629-638.

Turvey, C.G. and Baker, T.G. 1989. "Optimal Hedging under Alternative Capital Structures and Risk Aversion." *Canadian Journal of Agricultural Economics*. 37: 135-143.

Turvey, C.G. and Driver, H.C. 1987. "Systematic and Nonsystematic Risks in Agriculture." *Canadian Journal of Agricultural Economics*. 35: 386-401.

U.S. President. *Economic Report of the President*. Selected Issues.

Var Econometrics. *Regression Analysis of Time Series*. RATS Version 3.11.

Wilson, W.W. and Fung, H.G. 1990. "Information Content of Volatilities Implied by Option Premiums in Grain Futures Markets." *Journal of Futures Markets*. 10: 13-27.

Witt, H.J., Schroeder, T.C. and Hayenga, M.L. 1987. "Comparison of Analytical Approaches for Estimating Hedge Ratios for Agricultural Commodities." *Journal of Futures Markets*. 7(2): 135-146.

Wolf, A., Castelino, M. and Francis, J.C. 1987. "Hedging Mispriced Options." *Journal of Futures Markets*. 7: 147-156.

Wolf, A. 1984. "Options of Futures: Pricing and the Effect of an Anticipated Price Change." *Journal of Futures Markets*. 4: 491-512.

Wolff, C.C.P. 1988. "Exchange Rates, Innovations and Forecasting." *Journal of International Money and Finance*. 7: 49-61.

Working, H. 1953a. "Futures Trading and Hedging." *American Economic Review*. 43: 314-343. Reprinted in *Select Writings of Holbrook Working*. 1977. Board of Trade of the City of Chicago, Chicago.

Working, H. 1953b. "Hedging Reconsidered." *Journal of Farm Economics*. 35: 544-561. Reprinted in *Select Writings of Holbrook Working*. 1977. Board of Trade of the City of Chicago, Chicago.

Young, D.L. 1984. "Risk Concepts and Measures for Decision Analysis." In *Risk Management in Agriculture*. P.J. Barry (editor). Iowa State University Press, Iowa.

Appendix A Exact Parameters used in the Production Function

This appendix details the exact parameters used in the production function in the simulation and how these numbers are adjusted by different price indexes to provide costs in each month. The details of the production function especially in the area of the rates of gain and feed usage were checked with the Alberta Agriculture Beef Cattle Nutritionist[47]. There were no major adjustments required in the parameters used by Coles (1989). The major parameter values used in the production function follow.

Production Function Parameters

Parameters	Description
adg=1.48;	average daily gain in kg/head per day before shrink adjustment[48]
Bamount=.835;	barley in tonne of feeder ration based on Coles
bartran=6.5;	1988 barley transportation cost/ tonne
bedcost=.04;	bedding charge per head/day in 1987
bedding=.91;	kg straw used per day per head
Broker=75.0	Brokerage fee for hedging one contract in Dec. 1989 $
Buyer=5;	buyers charge for feeders in 1988
deathlos=.004;	steer death loss rate from Coles
distance=285;	km distance feeders trucked to feedlot
dressing=.57;	dressing percentage for steers used from Coles
feedcon=7.46;	feed conversion ratio based on 7.102 x 1.05 where the 7.102 comes for Coles (1989) - increased this ratio to account for extra feed in winter
feedproc=11.05;	1984 feed processing cost per tonne
lotsize=100;	number of 363+ kg (800+ lb) feeder steers purchased each month
Process=2.75;	feedlot processing cost/head in June 1987
ration=1.082;	factor to use to price ration using barley price
shrink=.04;	selling shrink fob feedlot
treat=6.94;	treatment cost per head in July 1978
truck=1.25;	trucking of feeders $/km per loaded km in 1987
truckcap=40;	holding capacity of truck for heavy feeders
yardage=.15;	feedlot yardage charge per head per day in 1987

The parameters are adjusted using different indexes. These adjusted production numbers are used with the price numbers to develop the simulation production function for each month. Barley transportation costs to the feed lot are adjusted using two indexes. The petroleum index times 0.33 and the motor vehicle maintenance index for Alberta times 0.67 adjust the barley transportation cost for each month. The feedlot yardage charge is adjusted by the supply and service index for Western Canada. The feed processing charge is adjusted by the supply and service index for Western Canada. The bedding cost charge is adjusted by the legume and grass production index for Western Canada. The treatment cost per animal in the feedlot is adjusted with the supply and services index for Western Canada. The feedlot processing cost for incoming animals is adjusted using the supply and services index for Western Canada. The buyer charge for purchasing feeder cattle is adjusted using the supply and services index for Western Canada. The trucking of feeders to the feedlot is adjusted by two indexes. The indexes are the petroleum index times 0.33 and the moving vehicle maintenance index for Alberta times 0.67. The brokerage fee is adjusted by the CPI. The brokerage fee for options is $50.00 per contract in December 1989 Canadian dollars. It is adjusted using the CPI.

---

47 Livestock Nutritionist. Barry Yaremcio.

48 Daily rate of gain after allowing for 4% sale shrink FOB the feedlot is 1.25 kg (2.76 lb).

Appendix B Significance Tests On Net Returns

The statistical tests used to determine whether the means of net returns reported in Chapter 5 are significantly different from zero requires further clarification. This appendix explains the test of significance used on the means. The net returns are tested for a time trend.

The tests on the mean of net returns are done using the usual t test with the sample standard deviation and sample mean. There is evidence that the data is not independent. The sample means calculated in the net returns table can be viewed as coming from the linear model:

$$Net\,Returns = \alpha i + \mu$$

where:
α is the coefficient to be estimated and if OLS is used on the model this is the usual sample mean,
i is a vector of ones and
μ is the error term.

The variance calculated using this model under OLS is the same as the usual sample variance calculation. Putting the model in this form allows the testing of autocorrelation in the data[49]. The Durbin Watson statistic can be calculated and the autocorrelation coefficient can be estimated. One selected net returns series is tested using this method for autocorrelation. This series is the net returns for the period April 1976 to December 1989 with no hedging and no NTSP.

The OLS regression of this model yields the following results:

OLS Of Net Returns Regressed On A Constant
No Hedging And No NTSP For 1976-1989

Var	Coef	Std. Error	T-Ratio	P-Value
Const.	6.02	3.57	1.68	0.09

The Durbin Watson is 0.51. However there are no tables for Durbin Watson statistics for OLS regressions on a constant. An alternative test for the significance of the autocorrelation coefficient is an asymptotic Wald test. The autocorrelation coefficient is asymptotically normally distributed as:

$$\sqrt{T}(\hat{\rho}-\rho) \overset{a}{\sim} N(0,\ 1-\hat{\rho}^2)$$

and the test statistic becomes

$$\frac{\hat{\rho}^2 T}{1-\hat{\rho}^2} \overset{a}{\sim} \chi^2(1)$$

The T is the total number of observations. The estimate of the autocorrelation coefficient, $\hat{\rho}$, 0.74, uses an OLS regression of the residuals on the same residual lagged one period. This estimator converges asymptotically to the Maximum Likelihood estimator of the autocorrelation coefficient. The Wald test statistic is 145 for the previous regression. This is significantly different from zero at the 5% level of significance.

The consequences of the autocorrelation (assuming the model is correct) is that the estimate of the mean is unbiased and the estimate of the sample variance is biased[50]. This reduces the confidence in any test of significance. This suggests two possible solutions to this problem. One solution is to determine the direction of the bias. A second solution is to estimate the same linear model (net returns regressed on a constant) using generalized least squares (GLS) that corrects for the autocor-

---

49 It should be remembered that in linear regression terms this may be a misspecified model with missing independent terms that contribute to possible bias. The test for autocorrelation may be picking up a misspecified model and not necessarily autocorrelation.

50 The observations are not independent. The assumption of independence is a crucial assumption in the usual test of significance of sample means using the sample variance.

relation. Time limitations prevent doing GLS for all the net returns numbers in the net returns tables. The GLS is done on the same selected return for the period 1976-1989 with no hedging and no NTSP in Table 7. This gives some idea of the direction of the bias. The actual estimation is an iterated Maximum Likelihood (ML) method equivalent to GLS. The results show:

Maximum Likelihood Estimation Of Mean Of Net Returns
No Hedging And No NTSP For 1976-1989
Adjusted For Autocorrelation

Var	Coef	Std. Error	T-Ratio	P-Value
Const.	6.48	8.90	0.73	0.47
auto	0.73	0.05	13.90	0.00

The estimate of the mean, 6.48, is weighted by the autoregressive structure of the estimated variance. The ML estimate of 6.48 is slightly greater than the OLS estimate of 6.02. The standard deviation estimate using ML is 8.90 versus the OLS estimate of 3.57. The OLS significantly underestimates the variance of the mean. The autocorrelation coefficient, 0.73, is significant and positive.

These results using ML adjusted for first order autocorrelation confirms the direction of bias reported by Judge et al. (1985, p. 281-282) for a model with first order autocorrelation and only one independent variable in the regression. The direction of bias of the OLS estimation of the variance in this special regression[51] is downward given the following conditions. The autocorrelation coefficient is positive. The independent variable also follows an independent first order autoregressive process and this autoregressive parameter is also positive.[52]

The autocorrelation coefficient is positive and the autocorrelation coefficient of the constant is assumed to be 1. The conclusion is that the sample standard deviation estimates for the means in the net returns tables underestimates the true standard deviations. The test to determine whether the mean is different from zero are biased towards rejection.

The direction of the bias in tests for differences between means of net returns is not clear. The direction of bias in the standard deviation of the difference between two means is downward if the two means are independent. If the two means are not independent then the covariance term enters the estimation of the standard deviation[53]. The covariance term complicates the direction of the bias. One possible solution might be to regress the differences between each observation of the two series of numbers on a constant. OLS or more likely GLS can be used in this case. Again, this is not done in this study.

The conclusion is to interpret these test with caution. Higher confidence can be placed in tests that suggest that the mean of net returns is not different from 0 since the direction of bias is towards the rejection of this hypothesis. The likely direction of bias in the tests between two means is toward rejection of the null hypothesis if the covariance term is positive. Again this would lead to the rejection of the hypothesis the means are the same when in fact the means are not significantly different.

The selected results of the net returns regressed on a time trend are shown in the following part of this section. The two periods covered are the period April 1976 to December 1989 and January 1980 to December 1989. The two situations examined are the net returns with no hedging and no NTSP and net returns for no hedging and with NTSP. The net returns are regressed on a time trend. Not surprisingly the OLS estimates show significant first order autocorrelation. The regressions are estimated again using ML correcting for the autocorrelation.

None of the time trends are significant at the 5 % level using the reported P-value. This indicates there is no linear time trend in the net returns.[54] This completes the discussion on the testing of net returns for significant differences and for a time trend.

---

51 The results on direction of bias are not generally applicable to other models.

52 The independent variable is constant in this case and can be considered to have an autoregressive parameter of 1. This particular case is not commented on by Judge et al. (1985).

53 Recall that variance of the difference between two variables X1, X2 is Var(X1-X2) = Var(X1) + Var(X2) - 2xCovariance(X1,X2).

54 The use of a time trend vector X'=1, 2, ..., T in the regression may not lead to valid statistical inference. A time trend such as X is a non stationary regressor. This violates the assumptions of the OLS or GLS models that the probability limit of X'X/T or X'Ψ^{-1}X/T converges to a constant where psi is a positive definite weighting matrix of constants (Judge, (1985)). The estimates are still unbiased. The actual asymptotic distribution of the coefficients in the model are still normal but different from the

Net Returns Time Trend

1980-1989 No Hedging and With NTSP

Var	Coef	Std. Error	T-Ratio	P-Value
const.	15.41	20.45	0.75	0.45
Trend	-0.10	0.18	-0.57	0.57
auto	0.65	0.07	9.46	0.00

1976-1989 No Hedging and With NTSP

Var	Coef	Std. Error	T-Ratio	P-Value
const.	19.24	16.51	1.16	0.25
trend	-0.13	0.17	-0.77	0.44
auto	0.72	0.05	13.28	0.00

1976-1989 No Hedging and No NTSP

Var	Coef	Std. Error	T-Ratio	P-Value
const.	21.94	16.75	1.31	0.19
trend	-0.19	0.17	-1.07	0.28
auto	0.72	0.05	13.47	0.00

1980-1989 No Hedging and No NTSP

Var	Coef	Std. Error	T-Ratio	P-Value
const.	23.32	21.15	1.10	0.27
trend	-0.20	0.19	-1.07	0.29
auto	0.67	0.07	9.82	0.00

---

estimates derived here. It seems that in practice (at least at this time) this problem is ignored. This same comment also applies to the tests for trends in the basis, and optimal hedge done elsewhere.

Appendix C Complete Hedge Results

This section reports the results of simulated hedging (selling) of live cattle futures contracts over different time periods. The 90 day hedge corresponds to the same period as the production function used in this research. The futures contracts are always closed one to two months prior to the contract expiration month.

Alberta hedge profits are in real 1981 Canadian dollars per cwt of slaughter cattle sold. The hedge involves selling live cattle futures contracts. No brokerage fees or margin costs are included. Brokers fees in 1981 Canadian dollars are approximately $0.12 per cwt. The approximate length of time of each hedge is from the Wednesday of the third week of the month to the Wednesday of the third week of the month when the contract is purchased back. All hedges are closed by December 1989. The dates used for counting a hedge in a time period are the dates the hedge position are opened.

Some time periods may have hedge profits significantly different from zero. The t value at the 5% level of significance for 44 and 119 degrees of freedom are about 2.02 and 1.98 respectively. However the hedge profits also exhibit autocorrelation. The same autocorrelation analysis and model used in Appendix B is used here. The hedge profits for the 90 day hedge length for 1976 to 1989 are regressed on a constant using OLS. The coefficient on the constant is -0.114. The estimated autocorrelation coefficient is 0.63. The Wald test statistic is 109. This indicates that the autocorrelation coefficient is significant at the 5% level.

The estimates of sample mean standard deviations are biased. Since the autocorrelation coefficient is positive and following the argument used in Appendix B, the sample mean standard deviation is underestimated. The confidence in any test on whether the means are different from zero is over stated.

The means for two selected numbers from the Alberta hedge returns are estimated adjusting for the first order autocorrelation. The 90 day hedge for the period April 1986 to 1989 and the 180 day hedge for the period 1980 to March 1986 are estimated using the ML method. The weighted mean calculation, the coefficient on the constant, is not significantly different from zero.

Alberta Hedge Profits or Losses

Period Jan. 1976-1989[1]

Hedge Length	Mean $/cwt	Std. Dev. Sample	Std. Dev. Mean	t Statistic[2]
30 day	-0.08	4.03	0.31	-0.24
60 day	-0.16	5.26	0.41	-0.40
90 day	-0.11	6.23	0.49	-0.23
120 day	0.14	6.83	0.53	0.25
150 day	0.24	7.22	0.57	0.43
180 day	0.42	7.57	0.59	0.70

Period Jan. 1980-1989

30 day	0.01	3.31	0.30	0.04
60 day	0.10	4.57	0.42	0.24
90 day	0.33	5.29	0.49	0.67
120 day	0.62	5.71	0.53	1.16
150 day	0.78	5.77	0.54	1.45
180 day	1.04	5.71	0.54	1.94

Period Jan. 1976-1979

30 day	-0.29	5.47	0.79	-0.37
60 day	-0.82	6.67	0.96	-0.85
90 day	-1.19	8.05	1.16	-1.02
120 day	-1.03	8.95	1.29	-0.79
150 day	-1.05	9.82	1.42	-0.74
180 day	-1.06	10.70	1.54	-0.69

Period Jan. 1980-March 1986

30 day	0.37	3.69	0.43	0.88
60 day	0.70	5.13	0.59	1.18
90 day	1.12	5.98	0.69	1.63
120 day	1.55	6.42	0.74	2.09
150 day	1.76	6.45	0.74	2.36
180 day	2.04	6.43	0.74	2.75

Period April 1986-1989

30 day	-0.61	2.44	0.37	-1.64
60 day	-0.95	3.17	0.48	-1.96
90 day	-1.09	3.37	0.52	-2.10
120 day	-1.10	3.57	0.56	-1.97
150 day	-1.06	3.60	0.57	-1.86
180 day	-0.90	3.26	0.52	-1.72

1. The time periods include the date of opening the hedge position by selling contracts. The number of hedges in a time period decreases as the length of the hedge increases. All hedges are closed by December 1989. Dollars are in June 1981 $.
2. T statistic is the test for the difference of the mean from 0.

90 Day Alberta Hedge Mean Calculation
March 1986 to September 1989 Adjusted For Autocorrelation

Var	Coef	Std. Error	T-Ratio	P-Value
const.	-1.13	0.79	-1.43	0.16
auto	0.42	0.14	3.00	0.005

180 Day Alberta Hedge January 1980 to March 1986 Adjusted For Autocorrelation

Var	Coef	Std. Error	T-Ratio	P-Value
Const.	2.02	1.57	1.28	0.20
Auto	0.65	0.09	7.44	0.00

The estimates using OLS, of sample mean variances in the hedging table are biased downward. The conclusion is that the Alberta hedge profits for 1, 2, 3, 4, 5 and 6 months over the periods 1976 to 1989 are not significantly different from zero.

Omaha hedge profits are in real 1982 United States dollars per cwt. of slaughter cattle sold. The hedge in this case is selling live cattle futures contracts. No brokerage fees or margin costs are included. The approximate length of time of each hedge is from the Wednesday of the third week of the month to the Wednesday of the third week of the month when the contract is purchased back. All hedges are closed by December 1989. The Omaha hedge profits are checked for autocorrelation. The hedge profits are based on the same data as the Alberta data. Therefore the data has the same autocorrelation and this overstates the confidence in the t tests on the means of Omaha hedge profits. The conclusion is that the CME live cattle contract is unbiased.

Omaha Hedge Profits or Losses
Jan. 1982 U.S. Dollars

Period Jan. 1976-1989

Hedge Length	mean	Std. Dev. Sample	Std. Dev. Mean	t Statistic[1]
30 day	-0.08	3.54	0.27	-0.27
60 day	-0.16	4.52	0.35	-0.46
90 day	-0.12	5.36	0.42	-0.28
120 day	0.11	5.83	0.46	0.25
150 day	0.21	6.15	0.48	0.44
180 day	0.38	6.39	0.50	0.76

Period Jan. 1980 to 1989

30 day	-0.09	2.84	0.26	-0.33
60 day	-0.10	3.95	0.36	-0.27
90 day	0.01	4.54	0.42	0.02
120 day	0.17	4.84	0.45	0.37
150 day	0.22	4.86	0.45	0.49
180 day	0.37	4.84	0.45	0.83

Period Jan. 1976-1979

30 day	-0.05	4.91	0.71	-0.07
60 day	-0.32	5.72	0.83	-0.38
90 day	-0.42	7.03	1.01	-0.41
120 day	-0.02	7.79	1.12	-0.02
150 day	0.20	8.55	1.23	0.16
180 day	0.39	9.14	1.32	0.30

Period Jan. 1980-March 1986

30 day	0.32	3.11	0.36	0.88
60 day	0.60	4.32	0.50	1.20
90 day	0.96	4.93	0.57	1.69
120 day	1.32	5.19	0.60	2.20
150 day	1.50	5.14	0.59	2.53
180 day	1.78	5.07	0.59	3.05

Period April 1986-1989

30 day	-0.77	2.17	0.33	-2.36
60 day	-1.31	2.87	0.44	-3.00
90 day	-1.70	3.10	0.48	-3.54
120 day	-1.94	3.22	0.50	-3.86
150 day	-2.18	3.13	0.50	-4.41
180 day	-2.34	2.88	0.46	-5.06

1. T statistic is the test for the difference of the mean from 0.

Appendix D Forecasting NTSP Pay outs

The objective of this appendix is to predict NTSP pay outs under the second prediction method mentioned in chapter 5, using the data collected for the simulation. The forecast is based on the program description in chapter 2. This forecast is compared to the forecast using 3 times the producer premium.[55] This appendix shows why the 3 times the producer premium is chosen as the NTSP forecast.

The proposed estimation method is to predict national cost and national price. With these predictions and the historical information on the 5 year average of costs and prices for the month or quarter, support levels are predicted. Then possible pay outs are predicted. Refer to chapter 2 for the description of the program.

The initial estimates look at the entire period and the linear relationship between national costs and lagged values of calf prices (East and West), bank rate, feeder prices, barley prices and the supply and services index. A simple OLS is done and the results viewed for quarterly data and monthly data. There is a strong relationship between the national cost (as estimated by the NTSP) and these variables. There is also autocorrelation and multicolinearity in the model. These are not corrected for in this part of the research[56].

There is a high degree of correlation between the national costs and the variables included in the model. The model is calculated for each month starting in the month January 1986. Complications in the calculations include the change over to monthly data from quarterly data in 1989. The model is updated each month. The general model includes the following variables.

Y=National Cost (dependent variable).
constant,
x1= Toronto str. calf price 8 month prior to sale,
x2= Edmonton str. calf price 7 months prior to sale,
x3=800+lb Edmonton feeder str. 3 months prior (90 days) to sale,
x4= open market barley price monthly average for Calgary 3 months prior to sale.
X5= bank price loan rate 7 months prior,
x6= supply and services index lagged 3 months.

Using information available at the time of the purchase of the feeder steers the national cost is estimated from this OLS regression. Linear OLS regressions are estimated to provide forecasts of national cost. Historical national costs are available from the program. Where quarterly data is used the lags are 2 quarters for 7 and 8 months and 1 quarter for 3 month lags indicated above. Quarterly data is developed from the monthly data.

The first estimates are required for cattle to be sold in April 1986. The period 1986 to December 1988 uses quarterly data in calculating support levels and 0.85 of gross margins. The period January 1989 to December 1989, uses monthly data to calculate support levels and 0.90 of gross margins. Quarterly costs are estimated using OLS and the variables listed above (plus a constant). The NTSP gives these quarterly costs. The relationship is used to estimate the coefficients for prediction. The quarterly data is estimated to get a set of coefficients for December 1985 (using the data from January 1976 to December 1985 adjusted for lags). The coefficients are used with the data available in January 1986 (adjusted for lags if required) to estimate quarterly support levels in the 2nd quarter in 1986. The regression is estimated again each month adding one new data point and dropping off the oldest data point. Within the quarter the estimate for each quarter is updated each month and for the second and third month the input variables are unweighted averages of the months in the quarter. (For example: The first month in a quarter uses only that months prices to predict. The second month uses the average of the two months. The third month will use the average of the three months.)

Monthly coefficients are estimated starting in October 1985 to provide an estimate for January 1986. The estimate uses the information from January 1976 to October 1988. The regression is estimated again each month adding one set of new data points and dropping the oldest month of data.

---

55 A fourth alternative was also explored. The investor in this cattle feeding simulation is predicting profits. The fourth alternative assumed that the NTSP would make pay outs equal to the simulations predicted losses. This method did not compare favorably with the other two alternatives explored.

56 Work on OLS NTSP pay out model was discontinued after seeing the difference in MSE between this model and the 3 x Premium model.

These estimates of national cost at the time of sale of the animals are made at the time of purchase. The five year monthly average national cost and national prices are available from the NTSP program (and these were used to calculate the quarterly national cost and national price). The national support level is then calculated for quarterly time periods:

Support=.85(National Price - National Cost) + Estimated National Cost

The estimate for monthly time period is:

Support=.90(National Price - National Cost) + Estimated National Cost

Then the estimated NTSP pay out is the Estimated National Price - Support. If this is negative then there is a pay out. The explanation of the price prediction used is covered in chapter 5. The forecast price chosen in chapter 5 is used here.

All these prices are given in $/cwt of live animal. The national cost is available from the NTSP since this a historical 5 year average. The MSEs of the two methods of predicting the NTSP pay outs per head are calculated. The MSE are shown in the following table.

Table
NTSP Prediction Mean Square Error

	OLS Estimate	3 x Premium
Root MSE	34.3	22.4
MSE	1178.8	499.3

The table indicates that the 3 x Premium gives the lower MSE. Various ad hoc methods to adjust the OLS estimate (adjusting the predicted price to reflect the National Price) reduced the MSE to 762. Statistically testing the difference of the MSE in the table presents difficulties. The MSEs are not independent. This prevents the use of tests that directly compare MSE similar to the direct F test of two independent variances.

The Ashley et al. (1980) test explained in Appendix F is used to compare the MSE of out of sample forecasts from competing models. The MSE of the NTSP prediction errors are compared using this method. The null hypothesis is that the MSE errors from the two models are not different. This is tested by checking if the coefficients are non negative and significantly different from zero. The interpretation of the test and the set up of the model changes depending on the sign of the means of the forecast errors. The model is set up with the 3 x premium as model two as shown in the Appendix F to determine if the 3 x premium model has the smaller forecast error. The means of the forecast error for 3 x premium and for the OLS estimate are 3.25 and -16.10 respectively. The negative mean is adjusted accordingly by multiplying it by negative 1 to make it positive for this test.

The usual OLS regression of this model shows significant first order autocorrelation as shown by the significant Durbin Watson coefficient of 0.31 with 45 observations. The model is estimated using ML adjusted for first order autocorrelation.

Table
Mean Square Error Test On NTSP Prediction Models

Var	Coef	Std. Error	T-Ratio	P-Value
const	16.81	18.81	0.89	0.38
X1	0.83	0.16	5.32	0.00
auto	0.83	0.08	10.09	0.00

OLS DW=0.31 Chi-Squared= 28.9 P-Value Chi=0.00
Means of Errors: 3xPrem=3.25 NTSP OLS=-16.10
(For regression NTSP OLS error vector multiplied by negative 1.)

Following Ashley et al. (1980) the coefficients of the model are both positive and one of them is significantly positive at the 5% significance level. The small sample F test for the significance of the regression is replaced with an asymptotic Chi-squared test. The Chi-squared with 2 degrees of freedom is 28.9 and this is significant at the 5% level. The coefficients are greater than 0. This rejects the null hypothesis. The 3 x premium is the better forecasting model.

NTSP model building using the data collected for the main simulation was not successful. Forecasting problems make this a difficult method to use. It does not provide superior forecasts to the 3 times premium model.

Appendix E Selective Investment Strategies - Number of Hedges or Selective Investments

The number of times hedges are placed for each selective hedging strategy and the number of times investors purchase T-Bills in the selective investment strategy are reported here. The total time period covered is 120 months.

Number of Times the Investor Hedges in Hedge Strategies

	Length of Hedge		
Strategy	1 Month	2 Month	3 Month
100% Hedge			
No NTSP			120.0
NTSP			120.0
Optimal Hedge			
No NTSP			120.0
NTSP			120.0
Selective Hedge 5%			
No NTSP	8.0	9.0	50.0
NTSP	13.0	13.0	50.0
Selective Hedge T-Bill			
No NTSP	9.0	6.0	43.0
NTSP	12.0	7.0	43.0
Selective Investment			
No NTSP			43.0
NTSP			45.0

Selective Investment-Number of Times Invest in T-Bills Instead of Feeder Cattle

	No Hedge No NTSP	No Hedge NTSP	Hedge No NTSP	Hedge NTSP
Number	76	74	77	75

Appendix F Mean Square Error Tests Of Significance

The MSE statistical test of Ashley et. al. (1980) is explained. This test is not described in the econometric texts. The test results for the price forecasting models and net returns strategies from chapter 5 are reported.

The MSE's of different models are not independent. This precludes the use of the usual small sample F test to compare variances or even the use of asymptotic tests to do the same thing. The following is one possible method proposed to compare MSE in a statistical manner. This test is used by Brandt (1985), Garcia et al. (1988) and Leuthhold, Garcia, Adam and Park (1989).

Ashley et al. (1980) proposed the following test to compare MSE between competing models forecasting the same out of sample values. Let $\hat{\mu}_1$ and $\hat{\mu}_2$ be the out of sample vectors of forecast errors from two competing models. These models predict the same price. Hypothesize that model 2 has lower forecast error than model 1. Ashley et al. (1980) use a regression equation defined as follows:

$$\hat{\mu}_{1,t} - \hat{\mu}_{2,t} = \alpha_1 + \alpha_2[(\hat{\mu}_{1,t} + \hat{\mu}_{2,t}) - mean(\hat{\mu}_{1,t} + \hat{\mu}_{2,t})] + e_t$$

where:
the mean(.) is the mean of the two forecast errors added together and
the e is an independent error term with zero mean.

Now assume that the means of the two forecast errors are positive. Test $\alpha_1 = \alpha_2 = 0$ against the alternative that both are non negative and at least one is positive. A significant negative coefficient implies that model 2 is not better. If one coefficient is negative but not significant and the other coefficient is positive and significant then model 2 is better. If both coefficients are positive an F test can be used to test if the coefficients are jointly greater than 0. Ashley et al. (1980) point out that the F test as used here in this model has a significance level equal to one half that obtained from F value tables.

If both means of the forecast errors are negative then a different interpretation can be placed on the test. The test for model 2 superiority is that the intercept term be negative and the other coefficient be positive. If one error mean is positive and one error mean is negative then the results of the test are ambiguous. Then the intercept term of the regression is only negative or positive depending on which error mean is negative. However the nature of the test should allow the multiplying of the forecast error vector with the negative mean by negative one. This then gives the same test interpretation as when both error means are positive. The question of interest is whether the errors are smaller or larger and not whether one has a negative mean or a positive mean.

This test requires an explanation of the rationale behind the test. Ashley et al. (1980) start with difference between the two MSEs.

$$MSE(\hat{\mu}_1) - MSE(\hat{\mu}_2) = [s^2(\hat{\mu}_1) - s^2(\hat{\mu}_2)] + [mean(\hat{\mu}_1)^2 - mean(\hat{\mu}_2)^2]$$

The s^2 is the sample variance of the errors. Using some algebra this expression is equivalent to:

$$MSE(\hat{\mu}_1) - MSE(\hat{\mu}_2) = Cov[(\hat{\mu}_1 - \hat{\mu}_2), (\hat{\mu}_1 + \hat{\mu}_2)] + [mean(\hat{\mu}_1)^2 - mean(\hat{\mu}_2)^2]$$

The cov(.) denotes the covariance. The estimates of the coefficients of the regression are the following expressions.

$$\hat{\alpha}_1 = \sum_{t=1}^{n} \frac{(\hat{\mu}_{1,t} - \hat{\mu}_{2,t})}{n}$$

and

$$\hat{\alpha}_2 = \frac{Cov[(\hat{\mu}_1 - \hat{\mu}_2), (\hat{\mu}_1 + \hat{\mu}_2)]}{s^2(\hat{\mu}_1 + \hat{\mu}_2)}$$

The tests on the coefficients of the regression are tests to determine if the covariance of the sums and differences of the errors is 0 and whether the mean of the difference of the errors is 0.

Multiplying one error vector by negative 1 does not change the original MSE difference expressions since everything is squared. It does change the regression coefficients. However it is the difference in absolute terms that is of importance in this test. Again some algebra shows that the change in $\hat{\alpha}_2$ by multiplying one error term by negative one does not change the sign of the coefficient but it does change the magnitude of the coefficient. Only the variance term of the calculation changes. The intercept term changes. It can now be positive or negative depending on the relative size of the errors.

This concludes the discussion on the test of Ashley et al. (1980) on MSE.[57]

Tests of Price Forecast MSE

The following tables gives the results of the tests to compare MSE on slaughter steer price forecasters using the procedure of Ashley et al. (1980). The first model in the title is considered model 2. The test is to determine whether the model 2 has smaller mean square error. Unless otherwise stated the test is estimated using ML corrected for first order autocorrelation. The chi-squared statistic is the asymptotic test for the significance of the regression that the coefficients equal 0 (Judge et al. (1985)). The first series of tests are the direct cash forecasters that do not use the futures market. The second series of test are on the forecasts that use the futures for forecasters. The final series of tests are selected comparisons between the two groups or forecasters.

Comparison of Direct Cash Price Predictions

Cash 3 Months Prior Vs. OLS Full Information

Var	Coef	Std. Error	T-Ratio	P-Value
const	-2.12	1.50	-1.41	0.16
X1	-0.17	0.03	-6.06	0.00
auto	0.86	0.05	18.61	0.000

OLS DW=0.33 Chi-Squared=39.13 P-Value Chi=0.00
Means of Errors: Cash=-0.96, OLS=-3.23

Conclusion: Cash 3 Months Prior is not a better predictor than the OLS full information. The constant is negative but insignificant. The X1 is also negative and significant actually suggesting that the OLS full information may be a superior forecaster. (Remember that with both means negative the test for model 2 superiority is that the constant be negative and that the X1 be positive.)

Cash 3 Months Prior Vs. OLS Limited Information

Var	Coef	Std. Error	T-Ratio	P-Value
const	-1.57	1.65	-.095	0.34
X1	-0.11	0.03	-3.60	0.00
auto	0.85	0.05	17.84	0.000

OLS DW=0.39 Chi-Squared=13.98 P-Value Chi=.001
Means of Errors: Cash=-0.96 OLS=2.45
Conclusion: Cash 3 months prior is not a superior price forecaster.

---

57 The authors used this test many times in this study. The test results may lead to conflicting conclusions. Most of the tests in this study require correction for first order autocorrelation. After this correction, the test results may suggest that a forecast model with a smaller MSE than another model, has significantly larger MSE than the other model.

Cash 3 Months Prior Vs. OLS Error Correction (OLS Estimation)

Var	Coef	Std. Error	T-Ratio	P-Value
const	-20.99	0.86	-24.31	0.00
X1	0.46	0.07	6.59	0.00

OLS DW=0.421 (The estimated autocorrelation coefficient is over one and the estimate is nonstationary with ML estimation to correct for first order autocorrelation.)

Means of Errors: Cash=-0.96, OLS Correct=-21.95

Conclusion: No conclusions possible given the nature of the data. The coefficient signs are the ones that lead to suggesting Cash 3 months prior is superior.

Cash 3 Months Prior Vs. Cash ARIMA

Var	Coef	Std. Error	T-Ratio	P-Value
const	-1.02	0.15	-6.98	0.00
X1	0.05	0.01	6.17	0.000
auto	0.43	0.08	5.20	0.00

OLS DW=1.26 Chi-Squared=85.90 P-Value Chi=0.00

Means of Errors: Cash=--0.96 Cash ARIMA=-1.98

Conclusion: The Cash 3 months prior is superior to the Cash ARIMA. The constant is negative, the X1 is positive and the asymptotic test for the significance of the regression is significant.

OLS Full Information Vs. OLS Limited Information

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.57	0.87	0.65	0.52
X1	0.05	0.01	3.18	0.002
auto	0.87	0.05	18.91	0.00

OLS Dw=0.27 Chi-Squared=10.59 P-Value Chi=0.01

Means of Errors: OLS Full=-3.23 OLS Limit=-2.45

Conclusion: The OLS full information may be superior to the OLS Limited Information. The constant is negative but insignificant. The X1 is positive and significant. The test for the significance of the regression cannot be used in this case since the signs of the coefficients are not in the right directions.

OLS Full Information Vs. OLS Error Correction (OLS Estimation)

Var	Coef	Std. Error	T-Ratio	P-Value
const	-18.72	0.55	-33.90	0.00
X1	0.38	0.04	9.71	0.00

OLS DW=0.36 (Autocorrelation non stationary)

Means of Errors: OLS Full=-3.22 OLS Error=-21.95

Conclusion: No test are applicable since the model has serious problems. The signs on coefficients support the superiority of the OLS Full Information.

OLS Full Information Vs. Cash ARIMA

Var	Coef	Std. Error	T-Ratio	P-Value
const	1.08	1.68	0.64	0.52
X1	0.24	0.30	7.94	0.00
auto	0.85	0.05	17.93	0.00

OLS DW=0.36 Chi-Squared=63.75 P-value Chi=0.00

Means of Errors:OLS Full=-3.23 Cash ARIMA=-1.98

Conclusion: The OLS Full Information may be superior to the Cash ARIMA predictions. The constant is positive but not significant. The X1 is positive and significant.

OLS Limited Information Vs. OLS Error Correction

Var	Coef	Std. Error	T-Ratio	P-Value
const	-19.50	0.68	-28.80	0.00
X1	0.31	0.05	6.67	0.00

OLS Dw=0.25 (Autocorrelation non stationary)
Means of Errors: OLS Limit=-2.45 OLS Error=-21.95
Conclusion: No tests are applicable to the regression. The signs of the coefficients are in the direction that suggest that the OLS limited information is the better predictor.

OLS Limited Information Vs. Cash ARIMA

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.53	1.83	0.29	0.77
X1	0.19	0.04	5.43	0.00
auto	0.84	0.05	17.07	0.000

OLS DW=0.44 Chi-Squared=29.60 P-Value Chi=0.00
Means of Errors:OLS Limit=-2.45 Cash ARIMA=-1.98
Conclusion: The OLS limited Information may be better than the Cash ARIMA. The constant is positive but not significant. The X1 is positive and significant.

OLS Error Correction Vs. Cash ARIMA (OLS Estimation)

Var	Coef	Std. Error	T-Ratio	P-Value
const	19.96	0.95	20.87	0.00
X1	-0.44	0.08	-5.62	0.00

OLS DW=0.48 (Autocorrelation coefficient non stationary)
Means of Errors: OLS Error=-21.95 Cash ARIMA=-1.98
Conclusion: No tests are applicable. The signs of the coefficients suggest that the OLS error correction is not better than the Cash ARIMA for predicting slaughter cattle prices in Alberta.
There is no direct cash price predictor of Alberta slaughter steers that is clearly superior (or at least not inferior) when compared within the group of cash predictors.

Comparison of Predictions Using Futures Prices

Basis ARIMA (constant) Vs. Average Basis

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.79	2.56	0.31	0.76
X1	0.63	1.05	0.60	0.55
auto	0.75	0.06	12.16	0.00

OLS DW=0.50 Chi-Squared=0.45 P-Value Chi=0.80
Means of Errors: Basis ARIMA (con)=0.08, Basis Avg.=-1.09
(Average Basis errors multiplied by negative 1 for regression)
Conclusion: The futures price predictor using the basis predictor with ARIMA with constant is not superior to average basis. The signs of the coefficients are both positive which is the direction required for the ARIMA Basis to be the better forecaster. The asymptotic test for the significance of the regression is not significant with a P-Value of 0.4. (The test for the significance of the regression if the signs of the coefficients are right is about 0.5 of the stated significance.) Alternatively if the test is reversed, the average basis forecast is not superior to the basis ARIMA with constant forecast.

Basis ARIMA (constant) Vs. Basis ARIMA (no constant)

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.33	2.55	0.13	0.90
X1	0.19	4.35	0.04	0.96
auto	0.74	0.06	12.12	0.00

OLS DW= 0.51 Chi-Squared=0.02 P-Value Chi=0.99
Means of Errors: Basis Ar. Con.=0.08 Basis Ar. No Con.=-0.63
(Basis ARIMA No Constant errors multiplied by negative 1 for regression)
Conclusion: The basis ARIMA with constant is not a superior forecaster than the basis ARIMA with no constant.

Basis ARIMA (constant) Vs. Basis 3 Months Back

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.11	2.56	0.04	0.97
X1	1.03	0.29	3.57	0.001
auto	0.74	0.06	12.15	0.00

OLS DW=0.515 Chi-Squared=12.77 P-Value Chi=0.002
Means of Errors: Basis Ar. Con.=0.08, Basis 3 months Pr.=-0.41
(Basis 3 Month Back Error multiplied by negative 1)
Conclusion: The basis ARIMA with constant is superior to the basis 3 months back prediction.

Average Basis Vs. Basis ARIMA (no constant)

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.49	0.36	1.38	0.17
X1	-0.001	0.01	-0.49	0.62
auto	0.85	0.05	17.38	0.00

OLS DW=0.31 Chi-Squared=2.12 P-Value Chi=0.35
Means of Errors: Avg. Bas.=-1.09, Basis Ar. No Con.=-0.63
Conclusion: The constant is positive, the X1 is negative and neither coefficient is significant. The average basis is not a superior forecaster to the basis ARIMA with no constant.

Average Basis Vs. Basis 3 Months Prior

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.71	0.42	1.71	0.09
X1	0.05	0.03	1.84	0.07
auto	0.43	0.08	5.14	0.00

OLS DW=1.21 Chi-Squared=6.35 P-Value Chi=0.04
Means of Errors: Basis Avg.=-1.09, Basis 3 Mon. Pr.=-0.41

Conclusion: The average basis is superior to the basis 3 months prior.

Basis ARIMA (no constant) Vs. Basis 3 Months Prior (Used OLS)

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.24	0.27	0.89	0.38
X1	0.05	0.02	2.40	0.02
auto	0.32	0.09	3.73	0.00

OLS DW=1.41 Chi-Squared=6.56 P-Value Chi=0.04
Means of Errors: Basis Ar. (no con.)=-0.63, Basis 3 Mon Pr.=-0.41
Conclusion: The basis ARIMA with no constant is superior to the basis 3 months prior.

The basis ARIMA with constant has the smallest MSE of the price predictors using the futures markets. The tests between the predictors using the futures prices shows no other model that dominates the basis ARIMA with constant prediction. The price prediction using the basis ARIMA with constant is now compared to all the direct cash predictors since no dominant cash price predictor was found in the previous test.

Comparison Between futures predictor with basis ARIMA with constant compared to all direct cash predictors.

Basis ARIMA (constant) Vs. Cash 3 Months Prior

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.65	2.56	0.26	0.80
X1	1.01	0.25	4.11	0.00
auto	0.74	0.06	12.16	0.00

OLS DW=0.62 Chi-Squared=16.94 P-Value Chi=0.17
Means of Errors: Basis Ar con.=0.08, Cash 3 mon. Pr.=-0.96
(Cash 3 month prior errors multiplied by negative 1)
Conclusion: The basis ARIMA with constant is superior to the cash 3 months prior at the 0.08 level of significance based of the test on the significance of the regression.

Basis ARIMA (constant) Vs. OLS Full Information

Var	Coef	Std. Error	T-Ratio	P-Value
const	2.75	2.17	1.27	0.21
X1	-0.45	0.33	-1.37	0.17
auto	0.72	0.06	11.26	0.00

OLS DW=0.59 Chi-Squared=3.54 P-Value Chi=0.17
Means of Errors: Basis Ar. Con.=0.08, OLS F.I.=-3.23
(OLS Full Information errors multiplied by negative 1)
Conclusion: The basis ARIMA with constant is not superior to the OLS full information prediction. The signs of the coefficients preclude the use of the test of the significance of the regression. The OLS full information does not dominate the ARIMA basis with constant. (The changing of the model definition changes the signs of the coefficients but no other changes occur in the regression. For example if the OLS full information is defined as model two then the regression coefficients become -2.75 and 0.45.)

Basis ARIMA (constant) Vs. OLS Limited Information

Var	Coef	Std. Error	T-Ratio	P-Value
const	2.11	2.32	0.91	0.37
X1	0.24	0.28	0.87	0.38
auto	0.72	0.06	11.50	0.00

OLS DW=0.54 Chi-Squared=1.57 P-Value Chi=0.46
Means of Errors: Basis Ar. Con.=0.08, OLS L.I.=-2.45
(OLS Limited Information errors multiplied by -1)
Conclusion: The basis ARIMA with constant is not superior to the OLS limited information prediction. The test for the significance of the regression is not significant at the 5% or 10% level.

Basis ARIMA (constant) Vs. OLS Error Correction (OLS Estimate)

Var	Coef	Std. Error	T-Ratio	P-Value
const	21.86	0.89	24.43	0.00
X1	0.54	0.08	6.96	0.00

OLS DW=0.54
Means of Errors: Basis Ar. Con.=0.08, OLS E.C.=-21.95
(OLS Error Correction errors multiplied by negative 1)
Conclusion: No test are applicable. The model did not properly estimate when corrected for first order autocorrelation.

Basis ARIMA (constant) Vs. Cash ARIMA

Var	Coef	Std. Error	T-Ratio	P-Value
const	1.73	2.74	0.63	0.53
X1	1.31	0.20	6.42	0.00
auto	0.76	0.06	12.90	0.00

OLS DW=0.60 Chi-Squared=41.49 P-Value Chi=0.00
Means of Errors: Basis Ar. Con.=0.08, Cash ARIMA=-1.98
(Cash ARIMA error multiplied by negative 1)
Conclusion: Basis ARIMA with constant is superior to the cash ARIMA based on the test for the significance of the regression.

No forecast model that directly forecasts the cash price is superior to the basis ARIMA(1,1,1) forecast model.

This concludes the MSE test on price forecast models. The general conclusions from these tests are in Chapter 5.

Tests of Net Returns MSE

The net returns MSE for the different investment strategies from the research are tested for differences using the test of Ashley et al. (1980). The first name in the title of each regression is considered as model 2. Unless otherwise stated the regressions are adjusted for first order autocorrelation using the ML procedure. The last line of each regression reports the autocorrelation coefficient. All tests are for the period of cattle sales January 1980 to December 1989 (120 months) unless stated otherwise. The first comparisons are between the base simulations of no NTSP-no hedging to NTSP-no hedging and no NTSP-100% hedging to NTSP-100% hedging for the period 1980 to 1989.

No NTSP, No Hedging Vs. NTSP, No Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.17	2.36	0.07	0.94
X1	-0.002	0.01	-0.22	0.82
auto	0.85	0.05	17.83	0.00

OLS DW=0.30 Chi-Squared=0.06 P-Value Chi=0.97
Means of Errors: Model 1=5.16 Model 2=4.58
Conclusion: No difference in MSEs. Recall that the significance of the regression chi-squared asymptotic test is not used if the coefficients have different signs.

No NTSP, No Hedging Vs. No NTSP, 100% Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.26	4.32	0.06	0.95
X1	-0.30	0.06	-4.88	0.00
auto	0.51	0.08	6.43	0.00

OLS DW=1.17 Chi-Squared=23.85 P-Value Chi=0.00
Means of Errors: Model 1=4.29 Model 2=4.58
Conclusion: The No NTSP, 100% hedging likely has the lower MSE based on the significant t statistic on X1.

No NTSP, No Hedging Vs. NTSP, 100% Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.86	4.64	0.19	0.83
X1	-0.30	0.06	-4.70	0.00
auto	0.53	0.08	6.76	0.00

OLS DW=1.12 Chi-Squared=22.09 P-Value Chi=0.00
Means of Errors: Model 1=4.96 Model 2=4.58
Conclusion: NTSP, 100% Hedging may have the smaller forecast error based on the significant t statistic on the X1.

The time period April 1986 to 1989 with and without NTSP is compared.

No NTSP, No Hedging Vs. NTSP, No Hedging April 1986 to 1989

Var	Coef	Std. Error	T-Ratio	P-Value
const	0.03	5.51	0.01	0.99
X1	-0.01	0.03	-0.31	0.76
auto	0.84	0.08	10.45	0.00

OLS DW=0.40 Chi-Squared=0.10 P-Value Chi=0.95

Means of Errors: Model 1=14.61 Model 2=13.03

Conclusion: There is no difference in the MSEs.

The conclusions for this series of tests is that the NTSP does not significantly reduce the MSE versus no participation in NTSP. The 100% hedge strategy is likely significantly different (lower) than the base simulation with no hedging.

The next set of tests compares the base simulation of no NTSP-No hedging to the different strategies. It is assumed that the most likely program at this time by a cattle producer is to enroll in NTSP and not hedge. This is compared to strategies that involve selective hedging or selective investing.

No NTSP, No Hedging Vs. No NTSP, Optimal Hedge

Var	Coef	Std. Error	T-Ratio	P-Value
const	-0.95	2.11	-0.45	0.63
X1	-0.27	0.03	-8.78	0.00
auto	0.38	0.08	4.63	0.00

OLS DW=1.28 Chi-Squared=77.35 P-Value Chi=0.00

Means of Errors: Model 1=3.38 Model 2=4.58

Conclusion: The No NTSP, No Hedging is not superior to the No NTSP, Optimal Hedge. The reversal of the test indicates that the optimal hedge has significantly lower MSE based on both coefficients are negative and the significant chi-squared test on the significance of the regression.

NTSP, No Hedging Vs. NTSP, Optimal Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	-0.94	2.09	-0.45	0.65
X1	-0.28	0.03	-8.78	0.00
auto	0.38	0.08	4.41	0.00

OLS DW=1.31 Chi-Squared=77.26 P-Value Chi=0.00

Means of Errors: Model 1=4.02 Model 2=5.16

Conclusion: The optimal hedge has significantly lower MSE based on the asymptotic chi-squared test for the significance of the regression. Recall that changing the order of the models (such as using the optimal hedge as model 2) changes the signs of the coefficients.

No NTSP, No Hedging Vs. No NTSP, Selective Hedging 5% Rule

Var	Coef	Std. Error	T-Ratio	P-Value
const	3.54	3.77	0.94	0.35
X1	-0.11	0.05	-2.41	0.02
auto	0.47	0.08	5.77	0.00

OLS DW=1.31 Chi-Squared=6.68 P-Value Chi=0.04

Means of Errors: Model 1=7.81 Model 2=4.58

Conclusion: The MSE of No NTSP, No Hedging is not lower. The evidence suggests that the selective hedge may have the lower MSE based on the t statistic of X1.

NTSP, No Hedging Vs. NTSP, Selective Hedging 5% Rule

Var	Coef	Std. Error	T-Ratio	P-Value
const	3.78	3.48	1.09	0.28
X1	-0.15	0.05	-3.06	0.003
auto	0.41	0.08	4.95	0.00

OLS DW=1.43 Chi-Squared=10.49 P-Value Chi=0.01
Means of Errors: Model 1=8.69 Model 2=5.16
Conclusion: The MSE of the selective hedge is likely the smaller MSE based on the t statistic on X1.

No NTSP, No Hedging Vs. No NTSP, Selective Hedging T-Bill Rule

Var	Coef	Std. Error	T-Ratio	P-Value
const	3.25	3.95	0.82	0.41
X1	-0.09	0.05	-2.00	0.05
auto	0.50	0.08	6.40	0.00

OLS DW=1.22 Chi-Squared=4.67 P-Value Chi=0.10
Means of Errors: Model 1=7.47 Model 2=4.58
Conclusion: The MSE of the selective hedge is likely smaller than the No NTSP, No Hedging based on the t statistic on X1.

NTSP, No Hedging Vs. NTSP, Selective Hedging T-Bill Rule

Var	Coef	Std. Error	T-Ratio	P-Value
const	3.47	3.77	0.92	0.36
X1	-0.11	0.05	-2.24	0.03
auto	0.47	0.08	5.87	0.00

OLS DW=1.32 Chi-Squared=5.85 P-Value Chi=0.05
Means of Errors: Model 1=8.33 Model 2=5.16
Conclusion: The MSE of the selective hedging strategy is likely smaller based on the t statistic on X1.

No NTSP, No Hedging Vs. Selective Investment, No NTSP, No Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	-3.49	11.38	-0.31	0.76
X1	-0.46	0.19	-2.35	0.02
auto	0.68	0.07	10.09	0.00

OLS DW=0.75 Chi-Squared=5.65 P-Value Chi=0.06
Means of Errors: Model 1=-1.94 Model 2=4.58
(Errors of this Selective Investment multiplied by negative 1)
Conclusion: The MSE of the selective investment is the smaller MSE based on the significance of the test on the regression. Recall that a P-Value on the Chi-Squared overstates the significance by at least a factor of 2 times.

NTSP, No Hedge Vs. Selective Investment, NTSP, No Hedge

Var	Coef	Std. Error	T-Ratio	P-Value
const	-4.24	11.54	-0.37	0.71
X1	-0.35	0.20	-1.74	0.08
auto	0.67	0.07	9.97	0.00

OLS DW=0.75 Chi-Squared=3.15 P-Value Chi=0.21
Means of Errors: Model 1=-1.64 Model 2=5.16
(Errors of this Selective Investment multiplied by negative 1)
Conclusion: The selective investment likely has the smaller MSE based on the test on the significance of the regression. The significance of this test is at least .105. (This is the P-Value of the chi-squared divided by 2).

No NTSP, 100% Hedging Vs. Selective Investment, No NTSP, Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	-2.71	1.58	-1.72	0.09
X1	-0.17	0.04	-4.53	0.00
auto	0.34	0.09	4.02	0.00

OLS DW=1.34 Chi-Squared=23.70 P-Value Chi=0.00
Means of Errors: Model 1=1.51 Model 2=4.29
Conclusion: The MSE of the selective investment is significantly lower based on the test on the significance of the regression.

NTSP, 100% Hedging Vs. Selective Investment, NTSP, Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	-2.62	1.42	-1.84	0.07
X1	-0.14	0.04	-4.01	0.00
auto	0.31	0.09	3.61	0.00

OLS DW=1.39 Chi-Squared=19.60 P-Value Chi=0.00
Means of Errors: Model 1=2.26 Model 2=4.96
Conclusion: The selective investment has the lower MSE based on the significance of the regression.

The general conclusion of the previous sets of tests is that the selective hedge strategies and the selective investment strategies have lower MSEs than the No NTSP, No Hedging base simulation or the NTSP, No Hedging base simulation.

The next series of tests compares the NTSP-100% Hedging to the different hedge strategies.

NTSP, 100% Hedging Vs. NTSP, Optimal Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	-1.08	2.44	-0.44	0.66
X1	-0.05	0.02	-2.38	0.02
auto	0.70	0.06	10.70	0.00

OLS DW=0.78 Chi-Squared=5.89 P-Value Chi=0.05
Means of Errors: Model 1=4.02 Model 2=4.96
Conclusion: The optimal hedging MSE is significantly smaller based on the signs of the coefficients and the test for the significance of the regression.[58]

NTSP, 100% Hedging Vs. NTSP, Selective Hedge 5% Rule

Var	Coef	Std. Error	T-Ratio	P-Value
const	3.67	1.95	1.89	0.06
X1	0.13	0.04	3.36	0.00
auto	0.29	0.09	3.31	0.00

OLS DW=1.41 Chi-Squared=14.98 P-Value Chi=0.00
Means of Errors: Model 1=8.69 Model 2=4.96
Conclusion: The 100% hedging has a significantly smaller MSE based on the test on the significance of the regression.

---

58 This conclusion requires further clarification. The MSE for the NTSP-100% Hedge is 339. The MSE for the NTSP-Optimal Hedge is 384. Yet the test suggests that the optimal hedge strategy is significantly smaller than the 100% hedge MSE. The original OLS estimate of this test had a coefficient for X1 of 0.04 with a standard error of 0.02. The adjustment for autocorrelation changed the sign on the X1 coefficient. These results suggest caution be used when interpreting and making conclusions from this test.

NTSP, 100% Hedging Vs. NTSP, Selective Hedging T-Bill Rule

Var	Coef	Std. Error	T-Ratio	P-Value
const	3.29	2.21	1.49	0.14
X1	0.16	0.04	3.62	0.00
auto	0.31	0.09	3.57	0.00

OLS DW=1.37 Chi-Squared=15.44 P-Value Chi=0.00
Means of Errors: Model 1=8.33 Model 2=4.96
Conclusion: The 100% hedge MSE is significantly smaller based on the test on the significance of the regression.

These previous tests lead to general conclusion that the 100 % hedge has a smaller MSE than the selective hedge strategies. The optimal hedge has a lower MSE than the 100% hedge strategy. It is interesting to note that the MSE for the NTSP-100% hedge is 339.0 and the MSE for the NTSP-Optimal Hedge is 384. The test for significance looks at other factors than the absolute level of the MSE.

The next series of test is between some of the different strategies. NTSP is included in the strategies.

NTSP, Optimal Hedging Vs. NTSP, Selective Hedge 5% Rule

Var	Coef	Std. Error	T-Ratio	P-Value
const	4.66	1.76	2.64	0.01
X1	0.13	0.03	3.81	0.00
auto	0.31	0.09	3.51	0.00

OLS DW=1.48 Chi-Squared=21.63 P-Value Chi=0.00
Means of Errors: Model 1=8.69 Model 2=4.02
Conclusion: The optimal hedge has significantly lower MSE based on the test for the significance of the regression.

NTSP, Optimal Hedging Vs. NTSP, Selective Hedging T-Bill Rule

Var	Coef	Std. Error	T-Ratio	P-Value
const	4.27	1.97	2.17	0.03
X1	0.16	0.04	4.36	0.00
auto	0.34	0.08	4.01	0.00

OLS DW=1.37 Chi-Squared=23.86 P-Value Chi=0.00
Means of Errors: Model 1=8.33 Model 2=4.02
Conclusion: The optimal hedge has significantly lower MSE based on the significance of the regression.

NTSP, Optimal Hedging Vs. Selective Investment, NTSP, Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	-1.53	2.33	-0.66	0.51
X1	-0.10	0.04	-2.28	0.02
auto	0.05	0.08	6.35	0.00

OLS DW=1.20 Chi-Squared=5.69 P-Value Chi=0.06
Means of Errors: Model 1=2.27 Model 2=4.02
Conclusion: The selective investment has significantly lower MSE based on the significance of the regression at 3%.

NTSP, Selective Hedging 5% Rule Vs. NTSP, Selective Hedging T-Bill Rule
(OLS Regression)

Var	Coef	Std. Error	T-Ratio	P-Value
const	-0.36	0.72	-0.50	0.62
X1	0.02	0.02	1.55	0.12

OLS DW=2.03 F(2,118)=2.40 P-Value F=0.09
Means of Errors: Model 1=8.33 Model 2=8.69
Conclusion: The selective hedging 5% rule is not superior to the selective hedging T-Bill rule.

NTSP, Selective Hedge 5% Rule Vs. Selective Investment, NTSP, Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	-6.27	2.01	-3.12	0.002
X1	-0.29	0.04	-6.49	0.00
auto	0.32	0.09	3.75	0.00

OLS DW=1.36 Chi-Squared=52.23 P-Value Chi=0.00
Means of Errors: Model 1=2.27 Model 2=8.69
Conclusion: The selective investment has a significantly lower MSE based on the significance of the regression.

NTSP, Selective Hedging T-Bill Rule Vs. Selective Investment, NTSP, Hedging

Var	Coef	Std. Error	T-Ratio	P-Value
const	-5.91	2.12	-2.79	0.012
X1	-0.33	0.05	-6.66	0.00
auto	0.29	0.09	3.35	0.00

OLS DW=1.42 Chi-Squared=52.45 P-Value Chi=0.00
Means of Errors: Model 1=2.27 Model 2=8.33
Conclusion: The selective investment has a significantly lower MSE based on the significance of the regression.

The general conclusion to this series of tests is that the optimal hedge has lower MSE than the selective hedge strategies. The selective investment has lower MSE than the optimal or selective hedge strategies.

This concludes the discussion on the tests for differences in MSE. The general conclusions on these tests are in chapter 5.

Appendix G T-Bill and TSE Calculations

This appendix explains how the real rates of return for T-Bills and the TSE 300 are calculated. This matches how the net returns in the cattle simulation are calculated. The means, standard deviations and MSE for the TSE are reported in this section. These are for comparison to other studies such as Coles (1989), if so desired. The MSE for the TSE 300 is calculated using the historical average as the predictor of future returns. This average is updated each month. The means, standard deviations and the MSE for the TSE are reported first.

Table
Real Returns for 91 Day T-Bills and the TSE 300

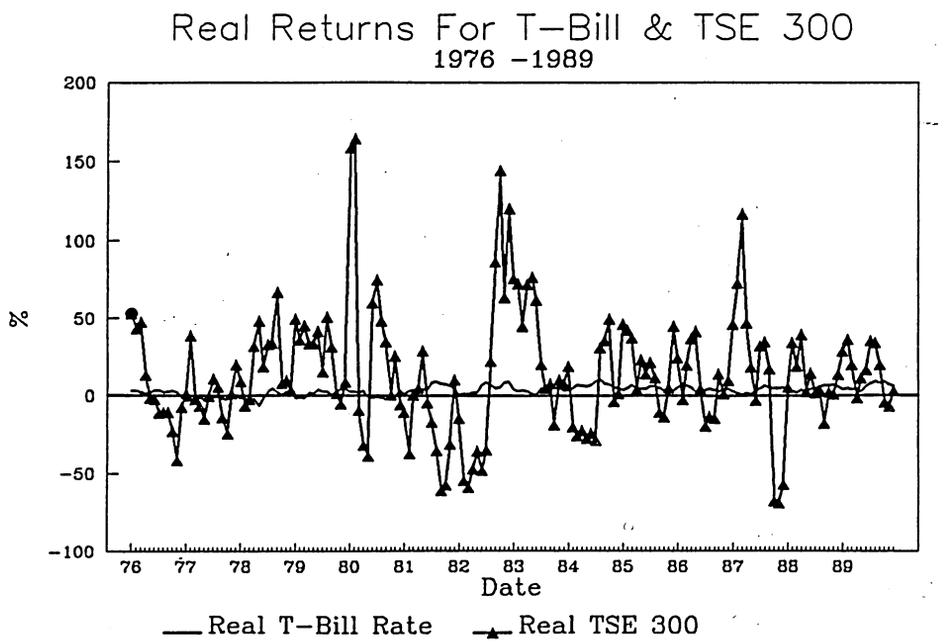
Time Period	T-Bill Returns % Annual Mean	TSE Returns % Annual Mean
1980-1989	4.74	14.04
1980-Mar86	4.67	14.85
Apr1986-89	4.87	12.68

Table
Standard Deviation And MSE For 91 Day T-Bills and the TSE 300

Time Period	T-Bill Std Dev Returns %	TSE Std Dev Returns %	TSE MSE	TSE Root MSE
1980-1989	2.60	42.83	1900.15	43.59
1980-Mar86	2.89	48.25	2891.63	53.77
Apr1986-89	2.05	32.28	1064.47	32.63

The Coles (1989) study reported a net return of 4.65% and a MSE of 1417 for the TSE 300 for the period 1973 to 1985. The T-Bill rate of return in his study was 1.41%. A graph of the calculated annual real returns used in this study for 91 day T-Bills and the TSE 300 follows.

Figure



The T-Bill and TSE data collected for this study is converted to real rates of return that match the calculations in the simulation. The method for doing this is explained here. The starting data for the 91 day T-Bill and the TSE 300 are:

TB_{t-3} is the reported nominal 91 day T-Bill rate reported as an annual rate at the time of feeder purchase.
CPI_{t-3} is the all item consumer price index.
$TSEP_{t-3}$ is the TSE stock price index for each month at the time of the feeder purchase.
$TSED_{t-3}$ is the TSE 300 dividend of monthly returns reported as a annual rate for the month of the feeder purchase.

The quarterly returns reported on an annual basis for the T-Bill are calculated as shown. The nominal quarterly T-Bill rate is:

$$TBQ_{t-3} = \left[\left(1 + \frac{TB_{t-3}}{100}\right)^{.25} - 1\right] \times 100$$

The real quarterly rate is:[59]

$$RTBQ_{t-3} = \left[\frac{1 + \frac{TBQ_{t-3}}{100}}{\frac{CPI_t}{CPI_{t-3}}} - 1\right] \times 100$$

---

59 The inflation rate could also be calculated as CPI_{t-1}/CPI_{t-4} since the investments are made in the middle of the month.

The real T-Bill rate on an annual basis over the same time period as the feeding period ending in time period t is:

$$RTBA_{t-3} = \left[\left(\frac{RTBQ_{t-3}}{100} + 1 \right)^4 - 1 \right] \times 100$$

The TSE 300 real returns are calculated by first constructing a total returns index including the capital gains and the dividends. The monthly capital gains on the TSE in percent per month is:

$$MTSEP_{t-3} = \left(\frac{TSEP_{t-3}}{TSEP_{t-4}} - 1 \right) \times 100$$

The monthly dividend return in percent per month is:

$$MTSED_{t-3} = \left[\left(1 + \frac{TSED_{t-3}}{100} \right)^{\frac{1}{12}} - 1 \right] \times 100$$

The total monthly returns combines the capital gains and the dividends.

$$MTRTSE_{t-3} = MTSEP_{t-3} + MTSED_{t-3}$$

A monthly returns index is now constructed. Let time period 0 equal 1000. The rest of the index is calculated as follows.

$$Period_0 = 1000$$

$$Period_1 = Period_0 \times \left(\frac{MTRTSE_1}{100} + 1 \right)$$

$$Period_2 = Period_1 \times \left(\frac{MTRTSE_2}{100} + 1 \right)$$

etc.

The nominal quarterly returns over the feeding period ending at time t is calculated from the total returns index.

$$NTSEQ_t = \left(\frac{Period_t}{Period_{t-3}} - 1 \right) \times 100$$

The real quarterly and real annual TSE rate of return are calculated.

$$RTSEQ_t = \left[\left(\frac{\frac{NTSEQ_t}{100} + 1}{\frac{CPI_t}{CPI_{t-3}}} \right) - 1 \right] \times 100$$

$$RTSEA_t = \left[\left(1 + \frac{RTSEQ_t}{100} \right)^4 - 1 \right] \times 100$$

This completes the calculations of the real rates of return for the 91 day T-Bill and the TSE 300.

Appendix H ARIMA Forecasting Models

Samples of the ARIMA models estimated in this study are presented here. ARIMA models are relatively easy to estimate with the statistical packages available. The ARIMA models used in this study have the following problems. Each ARIMA model is estimated 120 times. This suggests that the model should be identified and tested each time period. This is not done. The model estimation sometimes has difficulty converging in different time periods. This would suggest either a different numerical calculation method or a different model specification. This is not done here. This may be an area that could use more research.

The following are ARIMA models estimated in this study. These are models estimated for the period 1976 to September 1989. The data output is from the RATS statistical package (Var Econometrics).

ARIMA(1,1,1) With Constant For Alberta Basis in Nominal Cdn $[1]

NO.	LABEL	LAG	COEF	STAND. ERROR	T-STATISTIC
1	CONSTANT	0	-0.038	0.038	-1.01
2	AR	1	0.38	0.86	4.36
3	MA	1	-0.91	0.04	-24.12

1. AR is autoregressive and MA is moving average.

R Squared 0.27
DURBIN-WATSON 1.95
Q(36)= 43.47 SIGNIFICANCE LEVEL OF Q 0.183181

The Q statistic is a measure of autocorrelation in the model using in this test up to 36 lags.

ARIMA(1,1,1) No Constant For Alberta Basis Nominal Cdn $

NO.	LABEL	LAG	COEF	STAND. ERROR	T-STATISTIC
1	AR	1	0.36	0.09	4.07
2	MA	1	-0.90	0.04	-21.04

R Squared 0.27
DURBIN-WATSON 1.95
Q(36)= 44.12 SIGNIFICANCE LEVEL OF Q 0.17

ARIMA(1,0,1) with constant for Omaha Basis in US $ Nominal With Constant

NO.	LABEL	LAG	COEF	STAND. ERROR	T-STATISTIC
1	CONSTANT	0	-0.90	0.35	-2.56
2	AR	1	0.42	0.15	2.77
3	MA	1	0.060	0.17	0.36

R Squared 0.22
DURBIN-WATSON 1.98463315
Q(36)= 82.48 SIGNIFICANCE LEVEL of Q 0.17

ARIMA(1,1,1) with constant For Alberta Cash Steer Price in Nominal Cdn$

NO.	LABEL	LAG	COEF	STAND. ERROR	T-STATISTIC
1	CONSTANT	0	0.23	0.33	0.71
2	AR	1	0.017	0.49	0.035
3	MA	1	0.15	0.48	0.30

R Squared 0.94
DURBIN-WATSON 1.99
Q(36)= 107.58 SIGNIFICANCE LEVEL OF Q 0.47E-08

Appendix I Basis Testing

An analysis of the Omaha basis similar to that of the Alberta basis is presented in this appendix. This allows further comparisons between the basis faced by the Alberta investor and the Omaha investor. Further discussion on the autocorrelation in the Alberta basis variance test from Chapter 5 completes the Appendix.

Omaha basis is checked for trend and seasonality using the same form of model used to test the Alberta basis. The trend analysis is done using the ML estimator adjusted for first order autocorrelation since the OLS estimate of this model has a Durbin Watson statistic of 1.11 which is significant at the 5% level. The Omaha basis is first adjusted to January 1982 U.S. dollars using a GNP deflater. No significant trend is detected. There appears to be seasonality in 4 months at the 5% level of significance. This suggests that a different method of basis forecasting be tried.

Table
Omaha Nearby Trend and Monthly Seasonality Test Adjusted For First Order Autocorrelation

Var	Coef	Std. Error	T-Ratio	P-Value
constant	-1.10	0.87	-1.27	0.21
Trend	0.006	0.006	0.94	0.35
Jan.	0.31	0.72	0.43	0.67
Feb.	-1.88	0.85	-2.20	0.03
Mar.	-1.70	0.90	-1.88	0.06
April	-0.75	0.93	-0.81	0.42
May	0.40	0.93	0.43	0.67
June	2.38	0.94	2.55	0.01
July	1.30	0.93	1.39	0.17
Aug.	0.47	0.92	0.51	0.61
Sept.	-0.77	0.90	-0.86	0.39
Oct.	-2.12	0.85	-2.50	0.01
Nov.	-1.71	0.71	-2.43	0.02
auto	0.44	0.07	6.40	0.00

The mean of the basis for the past three years for the month is forecast by averaging the basis for that month in the three previous years. This forecast is based on the trend and seasonality results. For example, an average of the basis from February 1980, 1981, and 1982 is the forecast for February 1983. Omaha basis is also forecast by estimating a historical mean updated each month. Both these mean forecasts are done in January 1982 U.S. dollars. An ARIMA(1,0,1) with constant using nominal basis is identified using the autocorrelation plots, partial autocorrelation plots and the residual plots. The ARIMA forecasts are then converted to January 1982 U.S. dollars. It is interesting to note that the Omaha basis is considered stationary and no differencing is required in the model estimation. This contrasts with the Alberta basis ARIMA models that required first differencing. The reasons for this may be different inflation rates or some other unknown factor. The final forecast is basis in time period t to forecast basis in time period t+3 in January 1982 U.S. dollars.

The basis forecasts are used with the CME live cattle futures contract to forecast price. Another Omaha slaughter steer price forecast is to use the cash price at time t to forecast time period t+3. The results of one of the ARIMA models estimated for the Omaha basis are in Appendix H. The MSEs for five 3 month price predictors for Omaha are presented for information and comparison. All MSE are calculated in real 1982 U.S. dollars.

The F tests in Chapter 5, section 5.9, comparing Alberta basis variance from 1976 to 1980 to basis variance from 1985 to 1989 may be unreliable because of autocorrelation. A test for autocorrelation on the sample basis is done following the discussion in Appendix B. The time period covered is 1976 to 1989. The autocorrelation estimate from the OLS model (Alberta basis regressed on a constant) is 0.46. The asymptotic Wald statistic on the autocorrelation is 45, which is chi-squared with one degree of freedom. This is significantly different from zero at the 5% level. The same results for the Omaha basis (in U.S. $) is an autocorrelation coefficient of 0.47 and an asymptotic Wald statistic of 47.

Table
MSE Of Price Forecasts
Omaha MSE On Price Prediction - 3 Month Forecasts (1982 US $)

	Cash 3 Mon. Prior	ARIMA Basis	Average Basis	Average Basis For Mon. From 3 Past years	Basis 3 Mon. Back
MSE 80-89	23.49	25.74	26.95	28.93	25.54
1980-Mar86	29.22	33.01	34.18	35.37	30.95
Apr86-89	14.39	14.11	15.40	18.74	17.01

These results pose two possible problems for the tests between variances. The first problem is that the sample population of basis is not independent. This problem is solved by separating the two time periods in the test by four years. This minimizes any autocorrelation dependence between the two periods. The second possible problem is bias in estimating the sample variance. The test results do not change when the sample variances are estimated again using ML corrected for autocorrelation. The same F statistics for Alberta basis and Omaha basis are 3.19 and 1.49 if the sample standard deviations are estimated using ML adjusted for first order autocorrelation. There is no change in the conclusions from the tests. Alberta basis is less variable in the period 1985 to 1989. The Omaha basis variability is the same in 1985 to 1989.