Price Incentives for Resource Quality Investments: A Hedonic Study of Agricultural Land Markets in Quebec's Agricultural Regions 5,6,7, and 10

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March 1996

A Thesis submitted to the

Faculty of Graduate Studies and Research

in partial fulfillment of the requirements of the degree of

Master of Science in Agricultural Economics

ISBN 0-612-12231-X

Short Title:

Price Incentives for Resource Quality Investments in Agricultural Land

ABSTRACT

Public concern for the intergenerational transfer of natural resources has generated an interest in sustainable development and sustainable agriculture. Policy makers have a new mandate to insure the promotion of sustainable agriculture. At the same time these policy makers must also reduce public expenditures in agriculture. These two conflicting mandates can only be accomplished when private market values for various soil conservation investments are known. Once this market information is known, policy makers can formulate appropriate policies to achieve both goals.

The focus of this research is to measure the significant factors affecting land values in the study area. The sample farm sales data used were drawn from four of Québec's twelve agricultural regions. Two of these regions are among Québec's most productive. These data were used in conjunction with a Hedonic Pricing Model for the analysis.

This research seeks to quantify the implied price paid for land characteristics, soil conservation and capital improvement investments. The research should determine whether the studied land market provides adequate price incentives for private market implementation of soil conservation and capital improvement investments. These investments are necessary to achieve a sustainable agriculture scheme.

RESUME

La prise de conscience publique concenrant le transfert des ressources naturelles envers les générations futures a suscité un intérêt pour l'agriculture et le développement durables. Les responsables de la politique publique ont le nouveau mandat d'assurer la promotion de l'agriculture durable . En même temps, ils doivent réduire les dépenses publiques dans le secteur de l'agriculture. Ces deux mandats sont en conflit et ne peuvent être assurés qu'à la condition que des valeurs de marché privé pour des investissements en conservation des sols soient connues. Une fois cette information disponible, les responsables peuvent formuler les politiques appropriées pour atteindre ces deux objectifs.

L'objectif de cette recherche est de mesurer les facteurs les plus significatifs qui affectent la valeur de la terre dans la zone d'étude. Les données de vente d' exploitations ont été échantillonnées à partir de deux des douze régions agricoles du Québec. Deux de ces régions sont parmi les plus productives de la province. Ces données ont été utilisees dans le cadre d'un modèle hédonique de formation des prix.

Cette recherche tente de quantifier le prix implicite des caractéristiques pédologiques et des investissements pour la conservation des sols et l'amélioration du capital-sol. La recherche devrait déterminer si le marché des terres étudié fournit des incitatifs de prix adéquats pour des investissements privés en matière de conservation des sols et d'amélioration du capital-sol. Ces investissements sont nécessaires pour assurer la diffusion de l'agriculture durable.

Acknowledgments

I would like to acknowledge my thesis advisor and a person whom I cherish as a friend, Professor Paul J. Thomassin. His encouragement and ideas about the subject, my studies, and life in general often helped in the times when they were most needed.

I would also like to thank all the other professors in the Department of Agricultural Economics at Macdonald Campus for their patience with me while I metamorphosed from private citizen to student and finally to researcher. It is not every faculty that demonstrates such a high level of student support as I have experienced at the Agricultural Economics Department of McGill University. Finally, I would like to thank the faculty secretaries, Janet and Pat for their copious humour.

To Mr. Chamberlin at SITE for his information and insight about how the real estate market appraises land for value. I would also express my thanks to the people at MAPAQ for the funding of this project. Such support is both important and necessary for enlightened policy making. Furthermore, I would like to thank the people of the OCAQ who had started to collect the base data so essential to this type of project. I hope this study will help promote the information generating processes. This essential process is at the core of informed decision making in any enterprise, public or private. It helps forward looking organization to better manage their limited resources.

At the end of the day, research and the information generated from it helps save limited resources and directs them to their next highest and best use.

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Chapter 1.

Introduction

1.1 The Sustainability Paradigm

As communication and information systems improve, humankind's knowledge about the planet's natural resources becomes more comprehensive. Unlike the past, there are fewer new frontiers to exploit. Our planet is finally being recognized for what it is, an enclosed biosphere. Given a static time frame, natural resources are finite within this enclosed biosphere. However, these resources are not finite when changes in technology are considered. Erich Zimmerman developed the concept of "Phantom Resources." These phantom resources are a product of the remaining unused resources times the efficiency gains from new technologies. This technological change has the net effect of expanding the natural resource base (Becht and Belzung, p.63, 1975).

Still there is a concern within society for the apparent loss of quality agricultural soils. Society has been sensitized by the soil losses of the "Dust Bowl Era" and the diminishing top soil depth of western prairie soils. As a result, soil conservation has become a global issue.

It is possible to change soil resource consumption rates by utilizing new technologies or by changing the way crops are grown in soil based agriculture. However, there is a general perception within society that alternatives to soil based agriculture are few and far from being feasible. One general perception is that non soil based agriculture might not be as nutritious and may even have health compromising effects. Another perception is that it is uneconomical when compared to soil based technologies. Given these perceptions the resulting concern for soil conservation appears natural and socially important.

In Canada, the concern for agricultural sustainability culminated in the creation of the Science Council's Committee on Sustainable Agriculture during 1990-91. Several discussion papers resulted from this initiative. Most of the problems and concerns in Canadian agriculture are outlined in the Science Council's publication entitled "It's Everybody's Business: Submission to the Science Council's Committee on Sustainable Agriculture." Within this publication soil degradation was considered to be the primary challenge to sustainable agriculture in Canada. (Science Council of Canada, p. 12, 1991).

In Québec, sustainable agriculture is being adopted as a goal for the agricultural sector. The problem of soil degradation, as with any problem, needs to be defined before solutions can be found. The task of defining these soil degradation problems, on Québec agricultural lands, has been accomplished by Tabi et al in their publication entitled "Inventaire des

Problèmes de Dégradation des Sol Agricoles du Québec" (Tabi et al. 1990). This study respects the Québec Department of Agriculture's twelve distinct agricultural regions and ranks soil degradation problems within each region in order of severity.

1.2 Social Goals and Properly Functioning Markets

Social goals refer to the collective interests of individuals within a society. When a market system is functioning properly it generates price signals that provide economic incentives for individual decision makers to invest in the same activities that provide for societal goals. Markets fail when these incentives are missing or insufficient to provide for society's collective interests. When the latter occurs government intervention may be desirable. Government intervention may be used to assure conservation and is justifiable under three conditions. These three conditions were enumerated by Arthur Bunce and referenced in Barlowe's "Land Resource Economics" 3ed. 1978, page 261.

> "...social action to achieve conservation is desirable: (1) when it would be economic for the individual entrepreneur to conserve but he does not; (2) when conservation is not economic for the individual but is economic for society; and (3) when intangible ends desired by the majority of individuals in a democracy can be attained only by collective action."

This research seeks to investigate whether price signals exist for soil conservation investments. If these price signals are either missing or insufficient, then the market system will provide a sub-optimal level of soil conservation to meet society's collective interest.

1.3 Soil Conservation, Land Markets and Market Failure

Agricultural sustainability implies the prevention or minimization of soil degradation. It can also mean setting aside agricultural lands for use by future generations. Therefore, within the context of this document, agricultural sustainability and soil conservation are synonymous. Sustainable agriculture has become a social goal for both world and local communities (World Commission on Environment and Development 1987, Damsker, 1991).

The current economic situation, however, has caused most levels of government in Canada to observe fiscal restraint with respect to program spending and creation. This fiscal restraint goal requires that policy makers make judicious decisions with respect to public expenditures. Policies that result in spending on soil conservation programs must be preceded with the knowledge that the private market incentives to invest in soil conservation are insufficient or missing.

If incentives for soil conservation are not being provided by the private sector, then the public sector must decide whether to create policies that foster the creation of a market for soil conservation investments. This new market must include measurable benefits for soil conservation investments if a private market solution is to work.

Agricultural producers marginalize between their production inputs in order to maximize profits. If agricultural producers can measure the benefits of soil conservation investments then they can marginalize between the costs and benefits of an additional unit of soil conservation. Once the benefits of soil conservation investments are known, then a market for soil conservation investments can be created. If a market can be established, then a set of pareto efficient prices can be generated for soil conservation that will result in pareto efficient allocation of resources. These pareto efficient prices would provide the proper incentives for agricultural producers to incorporate soil conservation into their production input decisions.

Agricultural sustainability with respect to soil conservation helps ensure the possibility that future generations can meet their nutritional needs using agricultural land based technologies as their primary means of production. In this text soil conservation pertains to the act of creating favourable conditions that minimizes or avoids soil degradation. Soil conservation investments include man-made physical devices, altering natural structures, cropping schemes and favourable cropping practices and procedures.

Agricultural and land markets are said to be operating efficiently when all costs and benefits occurring from these investments are known and decision makers are *marginalizing* among their inputs to maximize profits. Therefore if soil conservation costs are to be incorporated into a private market decision makers' cost function, they must know both the costs and the benefits of such investments. Once the net benefit from an additional dollar of soil conservation investment is known the investment will be evaluated as compared to investments in other inputs.

The costs associated with soil conservation investments are tangible. The decision maker has no difficulty in measuring them. It is knowledge and the valuation of the benefits accruing from soil conservation investments that are more difficult to quantify. Part of this difficulty originates from risk and uncertainty about the future. Even with this difficulty the decision maker has the ability to estimate a personal value for each additional unit of soil conservation investment (van Kooten Chpt 10, 1993).

1.4 Methods of Land Valuation

The value a decision maker places on a soil conservation investment should be measurable at any given point in time. This value is made up of immediate and discounted future gains in productivity as a result of investment. When the land resource is transferred the remaining discounted future gains in productivity should be capitalized into the sale price of the land resource. Economic theories about land valuation define land prices as a function of the various characteristics of the land. Depending on the theory, different characteristics are important.

With respect to agricultural land markets there are two principal models of land valuation. The first and more traditional model is the Capital Asset Pricing Model. The second model is referred to as a Hedonic Pricing Model. The type of model to be used in the analysis is dependent on the type of question being asked. This research utilizes a hedonic pricing model, but the distinction between the two models and appropriateness of this choice will be explored in the literature review.

1.5 Problem Statement

This research seeks to measure the market value of soil conservation and capital investments. Both of these characteristics are non-priced characteristics with respect to the transfer of agricultural land. Using a hedonic pricing model, implicit prices will be estimated for the characteristics of agricultural land within the studied market. The problem statement for this research is: **Does the market provide positive returns for the existence of soil conservation and capital improvement investments in the purchase price of agricultural land?** If the characteristics of soil conservation and capital improvement investments can be identified then it should be possible to attribute implicit prices to the existence of soil conservation and capital improvement investments.

1.6 Testable Hypotheses

Hedonic pricing models have the capacity of attributing implicit market prices amongst the good's characteristics. If the market values soil conservation and capital improvement investments then there should be positive implicit prices for those characteristics. These positive implicit prices for investing in soil conservation and/or land improvements are an indication of a recognized benefit accruing from such investments.

Measured characteristics are divided into four groups: (1) physical characteristics such as size, slope, accessibility, location to markets, social centers or to the owners home, (2) quality characteristics such as level of available nutrients, pH, and organic matter, (3) the quantity of capital improvements and, (4) the presence of soil conservation investments. The first hypothesis to be tested is: **The purchase price of land is a function of its' physical, quality, capital improvements, and soil conservation characteristics.**

Physical characteristics are easily known and measured. The quality characteristics of an agricultural land purchase are more difficult to measure. Decision makers are seldom privileged with complete information about the property's ability to produce when purchasing land. This lack of information about the productivity of a given parcel of land creates a need for a measurable proxy for soil quality. Agricultural decision makers often use soil analysis for production input decisions to alter poor soil conditions that affect soil quality. The second hypothesis to be tested is: **Conventional measures of soil quality such as pH, potassium, phosphorus, calcium, magnesium, and organic matter can serve as proxies for actual production records.**

Capital improvements for the most part are self evident except in the case where either the previous condition was not known or the investment is not clearly observable as in the case of drainage. Given the limited number of observations and the capital improvements most frequently applied in the study area the third hypothesis to be test is: **Drained hectares of arable agricultural land receive a premium as compared to non-drained land.**

Intensive farming breaks down the structure of the soil and reduces organic matter in the soil making it susceptible to wind and water erosion. A healthy, well managed, and conserved soil is less susceptible to soil degradation forces of compaction, wind and water erosion. This resistance is due in large part to its' structure, organic matter content and the limited exposure to large machinery. The structure and permeability of the soil also allows it to resist water erosion. Therefore the fourth hypothesis to test can be stated as: **Organic matter content and Water Stable Aggregates measurements can serve as proxies for soil conservation investments.**

1.7 Hedonic Pricing Models

Given the fact that the value of an agricultural land purchase is a function of its characteristics it will be possible to estimate the implicit price paid for each given characteristic. Other assumptions that must be met are that the market is perfectly competitive and that the amount of each characteristic is varied amongst observations within the market. All characteristics that attribute value to the good must be measurable and included within the model. If these conditions are met then it is possible to use a hedonic pricing model and have reasonable confidence in the estimates that it generates.

Hedonic pricing models are capable of generating implicit prices for studied characteristics of a heterogeneous class of good within a defined market. In this research the class of good is agricultural farmland and the studied characteristics are its physical, quality, soil conservation, and capital improvement characteristics. A note of caution is that care must be taken in defining the market. If the market is ill defined then the estimates could be suspect. The results of the first stage of a hedonic pricing model are estimates of implicit prices for the measurable characteristics. In the process the characteristics that are important to the studied market are discovered. The hedonic price function yields the implicit value for the characteristic on a theoretically mean sized land purchase.

1.8 Justification for the Study

Society has expressed a concern about the ability of future generations to achieve an equivalent standard of life as previous generations using land based agriculture. This concern has been documented in the book "Our Common Future" (World Commission on Environment and Development 1987). This concern for future generations' right to inherit a quality environment has culminated in actions and activities referred to as sustainable development and sustainable agriculture.

Soil conservation is an integral part of sustainable agriculture. Incentives must be provided by either public or private means to ensure the sustainability of land based agriculture. The present state of public finances makes it difficult to finance an uninformed public policy solution to check soil degradation. Therefore, in order to create an efficient policy there exists a need for information on private markets to gauge whether public policy is necessary and what form it should take.

Private markets are created when there is a scarcity of an economic good. Society's ability to sanction and control a market is a result of its ability to establish and control property rights. These property rights are responsible for what constitutes a cost and a benefit within the market. Perfectly competitive markets result in market participants who are highly efficient. Agricultural producers function in a perfectly competitive market and must be efficient in order to be viable. This level of efficiency translates into accepting only the costs that are legally mandated and enforceable by the public sector (Randall Chpt. 8, 1987). Therefore, if public policy is desirable in order to achieve agricultural sustainability it must be designed carefully so that it has the characteristics of efficiency and high compliance with minimum enforcement cost.

Efficiency in public policy design requires knowledge about market prices. If prices are sufficient to induce the provision of soil conservation then public policy is unnecessary. This study seeks to quantify the market prices for soil conservation investments and improved soil quality characteristics.

Chapter 2.

Literature Review

2.1 The Dual Purpose of Land

Land has both productive and income generating properties. Therefore it is valued as a production input and as an investment vehicle. Valuation on either basis does not preclude considerations for the other (Barlowe chap. 10, 1978).

Land values are a function of the income beyond production costs that they can generate. The value of land is considered to be the discounted value of the future stream of revenues that the land can generate. The future stream of revenues is composed of gross receipts plus resale value minus the costs of owning and selling the land such as depreciation, maintenance costs, capital improvements, property taxes, capital gains taxes, etc. (Alston 1986, Featherstone and Baker 1987, Falk 1991, Just and Miranowski 1993). This discounting is caused by two factors; the first is the time value of money and second is the uncertainty of the future cash receipts.

The latter, the uncertainty of future cash receipts, is increased with extreme exploitation of the land resource. This over exploitation is sometimes referred to as "land mining" (Baker and Thomassin 1991). Land mining affects the ability of the land resource to continually produce and is contrary to sustainable agricultural practices that insure continual productivity over time. Land mining affects land prices when the productive top layer of soil is less than the plant's root zone (Gardner and Barrows 1985, van Kooten p.25-27, 1993).

Conservation has been defined as the wise use of resources over time. Arguably, this statement is normative in the terms "wise" and "time." S. V. Ciriacy-Wantrup defines conservation both more succinctly and in economic terms as the redistribution of use rates into the future (van Kooten p.166-168, 1993). With respect to agricultural production, a conserved land resource should not experience a diminution of productivity over time if properly conserved.

The agriculturally productive layer of the land resource is generally referred to as the "root zone" by plant biologists. If the productive layer is deeper than the root zone then it is economical to exploit this buffer of productive soil (Gardner and Barrows 1985, van Kooten p.25-27, 1993). Once the productive layer becomes equivalent to or less than the root zone the soil requires nutrient inputs to support plant production. Whether or not it will stay in production, depends largely on the costs of these inputs and the receipts that the production generates.

The market value of the land resource also affects production decisions. When the return to investment of sale proceeds are greater than the income from production the decision maker will make the marginalizing choice and sell the land resource (Barlowe p15, 1978). Competing non-agricultural uses will also impact on land value depending on the socio-economic factors that impinge on the land market, such as zoning, population density, closeness to transportation corridors and tourist sites, etc. (Barlowe p 16-18, 1978).

When a reduction in the productivity of the land resource is noticeable, the producers must make the decision to add capital inputs, stop production, or sell the property for its salvage value. Capital investments include fertilizers, land improvements, and soil conservation investments in order to maintain or increase the soil's productivity. Van Kooten describes the relationship between land rents and soil depletion as the interaction of four distinct economic aspects: the Perdurable Matrix, The Conservable Flow, The Revolving Fund, and the Expendable Surplus (Van Kooten p. 24-29, 1993).

Perdurable matrix consists of factors that render a *flow resource* more economically productive than a comparable land resource without the matrix factor. In this case the productivity of the flow resource is not in any danger of being depleted, but due to its nature, either physically, politically, or logistically, it is relatively more economical than the same resource elsewhere. The example given by van Kooten is two similar farms in the same location. One farm is more productive than the other due to the salinity of its soils. In this case the perdurable matrix factor is salinity and its value is the difference in economic return between the two farms on a per unit basis (van Kooten p.25, 1993).

The Conservable Flow refers to *flow resource* items that are within the critical zone of optimal productivity. Their presence creates benefits beyond the costs of conservation, thereby inducing conservation investment. Van Kooten uses humus and topsoil as examples. If the cost of protecting topsoil in the present is relatively less than the present value of future returns then it is worth the investment in this component of the conservable flow (van Kooten p. 26, 1993).

The Revolving Fund is a *stock resource* component of land. The example given by van Kooten is soil nutrients. They are not harvested directly but are essential to agricultural production. As such it is in the producer's interest to replenish these elements from some other source. The replenishment decision is based on an opportunity cost decision between their replacement and reduced production (van Kooten p.27, 1993).

Finally, the Expendable Surplus is a *stock resource,* and is referred to by van Kooten as the finite fund of the land resource. As its description implies, the expendable surplus can be extracted to a given level without affecting agricultural productivity. However, there is a cost associated with this extraction and it is referred to by van Kooten as a depletion charge. This component of land rent is equal to the income from the sale of the surplus minus the depletion charge. Initially this depletion charge is minor as the reserve of expendable surplus is at its greatest, but as extraction continues the remaining reserves of expendable surplus decreases and its associated depletion charge increases (van Kooten p.28, 1993).

2.2 Land as an Investment Vehicle

Investors in real estate regard their investment as capital instead of a factor of agricultural production. The criteria for investment in a land resource is based on a return on investment principle. They are cognizant that land rents arise from combining land and other inputs toward the creation of an agricultural output, but they are not necessarily interested in the agricultural process themselves. Moreover, real estate investors are prone to sell their agricultural properties if the rent that they extract does not meet or exceed returns from other investments (Barlowe p.177, 1978).

The extreme case, land speculation, would have land investors holding on to a land resource for a short term economic loss. They hold on to the land resource until its expected transformation into its next highest and best use. Once this occurs they gain from its associated increase in land rents (Barlowe p.201-202, 1978).

Land rent occurs when the chosen production results in an economic surplus referred to as land rent. Instead, land investors consider land as a capital good to be exchanged like any other commodity and for which they expect comparable returns to any other investment (Barlowe p.330-333, 1978). This type of real estate investment allows for the successful use of the CAPM (Capital Asset Pricing Model) when considering certain research questions. Specifically when the research deals with the financial or investment aspects of land resources.

2.3 Land as a Factor of Production

Agricultural producers view land for its ability to generate economic surpluses equal to or in excess of the rent paid for its use. This economic surplus occurs when land is combined with other factors of production to produce an output that is commercially viable and generates the needed revenues to pay the land rent. The price that producers pay for the land must not exceed the discounted net revenues received from agricultural production over time. More fertile lands are capable of higher levels of production with fewer inputs. Therefore producers would pay more for better quality lands according to the level of their quality (Barlowe p. 168-177, 1978). There are two classical factors that give rise to land value; location and fertility.

2.4 Von Thünen's "The Isolated City"

Johann von Thünen developed a theory that states that land value originates from its location. He used the example of a city at the hub of a flat open plain. The only available market was in the city, therefore, all agricultural production on the plain was sold to the city's residents. All producers experienced the same production costs and the same transportation cost on a per unit of distance traveled. When von Thünen wrote his theory transportation was a primary expense of agricultural production. Therefore, he attributed higher land values to land resources that were closest to the city. As one got further from the city's center land use became less intensive. The intensity of use was reflected in a pattern of decreasing rents for increasing distance to markets. This pattern of land rents was a reflection of transportation costs (van Kooten p.18, 1993, Barlowe p.36-39, 1978).

2.5 Ricardo's "The Principles of Political Economy and Taxation"

Ricardo chose a different approach in analyzing land rents. He saw several conditions as being necessary for land rents to exist. The first of these conditions was that the land resource, within a given area of market participants, should be of varying quality and of limited quantity. Population pressures caused agricultural production to expand to lesser quality and poorer situated lands in order to satisfy the expanding population's demands for food (Barlowe p. 168-172, 1978, van Kooten p. 17, 1993).

Ricardo stated that the poorest lands (lands with the highest cost of production for a given crop) would receive no rent. These lands were so marginal as to not produce any "profits" from production to pay a rent for their use. Better quality lands would receive land rents equivalent to the difference in production cost of the worst lands and the better quality lands. As the land quality improved the agricultural producer required fewer inputs and the economic surplus would be used to pay rent on the land.

The rational agricultural producer is indifferent between paying rent and buying inputs when their benefits are equal. In the process of agricultural production they will marginalize between the two inputs. They will choose between paying higher rents or buying more inputs to create agricultural products according to the marginal benefits and the marginal costs of each input.

2.6 Agricultural Land Pricing Techniques

There are two basic techniques used for the economic analysis of land resources. These two basic models are referred to as the Present Value Model, a derivative of the Capital Asset Pricing Model, and the Hedonic Pricing Model. The purpose of the analysis will dictate the technique to be used.

2.61 The Present Value Model

The first model of land pricing is a variant of the Capital Asset Pricing Model. This model is used when considering issues of price changes in a temporal context. The use of this model often disregards land quality variables for variables such as tax rates, subsidy programs, technological changes, consumer or wholesale prices of agricultural inputs and outputs. These models are used to answer questions related to price changes over a given period of time (Just and Miranowsky 1993, Featherstone and Goodwin 1993, Alston 1986).

2.62 The Hedonic Pricing Model

The second model used in land market analysis is referred to as a Hedonic Pricing Model. Unlike the CAPM model, hedonic pricing models are used in studies that require information about price formation. It is similar to the present value model in that it also accounts for the net present value of a future stream of returns, but it differs is in its valuation process. In the present value model the land resource is viewed as an asset and as such the researcher must make assumptions about what variables effect the land resource value. The variables used in such a study are of an *ex ante* nature. Usually the choice of variables consists of fiscal issues such as taxes, prevailing interest rates, subsidies, market prices, etc.

In the hedonic pricing model the net present value of the land resource is determined by the agricultural decision makers that are buying and selling the land resource. When the agricultural land is transferred, its sale price is a function of the characteristics that generate value in agricultural production. Therefore, the hedonic pricing model uses many of the same variables that Ricardo elucidated as being the cause of value for an agricultural land resource.

The hedonic pricing model is a general model used in economics to attribute an implicit value to the characteristics of a homogeneous class of good (Court 1941, Houthakker 1952, Griliches 1961). Sherwin Rosen was the first to treat hedonic pricing in a theoretically complete fashion although other authors have contributed to its refinement with respect to welfare measurements (Bartik and Smith p. 1211, 1987, Epple 1987). The general assumption for using the hedonic pricing model consists of a perfectly competitive market where a homogeneous class of good with heterogeneous characteristics are transacted (Rosen 1974).

2.7 Basic Criteria for Hedonic Pricing Models in Land Markets

Miranowski and Hammes outline the assumptions that must be made about the land market before a hedonic pricing model can be used for determining the implicit prices of land characteristics. The first assumption is that only one market is being modeled. The agricultural land market in Québec's agricultural regions 5,6,7, and 10 appear to meet this criteria. These regions are geographically close and under the same set of institutional constructs and restrictions, weather patterns, closeness to markets, etc.. This assumption seems to be met. The second assumption that must be made is that the market is in equilibrium. This assumption implies that participants within the market get the quantities of characteristics that they desire to buy and sell and that the market clears. Thirdly, there must be sufficient choice and availability so as to maximize the consumer's utility (Miranowski and Hammes 1984).

This research made use of a database gathered by the Office of Agricultural Credit known by its French acronym of the time as the O.C.A.Q.. Their recorded database for the four agricultural regions studied was extensive. Once the study criteria for selection were applied to the data set a hundred transactions were identified. The criteria for selection were: 1) that the transactions consisted of areas greater than 40 hectares, 2) transactions within the 150 kilometer radius from Macdonald campus, and 3) transactions occurring between January 1st of 1990 and June 1st of 1992.

This list was further reduced to those producers who were willing to participate and were of comparable production types. This strategy was used by King and Sinden in their 1988 study. The final number of observations totaled 63. Therefore, concerns for a *thin* market were not considered as being a serious problem within the confines of this study.

2.8 Hedonic Theory

Hedonic price modeling is a regression technique in which a homogeneous class of a commodity is described by varying quantities of observable characteristics and is regressed unto its sales price. The result of this process is an estimated implicit prices for each of the characteristics within the specified market. Agricultural land is the general class of good under consideration and its physical, quality, soil conservation and capital improvement investments are its characteristics. Positive amounts of the characteristics are desirable (concavity), therefore, more of a characteristic is considered better than less. The vector Z_{land} represents the land being transacted and describes the varying quantities of each characteristic in a parcel of agricultural land. The general mathematical model for land characteristics is as follows:

$$Z_{land} = (z_1, z_2, \ldots, z_n) \tag{1}$$

Associated with the vector of characteristics are the prices paid for each z_i characteristic within its market. Land prices can be represented by a function of the prices paid for its individual characteristics. It is this function $P(Z_{land})$ that is referred to as the implicit or "hedonic" price function. It is shown below (van Kooten p. 140-143, 1993).

$$P(Z_{land}) = P(z_1, \ldots z_n) \tag{2}$$

The price paid for a parcel of agricultural land, in a given market, is a function of the level of characteristics and the implicit prices paid for each of the characteristics. Characteristic prices are the result of the arbitrage process between buyers and sellers seeking to maximize their individual utility with respect to the individual levels of z_i present within the good. The implicit price of a characteristic is the tangency between the two agents' individual utility curves for a given level of z_i characteristic. Equation 2 represents the implicit or "hedonic" price function for characteristic z_1. It is defined by the locus of tangencies between the buyer's bid function and seller's offer functions for the individual characteristics. A graphic representation is given later in the text (see fig. 3).

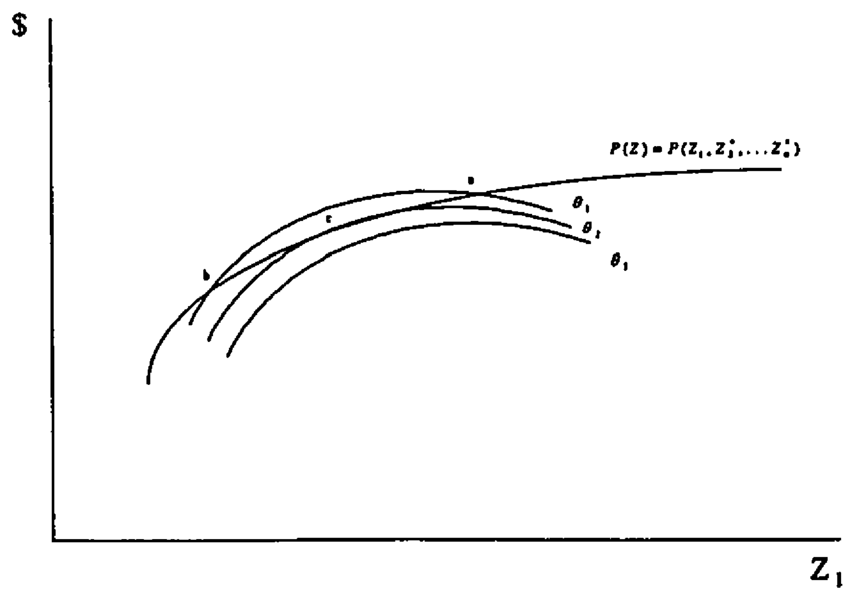
The implicit price function exists in n+1 dimensional space where price is plotted along the vertical axis and the individual quantities of the characteristics along the horizontal axes. Each characteristic exists in one slice of this space. Within a perfectly competitive market structure each decision maker treats prices as given. Both buyer and seller are trying to maximize their own utility function.

2.9 The Consumption Decision

Looking at the buyer's decision, they are seeking to maximize the utility function, $U(X,Z)$, where U represents the level of utility, X represents all other goods in the consumption bundle, and z represents the land purchase. The consumer is subject to the normal budget constraint conditions of $M = X + P(Z)$, where M is their money income, X the amount of money spent on all other goods and P(Z) the purchase price of the land. The consumer makes a choice between varying parcels of agriculture land being offered and all other goods. For a given purchase the consumer is willing to pay θ. The respective family of consumer's bid functions can be represented symbolically by $\theta = \theta(Z{:}u,M)$. This function represent a land purchase Z, at a given level of utility u, and a money income M. Implicitly defined is the equation for a family of consumer's bid functions is represented by the equation $U(M-\theta,Z)=u$ (Anderson and Bishop p.107, 1986).

Looking at the plane of an individual characteristic, Z_1, and varying its quantity while holding quantities of all other characteristics fixed the implicit price function can be stated as $P(Z)=P(Z_1,Z_2^*,\ldots,Z_n^*)$. Plotting this curve

Figure 1. The consumption decision



with income on the vertical axis and the quantity of Z_1 on horizontal axis the relationship between the implicit price function and the consumer's bid functions are shown in figure one.

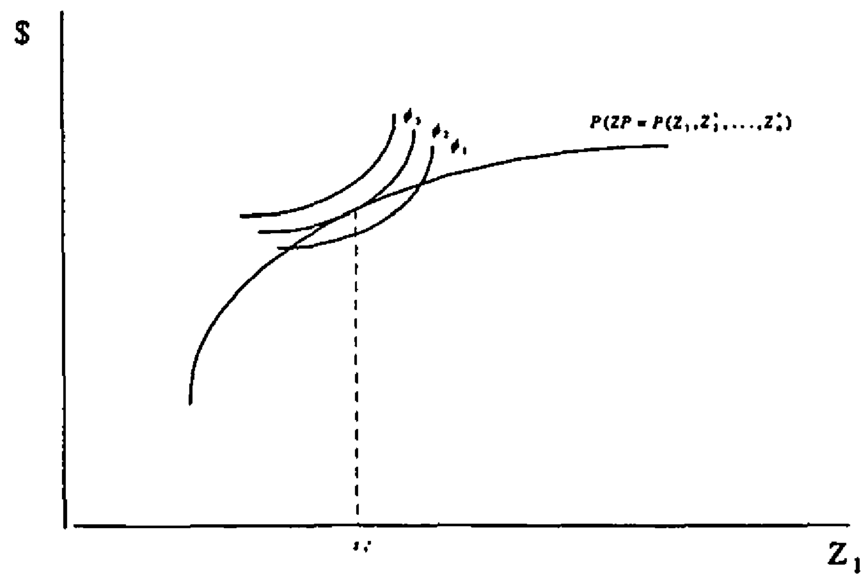
As the θ_i increases there is an increased level of utility and investment in land occurring, simultaneously occurring in this process is a decrease in income for purchasing all other goods. At points a and b the consumer can afford those quantities of Z_1, but is not maximizing their utility from the purchase. At point c the consumer is maximizing their utility from their purchase.

2.10 The Production Decision

The production decision becomes the inverse of the consumption decision in that higher levels of characteristics increase the producer's income. The producer seeks to optimize their profit by optimizing the return for investment in each characteristic. Assume the producer only produces agricultural land with characteristics Q(Z). This producer's profit function is $\pi = P(Z)Q - C(Q)$ where $C(Q)$ represent the cost of characteristic investment and $P(Z)Q$ the revenue from the investment. For any given parcel of agricultural land the producer will invest in a characteristic to the point where the marginal return to investment is equal for all characteristics. Plotting the implicit price function, $P(Z)$, for various quantities of Z_1 while holding all other Z_i's fixed is shown in fig 2.

Each producer is associated with an offer function ϕ. An individual offer function represents a producer's efficiency at producing characteristic Z_1, and can be represented symbolically by the equation $\phi = \phi(Z;Q,\pi)$. Given a fixed level of characteristics, Q, there exists a family of producer offer functions or isoprofit functions. These offer functions have positive slopes as more of the characteristic will only be provided at additional cost.

Figure 2. The production decision

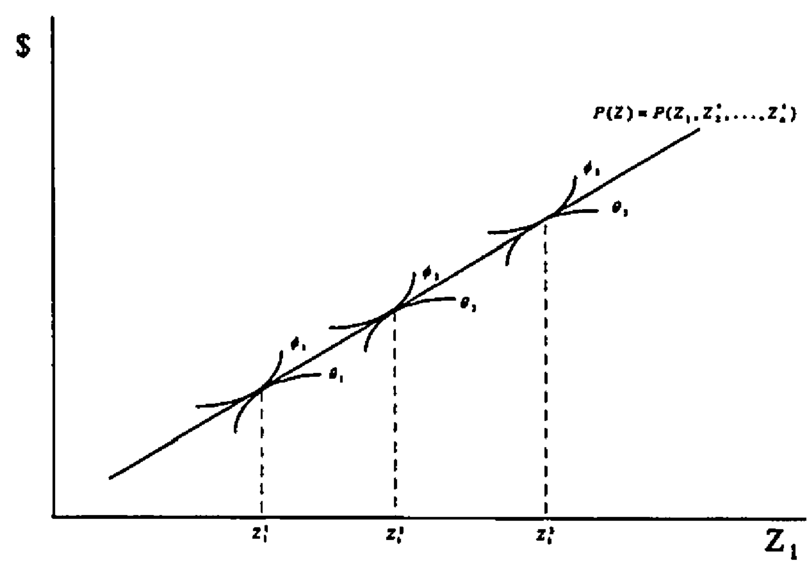


The convex property of the offer curve is a result of the diminishing marginal return from providing additional amounts of the characteristic. Various producers will be willing to provide the fixed level of characteristic, but few will be optimally profitable. In figure two only producer ϕ_2 is optimally profitable for the quantity Z_1^*. Because each producer is efficient at different levels of production, economies of scale will make different firms optimally profitable at different level of production. (Anderson and Bishop p. 108, 1986).

2.11 Market Equilibrium

Market participants seek to maximize their utility. Within the framework of perfect competition, producers seek to achieve the highest possible offer function, an‹ ‹onsumers the lowest possible bid function across the vector of Z characteristics belonging to the agricultural land resource. With respect to a given characteristic, producers and consumers will only meet and satisfy

Figure 3. Market Equilibrium.



this condition at the point of tangency between the two functions. When considerating all transactions, within a given market for a given characteristic is taken the full implicit price function for the agricultural land resource for all of the characteristic can be derived. This individual characteristic relationship is presented in figure three where only the producers who achieve the highest offer function and the consumers that attain the lowest bid function meet for any given level of Z_1.

Given it's many characteristics the price of the agricultural land resource becomes a market process between producers and consumers. When a transaction takes place it is assumed that all individual characteristics prices are agreeable to the market participants. Individual characteristics can be regressed when this assumption is made (Anderson and Bishop, p. 110, 1986).

2.12 Hedonic Pricing Models and Functional Form

When using hedonic pricing models the functional form is never known apriori. It is important that the functional form for the market is correct so that any estimates arising from the hedonic pricing model be correct (Brown and Ethridge 1995). Also dependent on functional form is the type and extent of the analysis that can be performed (Rosen 1974, Epple 1987). When the implicit price function for a market is non-linear, it is possible to perform some welfare and market power analysis (Epple 1987, King and

Sinden 1988 and 1994). Given the data from this agricultural land market, it was determined a linear functional form modeled the market best.

2.13 Soil Conservation and Capital Improvement Investments

Soil conservation investments are changes in agricultural practices, physical properties, or the addition of physical structures for the purpose of slowing down the erosion rate of the agricultural land resource. Depending on the agricultural production, physical properties, and climatic conditions different conservation measures will be more appropriate than others. An appropriate text for edification on this specific problem would be "Soil and Water Conservation" by Frederick Troeh et al. (chap. 1., 1991).

Soil is created when the parent material is broken down through geological processes into its constituent minerals. Zero soil loss, from a soil conservation perspective, occurs when the soil loss rate is equivalent to the geological soil erosion rate. Geological soil erosion rates are explained as the level of erosion if no cropping practices were employed and the only erosion occurring is from the passage of geologic time. When soil erosion is accelerated through intensive agriculture, the soil has a reduced capacity for supporting plant growth as a result of its diminished capacity to retain water, nutrients, poorer structure, and reduced air content (Troeh et al. Chap. 1, 1991).

Plants depend on the previously mentioned characteristics for growth. The most important components of soil fertility are clay particles and humus (organic matter). These components are the repositories of soil nutrients in their elemental form. Plants can only absorb nutrients as elemental ions that are necessary for their existence and growth. When soils are eroded by moving forces such as wind, water, gravity, and glaciers, the clay and humus particles are removed. What remains is inert gravel, sand and stone.

Left alone soil erodes at an imperceptible rate. Once tilled and stripped of its natural cover intermediate and accelerated soil erosion begins. The degree of erosion depends on physical properties of the soil, the landscape, and the weather (Troeh et al. p. 3-7, 1991).

Tolerable soil loss from agricultural activities was defined by Wischmeier and Smith as being soil loss that will permit a high level of cropping activity to be sustained economically and indefinitely (Wischmeier and Smith 1978). In underdeveloped countries the needs placed on agriculture production are so great that the need to conserve the soil is secondary to survival. Marginal, highly erosive lands are put into production to achieve the goal of survival (World Commission on Environment and Development p. 12, 1987).

In developed countries land rents are excess revenues from agricultural sales beyond the cost of agricultural inputs. This excess revenue creates "Ricardian" rent from the agricultural production process. These rents, if sufficient and marginally beneficial, will be the source of funds for soil conservation and capital improvement investments. The market must recognize the benefits of soil conservation or capital improvement for investments to occur. Soil conservation is achievable via the market incentive if the proper price incentives exist within the market (McConnell 1983).

Capital improvements and soil conservation investments will occur if they are marginally beneficial. The investment will occur as a result of market incentives in the form of positive price signals for investment. The decision to invest in either capital improvement or soil conservation depends on the marginal cost and the marginal benefit of the investment. If a market does not recognize the marginal benefit (resale value + increased revenues) of such investments, investment will occur at suboptimal levels (Gardner and Barrows 1985).

In the case of soil conservation investments, a residual should occur for the improved soil quality characteristics that is attributable to a soil conservation investment. The same would be true for the unused portion of a capital improvement. Therefore, if there is a residual for investment within private markets - investment should occur, and if there is no residual included in the land transfer then investment will only occur when the potential for return is possible during the planning horizon of the investor.

The Net Present Value model requires five distinct types of information. Of the five types of information, the net cash flows from investment, the salvage value of the investments, and the discount rate are the most important to the decision maker when deciding to invest (Barry et al. p 213-215, 1988). Net cash flows arise from the interaction of investment payments and changes in production revenues. These opportunity costs are tangible, therefore tractable. The salvage value of a conservation or capital improvement in the future is not explicitly known. Their value comes from the interaction of market forces. These have to be implicitly derived. This can only be done through hedonic modeling when the studied characteristic is an inseparable part of a larger good. If the market assigns a salvage value to that characteristic then it should be a significant positive variable in a hedonic price equation.

2.14 Soil Conservation and Improved Soil Quality

Ricardo attributed land rents to differences in land quality and location. Agricultural land that is of poor quality and located the furthest from the markets for agricultural products do not receive rents. Agricultural lands that are of the highest quality and closest to the markets for agricultural products receive the highest rents. Therefore, lands with soil conservation and capital improvements should receive higher sales prices (rents) for superior land quality characteristics, all other things being equal. This is exactly how a hedonic pricing model works. It estimates the value of a characteristic that would originate from a theoretically mean sized land sale. Therefore a per unit value of the characteristic for the sample is tractable. If the characteristic is valued by the market it should have a positive significant value attributable to its existence in the land resource market.

Soil conservation investments are carried out with the purpose of preventing soil erosion. Wind erosion occurs when exposed soils are subject to being blown away. The most dramatic example of this phenomenon is the dust bowl era of the 1930's. To combat wind erosion's effects two principle strategies are windbreaks of either manmade or natural materials and minimizing the amount of time the soil is left without plant cover (Troeh et al. Chap. 5, p. 10-16, 1991).

Water erosion is caused by the velocity of water carrying away larger aggregates of soil as the water's speed increases. The slope of the land and the length of the slope contribute to the speed of draining water. Water draining off land carries soil from the field into nearby streams. Even on flat fields if the rains falls hard and fast enough sheet erosion of precious top soil can occur (Troeh et al. Chap. 4, p. 10-16, 1991).

Conservation techniques seek to modify the exposure of soils to these two sources of erosion. One of the principle ways of lowering erosion is through vigorous plant cover and minimizing the length of time bare soil is exposed to these destructive forces. A buffer of vegetation prevents direct erosion of water and wind. Topography also plays a role in both types of erosion. Slope affects the potential for water erosion in that increased slopes have greater potential for water erosion, and the flatter and more treeless the landscape the more susceptible these lands are to wind erosion.

Several strategies are used to alter the effects of sloping topography such as contour plowing and terracing and non-cultivation of steeper grades of land (Troeh et al., Chap. 10, 1991). Vegetative covers either in the form of mulches or live growth help reduce the impact of rain on soils and slow down the water's velocity as it is draining off the land. Most soil conserving techniques also build up the organic matter in the soil thereby increasing its permeability and increasing the nutrients available to plants (Troeh et al., Chap. 11 and 12, 1991). All soil conserving techniques may not be optimal from a production output point of view, but when considering the decrease in erosion of the land resource may prove to be economical. The accompanying increase in land quality should be reflected in increased rents as the productive horizon of the soil resource is extended and the option value of increased cropping opportunities are increased.

Soil conservation investments improve the presence of organic matter in some instances. This improved land quality should come with increased rents therefore an increased sale price. This increase is with the proviso that the soil's top soil depth is approaching the root zone depth (Gardner and Barrows 1985, van Kooten p. 24-29, 1993).

2.15 Capital Investments and Improved Soil Quality

Within the studied market, drainage is the most frequently observed land investment. With respect to agricultural production, drainage insures crop production even in wet years by removing excess water from the field surface. Therefore, the market value of drainage is that it reduces crop failure risk. Drainage may also be considered as a soil conservation investment as it aids in the prevention of sheet erosion. By increasing the permeability of the soil it prevents water from accumulating at the surface of the soil and washing it away on the way downstream (Troeh et al., p66, 1991).

Other investments that were observed on a less frequent basis where leveling, terracing, and windbreaks. The infrequency of these structures made them questionable characteristics for inclusion in the hedonic regressions.

2.16 Previous Applications of Hedonic Models

Hedonic pricing is used when the market for the good does not explicitly reveal the prices for the characteristics of the good. Soil conservation investments are expected to yield positive price signals within the market. The investment itself has known costs but the benefits and the market resale value are not as easily quantifiable. Past studies have sought to quantify implicit prices for characteristics that add value to a good but are not explicitly priced in the market in which they are traded (Palmquist and Danielson 1989, Gardner and Barrows 1985, King and Sinden 1988).

Hedonic modeling is the major tool for measuring the value of a non-priced characteristic when it is not explicitly priced in the market where it is sold. Policy considerations are another source of motivation for these studies as policy makers want to ascertain how the studied markets value the non-priced characteristic. Sometimes, hedonic pricing is used to value an environmental characteristic such as clean air or a crime free neighbourhood as it becomes part of the value of the good. Finally, hedonic modeling has been used to test the validity or to measure the effect of economic principles and theory.

2.17 Hedonic Models and Land Pricing

Hedonic pricing of land acquisitions "is analogous to the subjective process followed by a farmland appraiser when attempting to place a market value on a parcel of land" (Miranowski and Hammes p.745, 1984). Miranowski and Hammes sought to establish whether the land market in Iowa was properly discounted for soil erosion (forgone soil productivity due to erosion) and also if government subsidy programs affected farmland prices. The researchers attempted to answer whether the market was providing proper incentives to safeguard the production capacity of the land or was government intervention needed because of market failure. In this particular case there was a market incentive to conserve soil.

The authors stated some of the shortcomings of the basic assumptions of the model and how it would affect their conclusions. The first problem originated with the basic assumptions about the market, namely, the assumptions of perfect information, market equilibrium, and continuity of choice in characteristics. These assumptions are necessary for the proper functioning of the model, but are not easily observable. The second problem is in knowing whether the market being modeled is indeed one market or more than one market. The authors feared that because they were using data from the whole state of Iowa that they have been aggregating data from more than one agricultural land market (Miranowski and Hammes 1984).

Miranowski and Hammes's study also identified functional form problems with hedonic pricing models. Basic problems arise from the fact that there is no predetermined functional form in hedonic price modeling. When using hedonic models, the researcher must pay strict adherence to economic theory and econometric principles when choosing the appropriate functional form for the market being studied. Researchers must be clear on the economic relationships between the dependent variable and the independent variables, and also of the relationships between the independent variables themselves (Brown and Ethridge 1995).

A second functional form problem elucidated by Miranowski and Hammes was that the estimated implicit prices were sensitive to the observations being used. The authors noted how the inclusion or exclusion of certain observations would greatly impact the estimates. As in any statistical problem the inclusion of more observations greatly improves the stability of the estimates. However, because of the infrequency of land transactions and the inability to greatly alter the lands level of characteristics, estimates within a given market appear very sensitive to the data points included in the regression process (Miranowsky and Hammes 1984).

Finally, the authors found it unfortunate that the model could not be used to measure society's value for soil conservation. Because agricultural land transactions only involve the buyers and sellers of agricultural land, there is no information about society's valuation for varying levels of soil conservation investments. Hedonic pricing models can not imply a price for participants outside the market (Miranowsky and Hammes 1984).

Palmquist and Danielson, 1989, authored the next significant piece of research with respect to erosion, drainage, and farmland values. Their research demonstrated another aspect of this type of modeling. Hedonic models will only supply estimates for significant variables. Therefore, complete information about potential economic variables is needed. Economic theory will provide a partial list of economic variables, but not all of them will be significant within the studied market, nor will this list be necessarily complete.

Economic theory and knowledge of physical characteristics that result in economic consequences is needed for a complete list of possible economic variables. This research was carried out in an environment where drainage was of practical concern. Hedonic models require comprehensive data bases. Informational requirements are sometimes a deterrent to their use. If a variable is not specified or properly measured, its influence in the market may end up being included in the error term. This occurrence would bias the remainder of the estimates in the regression.

Palmquist and Danielson, 1989, were able to increase the number of observations they could include in their research by using the rental value of agricultural land instead of its sales value. This choice allowed them to avoid thin markets. Using agricultural land rental rates gave them a greater quantity of usable observations. Even farm owners could be considered as renting farmland to themselves (Palmquist and Danielson 1989).

Another concern about hedonic pricing models relates to what the estimates from these models actually mean and how they should be interpreted. Palmquist and Danielson, 1989, stated that the estimates for the improved lands with drainage and soil conservation investments was only an upperbound estimate. Estimates for implicitly priced variables within a hedonic regression can only be thought of as accurate when the inclusion of more observations does not significantly change the estimates of all other variables within the original equation (Bartik 1988).

A recently published study Elad et al (1994) on the agricultural farmland market in Georgia helps elucidate Miranowski and Hammes concerns about modeling only one market. This study identified several agricultural land markets within the state of Georgia. Furthermore, the functional form of the hedonic price function was dependent on the market being modeled. It is not uncommon to observe different functional forms for different local markets.

Due to the unique physical properties or societal pressures that exist within each agricultural land market, a studied market may have to be subdivided to account for such influences. Urban sprawl, proximity to historical or recreational sites, changes in soils or topography, may have a profound affect on land values. These influences may affect the type of functional form and the choice of variables used in the hedonic pricing model. The Elad et al article emphasizes the differences between exogenous and endogenous variables, and elucidates the types of information that can be extracted from a given market. It also demonstrates how the particular functional form affects the ability of the model to provide information on such matters as seller's offer curve or the buyer's bid curve.

Elad et al studied whether Georgia was comprised of one or several land markets. Changes in the implicit values and appropriate functional forms from one geographic region indicated that there were several markets in Georgia. The conclusion of this study was that hedonic studies necessarily should be performed in logically determined geographic areas where socio-economic forces are similar (Elad et al. 1994).

A study performed in Washington state by Xu et al that also supports this conclusion. They concluded that there were definite regional markets within their study area. When the studied market was subdivided into regional markets, varying functional forms and implicit values were deemed appropriate to the regional markets within the state (Xu et al. 1993).

2.18 Hedonic Models and Non-land Goods

Land markets are not the only subject of hedonic price models. Its versatility is demonstrated by the range of goods used in this type of analysis. Common factors in these studies are that they concentrate on a class of goods with varying levels of characteristics, and that the goods' characteristics are not explicitly priced in the market. Information and uncertainty is the subject of a study conducted by Kask and Maani in 1992. The study was performed on consumers buying homes within the potential blast area of a high pressure gas line. Information was divided into endogenous information and probabilistic information. These researchers discussed the possibility of bias in hedonic price estimates and described a set of possible guidelines to insure against bias when situations involve uncertainty and information variables. They felt comfortable with the estimates generated from their hedonic price model as their estimates were relatively stable for each year in the three year study (Kask and Maani 1992).

Graves et al performed a hedonic pricing study to evaluate the robustness of hedonic models when dealing with air quality's impact on housing values. Specifically, they wanted to perform empirical tests in the problem areas of: (1) variable selection and treatment, (2) measurement error, (3) functional form, and (4) error distribution (Graves et al., 1988). Due to the number of records and variables available in the data set it was possible to cross check the estimates generated for the independent variables. By using other variables and other previously published estimates it was possible to study the accuracy and robustness of the hedonic pricing model. Graves et al found that with respect to variable selection certain air quality measures performed better than others in estimating the value of neighbourhood air quality. They found that measurement error affected estimates substantially enough to warrant careful measurements of air quality variables. They also stated that depending on the choice of variables the estimated coefficients could range from insignificant to significant and from proper to improper signs (Graves et al., 1988).

With respect to functional form they preferred to use general functional forms rather than more traditional restrictive functional forms stating that they performed "significantly" better. This choice is only possible when your data base contains a significantly large number of observations. Finally they made the point that the accuracy of their estimates is subject to the proper mathematical representation of the equation. The exclusion of variable interrelationships, or the complete omission of significant variables would have its influences felt in the error term (Graves et al. 1988).

Guy Garrod and Ken Willis estimated the impact of different tree communities on land values in the British Isles. The study was undertaken for the Forestry Commission and was limited to Forestry Commission land. The object of their study was to estimate the implicit value paid for living in particular forest communities. Measuring forest characteristics such as tree type, density, and age, the researchers found significant values for the different forest types, but cautioned about the interpretation of the information. This caution was introduced because housing from non forest and non Forestry Commission land was not included in this study. As a result, the difference in housing's price was only a function of the type of forest in which it was located and not a function of the housing location itself. They also mention the difficulty in quantifying the type of forest as being an issue to consider. How do you define a deciduous forest that has a percentage of coniferous trees in it? Their conclusion was that deciduous tree communities increased the value of housing, however, the benefits of these increased values accrued to the home owner and not the Forest Commission (Garrod and Willis 1992).

In a 1992 article the non-price characteristics of cotton fiber were studied by Bowman and Ethridge. This article demonstrates the ability of using hedonic price models to derive implicit prices for certain cotton fiber characteristics, and to estimated the supply and demand curves for these characteristics. It was possible to identify characteristics that contributed to premiums and discounts in the cotton markets (Bowman and Ethridge 1992).

2.19 Applications of Hedonic Models to Social Welfare Questions

The impact on social welfare is often the subject of economic studies. Under the proper conditions (a non-linear functional form) it is possible to define the buyer's bid curve or the seller's offer curve. Rosen briefly outlines the details for welfare measurement in his seminal article (Rosen 1974).

Raymond Palmquist attempted to measure the benefit of land as a differentiated factor of production (Palmquist 1989). Welfare measurement generally implies measurements of either consumer or producer surpluses. When the functional form of the hedonic model is non-linear (i.e., logarithmic or quadratic) the second derivative estimates the slope of either the demand or supply functions (Epple 1987, Palmquist 1989). The dependent variable used for this type of analysis is generated from the implicit price of the characteristic multiplied by the quantity of the characteristic in each observation. The independent variables include the respective shifters of demand or supply.

In 1991 a Hedonic model was used to evaluate the implicit value of expanding an Australian water supply pipeline. The advantage of using the hedonic pricing model is that instead of interviewing farmers on what they thought the value of having their farms connected to the water pipeline would be, the value was determined from market data. Agricultural land value was estimated for land that did and did not have access to water. In this way the benefit of the planned pipeline was based on market information rather than on a synthetic evaluation (Coelli et al. 1991).

2.20 Testing Economic Theory with Hedonic Models

Economic theory needs to be tested in order to understand to what extent it is operational and to develop new understandings of our economic concepts. Often in the course of economic activity a behavior appears that does not seem to be rational. Later, after careful observation, these anomalies reveal the effects of a theoretical concept that was not considered.

An example of economic theory testing was a study preformed by King and Sinden. They investigated which of the market participants, buyers or sellers, possessed market power for the given market. Recall that deriving the implicit price schedule of a characteristic with respect to buyer or seller characteristic yields either a supply or demand curve. However, with additional information about the buyer's bid prices and the seller's offer prices it was possible to further describe the agricultural land market by providing an estimate of which market participants had market power and influenced price formation (King and Sinden 1994).

2.21 Summary

Hedonic modeling is becoming widely accepted and used in situations where the characteristics of a good are non-priced. Agricultural land is valued as a factor of production. Its value as a production input increases as its quality and closeness to markets increases. Soil conservation techniques by definition improve the quality of the soil resource. Capital improvements also improve the quality of a given agricultural land resource. Given the fact that these two characteristics help improve the quality of the land resource it should be observed that with increasing levels of investment, there should be a corresponding increase in the sales price of the land resource at the time of transfer.

Hedonic models are capable of attributing an implicit value, within a given market, to a characteristic if it is valued by the market. If this is the case then positive coefficients, in the hedonic pricing model, for investments in soil conservation and capital improvements should be observed.

Chapter 3.

Data and Procedures

3.1 Sample Population and Periodicity

Québec is divided into 12 distinct agricultural regions as designated by the Ministry of Agriculture in Québec. The study was designed to investigate the agricultural land market in Québec's southwestern agricultural regions. Therefore, the sample population was extracted from the following agricultural regions of Québec: region 5 - Esterie, region 6 -Richelieu/Saint Hyacinthe, region 7 - Sud-Ouest de Montréal, region 10 - Nord de Montréal. All of these regions are within a 300 kilometer diameter from Macdonald campus. This fact helped assure the probability of only one agricultural land market.

In addition to limiting the geographical area, the sample had to satisfy a number of other criteria. All sample land transactions occurred between January 1st 1990 and July 1st of 1992. All sales were of agricultural land transfers of approximately 40 hectares or greater. This criterion was used to exclude the distorting effects that gentlemen and hobby farmers could have on the agricultural land market.

Finally, all transfers had to be at "arms length." The existence of "family farm transfers" often results in one generation passing the farm to the next generation at a discounted value or with preferential financing arrangements.

The total number of agricultural land transactions that fit the above criterion numbered approximately one hundred. Once contacted, sixty-five buyers agreed to participate in the study. Of these, two observations were dropped because the number of apple orchards and maple sugar operations were too few to be included in the study.

The observations were a mixture of land only transactions and land with capital buildings and other assets. In the latter cases, the market value of the non-land resource items was subtracted from the sales price of the property. The dependent variable was based on the nominal value of the land transfer with the non-land assets removed from the actual sales price. Further modification was done to render prices in constant 1992 Canadian dollars. Observations occurring before 1992 had the appropriate price index applied to them. The index rates used were Statistics Canada's price indices for agricultural land and buildings. This procedure was used instead of the more typical dummy variable approach in order to conserve the number of degrees of freedom in the estimation process.

Finally, the regression software that was used for estimation was Shazam V. 7.0. It was felt that it performed well and had all the necessary power and functions to carry out the required task.

3.2 Tools for Data Acquisition

There were three principle tools for data acquisition. The first tool consisted of sales records as collected from the then called OCAQ (l'Office de Credit Agricole de Québec). The organization has since adopted the name of Societe de Financement Agricole du Québec. They had created a data bank of land sales that contained information on the various agricultural land transfers. This information is similar to that of urban real estate data, i.e., detailed information on the characteristics of the property.

The second tool used to acquire data was a personal survey that was created and conducted by the principle researcher. The purpose of the survey was to gather information on the market participants, the condition of the land at the time of sale, locational characteristics, etc.. A copy of the survey is included in the appendix.

Finally, data was collected from soil samples for all the observations. These soil samples originated from all the arable fields in an observation. The soil measurements included soil acidity, levels of potassium, phosphorous, calcium, and magnesium, as well as the rates of organic matter and water stable aggregates.

It was hypothesized that land prices were a function of four types of characteristics. These four types of characteristics were classified as physical, quality, capital improvement, and soil conservation characteristics. The following tables explain the variables, their origin, and a description of what they represent.

3.3 Physical Characteristics

Table 1 below describes the physical variables considered in the regression. The existence of drainage, a capital improvement and a soil conservation measure was included as a physical characteristics due in part to its quantifiable nature.

Table 1. Physical characteristics

Variable Name	Source of data	Description of the variable
Cultha	Land sales record	This variable is the total number of arable hectares sold with the property
Drainha	Land sales record	This variable is the total number of drained arable hectares sold with the property.
Pastha	Land sales record	This variable is the total number of pasture hectares not including any wooded land.
Woodha	Land sales record	This variable is the total amount of wooded hectares not including apple or sugar orchards
Orchha	Land sales record	This variable is the total amount of hectares in apple orchards transferred in the sale
Sugrha	Land sales record	This variable is the total amount of hectares in maple tree orchards transferred in the sale
Live	Survey	This variable is a binary variable indicating if the seller or buyer is involved in animal production on the property.
Township	Land sales record	Whether or not the land purchase was located in the Esterie region of Québec (Region 5)
Richelie	Land sales record	Whether or not the land purchase was located in the Richelieu/Saint Hyacinthe valley area of Québec (Region 6)
SW_Mont	Land sales record	Whether or not the land purchase was located South-west of Montréal (Region 7)
N_Mont	Land sales record	Whether or not the land purchase was located North of Montréal (Region 10)

3.4 Quality Characteristics

Table 2 below contains the quality variables considered in the regression. As mention in the introduction it is often difficult for a buyer to get information on the quality of the soils prior to purchase. Therefore it is assumed that conventional soil quality measurements may be a proxy for actual productivity information. Variable names with the "W_" prefix are weighted averages for the farm. The weightings were performed on the basis of field size to give a more accurate representation of the farm's overall value.

Table 2. Quality characteristics

Variable Name	Source of data	Description of the variable
W_pH	Soil sampling	This variable is the weighted result of the pH test.
W_P	Soil sampling	This variable is the weighted result of phosphorus.
W_K	Soil sampling	This variable is the weighted result of potassium.
W_Ca	Soil sampling	This variable is the weighted result of calcium.
W_Mg	Soil sampling	This variable is the weighted result of magnesium.
W_OM	Soil sampling	This variable is the weighted result of the percentage of organic matter present in the fields.
Adjust (WSA)	Soil sampling	This variable is an average of the amount of Water Stable Aggregates present on the farm adjusted for sand content.

3.5 Capital Improvements

This category of characteristics was considered as a binary variable. Therefore the variable values consist of a "0" if not present and a "1" if present (table 3).

Table 3. Capital improvement investments

Variable Name	Source of data	Description of the variable
Levling	Survey	Seller leveled fields
Terrcing	Survey	Seller terraced fields
Surfirra	Survey	Seller installed surface irrigation
Burrira	Survey	Seller installed buried irrigation
Othrwrk	Survey	Other seller installed capital improvements

3.6 Soil Conservation Investments

Cataloging of soil conservation investments was limited to the existence of observable investments (table 4). Investments like specific crop rotations are not usually observable by the purchaser of an agricultural land resource because they have occurred over an extended time horizon. If the cropping pattern was observable by the purchaser then the purchaser would have some insight into the land's productive capacity.

Table 4. Soil Conservation investments

Variable Name	Source of data	Description of the variable
Surfdrn	Survey	Seller installed surface drainage
Grrswtyr	Survey	Seller installed grassed waterway drainage system
Catchbsn	Survey	Seller installed catch basin water drainage system
Wndtree	Survey	Seller installed arboreal wind break
Wndothr	Survey	Seller installed man-made wind break

3.7 Modified Variables

Not all variables come from primary data. The following table describes those variables and the accompanying procedures necessary to convert the original data into these modified variables (table 5.).

Table 5. Modified variables

Variable Name	Source of data	Description of the variable
Valanfa	Land sales records	Converted sales value in 1992 constant dollars using Statistics Canada's inflation index for Agricultural Land and Buildings.
Lnval	ln (valanfa)	Transformed valanfa for use in log-lin, lin-log and log-log models
Nondr	Land sales records	This variable represents the non drained arable hectares. It results from subtracting drained hectares from total arable hectares.
Lndrain	ln(drained)	Logged value of "drained" for use in log-lin, lin-log, and log-log models
Lnnodr	ln(nodrain)	Logged value of "nodrain" for use in log-lin, lin-log, and log-log models
Lnpast	ln(pastha)	Logged value of "pastha" for use in log-lin, lin-log, and log-log models
Lnwood	ln(woodha)	Logged value of "woodha" for use in log-lin, lin-log, and log-log models
Scrub	Land sales records	This variable is the combined total of pasture and non-orchard wooded land.
Ln_ph	ln(w_ph)	Logged value of "w_ph" for use in log-lin, lin-log, and log-log models
Ln_OM	ln(w_OM)	Logged value of "W_OM" for use in log-lin, lin-log, and log-log models
Adjust	Normalized WSA	This is a variant of Water Stable Aggregates in that the samples were normalized for sand content.
Avgsize	Survey, Land sales records	This variable originates as the total number of fields at the time of transfer divided into the amount of arable hectares.

3.8 Acquiring the Raw Land Price

The sample population used for this research included various types of agriculture. The land sales themselves also varied. Some of the observations included capital structures and investments. In order to isolate the price paid for the land it was necessary to subtract the market value for any buildings, livestock, equipment, quota, and any other capital goods that might have been transferred with the property from the sales price.

Where the market value was clearly established it was used. For items like buildings, however, a market value was not clear due to the uniqueness of each building and its remaining usable life. Therefore, two methods of evaluation were compared for items that did not have a clear market value. The first method was to accept the valuation of the OCAQ appraiser for the asset in question. Their method involved listing the non-land capital good at a fraction of replacement value due to depreciation.

The second method was to ask the buyer what value they estimated the capital item was worth to them at the point of sale. For most items there was little significant difference between the two types of evaluations. Therefore, because implicit prices are based on the interaction of market participants, the buyer's valuation took precedence over the OCAQ estimated value when both were available. Other items like tractors, livestock, and quota had clearly understood market values therefore the OCAQ market valuations were used. Again, in most cases the buyer's and the OCAQ's estimates were equal most of the time.

3.9 Sample Population

The sample population included farms of various qualities and sizes as can be seen from the minimum and maximum agricultural land prices, as indicated in table 6. Some of the parcels were almost overgrown in brambles while other parcels were simply one large open field. The mean sized agricultural land transfer consists of 35 hectares of drained land and almost 20 hectares of undrained land, and sold for $134,290 dollars (1992 constant). This fact is important to remember as implicit prices are derived for a statistically mean-sized transaction. The average pH was 5.8, which is lower than 6.3, the pH which provides the greatest range of available nutrients. The ideal pH is relative to the crop being grown. Average field size becomes an important factor as agriculture moves towards larger scales of operation and with it larger pieces of machinery. The variables with the greatest standard deviation were non-drained pasture, wooded land hectares. These large variations in composition of agricultural land provides some clue to the large variation in the average agricultural land sale.

Table 6. Sample population statistics

NAME	MEAN	STD. DEV.	MINIMUM	MAXIMUM
VALANFA	$134,290	$71,870	$23,775	$378,210
DRAINED	35.300	27.458	0.00000	112.30
NODRAIN	19.499	28.721	0.00000	136.80
PASTHA	1.8413	6.0915	0.00000	34.200
WOODHA	7.8548	19.901	0.00000	116.00
AVGSIZE	8.7261	11.425	1.9875	87.000
W_PH	5.8051	0.41002	4.8932	7.0102
W_OM	7.6275	14.518	1.8865	92.774
ADJUST	36.216	11.832	14.600	76.300

3.10 Functional Form Decision

The initial set of variables that is used in the hedonic pricing model is not known a priori. Economic theory will lead the researcher to the principle variables, and local geographic and socio-economic conditions will give the researcher clues as to other variables that are significant to the market. Given that the functional form is also unknown a priori a number of functional forms were tested. The criteria for selection of the correct functional form followed along conventional lines of "goodness of fit" criteria. These criteria included: correct sign for the coefficient, adjusted R^2 , significant t and F statistics, and considerations for heteroskedasticity.

3.11 Variable Choice Decision

Decisions on which variable to run in any regression is primarily a matter of theory. Here Ricardian land rent theory places physical then locational theory variables as a starting point. Therefore the initial choice of variable had to do with the different quantities of arable land, pasture, and woodland. Locational variables consisted of the agricultural region of origin. Any additional variables were to be chosen from the remaining available variables in the quality, capital improvement, and soil conservation investments categories. Choice was based on theoretical principles and the significance of the variable in the regression.

3.11.1 T-Statistics

T-tests, depending on the context of their use, indicate the significance of a variable. Whether a variable should be included in a regression is primarily a matter of economic theory. A second criteria for inclusion of a variable is established through the use of the t-statistic for a coefficient estimate. When used in the context of a statistical test where $H_o\!:\beta_x = 0$ the t-statistic will indicate whether the variable is significantly different from a zero value. Therefore, the t-statistic value must lie in the rejection region of the appropriate t-distribution for the variable to be significant. Variables that do not pass this test are not necessarily omitted if by the strength economic theory deemed them to be essential variables (Griffiths et al. chap. 10 1993).

3.11.2 F-Statistic

The primary use of the F-statistic is to test if the equation as a whole is significant. In this case the null hypothesis is that all the coefficients are equivalent to each other and equivalent to zero simultaneously. The null hypothesis is written: $H_o\!:\beta_{x_1} = \beta_{x_2} = \ldots = \beta_{x_n} = 0$. The test statistic of an F-test for equation significance must be greater than the critical value for the null hypothesis. Therefore, a favourable outcome is the rejection of the null hypothesis. This rejection means that all the variable coefficients are dissimilar to each other and to 0.

One explanation for accepting the null hypothesis is that the chosen independent variables are either not related to the dependent variable or that the important variables in the relationship have not been identified thereby inflating the error term and causing the acceptance of the null hypothesis. Equation misspecification increases the error term and is the cause of inefficient or biased estimates for the independent variables in a regression equation (Griffiths et al. chap. 10, 1993).

3.11.3 Heteroskedasticity

Heteroskedasticity is a commonly occurring phenomenon with cross-sectional data sets. The frequency of occurrence warrants testing as a standard procedure in cross-section data sets. The chosen test for heteroskedasticity was a Breusch-Pagan/Geoffrey test.

Heteroskedasticity consists of variances that are not proportional to the scale of the dependent or independent variables. An example would be small land purchases varying greatly in price while larger land purchases varying significantly less in price. Data sets with heteroskedastic errors result in inefficient coefficient estimates of their respective independent variables.

The test used in this research will be the Breusch-Pagan/Geoffrey test. This test was chosen based on the fact that its validity is independent of the functional form of the equation and it can deal with multivariate equations. It is assumed that the errors are normally distributed with this test.

This assumption is reasonable due to the number of observations in the data set and the Central Limit Theorem (Griffiths et al. sect. 15.2.3b, 1993).

3.11.4 Multicollinearity

Another area for possible bias in equation estimation occurs as a result of multicollinearity. This phenomenon is a problem only with sample data sets and not with population data sets. It occurs when two or more variables trend together in either the same or opposite directions. There are two types of multicollinearity; perfect and imperfect.

The first type of multicollinearity is perfect multicollinearity. It occurs when there is a direct functional relationship between variables. Knowing the relationship allows the researcher to create a data set given one of the variables. One example of perfect multicollinearity is referred to as the dummy variable trap. This occurs when all observations belong to one class of binary variable. If all observations belong to one of four variables, and if all four variables are used in the regression the resulting coefficients would be the weighted share of the variable. The solution to this particular problem is the omission of one of the four dummy variable categories from the equation.

The second type of multicollinearity is imperfect multicollinearity. It occurs when a group of variables might be related in some way and as a result they trend in either the same or in an opposite direction depending on the relationship. This trending is given in terms of percentage of correlation between the variables. Sometimes a clear relationship is not self evident, but remains a problem especially if the t-statistics for their estimators are weak. In the former case where a clear reason is understood for a relationship, possible solutions include combining or omitting one of the variables or possibly redefining some of the variables to eliminate the multicollinearity. In the latter case where no reason is apparent for a relationship, considerations like the t-statistics, correlation statistics, and the variance should be taken into consideration to make a decision on the appropriate course of action (Kmenta sect 10.3, 1986).

Chapter 4.

Results and Discussion

4.1 Initial Data Setup

As with most hedonic price model regressions the choice of variables is not known with certainty a priori. Econometric regressions use economic theory as the basis for variable choice, however, economic decision makers are not necessarily bounded by economic theory. It is important for the researcher to not only know the theory behind the phenomenon they are modeling, but also to recognize the practical decisions that are being made within the population being modeled. Ricardian theory was used as the basis for the selection of regression variables. However, in administering the survey a new variable was discovered. The new variable, average field size, reflects the reality of corporate farming and economies of scale. As agricultural equipment is getting bigger the surface areas that they tend must also get bigger.

Not all variables are significant within a regression equation. The researcher must view the data as an indicator of what is important within the market. Other variables, that according to theory should be significant, prove to be of lesser concern to the market participants. Depending on the variable's importance it may become part of the error term of the regression.

This is not to say that these variables are not important to certain individuals in the market place, but instead it does say that these variables do not affect the studied market as a whole. It is for this reason that some variables are not retained. In the process of testing the hypotheses generated by the problem statement, decisions about which variables to run in the regression had to be made. The inclusion of variables inappropriate to the studied market has econometric consequences such as inappropriate estimates, counterintuitive coefficient signs, strong multicollinearity with other variables, and the effect of increasing regression error. The variables that were chosen for inclusion in the regression are listed in table 7.

4.2 First Hypothesis

The first testable hypothesis is: **The purchase price of land is a function of its' physical, quality, capital improvement, and soil conservation characteristics.** In order to test this hypothesis the appropriate functional form must be determined. Using Ricardo's theory for land rents the variables in table 7 and their respective transformations where used to test for the proper functional form.

Table 7. Regression variables

Valandf	The dependent variable adjusted to reflect constant 1992 Canadian dollars
Constant	The normal intercept term of a regression
drained	Hectares of drained arable land
nodrain	Hectares of non-drained arable hectares
pastha	Hectares of pasture land
woodha	Hectares of wooded-non orchard land
w_pH	The weighted acidity of the arable fields
W_OM	The weighted percentage of organic matter in the arable fields.
Adjust	Adjusted Water Stable Aggregates
Avgsize	Average field size in Hectares

In this process, the measure for success is the highest rate of explanation i.e., the highest adjusted R^2. Variables from each of the four groups (physical, quality, capital improvement, and soil conservation characteristics) were chosen to be included in the regression equation. The specific variables chosen for these initial regressions were: Non-drained and drained arable land, pasture land, wooded land, weighted pH, weighted percentage of Organic Matter, a sand content adjusted Water Stable Aggregates variable, an average field size variable of the cultivable fields at the time of purchase and the physical/locational variable of regions 6,7, and 10.

Because the locational variables where represented by dummy variables region 5 was omitted to avoid the dummy variable trap. After the initial regressions were estimated, it was decided that the locational variables were not representative of the differences in location. As a result they were dropped from the regressions.

With respect to the first testable hypothesis all regression equations pass the F-test for joint significance of the explanatory variables. This test determines whether the variables within the equation jointly influence the dependent variable. The null hypothesis for this test is as follows: $H_o\!:\alpha_0 = \alpha_1 = \alpha_2 = ... = \alpha_n = 0$. The preferred outcome is for the null hypothesis to be to rejected. In this case the most stringent critical value for the F-statistic is 2.708 at 1% probability in a two-tailed test. This value is based upon 8 degrees of freedom in the numerator and 54 degrees of freedom in the denominator, based on linear interpolation.

The next step would be to ascertain which functional form best models the studied market. This is done by using a combination of criteria. The first criterion being an agreement with known economic theory and the correspondence with the expected signs for the variables. The second criterion was the R^2 and adjusted R^2 values for each equation. Here the criterion is to choose the equation with the highest values of the two measurements previously mentioned.

Various functional forms were tested. Table 8 summarizes the regression results. The t-statistic values, measuring the significance of individual estimates, are located directly below the variable estimates. Given the fact that there are 63 observations in the regression the t-statistic value for significance originates from the value given from the Student's t Distribution with n-1 observations for degrees of freedom, i.e. 62. Depending on the null hypothesis test, the critical value will change (see legend for level of significance key).

An alternative test for the level of significance of a variable is the p value. It reverses the process and is a measurement of probability of accepting the null hypothesis. P-values are already in two-tailed format and therefore must be double for one-tailed tests. Using a criterion level of 95% there are 4 significant variables in linear, log-linear, log-log functional forms and 5 significant variables in the lin-log functional form.

Given the information in table 8 the choice of functional form should be linear. The results generated by other functional forms did not warrant their consideration. This conclusion is based on the following factors: (1) The correspondence to expected economic theory with respect to sign. (2) The strength of the R^2 and adjusted R^2 values (3) The strength of the F statistic relative to the other regressions. (4) regression estimates approximate the statistical mean of the observations.

The linear functional form produced the best results (table 8). The adjusted R^2 of .6304 is quite respectable for cross sectional data of this sample size. When testing the equation's significance, an F-test was performed for the joint significance of all explanatory variables using the null hypothesis of $H_0{:}\alpha_1 = \alpha_2 = ... = \alpha_n = 0$, the test statistic far exceeded the critical value of 2.708 at 99% level of significance necessary to reject insignificance. This outcome indicates that the variables are significantly

Table 8. Regression results

Functional form values and information table					
Variable	**Unit description**	**Linear**	**Log-linear**	**Lin-log**	**Log-log**
Mean Purchase		**$134,290.00**	**$115,266.00**	**$134,290.00**	**$115,266.00**
Constant	**$/purchase**	**$(158,610.00)**	**$20,349.00**	**$(523,340.00)**	**$1,564.62**
		-1.761*⑪	12.06***⑪	-2.19**⑪①	3.865***⑪①
		8.40%	0.00%	3.30%	0.00%
Drained Ha	**$/additional hectare**	**$2,273.50**	**$2,129.07**	**$1,525.62**	**$1,822.74**
		7.579***	6.739***	3.315***	4.314***
		0.00%	0.00%	0.20%	0.00%
Undrained Ha	**$/additional hectare**	**$1,894.10**	**$1,516.32**	**$4,264.24**	**$4,454.93**
		6.286***	4.779***	2.875***	3.271***
		0.00%	0.00%	0.60%	0.20%
Pasture Ha	**$/additional hectare**	**$(298.90)**	**$(1,212.19)**	**$(9,678.35)**	**$(9,586.00)**
		-0.2993	-1.152	-1.275	-1.375
		76.60%	25.40%	20.80%	17.50%
Woodland Ha	**$/additional hectare**	**$(539.16)**	**$(357.79)**	**$(4,331.90)**	**$(390.87)**
		-1.783*	-1.122	-1.711*	-1.682*
		8.00%	26.70%	9.30%	9.80%
Average field size	**$/additional hectare**	**$1,584.20**	**$1,166.84**	**$6,471.37**	**$5,463.85**
		2.968***	2.076**	3.468***	3.19***
		0.40%	4.30%	0.10%	0.20%
Weighted pH	**$/additional .1 units**	**$3,219.80**	**$1,799.30**	**$5,374.81**	**$3,511.13**
		2.246**⑪	1.166⑪	2.793***⑪	1.992*⑪
		2.90%	24.90%	0.70%	5.10%
Weighted O M	**$/additional 1% of O M**	**$257.61**	**$200.65**	**$1,107.[illegible]3**	**$322.64**
		0.6098	0.451	0.3888	0.1233
		54.50%	65.40%	69.90%	90.20%
Water Stable Aggregates	**$/additional 1% of W S A**	**$(728.58)**	**$(441.54)**	**$(503.85)**	**$(263.99)**
		-1.452	-0.8355	-0.7241①	-0.4133①
		15.20%	40.70%	47.20%	68.10%
Statistical tests:					
F-statistic		14.219	9.807	5.643	6.205
R^2		0.6781	0.5948	0.4553	0.479
Adjusted R^2		0.6304	0.5347	0.3746	0.4018
Breusch-Pagan/Geoffrey		8.907	6.086	15.547	9.086

⑪Constant highly correlated to Weighted pH

①Constant highly correlated to Water Stable Aggregates

*** 99% level of significance

** 95% level of significance

* 90% level of significance

different from 0 and from each other. In this case the numerator degrees of freedom is k-1 or 8 and n-k or 54 in the denominator and the critical value was linearly interpolated. Where k represents the number of coefficients in the equation and n is the number of observations. The F-test statistic value for this equation was 14.219, and results in rejection of the hypothesis that all variables are jointly not significant different from zero. This would indicate that agricultural land characteristics chosen provide a means of predicting the selling price of agricultural land. This conclusion is supported by the individual t-statistics of the equation coefficients (table 8).

4.3 Second Hypothesis

The second testable hypothesis is: **Conventional measures of soil quality such as pH, potassium, phosphorus, calcium, magnesium, and organic matter can serve as proxies for actual production records.** Weighted pH, the variable measure the average pH of all the arable fields, is significant. The variable organic matter had the appropriate sign but its t-statistic indicated that it was not significantly different from zero.

The measure of erodibility and good land stewardship, adjusted water stable aggregates, had the wrong sign and was also not significantly different from zero. All other variable in this category had negative effects on the regression and were not included in the final regression.

The level of a soil's acidity, pH, is important to plants as nutrients are only made available when the pH is in a certain range. A pH of 6.5 is the optimal range for the greatest number of available nutrients (Brady p. 228, 1990). Each plant variety has their preferred pH according to their nutrient requirements. The average observational pH was 5.85 on a whole farm basis. An additional tenth of a unit of pH on a farm wide basis seemed to contribute an additional $3220.00 dollars to the overall sales price of the land. Spread over the mean number of hectares this estimate would amount to an investment of $60.08 per hectare to raise soil pH by a tenth of a unit. The reliability of this estimate was quite good with a p-value (percentage of accepting the null hypothesis) of 2.9%, and it is also a reasonable estimate from a practical point of view given the cost of liming and the absence of considerations for the specific soil type.

A problem occurred with the pH estimate in that it is highly correlated to the regression's constant in all four models. There is no a priori reason for this problem. It is thought that this correlation might be due to the nature of the variables. Both variables have observations that cluster around a given value and therefore produce a high correlation to each other.

With respect to organic matter, the purchasers of agricultural land did not seem to pay a premium for increasing levels of this desirable characteristic. The estimated coefficient for organic matter was $275.00 for a one percent increase in organic matter on a farm wide basis. This estimate is not reasonable for the agricultural land resource base being considered. The probability of the coefficient being equal to zero was better than 54%.

Water Stable Aggregates is a variable that was capable of measuring the future soil erodibility on agricultural land. The resulting coefficient was counter intuitive to economic theory. A well managed soil should contain more water stabile aggregates than the converse. Therefore, the expected coefficient sign should be positive for increasing amounts of water stable aggregates. This variable was not especially significant with a t-statistic of -1.452 and a p-value of 15.2%.

4.4 Third Hypothesis

The third testable hypothesis was: **Drained hectares of arable agricultural land receive a premium as compared to non-drained land.** In this case the evidence is quite clear. The estimated difference was a reasonable representation of actual market observations. There was a high collinearity between drained and undrained arable land. This problem originates from the physical relationship they hold to each other (i.e., one variable is the other with the only difference being the investment in drainage). In this case the correlation between coefficients is 70%, but when considering the t-statistics for each of the variables this concern is reduced. In this case the t-statistics for drained and non-drained lands were 7.6 and

6.3 respectively. Given that the critical t-statistic value for 99% certainty is 2.704, confidence in these estimates are extremely strong.

The fourth hypothesis, **Organic matter content and Water Stable Aggregates measurements can serve as proxies for soil conservation investments,** was not testable due to the fact that these variables were not significant and sometimes were not of the right economic sign in any of the regressions. There are two possibilities for their faillure: 1) that the variables are not testable, and 2) that they are poor proxies of soil conservation investments.

4.5 Summary

With the exception of the correlation between the constant and pH, all variables appear to reflect the agricultural land market that they modeled. One additional piece of information of a serendipitous nature is the significant and positive coefficient for average field size. This variable's positive coefficient is most probably due to efficiencies of scale through the use of large machinery.

Chapter 5.

Conclusions and Discussions

5.1 The Nature of the Study

The question asked in this research was: **Does the market provide positive returns for the existence of soil conservation and capital improvement investments in the purchase price of agricultural land?** To answer this question a sample of 64 agricultural land sales was taken within Québec agricultural regions 5,6,7, and 10. All properties were located within a 150 kilometer radius of the Macdonald Campus of McGill University. Furthermore, transactions were "arms length" to isolate any effect of preferential pricing when properties are exchanged between family members.

The periodicity of this data occurs from January 1, 1990 until July 1, 1992, and prices were standardized to 1992 dollars via Statistics Canada Price Indices. All sample observations were of land transfers of approximately 40 hectares and greater. Some observations were of bare land while others included buildings, livestock, quota, and other non-land items. The market values of these non-land items were removed from the purchase price in order to estimate the bare land value. Using a hedonic pricing model the characteristics of the land purchase were regressed on the purchase price. This method yields useful information about the mean value of an additional unit of the characteristic on a theoretically mean sized purchase.

5.2 Study Conclusions

The sample population originates mostly on the sandy-loam soils native to the St. Lawrence river basin. Physical characteristics such as available hectares of arable land invariably yielded positive price signals. In this study land was differentiated into arable, pasture and woodland. Arable land was further subdivided into drained and undrained land. Due to its proximity to sea-level a majority of the hectares were drained. Drainage has several positive effects on agricultural production in this region. First, it can be viewed as a capital investment that can reduce the risk of crop failure due to water inundation. Secondly, it can be viewed as a soil conservation technique as it increases the permeability of the soil and prevents sheet erosion. Finally, it helps provide insurance that fields can be planted early in the production year.

This study estimated that the implicit price premium for a hectare of drainage was $379.00 dollars over non-drained land. This amount is superior to the cost of some but not all forms of drainage. Therefore, the positive price incentive to install drainage is sufficient to induce the capital investment. As a result, no market failure occurs and there is no need to provide an incentive to install drainage. Some of the practical reasons for non-investment would be: (1) That the physical properties and soil characteristics do not warrant drainage. (2) Cash flow restrictions prohibit the implementation of drainage projects where necessary and beneficial. (3) Investment in drainage is not part of the decision makers' goals.

The theoretically mean-sized land transaction represented by the regression included a mixture of arable, pasture, and woodlands. Changing this mixture to include an additional hectare of pasture did not clearly affect the sales price of the land transaction because its estimate was not significantly different from zero. Changing this mixture to include an additional hectare of woodland to the mean-sized land transaction decreased its sales price by $539.00 dollars. This occurs because in order to change the mixture a reduction of either pasture or arable land would have to occur. This reduction would lower the overall productivity of the parcel of land.

Average field size is a physical characteristic that was serendipitously discovered to be significant during this research. While interviewing the participants of this study, a common theme amongst purchasers was discovered. Producers who purchased land were filling in the open drainage ditches and consolidating fields. It was thought that this activity might be a reflection of the agricultural land market's value for larger sized fields. Information on the original number of fields at the time of purchase was available. This information was used to establish the average field size at the time of purchase.

The average field size for the sample population was 8.7 hectares. The price signal for an increase of one hectare in this average field size raised the overall sales price by $1584.20 dollars. This premium infers that larger field sizes increase efficiencies and results in increased land rents (sales price). Efficiencies in agricultural production are achieved by using large machinery. Large machinery is most efficient on large tracts of land.

Two factors may explain this outcome: (1) the resulting economies of scale from using large machinery and (2) the efficiency of time usage in large scale production. Further support for this conclusion is given by the Tabi et al (1990) study for this trend toward larger field sizes. However, large machinery results in soil compaction, and compaction was cited as a problem of Québec soils.

Quality characteristics of agricultural land, while undeniably beneficial to agricultural productivity, produced ambiguous results with regards to positive price signals for increasing units. A natural expectation would have been positive price signals for pH, organic matter, and water stable aggregates (an indicator of good stewardship). Other soil quality indicators such as phosphorous, calcium, magnesium, and potassium did not produce any significant implicit prices in the preliminary regressions.

PH was the only quality variable with an influence on sales price. A premium of $60.00 dollars per hectare per tenth of a unit increase in pH level was estimated. The confidence was strong at greater than a 95% level of significance. This estimate was compared to the actual cost of liming a hectare of land and the subsequent increase in pH and it appeared to be reasonable. Caution must be exercised with regards to this estimate, as it was highly correlated with the constant. A possible explanation might be that both the constant and pH have a tendency to cluster around a given value.

The hypothesis that conventional soil tests would proxy actual production information was not supported by this study. Soil tests aid the agricultural producer in rationalizing agricultural inputs, but it does not appear to have been adopted as a decision making aid for agricultural land purchases. Measurements of organic matter content and water stable aggregates also failed to indicate that agricultural land purchasers valued these characteristics.

Soil conservation practices result in decreased soil erosion and increased yields over the long run (Troeh et al. chap. 18, 1991). The variable for organic matter was of the correct sign but did not produce a significant price premium, nor was it significant statistically. This variable did not yield any useful information about this agricultural land market other than it was not a financial consideration. The same could be said of water stable aggregates. Elevated water stable aggregates is an indicator of good soil structure. The estimate of water stable aggregates carried a p-value of 15.2% and, therefore, was not extremely reliable. Moreover, from a theoretical point of view, its coefficient carried the wrong sign. It can be concluded that this variable does not produce a positive price signal and is statistically insignificant in this agricultural land market.

The studied agricultural land market would appear to value cultivable land and penalizes agricultural land producers for woodland. It also provides an incentive for large open tracts of land that have installed drainage. This market does provide an incentive for maintenance of field pH. Soil conservation is not an agricultural land market consideration. In spite of the tangible benefits, no premiums were being paid for increased levels of organic matter or water stable aggregates. Assuming sustainable agriculture is a common social goal, this research indicates that private markets are not providing the proper price incentives to induce agricultural producers into a sustainable agriculture scheme. The incentives for sustainable agriculture and soil conservation must therefore come from the public sector.

5.3 Recommendations for Future Studies

Hedonic studies require vast amounts of information. The required information and the functional form of the regression are not known a priori. Even though this research enjoys relative success, several procedural points could be improved. The first improvement would be the use of some form of land classification variable. This study was performed on relatively homogeneous lands. The inclusion of land classifications might have improved the study.

Future studies repeating this research might yield interesting insights on the adoption rate of soil conservation investments into agricultural producer's operating budgets. Once integrated on a market wide basis the agricultural land market should provide an incentive for investment. This recognition is necessary for private markets to provide incentives for soil conservation investments. Investment in soil conservation by the private decision maker is not likely to occur without this market wide recognition of its benefits.

To date only a few studies have indicated that agricultural producers view some types soil conservation investments as a benefit. Economic theory would suggest that if agricultural producers realized soil erosion as a production cost they would marginalize soil loss along with other inputs into the cost of production. Once done an optimal level of soil conservation should occur within agricultural production.

New and related areas of study might be: 1) an analysis of the exact cost of drainage installation, and 2) an analysis of the exact costs of various sustainable agricultural practices. Finally, it would be interesting to know if the average field size variable, introduced in this study, reoccurs in other agricultural land markets. This might be viewed as new phenomenon in land markets.

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Appendix:

Study Questionnaire

Cette enquête vise à faire ressortir !es points que les agriculteurs considèrent importants lors de l'achat d'une terre agricole. Il importe de connaître aussi précisément que possible l'état de la propriété au moment de l'achat et les changements qui y ont été apportés depuis.

Cahier 1: Informations générales

Cette section sert à fournir des informations générales concernant la vente, la propriété et ses caractéristiques.

1- Quelle est la date (mois, année) de la signature du contrat d'achat? ________________

2- Combien d'habitations avez-vous achetées avec la propriété? ________

3- Combien d'édifices autres que des habitations avez-vous achetés avec la propriété? _______

4- Quelle était la principale production de la ferme avant l'achat? ___________________

Grandes cultures [1]
Tabac [2]
Pomiculture [3]
Pommes de terre [4]
Petits fruits [5]
Légumes de conserverie [6]
Cultures maraîchères [7]
Serriculture [8]
Spécialités horticoles [9]
Pépinière et gazonnière [10]
Foresterie [11]
Vaches-Veaux / Boeuf [12]
Vaches-Veaux / Lait [13]
Veaux seulement [14]
Naisseur (truies, porcelets) [15]
Naisseur-engraisseur (truies, porcelets, porcs) [16]
Engraisseur (truies, porcs) [17]
Oeufs de consommation [18]
Oeufs d'incubation [19]
Poulets et dindons [20]
Autres voiailles [21]
Moutons [22]
Chèvres [23]
Visons [24]
Lapins [25]
Renards [26]
Pisciculture [27]
Autre [99]

5- Quelle est la principale production de la ferme actuellement? ___________

Grandes cultures [1]
Tabac [2]
Pomiculture [3]
Pommes de terre [4]
Petits fruits [5]
Légumes de conserverie [6]
Cultures maraîchères [7]
Serriculture [8]
Spécialités horticoles [9]
Pépinière et gazonnière [10]
Foresterie [11]
Vaches-Veaux / Boeuf [12]
Vaches-Veaux / Lait [13]
Veaux seulement [14]
Naisseur (truies, porcelets) [15]
Naisseur-engraisseur (truies, porcelets, porcs) [16]
Engraisseur (truies, porcs) [17]
Oeufs de consommation [18]
Oeufs d'incubation [19]
Poulets et dindons [20]
Autres volailles [21]
Moutons [22]
Chèvres [23]
Visons [24]
Lapins [25]
Renards [26]
Pisciculture [27]
Autre [99]

6- Quelle est la superficie totale de la ferme en hectares? ___________

7- Si on définit un champ comme une superficie de terre continue sur laquelle se pratique une seule culture, combien de champs retrouve-t-on sur la propriété? ________________

8- Quelle est la superficie des champs en hectares?______________

9- Combien de pâturages se retrouvent sur la ferme?_____________

10- Combien d'hectares de pâturage compte la ferme?_____________

11- Quelle est la superficie boisée sur la ferme en hectares?_________

12- Combien de types différents de vergers se retrouvent sur la ferme?_______

13- Quelle est la superficie en hectares des vergers?___________

14- Quelle est la superficie totale en hectares de l'(ou des) érablière(s) de la ferme?

____

15- Veuillez indiquer si un ou plusieurs des biens suivants faisaient partie de l'achat. Si oui, indiquez la valeur.

BIENS	OUI ou NON	VALEUR $
a) Bovins		
b) Porcs		
c) Moutons		
d) Volailles		
e) Autres animaux		
f) Machinerie agricole		
g) Equipement d'érablière		
h) Foin		
i) Maïs		
j) Autres grains		
u) Quotas		
w) Autres biens		

Cahier 2: Caractéristiques des maisons

Cette section sert à établir la valeur des maisons vendues avec la propriété.

1- Quel est l'âge de la maison? ____________________________

2- Quel est le revêtement extérieur de la maison?

BOIS	BRIQUE	PIERRE	autre_____________

3- Combien d'étages possède la maison? ___________________

4- Quelle est la superficie de plancher de la maison (en mètres carrés)? ______________

5- La maison possède t'elle un sous-sol? ______________

6- Combien de pièces retrouve-t-on dans cette maison? _____________

7- Combien de chambres à coucher retrouve-t-on dans cette maison? ______

8- Combien de salles de bain retrouve-t-on dans cette maison? ________

9- Cette maison est-elle votre résidence principale? _________

10- Cette maison est-elle la résidence de vos employés ou d'autres personnes? __________

11- Avez-vous apporté des améliorations à cette maison depuis l'achat? _________

12- Si oui, combien avez-vous dépensé en améliorations? $________

Cette section sert à recueillir des informations concernant les constructions autres que des habitations et qui étaient inclus dans la vente de la propriété.

Cahier 3: Caractéristiques des édifices

1- Indiquez dans quelles catégories se situent les constructions vendues avec la propriété.

Structure - Type de construction	**Dimension**	**l'âge**	**Vie utile restante**	**Valeur**
1. Serres				
2. Poulailler				
3. Silo				
4. Étable d'élevage				
5. Porcherie				
6. Étable pour vaches laitières				
7. Écurie				
8. Remise (entrepôt)				
9. Garage				
10. Réservoirs pour fumier liquide				
11. Sucrerie				
12. Bassins pour pisciculture				
13.autre:				
14.autre:				
15.autre:				
16.autre:				
17.autre:				

2- Lesquelles de ces constructions sont actuellement louées à d'autres? (Veuillez inscrire les numéros de la liste ci-dessus qui correspondent aux constructions louées).

_____ ____ ____ ____ ____ ____ ____ ____ ____

3- Avez-vous modifié, détruit ou amélioré les constructions mentionnées à la question 1? (Inscrivez les numéros correspondant à la liste de la question 1)

Construction #	**Modification/destruction ou amélioration**	**Coût du changement**

Cette section vise à recréer un portrait de la ferme au moment de l'achat. Il est très important de fournir des informations précises concernant les travaux effectués sur ce terrain depuis l'achat. Ces données seront ensuite jumelées aux résultats des analyses de sol, afin d'obtenir un estimé de l'état des sols au moment de l'achat. On vous demandera aussi des informations sur les pratiques culturales du propriétaire précédent et sur ses investissements en conservation des sols.

Cahier 4: Caractéristiques des champs

1- Au moment de l'achat, lesquels des travaux d'aménagement suivant avaient été effectué par le propriétaire précédent?

1- Nivellement O

2- Terrassement O

3- Drainage a) Souterrain O

b) de surface (fossés) O

c) voie d'eau engazonnée O

d) bassins de rétention O

4- Brise-vent a) arbres O

b) autres O

5- Irrigation a) de surface O

b) souterraine O

6- Autres travaux O ______________________________

2- Quelles cultures étaient pratiquées sur cette ferme par l'ancien propriétaire?

a) Céréales: maïs O, orge O, avoine O, blé O, seigle O

b) Légumineuses à graines: pois secs O, soya O, haricots secs O, féverole O,

c) Cultures commerciales: sarrasin O, tournesol O

d) Légumineuses fourragères: luzerne O, trèfle rouge O, ladino O, lotier O

e) Graminées fourragères: mil O, brome O, dactyle O, alpiste roseau O

f) Légumes O

g) Gazon en plaques O

h) Vergers: pommes O, poires O

i) Conifères: pins O, sapins O, épinettes O

j) Fleurs O

3- Quels types de fournitures étaient utilisés sur cette ferme par l'ancien propriétaire? (Veuillez fournir autant de détails que possible sur l'utilisation.

Fournitures	Oui	Non	Quantité
Pesticides Herbicides			
Chaux			
Engrais Minéraux			
Fumiers / Compost			
Lisiers de porc			
Boues d'usines d'épuration			

4- Le type de production agricole que vous pratiquez sur cette propriété est-il différent de celui du propriétaire précédent?

Grandes Cultures	Tabac	Chevaline
Vaches-Veaux/Boeuf	Vaches-Veaux/Lait	Veaux Seulement
Naisseur (truies,porcelets)	Naisseur-Engraisseur (truies, porcelets, porcs	Engraisseur (truies, porcs)
Oeufs de Consommation	Oeufs D'Incubation	Poulets et Dindons
Autres Volailles	Moutons	Chèvres
Visons	Lapins	Renard
Pisciculture	Pomicultures	Pommes de Terres
Petits Fruits	Légumes de Conserverie	Cultures Maraîchères
Serricultures	Spécialités Horticoles	et Gazonnière
Forestière	Autres	

5- Avez-vous effectué des améliorations ou travaux reliés à la conservation des sols depuis votre achat?

1- Nivellement O

2- Terrassement O

3- Drainage a) Souterrain O

b) de surface (fossés) O

c) voie d'eau engazonnée O

d) bassins de rétention O

4- Brise-vent a) arbres O

b) autres O

5- Irrigation a) de surface O

b) souterraine O

6- Autres travaux O ______________________________

Nous vous demandons maintenant de fournir des informations sur vos pratiques culturales. Il serait aussi utile de savoir à quelle période de l'année s'effectuent ces travaux.

6- Veuillez indiquer les opérations culturales que vous utilisez et aussi quand cela c'est passé.

1- Labour
2- Hersage
3- Labour et hersage
4- Labour sur courbes de niveau
5- Travail minimum
6- Aucune opération culturale

7- Quelles cultures avez-vous semées sur cette propriété depuis l'achat?

a) Céréales: 1) maïs, 2) orge, 3) avoine, 4) blé, 5) seigle

b) Légumineuses à graines: 1) pois secs, 2) soya, 3) haricots secs, 4) féverole
c) Cultures commerciales: 1) canola, 2) sarrasin, 3) tournesol
d) Légumineuses fourragères: 1) luzerne, 2) trèfle rouge, 3) ladino, 4) lotier
e) Graminées fourragères: 1) mil, 2) brome, 3) dactyle, 4) alpiste roseau
f) Légumes
g) Gazon en plaques
j) Fleurs

Nous amerions connaître les types de fournitures actuellement utilisés sur cette ferme. Il demeure important de fournir des informations sur les quantités et la saison d'utilisation.

8- Quels types de fournitures utilisez-vous sur cette ferme? Indiquez à quelle période de l'année se fait l'utilisation.

1- Pesticide / Herbicide
2- Chaux
3- Engrais minéraux
4- Fumiers
5- Lisiers de porc
6- Boues d'usine d'épuration
7- Aucune fourniture

L'information qui suit servira à établir la productivité de la ferme.

9- Quelle est la production totale annuelle de chacune des cultures récoltées. Spécifiez la production pour chaque année depuis l'achat. (Utilisez les unités de mesure de l'agriculteur. Si celles-ci sont imprécises, tentez de les préciser).

Cultures	récoltées TOTAL 1990	TOTAL 1991	TOTAL 1992

ANNEES DE RECOLTE 1990

# de CHAMP et grandeur (Ha)	Cultures semées	Opérations culturales pratiquées et Saison de l'année effectuée	Fournitures utiliseés et Saison de l'année effectuée

ANNEES DE RECOLTE 1991

# de CHAMP et grandeur (Ha)	Cultures semées	Opérations culturales utilisées et Saison de l'année effectuée	Fournitures utilisées et Saison de l'année effectuée

ANNEES DE RECOLTE 1992

# de CHAMP et grandeur (Ha)	Cultures semées	Opérations culturales utilisées et Saison de l'année effectuée	Fournitures utilisées et Saison de l'année effectuée

Les questions suivantes serviront à compléter l'information nécessaire à une évaluation de la régie du propriétaire précédent, des investissements et de la qualité de la ferme.

Cahier 5: Caractéristiques des pâturages de la ferme

1- Quels types de pâturages se retrouvaient sur la ferme au moment de l'achat?

1) Situés sur un sol cultivable O

2) Situés sur un sol non-cultivable (pente, roches, humidité, etc.) O

2- Quelle était la superficie de chacun des types de pâturages mentionnés à la question 1?

3- Est-ce que la superficie et la composition des pâturages étaient variables ou stables?

Pâturages # et Type de pâturages	Superficie du pâturage	Changement de superficie + -

4- Quels types de fournitures avez-vous utilisés sur les différents pâturages de cette propriété?
1) Chaux 2) Engrais minéraux 3) Fumiers et composts 4) Lisiers de porc 5) Boues d'usine d'épuration 6) Aucun

5- Indiquez la période de l'année à laquelle se fait l'utilisation de ces forunitures.

6- Indiquez la quantité totale de chacun de ces forunitures qui a été utilisée sur les pâturages à chaque année depuis l'achat de cette propriété.

Pâturages #	Fournitures	Quantité et Année

Ces questions serviront à fournir l'information nécessaire à une évaluation de la valeur des boisés retrouvés sur la propriété.

Cahier 6: Caractéristiques du boisé

1- Quelle était la superficie des boisés retrouvés sur la ferme au moment de l'achat?

2- Quelle était l'état des boisés au moment de l'achat?

3- Quels types de boisés se retrouvaient sur la propriété au moment de l'achat?

1 = Forêt à maturité	2 = En croissance	3 = Fraîchement coupée
A = Boisé mixte		C = Boisé sans valeur
B = Peuplement homogène	B1) Bois mous	B2) Bois durs

Boisés #	Superficie du boisés	L'état et le type de boisés

4- Avez-vous coupé du bois dans ces boisés?

Oui _____ Non _____ Valeur $ __________

5- Est-ce que la superficie boisée a changé sur cette propriété depuis l'achat?

Boisés # Changement (Ha +-) 1990	Boisés # Changement (Ha +-) 1991	Boisés # Changement (Ha +-) 1992

6- Avez-vous investi dans les boisés de cette propriété depuis l'achat?

1- Plantation...............$__________.__
2- Fertilisation............$__________.__
3- Structures...............$__________.__
4- Bulldozer................$__________.__
5- Drainage.................$__________.__

Ces questions serviront à fournir l'information nécessaire à une évaluation de la valeur des boisés retrouvés sur la propriété.

Cahier 8: Caractéristiques de l'érablière

1- Quelle est la superficie de l'érablière en hectares? ______

2- Quel était le nombre d'entailles au moment de l'achat? ______

3- Quelle quantité de sirop a été récolté lors du dernier printemps avant l'achat? ______

4- Quel est l'âge approximatif du peuplement? _____

5- Quel était la valeur des équipements de sucrerie inclus lors de l'achat de cette propriété?

______

La section suivante traite des changements et investissements que vous avez effectués dans cette érablière durant la première année de possession.

6- Avez-vous changé le nombre d'entailles dans cette érablière?

7- Quelle quantité de sirop avez-vous récolté sur cette érablière durant les 3 dernières années?

	Saison 1990	Saison 1991	Saison 1992
nombre d'entailles			
quantité de sirop			

8- Combien d'érables avez-vous éliminés durant les 3 dernières années?

# éliminés 1991	# éliminés 1991	# éliminés 1992

Cette section servira à cerner l'impact de certaines variables quantitatives et non-quantitatives associées à l'achat d'une terre agricole.

Cahier 9: Analyse qualitative

1- Quel était le prix demandé pour cette ferme? $___________

2- Quel a été le prix de vente final? $_____________

3- Lesquels points suivants ont influencé la négociation du prix final?

La qualité des bâtiments O

La qualité des habitations O

Le voisinage O

La distance par rapport aux marchés O

L'état des champs O

L'érosion visible des sols O

L'état des machineries et équipements O

Autre O ____

Les énoncés suivantes réfèrent à la propriété au moment de l'achat.

4- Quelle proportion de la ferme était utilisée au moment de l'achat?

0%___ 25-50%___ 51-75%___ 76-99%___ 100%___

5- Au moment de l'achat, le sol était en _____

a) très mauvais état
b) mauvais état
c) bon état
d) très bon état
e) excellent état

6- Au moment de l'achat, les champs étaient faciles à cultiver.

Très en désaccord	En désaccord	Indifférent	D'accord	Très en accord

7 A quelle distance se retrouvent les marchés pour les divers produits de la ferme?

	Distance	Coût du transport / unité (précisez)
Produit 1	____________KM	$______________/______________
Produit 2	____________KM	$______________/______________
Produit 3	____________KM	$______________/______________

8- Quelle distance sépare la ferme des 3 villes les plus proches?

Distance		Villes
1) __________	km	_____________
2) __________	km	_____________
3) __________	km	_____________

9- Quel est le montant des subventions que vous avez obtenues pour des travaux de conservation des sols sur cette propriété, à chacune des années depuis l'achat?

1990	1991	1992
$	$	$

10- Quel est le montant des subventions que vous avez obtenues pour les cultures exploitées sur cette propriété, à chacune des années depuis l'achat?

1990	1991	1992
$	$	$

Cette section aidera à estimer les influences qui pourrait exister dans la transaction, en déterminant la motivation de l'acheteur et du vendeur.

Motifs de l'acheteur

1- Veuillez décrire le niveau de votre intérêt dans la propriété au moment de l'achat.

Motivé par le prix faible	Un peu intéressé	Intéressé	Aurait payé un peu plus cher	Aurait payé beaucoup plus cher

2- Quels sont les motifs qui vous ont incités à acheter cette propriété?

a) Proximité de ma ferme originale O

b) Prix inférieur à la valeur marchande O

c) Ferme bien située O

d) Constructions très intéressantes O

e) Le financement disponible a rendu l'achat possible O

f) La qualité des sols était meilleure que sur les autres fermes que j'ai visitées O

3- Au moment de la transaction, j'avais l'intention de changer la production de la ferme.

Oui _____ Non _____

Motifs du vendeur

4- Lesquels des motifs suivants ont poussé le propriétaire à vendre cette ferme?

a) Désintéressement de l'agriculture O

b) Mauvais état de santé O

c) Retraite O

d) Changement de profession O

e) Problèmes familiaux O

f) Problèmes financiers (faillite) O

g) Pas de relève O

h) Décès du propriétaire (règlement de succession) O

i) Autre motif O____________________

Caractéristiques de la transaction

1- Quelles sources de capital ont été utilisées pour acheter la propriété?

2- Quel montant avez-vous reçu de chacune des sources?

3- Quel taux d'intérêt est chargé sur ce montant?

4- Quelle est l'échéance de ce prêt?

Source	Montant ($)	Taux (%)	Échéance (années)
Épargnes			
Héritage			
Loterie			
Prêteur commercial			
Prêteur gouvernemental			
Subvention à l'achat			
Vente d'une autre propriété			
Prêt familial			
Autre			