the advantages of early agricultural returns, easy stand access, simpler stand management and reduced fire risks (Tustin et al., 1979).

A number of U.S. studies (Lewis et al., 1983, 1984; Halls and Suman, 1954) have looked at the possibility of cattle production in pine plantations and found that with proper management this system could be very economic. A major study by Lewis et al. (1983) on the integration of pines, pastures and cattle examined the response of combining the production of slash pine and beef. While the treeless pastures had higher beef gains, this was more than compensated by the income received from the sale of the tree crop on the forest-grazing land. Productivity per unit area of land could be further increased if pre-commercial thinning, which is a recommended silvicultural practice, is carried out. The forage yield is increased as a result, which allows more cattle to graze the area, and an income is derived from the production of firewood from the thinnings. Additionally, a higher income was received because the heavier thinning produced more pulpwood, and higher quality sawlogs and the fewer trees resulted in easier access for harvesting machinery. Another project by Lewis et al. (1984) looked at further improving the economics of forest grazing by introducing hay production during the first three years of the plantation. Grazing on pasture plantations has to be delayed for at least three years to prevent injury to the young pines by the cattle. The study showed that hay can be harvested in woodland pastures when pines are planted wide enough apart to allow for the adequate operation

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THE AGROFORESTRY OPTION IN
CANADA WITH AN EMPHASIS
ON EASTERN ONTARIO

E.N. Hogan, B.A. B.Sc.

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A Thesis Submitted to the Faculty of
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Department of Geography
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August, 1988

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The undersigned recommend to the Faculty of Graduate
Studies and Research acceptance of the thesis

THE AGROFORESTRY OPTION IN CANADA
WITH AN EMPHASIS ON EASTERN ONTARIO

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B.Sc (Honours), B.A. (Honours), Carleton University
in partial fulfilment of the requirements for
the degree of Master of Arts.

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ABSTRACT

The objective of this thesis is to determine whether agroforestry has a potential for implementation in Canada. The study defines and describes agroforestry systems and outlines how they are being used to solve the environmental problems in developing countries. The forestry and agricultural sectors in Canada are examined and found to be developing resource degradation problems similar to the Third World. It is then proposed that agroforestry systems could similarly be used to help mitigate the problems facing these two resource sectors. Existing agroforestry applications and research in Canada, or those suitable to the Canadian environment are identified, described and their potential contribution is examined.

Eastern Ontario is selected as a case study to allow the implementation of agroforestry systems to be evaluated at a level where the analysis can provide detailed and applied results. The physical parameters of climate and terrain and soil, and socio-economic parameters of land, labour capital and management are examined and determined to be amenable to the implementation of agroforestry. As a result of this conclusion, an adoption strategy and assessment of potential for the introduction of agroforestry to Eastern Ontario is considered.

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CHAPTER ONE

INTRODUCTION

Growing concern has been expressed over the past decade regarding the accelerating deterioration of Canada's agricultural and forest resources. Agriculture in Canada is facing two major problems. As stated in the World Conservation Strategy - Canada (Pollard and McKechnie, 1986), the trends toward the intensive management of a narrow range of crops, the introduction of marginal land into production, the increase in the capitalization of farm operations and the decrease in integrated animal-crop farm units have reduced the flexibility of farm operations. The resulting soil degradation has been outlined in a number of recent reports (see for example; Agriculture Canada, 1986; Coote et al, 1981; McGill et al, 1981; Science Council, 1986; Senate Committee on Agriculture, Fisheries and Forests, 1984; Voyer and Murphy, 1984). The other problem facing this sector is that rising production costs and low commodity prices have produced a declining net farm income, which is threatening the existence of the agricultural community.

For forestry, recent surveys of Canada's forests have been unanimous in their view that our forests are in trouble (Anderson, 1983; Benson, 1983; de Fayer, 1983; Keating, 1982; MacKay, 1985; O'Hara, 1983; Science Council of Canada, 1983; Voyer and Murphy, 1984). This country's commercially accessible timber reserves have declined to a point where there is a concern whether our remaining timber resources will be adequate to sustain the industry at its present level of production.

The Third World faces similar resource degradation problems and one successful solution has been a land use concept called agroforestry.

Agroforestry is a system in which trees and agricultural enterprises each provide a product which meets the needs of the end users of the system and which at the same time provides environmental and production stability and, in a number of cases, improvement (Steppler, 1984).

The objective of this paper is to examine the agroforestry concept to determine whether it could be implemented in Canada, and in eastern Ontario in particular. It will investigate the potential of integrating agroforestry systems into traditional agricultural or forestry practices. Eastern Ontario will be used as a case study to establish a framework for evaluating the potential of implementing an agroforestry system and developing an adoption strategy. While one might question the relevance of such systems, which are practised largely at a subsistence level in tropical climates, to Canada, which has a capital-intensive, high-efficiency, monocultural approach to agricultural production, there are indications that an agroforestry approach would be beneficial.

A number of changes will have to be implemented to bring about the solutions that can deal with the problems in the agriculture and forest sectors. In noting the prerequisites for these changes, Hill (1985) states that too much of our expertise is spent trying to deal with the recurring symptoms of poorly designed, malfunctioning systems. The proper approach should be to redesign those parts of the system and those approaches to management that are generating the problems. In a redesigned agroecosystem, more time would be spent maintaining functional

relationships among the components, thereby preventing problems, and less time trying to solve them. These systems would not only respect natural cycles and limits but also exhibit much greater functional diversity than most present systems. Efforts towards more complex rotations, multiple cropping, companion planting, inter-cropping, multistory systems and polyculture, in essence agroforestry practices, represent important moves in this direction at the farm level. The Science Council (1986) stated that the optimal solution to soil degradation lies in the provision of an integrated land management program, together with the necessary information programs, technical and material inputs and government direction to transform the plan into reality.

Definition

It was not until the late 1960's and early 1970's that the term agroforestry started to appear, occurring mainly in forestry circles as a collective name for all the various forms of taungya forestation systems long in practice in many tropical countries (King, 1968). (The taungya system is a reforestation technique which combines the partial overlap of an annual crop with young forest trees. After two or three years, the increasing shade brought on by the closing of the tree canopy marks the end of this kind of association, which then has to be renewed on another field.). The breakthrough of the concept can probably be dated to the report of Bene et al. (1977). Because of this relatively recent introduction of the agroforestry concept, there is no general consensus on what agroforestry is. The following is a generally accepted definition: "Agroforestry is basically a collective name for land use

systems and technologies where woody perennials (trees, shrubs, palms, etc.) are deliberately used on the same land management unit as agricultural crops and/or animals, either on the same form of spatial arrangement or temporal sequence or both. In agroforestry systems there are both ecological and economic interactions between the different components." (Agroforestry Systems, 1982). This paper will also include any incorporation of trees into farm operations, and the growing of forests using practices common to agriculture in the examination of alternate methods of production for agricultural and forest resources. While some of these practices cannot be called agroforestry as per the above definition, they still constitute a significant enough departure from traditional agriculture or forestry to warrant examination.

The above definition of agroforestry outlines the broad boundaries of agroforestry and the characteristics of such systems (Lundgren and Raintree, 1983) as follows:

- 1) agroforestry involves an interaction between two or more species of plants, at least one of which is a woody perennial;
- 2) an agroforestry system has two or more outputs;
- 3) the cycle of an agroforestry system is always more than one year;
- 4) even the most simple agroforestry system is more complex ecologically (structurally and functionally) and economically than a monocropping system

The Agroforestry Approach

It is apparent that this definition of agroforestry encompasses many well known land use systems long practiced in the tropics. What is important

about agroforestry is that it is the first concrete concept that builds on a synthesis of much of the practical experience and scientific knowledge acquired over the past decades in agriculture, forestry, ecology, soil science and rural socio-economic development (Lundgren and Raintree, 1983). Agroforestry is important because it emphasizes the use of trees for multiple purposes and the integration of tree growing with agriculture. It could be an appropriate mechanism in helping meet future forestry and agricultural demands because of its emphasis on factors not considered by traditional forestry and agricultural practices (Bene et al, 1977).

Lundgren and Raintree (1983) describe the aim of agroforestry systems as being to optimize positive interactions between the different components (trees, shrubs, crops and animals) and between these components and the physical environment in order to obtain a higher, more diversified and more sustainable production per unit area from available resources than is possible with other forms of land use under prevailing ecological and socio-economic conditions. Its intent is to maximize the use of radiant energy, minimize losses of plant nutrients in the systems as well as optimize water use efficiency and minimize run-off and soil loss. Thus, it retains any benefits in these respects that may be conferred by woody perennials compared with conventional agricultural crops and so maximizes total output of benefits from the land while conserving and improving it.

Classification

Agroforestry classification is intended to provide a framework for analysis. Classification schemes should: logically group the major factors determining production; indicate system management; offer flexibility in regrouping information; and be readily understood and handled (Nair, 1985). Most land use systems are oriented to the production of a specific commodity or groups of similar commodities, but the complex and multiple output nature of agroforestry systems does not allow a single or simple classification scheme to be used. A series of approaches is needed, with each one serving a different purpose. The most commonly used criteria have been the spatial and temporal arrangements of components, the relative importance and role of components, the production aims and output from the systems and the social and economic features (Lundgren, 1982). Nair (1985) has proposed the following criteria be used in categorizing agroforestry systems:

- structural basis - refers to the composition of the components including spatial mixture of the woody component, vertical stratification of the component mix and temporal arrangement of the different components.
- functional basis - refers to the major function or role of the system, mainly of the woody components.
- socio-economic basis - refers to the level of input of management or intensity or scale of management and commercial goals.

- ecological basis - refers to the environmental condition and ecological suitability of systems, on the assumption that certain types of systems can be more appropriate for certain ecological conditions.

Two things are apparent in this classification; first the categories are interrelated, and second, the structural and functional bases relate to the woody components of the system while the socio-economic and ecological ones refer to the organization of the systems according to certain defined conditions. Since every system will have specific structural and functional components, Nair proposed that the complexity of agroforestry classification could be simplified if the structural and functional aspects were used as primary considerations in the categorization of the systems and the socio-economic and ecological factors were taken more as a basis for stratifying or grouping the system. This approach to the classification of agroforestry systems is described below.

The structure of the system refers to the nature and arrangement of components (Nair, 1985). The nature of components in agroforestry land use systems consists of three basic sets of elements: the tree; the agricultural crop; and the animal. For a land use system to be designated as an agroforestry system, the tree component must be present. This leads to a classification of agroforestry systems as follows: agrisilvicultural - crops and trees including shrubs/vines/trees; silvopastoral - pasture/animals and trees; agrosilvopastoral

- crops, pasture/animals and trees; and, other - a few systems such as multipurpose wood lots, apiculture with trees, and aquasilviculture, that for lack of a better term, are grouped together here. The arrangement of components refers to the spatial and temporal distribution of the trees. Spatial distribution can be broken into two categories; regular distribution is when the trees are grown in association with the farm crop, or scattered regularly among it (Combe, 1982). Irregular distribution is when the trees are placed alongside or around the farm crops with which they are associated. Distribution through time can have a number of combinations including overlapping, separate, intermittent and coincident arrangements. In examining the functional basis of the forest component, it will be necessary to distinguish productive and protective agroforestry systems. After being categorized according to these two parameters, the systems can be grouped according to their ecological and socio-economic bases.

As has been stated, agroforestry has had long and extensive applications in the Third World. Descriptions of these would be too extensive and outside the scope of this paper. Global reviews of such practices can be found in a number of reports, for example Combe and Budowski (1979) and Nair (1982). Examples of successful agroforestry systems include the taungya system, the production of commercial timber in tea, coffee and cacao plantations, the use of nitrogen fixing trees such as Acacia and Leucaena for soil improvement, and the grazing of animals on hardwood plantations.

This chapter has introduced the agroforestry concept as a different approach to agricultural and forestry development, outlined how it has been a successful land use system in the Third World, and posed the question as to whether it could be successfully applied in Canada. The next chapter will investigate the use of an agroforestry approach within the Canadian context.

CHAPTER TWO

AGROFORESTRY APPLICATIONS

The initial suggestion that large scale tree growing might make a contribution to human and animal nutrition and environmental stability in the developed world came in 1929, when J. Russell Smith introduced a new agricultural concept which he termed 'tree crops'. In his book entitled "Tree Crops - A Permanent Agriculture," a system was put forth to develop a sustainable food production system based upon the use of trees to produce an annual crop of pods, fruits, nuts and berries. These crops would provide food for both human and animal consumption as well as conserve the environment. However, with improved row crop farming practices, increased mechanization, the development of grassland farming on marginal land and an increase in the use of soybean for animal feed, Smith's permanent agricultural systems idea faded into oblivion in North America.

A major argument of this paper is that the concept of agroforestry in temperate, industrialized countries should be re-examined to determine whether it can improve the agricultural and forest resource base. A number of recent developments indicate that agroforestry could now be beneficial: (1) the oil crises of 1973 and 1979 awakened the realization that fossil fuels are a finite resource and this spurred the increased emphasis on alternative energy technologies. This potentially large increase in demand will place a strain on the biomass

resource in this country; (2) Smith put his concept forward during the 1930s dustbowl era of the U.S.. Soil degradation has again become a major problem on agricultural lands, and trees can be part of soil conservation programs; (3) a large amount of abandoned marginal land exists in various parts of the country, particularly eastern Canada. If this could be brought back into some higher form of production, then a number of social and economic improvements could occur in these regions; (4) the increasing surpluses of conventional agricultural crops and accompanying low commodity prices are forcing farmers to look for alternative farm crops. In Europe, serious consideration is being given to the concept of introducing tree crops onto agricultural land as a means of reducing agricultural surpluses and providing alternative agricultural enterprises; and, (5) there is evidence from both research and practical applications that agroforestry in temperate zones is feasible and in some situations more profitable than forestry or agriculture alone.

This chapter has two objectives. The first is to establish a baseline of what the present agroforestry situation is in this country to show that agroforestry systems already exist. The second objective is to examine other temperate zone agroforestry applications and research to determine what their potential would be in Canada.

(1) Windbreaks and Shelterbelts

A major contribution of trees to agricultural operations in Canada has

been as windbreaks or shelterbelts. A windbreak or shelterbelt is defined as a physical barrier of living trees designed and grown to reduce or eliminate the undesirable effects of wind and water erosion.

The importance of windbreaks and shelterbelts is evidenced in the fact that the federal government and most provincial governments provide financial and/or technical assistance for the increased usage of these systems on farms (OMNR, 1982a).

This discussion of windbreaks and shelterbelts will examine their benefits as they pertain to wind and water erosion.

Wind Erosion

Wind erosion has been a problem in regions with a dry climate and fine, sandy soils. While farmers cannot do anything about soil type or climate, they can still affect the degree of wind erosion through a number of conservation practices. As is the case with most soil conservation measures, one practice alone will rarely solve the problem. An effective control program is usually achieved when several good soil management practices are employed, and the use of tree shelterbelts is an effective measure to reduce the effects of wind erosion.

Data from Europe and the USSR have shown that windbreaks do significantly improve the growth, quality and yield of crops. Recent research in Canada and the United States supports these earlier

findings. The Ridgetown College of Agricultural Technology has investigated the effects of one or two row stands of spruce on corn and soybean yield (OMAF, 1984b; Baldwin, 1982). Ten percent increases in yields above the average were obtained for corn in fields which had windbreak protection. These increases were recorded on the leeward side of the windbreak and occurred out to a distance of 10 times the windbreak height. Additionally, at a number of locations, yield increases of 4 percent were recorded on the windward side, out to a distance of 4 times the windbreak height. Results for soybeans were even more dramatic. Yields were found to be 25 percent above the unprotected field averages, out to a distance of 4 times the windbreak height and averaged 20 percent for the distance out to 10 times the windbreak height.

The Prairie Farm Rehabilitation Administration (PFRA) studied the effect of shelterbelts on the yield, maturity and value per acre of potatoes, and found all factors increased by approximately 50 percent at 3 times the windbreak height with yield gain slowly decreasing and ending at 20 times the windbreak height (control) as the effect of the shelterbelt diminished (PFRA, 1985). In another PFRA study on the effect of caragana shelterbelts on the yield of wheat, the use of shelterbelts increased the number of bales harvested (PFRA, 1985). Research at the University of Nebraska has shown that using 10 percent of the land for field shelterbelts can substantially increase overall crop yields (Ogbuehi and Brandle, 1982). When comparing open, 40 acre

plots to similar plots protected by shelterbelts (4 acres of trees, 36 acres of row crops), the 36 acres protected by trees produced 23 percent more soybeans and 18 percent more wheat than the 40 unprotected acres. The influence of shelter on fruit production has also been noted. Benefits include a reduction in the percentage of wind thrown fruits, an increase in fruit quality because of decreased bruising, protection against dessicating winds, more pollination by insects, and higher fruit yields.

Shelterbelts have additional benefits which provide further incentives for their implementation. Planted near roads, the shelterbelts can act as living snow fences to capture snow in and just beyond the trees rather than allowing it to drift onto the road. This prevents highways from being blocked by drifting snow and reduces road maintenance costs. Trees can also provide significant home energy savings when planted as farmstead shelterbelts. Research in South Dakota showed that for dwellings protected by windbreaks on three sides, heating bills may be reduced as much as 30 percent (Rosenow, 1983). A study by the Prairie Farm Rehabilitation Administration, has shown that heating costs for a house placed on the lee side of a windbreak are reduced by 5 percent for every 13 Kilometers per hour of average open field wind speed (PFRA, 1984). Livestock also benefit from windshelters, making greater weight gains, suffering smaller herd losses and making more efficient use of feeds. Ranches in open and unprotected areas require 50 percent more winter feed than ranches having natural protection

(Simpson-Lewis et al. 1979). Cattle in feedlots consume less feed, suffer less from diseases and have lower mortality when they are protected from strong winds. Shelterbelts can be designed to produce a variety of forest product crops. Pines planted in rows can be thinned in 6-8 years with alternate trees being sold as Christmas trees. Firewood could be taken from alternate shelterbelt rows as their size increased; the Mennonites in the Winkler, Manitoba area, for example, have a multi use system in which shelterbelts are also used to provide firewood and other products for the nearby Winnipeg market (Howe, 1986).

Water Erosion

Erosion of soil by water is the most widespread type of soil degradation and occurs all across Canada (Agriculture Canada, 1986; Senate Committee on Agriculture, Fisheries and Forestry, 1984). The areas most susceptible to water erosion are those which have silty or loamy soils and have a continuous cropping of these soils on sloping land. The removal of fencerows to accommodate larger machinery has magnified the soil erosion problems by increasing the length of field slopes and the return of these fencerows would be a relatively cheap way of reducing erosion. Natural vegetative cover, including trees, helps avoid water erosion by increasing the downward infiltration rate of rain and decreasing the overland flow.

Trees can also be effective as a conservation tool in streambank and shoreline erosion and the use of trees as a water management technique

is common practice in North America. Bottomland forests can be used as a natural form of flood control. When a river floods its banks, the bottomland forest stores the excess in floodstage, and releases it as the stage drops, reducing flooding and stabilizing river flow. Without this type of control, communities downstream would have to invest money in construction and maintenance of flood control systems.

In summary, the use of windbreaks and shelterbelts as a conservation measure will likely increase in the future. Provincial governments are increasing the promotion of their use as a cost-effective means of decreasing energy, fertilizer and irrigation costs, increasing crop productivity and preventing or reducing the effects of soil erosion. As the economic and agronomic benefits of windbreaks are verified in Canada, farmers will be more receptive to this information that is specific to their area. As innovators begin to apply the information, the demonstration of the benefits will convince neighbouring farmers to implement agroforestry systems as conservation tools.

(2) Pioneer Trees

Combe (1982) used the term pioneer trees to describe tree systems which provide soil improvement and stabilization, plant protection and nitrogen fixation to the crops with which they are associated.

Trees can be planted on marginal land to restore a degree of productivity to it. The use of trees in land rehabilitation has

received considerable worldwide attention and application. Whatever the cause of desertification - overcultivation, overgrazing, deforestation - trees can be used to solve the various degradation effects. Tap roots can extend deep into the ground to retrieve water and dissolved minerals, and at the same time the roots will loosen and aerate the soil, thereby improving drainage and attracting a good microbial and earthworm population necessary for nutrient breakdown. Trees, through their leaves, will provide a substantial amount of nutrients to the upper soil profile, improving the quality of the ground vegetation.

There is a need for this type of rehabilitation in eastern Canada, where large areas of underutilized land now exist. The spread of agriculture onto these lands was a major cause of this degradation. Forests were clear-cut and the land, which was not high quality agricultural land, was farmed continuously until the soil, over time, lost its fertility. Cultivation practices were then abandoned and the land left idle. Trees have been used to a fairly large extent for land rehabilitation in Canada. The Ontario Ministry of Natural Resources has used red pine throughout the province to reduce soil erosion and stabilize low productivity sandy soils that have been degraded by overfarming. A number of forest agreements have been made for the rehabilitation of poor quality agricultural land. Alders have been used for land reclamation after strip-mining or on sand dunes (Mason & Maine, 1984).

Trees, especially fast growing species such as poplar, can also be used as a nurse crop for commercial species. A nurse crop is defined as a crop of trees, shrubs or other plants introduced to foster another and generally more important crop during its youth (Ford-Robertson, 1971). The Ontario Ministry of Natural Resources uses this approach to reestablish hardwood forests that had been clear-cut for agriculture. The valuable, shade tolerant, hardwoods are difficult to establish in open areas. In order to get them established, the area is first planted with conifers. As the conifers grow, they create a forest canopy, providing shade and wind protection that allows the hardwood coppice to establish itself in the understorey. Once the hardwoods have attained a certain size, the conifers are cleared and the hardwoods take over. These plantations yield two principal crops; the initial conifer trees for such end uses as energy, pulp or lumber, and the higher value hardwood species for lumber and veneer markets. Work by Jaciw (1979), Schlesinger and Williams (1984) and Zsuffa et al. (1977) has shown that under the proper conditions, the interplanting of black locust, European alder and poplar can be beneficial to the growth of commercial trees, such as red oak or black walnut. The result is higher growth rates, good tree form, reduced infections and insect defoliation, and protection from climate extremes and physical damage.

Trees can also add fertilizer value to the soil. In most forest soils, nitrogen is not present in sufficient quantities to support maximum tree growth, and nitrogen fertilizers are not widely used in Canadian

forestry, presumably because they are not economically feasible (Mason & Maine, 1984). Nitrogen fixing plants can contribute from 30 - 200 kg of nitrogen per hectare per year (Davey and Wollum, 1979), and some species of red alder have been reported to fix as much as 320 kg of nitrogen per hectare per year (Newton et al., 1968). Because of this nitrogen fixing ability, alder can improve yields when employed in rotation with a non-nitrogen fixing species. Soil nitrogen content has been found to be generally higher in mixed stands of conifer and alder than in pure conifer populations (Bellen and Lu, 1968). Red alder introduced in a Douglas fir plantation in Wisconsin doubled total wood volume production and increased bole volume of average size Douglas fir by 60 percent (Binkley, 1983). Wollum and Youngberg (1964) observed that conifers have better growth rates on a given site when associated with alder. In Ontario conifer plantations, black alder is often used as a supplement for soil improvement (Hosie, 1975). Hansen et al. (1979) planted mixed plots of poplar and alder and observed that an increase in the proportion of alder planted resulted in increased poplar growth. The alder grew slower than the poplar, were over topped and eventually were suppressed. A number of nitrogen fixing tree and shrub species are also being evaluated in eastern Ontario for use in mixed plantings with other fast growing hardwoods (OMNR, 1983).

The use of trees as a nurse crop to introduce the slow growing, shade tolerant hardwoods into an area is expected to continue at a similar level in the future. With the increased awareness and concern about

land degradation and programs such as Ontario's Soil Conservation and Environmental Protection Assistance Program II, which covers the costs of planting trees on highly erodible soils, the use of trees on farmland as a means to combat soil erosion and rehabilitate degraded land is expected to increase.

(3) Intensive Culture Plantations

The next concept to be considered is the growing of large quantities of biomass under intensive cultivation. Raitanen (1978) used the term agriforestry to describe the application of the principles and procedures of agriculture to the growing of forest trees. The intensive planting of tree species is expected to become more common in response to an increasing demand for wood fiber. One example of an intensive culture system that has been in place in Canada for a number of years is the growing of Christmas trees.

Poplars have many of the management and utilization prerequisites for industrial biomass production and have been given most of the attention in Canada as an intensive culture crop. While the concept of growing poplars in plantations is not common practice in Canada, European farmers have been growing cottonwood hybrids for the past 250 years to produce firewood, pulp fibre and veneer logs because much of their native forests had been denuded (Anderson and Zsuffa, 1977). Poplar culture was considered to be more agriculture than forestry and the trees were grown as a rotation crop that was competitive with

traditional cash crops. Farmers planted poplar as a 20 year rotation crop for the veneer market on up to one quarter of their land.

While Europeans have long had to contend with short supplies of domestic wood, North Americans, for the most part, have always been able to count on their native forests for their supplies of wood for lumber, pulp and paper and firewood. However, this is changing as forest reserves are now being depleted and forest companies are beginning to realize the need for improved forest management practices. Production scale poplar plantations have been established in Quebec, British Columbia and Ontario, and experimental scale poplar plantings exist in most provinces in Canada (Zsuffa et al., 1979).

Depending on the desired size of the trees at harvest and the end use of the harvested material, three rotation systems - mini, midi and short - are available for producing fast growing trees in intensive culture plantations (Gambles, 1984):

- (1) Mini - closely spaced intensely managed coppice plantations, on one to three year rotations, with stand densities in the order of 10,000 - 35,000 trees/hectare. The biomass from these rotations has mainly an energy purpose, but alternate uses could include protein production, petrochemical replacements or as a component in pulpwood finishes;

- (ii) Midi - stand densities are about 4,000 plants per hectare on average. Biomass is harvested five years after planting and then from coppice growth at five year intervals. Trees grown in midi rotation will have much the same application as those in mini rotation;
- (iii) Short - are designed to produce traditional sized trees that can be used for conventional forest applications such as lumber, construction timber, veneer, pulp and composition board as well as biomass applications. Stand densities are approximately 1,000 trees per hectare with the initial harvest occurring about 10 years after planting.

Research in intensive culture is also being carried out on a number of other deciduous species. Aspen, sycamore, alder, willow, and to a lesser extent birch, maple and ash all exhibit good silvicultural characteristics and are being looked at closely in various parts of the country for their intensive culture potential. For example, short rotation willow plantations have generated interest as an inexpensive means of producing a high-yielding biomass energy source in cool climatic regions. Robertson (1984) has suggested that willow has a future as a "multi-component agroforestry crop" in the northern coniferous or boreal regions.

Conifers have not been considered to any great extent for intensive

culture plantations. They have slow initial growth and coppice production (generation of trees from shoots or rootsuckers rather than seed) after harvesting is not possible. However, species such as jack pine and larch are being seriously looked at because they have good juvenile growth rates and are of immediate interest to the forest products industry for pulp and timber. Conifers have a number of advantages in that they are generally less demanding than deciduous trees in terms of site quality, and can be planted both in humid heavy soils and dry sandy soils. Through improved selection and planting technologies, the conifer species could become a more suitable tree for intensive culture.

The implementation of intensive culture plantations is one area of agroforestry that is expected to grow in the future. While it has been argued that because Canada's natural poplar resources are already significantly underutilized and with the requirements for site preparation, fertility and thinning, plantations will never be economic, there are a number of arguments against this. There is a good demand now for poplar in lumber and pulp markets, and this demand is expected to increase. In some parts of Ontario, poplar is rapidly nearing its allowable annual cut (Marcus, 1986). The prevailing consensus in the literature is that the low level of poplar utilization cannot be attributed to inadequate process technology, the inferiority of poplar as a wood or limited product suitability. Rather, it is due to factors such as the remoteness of the resource from major

markets, a high incidence of decay within a harvested area and variable tree sizes, with a large number of the trees being on the small side. A poplar plantation would not have these limiting factors. It would be on land close to markets, the thinning operations would ensure healthy growth and resistance to pests, decay, deformities, etc., and the trees in the plantation would all be the same size when harvested.

Additionally, a survey by Balatinecz and Morley (1987) on the supply and demand of poplar wood in Ontario has shown that, while forest companies using poplar for pulp were not interested in hybrid poplar plantations, those using poplar for lumber or veneer were. These companies are concerned about the continued supply of quality logs, and either have intensive culture programs underway or are interested in getting them established. Farmers are also looking at the establishment of short rotation plantations as a means of producing additional income. Domtar has signed on a number of private landowners to provide wood for their Cornwall mill, and there is no reason to believe other companies could not get similar cooperation when they implement forestry extension programs. Farmers are also looking at growing poplar to meet their own needs. For example, a farmer in southern Ontario is using previously idle land to grow poplar which is used to fuel his greenhouse operation (Poplar Council of Canada, 1986).

(4) Forest Grazing

Another major agroforestry option cited by Combe (1982) that is in use in Canada is that of forest grazing. Forest grazing systems refer mainly to low density grazing of animals on forages in either natural forests or plantations.

The grazing of animals in natural forest forage will be looked at first. This type of forest grazing occurs in western Canada, particularly in British Columbia and to a lesser extent in Alberta and Saskatchewan. A major land use concern in western Canada is resource allocation in the face of competing claims for the same land area from a number of potential users. For example, in British Columbia, less than 5 percent of the land is available for agriculture, and only approximately 1 percent of the province can be considered open grassland area. Due to this, of the approximately 4.4 million hectares used for grazing, 80 percent is under a forest cover, and most of this is Crown forest land (McLachlan, 1986). The land use opportunities for both forestry and grazing exist mainly in the drybelt areas of the province because of the complex intermingling of open, semi-open and closed forests with grasslands and lakes in these areas (McLean, 1984). A cyclical, integrated, resource management system for grazing occurs in these areas. The area is first logged, either selective or by clear-cutting. The forests are seeded with grass, and the area is either reforested or allowed to regenerate naturally. Cattle are brought on to graze, usually in the second or third year, and rotated

as needed. Grazing continues in the area until the grass quality is reduced because of the closing canopy. Work by Weyerhaeuser Corp. and Oregon State University, cited by Andre (1981), indicates that the forestry grazing approach will work provided certain management practices are followed. Fences are required to divide large range areas into smaller units to provide for easier management and more even use of the ranges. Continued monitoring of the cattle grazing area is needed, and if browse damage is observed the cattle must be moved to another area.

A forest grazing system has benefits for both the rancher and the forester. For the rancher the benefits are obvious. Even though more management is required, a greater production of beef is realized than would be otherwise possible. For foresters, the benefits may not be as direct, but include the removal of undergrowth, which will reduce fire hazards, seedling growth competition, and the cost of chemicals used to keep grass growth down. Indications are that forest companies will continue with this type of agroforestry system, and may even increase the areas of forest grazing operations. The opinion of the forest products company Weyerhaeuser Ltd. is that with proper coordination and management both trees and cattle can be produced in an area with little deterioration to forestry and a resulting greater production per unit area of land.

Concern has been voiced by foresters that forest grazing could

negatively affect wood fibre production. However, a number of studies (McLean and Clark, 1974, 1978, 1980; Krueger and Winward, 1976) have determined that the presence of grass had little effect on the germination, survival or growth of conifer seedlings and if the numbers of cattle and period of grazing were managed, damage to seedlings was negligible. The successful establishment of forest grazing operations in New Zealand and Australia and recent demonstration projects in Oregon also support these findings. Furthermore, a Task Force study initiated by the British Columbia government to examine all the issues involved in forest grazing found that problems relating to forest grazing were human or social rather than technical in nature (B.C. Ministry of Forests, 1984). It was the lack of communication between the foresters, ranchers and environmentalists, which led to the mistrust and misunderstandings on the subject. The Task Force issued a number of recommendations to resolve the problem including the development of an integrated land use policy and a greater interaction between forest and range management managers on an organized basis.

The other forest grazing system to be examined, which would be more applicable to a cleared land areas such as eastern Ontario, is the establishment of forest plantations in grazing pastures. Most of the existing operations and research work on plantation forest grazing in developed countries has occurred in the southern U.S. and New Zealand. Initial interest in the concept of forest grazing, or forest farming as it is called in New Zealand, came from forest companies who realized

the advantages of early agricultural returns, easy stand access, simpler stand management and reduced fire risks (Tustin et al., 1979).

A number of U.S. studies (Lewis et al., 1983, 1984; Halls and Suman, 1954) have looked at the possibility of cattle production in pine plantations and found that with proper management this system could be very economic. A major study by Lewis et al. (1983) on the integration of pines, pastures and cattle examined the response of combining the production of slash pine and beef. While the treeless pastures had higher beef gains, this was more than compensated by the income received from the sale of the tree crop on the forest-grazing land. Productivity per unit area of land could be further increased if pre-commercial thinning, which is a recommended silvicultural practice, is carried out. The forage yield is increased as a result, which allows more cattle to graze the area, and an income is derived from the production of firewood from the thinnings. Additionally, a higher income was received because the heavier thinning produced more pulpwood, and higher quality sawlogs and the fewer trees resulted in easier access for harvesting machinery. Another project by Lewis et al. (1984) looked at further improving the economics of forest grazing by introducing hay production during the first three years of the plantation. Grazing on pasture plantations has to be delayed for at least three years to prevent injury to the young pines by the cattle. The study showed that hay can be harvested in woodland pastures when pines are planted wide enough apart to allow for the adequate operation

of haying equipment, Tree rows took up only 5 to 8 percent of the area designated for hay production and hay yields of 17 mt/ha were achieved, which is comparable to production in open pastures. Additionally, cattle liveweight gains under this more open spacing were found to be almost similar to the norm, and the pines grew rapidly and at age six were of merchantable size and could be sold for pulpwood. The production of pines, beef and hay on improved pastures offers an opportunity for multiple product yields. Examples in the southeastern United States of successful pine/pasture integrations are now becoming more common, as farmers are beginning to realize the benefits of intensive land use management for multiple product yields (McKathen, 1980; Peebles, 1980).

Hardwoods have also been looked at for use in forest grazing systems, but not to the same extent as softwoods. Major reasons for this are that; 1) softwoods constitute the majority of the forest industry's input material, and 2) hardwoods require a longer growth time before they can be marketed. However, some hardwoods such as walnut and oak have been used in forest grazing operations.

Forest grazing operations should receive greater interest in the future. Successes have been demonstrated in the U.S., New Zealand and Australia and there is no reason to believe this could not be repeated in Canada. The high cost of land, higher taxes, increased production costs and limited land resources are forcing farmers or other land

managers to consider alternate methods for increasing net returns from their land. Although timber can be an attractive investment, small non-industrial owners may not be able to wait the 20 or more years required for a financial return. However, if the multiple use approach is practiced, cattle could be produced without any real loss in timber production. Opportunities to increase the productivity per hectare of land, improve ecological efficiencies and provide early financial returns by grazing livestock on plantations would be available to the farmer. Eastern Canada, especially, has two conditions that make it amenable to forest grazing. It has good pasture and forestry land which is now idle, and there is a good portion of mixed farming already underway in places like eastern Ontario.

(5) Tree Crops

In 1929, J. Russell Smith proposed that certain crop yielding trees could provide useful substitutes for cereals in animal feeding programmes, and help conserve the environment as well. Multipurpose trees and shrubs are those which are grown and managed for more than one economically and/or ecologically motivated major product and/or service in multipurpose land use systems (Burley and von Carlowitz, 1984). The maple syrup industry, unique to eastern North America, could be considered a tree crop system. The advantages of tree crop systems include minimal maintenance and energy input requirements, adaptability to semi-acid conditions and poor soils, sustainable production without soil loss and a number of secondary benefits including rainfall

retention, wind control, wildlife protection and environmental compatibility. Disadvantages include high establishment costs, long growth periods until production commences and difficulties in harvesting. The usage of trees to provide a continuous crop for end uses such as food, forage and chemicals in temperate zones has been looked at to some degree but there have been limited applications.

This is not to say, however, that the potential is not there. A 1980 conference on "Tree Crops for Energy Co-Production on Farms" looked at the possibility of growing trees and using the crops produced - fruit, pods and leaves, for ethanol production (SERI, 1980). The conclusion from the conference was that farmers can obtain greater resource and economic efficiency by managing trees as multiple rather than single, product systems. For example, they noted that tree crops planted on hillsides would improve soil characteristics and allow millions of acres of currently non-arable land in the U.S. to produce an income.

An interesting tree crop option could be the growing of nut crops. Nut culture in eastern Canada and the northeastern U.S. has been slow to develop compared with the southern states and Pacific Coast areas. The main reason for this has been the lack of suitable varieties - most of the species are not hardy enough to be grown under our climatic conditions. This is changing, however, as crosses between native nut trees and other varieties are producing trees that are more tolerant of Canadian climatic conditions. Additionally, since nut trees have not

constituted a commercial crop in Ontario, they have, for the most part, been planted on soils that cannot be used for other crops, such as rocky hills, low swampy places, thin eroded soils and poorly drained heavy upland soils. As a result, the crop production has been low and the full potential of nuts as an economic crop has not been realized.

Walnut species could provide excellent potential as an agroforestry option in Canada. The wood of black walnut is the most valuable of the hardwoods grown in North America, and considerable information on growing black walnut is available. Its best growth occurs on those sites which are also best suited for agriculture, which may result in a land use conflict. While the long rotation period could discourage farmers from dedicating good farm land to growing walnut trees, the production of nuts, wood from thinnings and perhaps forest grazing could offset this. Additionally, studies have indicated that planting black walnut in conjunction with agricultural crops can be a profitable venture throughout the entire rotation and can economically justify growing trees on good agricultural soil.

Looking first at forest grazing, it has been demonstrated that pastures can be improved by the presence of widely spaced black walnut trees (Smith, 1973). Dry weight forage yields were found to be 50 percent greater the first year after establishment, and 33 percent greater the second year than in open areas and the overall quality and digestibility of the pasture grasses were increased. Previous

researchers in this area have had similar findings. Neel (1939) found that increases in herbage yield, produced by growing walnut in pastures, resulted in a 20 percent increase in steer days per acre and a 22 percent increase in steer gain per acre. Brooks (1951), in an extensive survey of black walnut in the eastern U.S., reported that the presence of grasses, often species of superior forage value, apparently increased under black walnut.

For intercropping, Smith (1973) assessed the economics of producing fescue seed in combination with black walnut and showed that higher profits can be achieved under this more intensive agricultural practice. Garrett and Kurtz (1983) expanded on Smith's study by using additional cropping alternatives. They examined four multicropping regimes for planting black walnut, listed by decreasing management intensity as follows: 1) intercropping with soybeans and winter wheat for the first ten years, followed by five years of fescue hay and seed production and then grazing; 2) intercropping with soybeans and wheat for ten years, followed by five years of fescue seed and hay production, followed by hay production for the remainder of the rotation; 3) fescue seed and hay intercropping for the first fifteen years followed by grazing; 4) grazing throughout the rotation. It was determined that the greater the degree of management intensity, the greater the financial return. The higher intensity management regimes, however, represent a departure from more traditional agronomic practices and it should be realized that more management expertise will

be required in their applications, with accompanying risks. Gordon and Williams examined the feasibility of intercropping black walnut with corn on a 40 acre farm, over a 40 year period. They estimated the final value of the trees, which were to be sold as veneer, to be \$800,000., which translates into an annual yield of \$500 per acre over the 40 year period. Nut production could add additional revenue. Yield loss in crops due to intercropping would be in the neighbourhood of 5%.

The introduction of tree crops has the least potential in Canada to make any significant contribution as an agroforestry system in the near term. Most of the trees that have been found to be good candidates for tree crop systems cannot survive the climate in Canada. The introduction of these tree crops on farms may also be a significant enough change from current agricultural practices to introduce uncertainties and risks that most farmers would not want to get involved with.

(6) Dual Cropping/Polyculture Systems

Agri-silviculture or forest intercropping is the simultaneous production of forest and agricultural crops on the same site.

Interculture systems, combining cereals and other crops with poplar, have been underway in parts of Europe for a number of years. Farmers planted poplar on up to one quarter of their land as a 20 year rotation crop which, if planted wide enough apart, allowed for dual cropping systems. This type of operation is still common practice in Italy.

Using a 6 m x 6 m poplar spacing, maize is produced the first year, while leguminous and graminaceous crops are grown for the subsequent three years. Stands with both tillage and intercropping have been found to yield higher economic returns than those stands with tillage alone (Sekawin and Prevosto, 1978).

There are a number of advantages to dual cropping systems (Raitanen, 1978): (1) there is more intensive use of the land, and consequently, more productivity per hectare; (2) more acres of high quality land could be brought into fibre production without diminishing other crop returns; (3) as the agricultural crop is planted, fertilized, weeded and harvested, the fibre crop is tended as well; (4) an early return from the agricultural crop could recoup all or part of the costs for the establishment of the fibre crop and improve the overall return on investment; and (5) unwanted plant growth normally controlled by continuous applications of herbicides and cultivation is replaced by a useful crop. Once the cover crop has been established, the plantation can be opened up as a pasture for cattle. To this Gordon and Williams (1988) added; an increase in farm profitability and diversity, decreased dependence on imported hardwoods, increased wildlife habitat, soil and water conservation and improved land stewardship.

In addressing the problem of the long-term investment required for plantation forests, McNeel and Stuart (1984) examined the feasibility of agri-silviculture for pine plantations. Their financial analysis of

intercropped and conventionally managed pine plantations indicates (Figure 2.1) that interplanting agricultural crops (tomatoes and soybeans) with pines can be more profitable than a monocultural pine plantation. The intercropped stand will provide an annual revenue from the agricultural crop until the pines overtake the site, while the conventional plantation will generate revenues only once at the end of the 25 year rotation. Results from the analysis show that although the per hectare yield of wood from the intercropped plantation was lower, revenues were comparable to those from conventional plantations because the intercropped stand provided 142 percent more high value veneer.

The previous section on tree crops discussed the economic benefits that could accrue from interplanting black walnut with agriculture crops.

Gordon and Williams (1988) also stated that other valuable hardwoods such as oak, maple, ash and hickory could be planted among agricultural crops for economic and environmental benefit.

The possibilities of growing agricultural crops or forages in poplar stands have been explored in eastern Ontario. Instead of using herbicides for weed control, agricultural crops such as corn, potatoes and other vegetables have been planted between the tree rows. The Ontario Ministry of Natural Resources carried out trials with agricultural crops and found corn to be the most successful. When planted between poplar rows, the system produced a crop until the fourth year when yields decreased significantly (OMNR, 1983).

Figure 2.1 : Cash flows over time for a conventional and intercropped pine plantation.
(from McNeel and Stuart, 1984)

Potatoes, squash, cucumber, tomatoes, onions, sunflowers and soybeans are other examples of crops that have been successfully dual cropped (Raitanen, 1978). As crop yields begin to decline due to the increase in tree size, the emphasis shifts to cover crops (alfalfa, clover, lupine) to provide weed control. Red clover and alfalfa have been found to be the most successful cover crops examined to date (OMNR, 1983). They can grow under partial shade, and they form high density stands which prevent the growth of weeds. As leguminous plants, they offer the additional benefit of increasing the nitrogen content of the soil.

The term "agrenforestry" has been coined in Europe to denote the integration of agriculture, energy and forestry operations. It could be one of the solutions to the phased introduction of forestry onto agricultural land in order to alleviate the surplus agricultural production in the European Community. This approach is now being demonstrated through the Large European Bio Energy (LEBEN) Project as a way of accelerating the acceptability of an agro-energy concept and as a means of fostering socio-economic development, especially in less advantaged agricultural districts (Grassi and Gheri, 1987). The successful demonstration of this concept could facilitate the acceptance and penetration in Canada of dual cropping systems.

This chapter concludes the first phase of the thesis. It attempted to give an overview of the concept of agroforestry, the extent to which

agroforestry and agroforestry related practices have been applied in this country and, given the present agriculture and forestry situation, what the opportunities could be for the future. In order to determine whether agroforestry could be implemented in Canada, a detailed case study of a region and the parameters influencing implementation are required. These will be examined in the following chapters.

CHAPTER THREE

IMPLEMENTATION PARAMETERS

The previous chapter demonstrated a promising application potential for agroforestry in Canada. The next issue to be addressed is the development of mechanisms for implementing an agroforestry scheme. A number of factors will influence the decision of whether or not to adopt agroforestry systems, including: physical parameters such as climate, land availability and land suitability; socio-economic parameters such as labour and capital requirements; government policies; and the ability and willingness of landowners to get involved in this type of land use, which will depend on factors such as economic returns, markets, perceived risks, and state of the technology.

In order to develop an agroforestry implementation strategy at a scale that is functional, the factors influencing whether agroforestry practices can be adopted should be considered, at a minimum, on a regional level. There are a number of reasons for this:

- (1) The administrative and management responsibility for public lands and land use legislation rests for the most part with the provincial governments. The policies and initiatives pertaining to land use will therefore be different for each province.
- (2) Land use trends and land allocation issues are diametrically opposite between eastern and western Canada. Agriculture has been

advancing into forested lands in western Canada, whereas in eastern Canada forest cover has been invading former agricultural land (McCuaig and Manning, 1982). In western Canada, resource allocation in the face of competition and conflict between resource users, notably forestry and agriculture, is the major issue (Fox and Macenko, 1985). In the east, a large amount of the agricultural land losses are due to the abandonment of farmland and this is leaving large areas with no real resource allocation strategy. The lack of competition for land has led to the problem of underutilized and idle land, and focussed concern on the social and economic impact of widespread withdrawal from agriculture and the allocation of land for the anticipated future rather than immediate use (Fox and Macenko, 1985). The issues of land use management and allocation, as seen by Fox and Macenko, are further delineated in Table 3.1.

- (3) It is only through a detailed case study analysis of a region that one can really assess the potential of an agroforestry approach. The information from the case study can then be used to examine developments on a national basis.

Eastern Ontario was selected for an in-depth analysis of the physical and socio-economic factors influencing land use and management developments. More specifically, the six counties examined by the Ontario Ministry of Natural Resources in The Forestry Agricultural

TABLE 3.1

LAND MANAGEMENT AND LAND ALLOCATION ISSUES IN THE AGRICULTURE-FOREST INTERFACE ZONE:¹
A PRELIMINARY LIST

Issues of Land Management and Land Allocation	AREA							
	West				East			
	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B./N.S.	Nfld.
<u>Land Management</u>								
Agriculture - adequate land base	*	**		*	**	*	*	**
- preserve capability	*	*	*		*	*	*	*
Forestry - adequate land base	**	*		*	*	**	*	*
- maintain sustained yield capability (reforestation)	*				*	**	**	
- manage for multiple use	*	*	*	**	*			
- stability of forest boundary		*						*
Fragmentation of ownership							**	
Integrated Resource Management (timber/range)	*	*						
<u>Land Allocation</u>								
Agriculture - land abandonment					*	**	**	
- land left idle or underutilised					**	*	*	
- extension on low capability land	*	**	*	**				*
Forest - clearance of high capability forest land for farming	**							
- reclaim marginal agricultural land to productive woodland					*	*	*	*

*Issues mentioned.

**Most predominant issues.

¹Source: (Fox and Macenko, 1985)

Resource Inventory in Eastern Ontario (FARINEO) study (Dundas, Glengarry, Grenville, Prescott, Russell and Stormont) and the Ottawa-Carleton region will be assessed. These areas are shown in Figure 3.1. The FARINEO study will be explained in greater detail later in the chapter.

PHYSICAL RESOURCE

The physical suitability of any region for various crops will depend primarily upon parameters of climate, soils and topography, the "physical frontiers of agriculture" (Williams, 1974). This section will examine eastern Ontario in relation to these parameters to determine whether the area is suitable for agroforestry. This approach is similar to the analysis of marginal lands by Beattie et al. (1981).

1. Climate

Analyses of the climate of eastern Ontario by Chapman and Brown (1966) and Simpson-Lewis et al. (1979) reveal that climatic factors are better than average when comparing this region with other regions in Canada for agricultural or forestry production. Troughton (1977) defines a marginal zone of Canadian agriculture as having a climate marked by a long, cold winter (4-5 months, mean daily temperature below 0°C), a corresponding short, cool summer (less than 2,600 growing degree-days) and a short frost-free period. The eastern Ontario area has; 3250

growing degree days; approximately 1800-2000 sunlight hours over the growing season; adequate precipitation; and a mean frost-free period of over 130 days.. The Agroclimatic Resource Index (ACRI) is a qualitative scale developed to approximate potential agricultural productivity per unit area Williams (1975) . Canada's agricultural margins generally have an ACRI between 1.0 to 1.5. Eastern Ontario has an ACRI of 2.0 or better, while the southern Prairies in comparison, have an ACRI of 1.5. As such, climate will not be a major limiting factor in the establishment of agroforestry systems in marginal areas of eastern Ontario.

2. Terrain and Soil

Soils in Canada have been described in terms of agricultural and forest capability classification systems (Environment Canada, 1972). This classification, called the Canada Land Inventory (CLI), is a planning tool which permits informed land use and management decisions concerning the land resource.

In the CLI for agriculture, mineral soils are grouped into seven classes and various subclasses according to their potential and limitations for agricultural use. The first three classes are considered the best for agriculture and are regarded as suitable for most field crops if properly managed. Classes 4 and 5 are physically marginal for sustained crop production and are only suitable for a few

crops. Class 6 soil has serious climatic, soil and/or topographic limitations and is suitable only for pasture and hay. Class 7 has no Capability for agriculture (CLDS, 1980). The main data sources on the land resources of eastern Ontario are the soil reports issued for each county. Each county soil map has been interpreted in terms of the capability and limitations of each soil type to sustain production of common field crops.

A few observations can be made from these inventories about the agricultural land capabilities for eastern Ontario. Sixty percent of the area is Class 1-3 and 12 percent of the land is Class 4, indicating the region does have good agricultural potential. McCuaig and Manning (1982) classified this region as being part of the Canadian agricultural heartland. Thirty-five percent of the area is limited by excess water, caused by imperfect drainage. Adverse soil characteristics are found in 22 percent of the area. Thirteen percent of the area is limited by stoniness, and 11 percent of the area is limited by shallowness to bedrock. These limitations in Classes 4, 5 and 6 land can result in land that is considered marginal to current agricultural practices and will result in low intensity land uses, or even more probable, idle or abandoned land.

The forestry sector of the CLI has objectives and criteria that are directed toward providing a classification system which rates the potential productive capability of the land under indigenous tree

species growing at full stocking and under good management. In the CLI for forestry, Classes 1-3 are capable of good forestry production, Class 4 land has moderately severe limitations to the growth of commercial forests, and Classes 5 and 6 have severe limitations. Class 7 has limitations which preclude the growth of commercial forests (CLDS, 1981). In eastern Ontario, 53 percent of the area is Class 1-3 and 31 percent Class 4.

While the Canada Land Inventory provides information on soil capabilities and the amount of land in each class, it does not provide full information on which land would be available for agroforestry operations. To develop an agroforestry implementation strategy the present use of the land resource must also be known. (Huffman and Dumanski (1983) developed the concept of land use systems to provide detailed information on agricultural activities within a region. The farming systems concept assesses land use on the basis of the type of crops grown and the relative proportions of these crops within the land unit. The Regional Municipality of Ottawa-Carleton was mapped, beginning in 1977, using this "farming systems" concept (Agriculture Canada, 1977). To produce a map that would remain valid over a number of years, agricultural land use systems were identified on the basis of the crop rotations on each parcel of agricultural land. In the resulting map units, the only short term change is the specific fields on which the various crops are grown. Six agricultural land use systems were derived for Ottawa-Carleton. From 1978 to 1980 the

Ontario Ministries of Agriculture and Food and Natural Resources undertook an inventory of the existing forestry, agricultural and other land uses in the six eastern counties of Ontario - Dundas, Glengarry, Grenville, Prescott, Russell and Stormont using this method (OMAF and OMNR 1982). This Forestry Agricultural Resource Inventory in Eastern Ontario (FARINEO) was designed to provide a resource data base for recommendations on the optimization of agricultural and forestry production in eastern Ontario (OMAF, 1978). The FARINEO study divided the eastern Ontario area into its various agricultural and non-agricultural uses and quantified the area within each land use system. An example of these agricultural land use systems for the Mountain township in Dundas County is shown in Appendix 1.

The areas under each land use system and an accompanying legend for the FARINEO and Ottawa-Carleton areas are listed in Appendix 2. For the FARINEO study, the large amount of land used for agriculture (57 percent) and the significant forest cover (27 percent) emphasize the important contribution these activities make in the region. Using the FARINEO and Ottawa Carleton studies, the amount of idle or underutilized farmland which could be used for agroforestry options can be quantified. In the FARINEO study, 23,337 hectares of land which have been idle for one to ten years and 37,951 hectares of land which have been idle for more than ten years were identified. The Ottawa-Carleton study indicated that 28,300 hectares of abandoned land and scrubland were in the municipality, and this figure combined with

the FARINEO data gives a total of 89,588 hectares of idle land in this eastern Ontario area. Agroforestry systems could also be introduced on land that is now under grazing and pasture systems, and the total for these in the FARINEO area is 52,657 hectares. In the Ottawa Carleton region these two systems constitute an area of 34,300 hectares, for an eastern Ontario total of 86,957 hectares. Another 1,505 hectares of land exist as pastured forest in the FARINEO. The FARINEO study indicates that the area which could potentially be used for agroforestry is 115,450 hectares or 18 percent of the total land base. For Ottawa-Carleton, the area available is 62,600 or 23 percent of the total land base. The forest cover in the FARINEO and Ottawa Carleton areas are 175,965 hectares and 59,000 hectares respectively and under more intensive management, these areas could contribute to an overall agroforestry scheme. The conclusion that can be drawn from the FARINEO study supports that from the CLI information: there is enough idle land, forest cover and low intensity land use to allow the adoption of agroforestry on a scale large enough to have a significant impact on the region's land base. While 178,050 hectares have been identified as being potentially suitable for agroforestry, there is still some uncertainty regarding the capability of this land to support agroforestry systems. For example, what is the agricultural potential of the A1 - abandoned land? As a means of addressing this problem, the CLI forestry and agricultural classifications and FARINEO study could be combined to provide the specific data that would be required when planning a strategy for an actual area. The integration of FARINEO

information with CLI soil capability data to provide an assessment of the degree of land utilization was put forth in the PARINEO study as a potential land use analysis tool.

The overlapping of agricultural resource inventories with CLI soil capabilities for agriculture was done on an intensive basis by the Land Resource Research Institute of Agriculture Canada for the Regional Municipality of Ottawa-Carleton (Huffman 1983). In order to overlay land use intensity and soil capability on a single map, some generalizations were required. In the 'land use' category, monoculture, corn, mixed and specialty agriculture were grouped as high intensity uses, hay was medium intensity, and pasture and grazing were classed as low intensity uses. Abandoned farmland and scrubland were grouped under 'abandoned' and all forest cover was classed as 'forest'. For soil capability, classes 1 and 2 were considered high quality, class 3 was medium high quality, class 4 was medium quality and classes 5, 6, 7 and organic soils were low quality. For agro-forestry purposes, areas with low intensity uses but medium or medium high quality soil types could be identified and specific agroforestry systems could be implemented.

By amending the land use legend to accommodate local differences in agriculture, the overlapping of the agricultural resource inventories with CLI soil capabilities could be mapped for all the agricultural areas of eastern Ontario (OMAF & OMNR, 1982). OMAF is in the process

of digitizing the agricultural resource inventory information, and once this has been completed, the overlay of land use data and the CLI data will supply the same information as that in the Huffman (1983) study for the province of Ontario.

SOCIO-ECONOMIC RESOURCE

The suitability of the physical resources in eastern Ontario for the implementation of agroforestry practices has been indicated, but other factors can come into play which will affect the agricultural capability of the land. Simpson-Lewis et al. (1979) stated that economic considerations, such as distance to market, transportation costs, land supply, and product demand competition for land, form part of an economic evaluation and are significant in delineating the value of agricultural land. Beattie et al. (1981) pointed out that agricultural frontiers rarely coincide directly with the actual physical limits of cultivability. They state that if the factors of temperature, moisture, soils and topography are the four physical frontiers of agricultural production, then land, labour, capital and management are central to the discussions of the socio-economic parameters of agriculture. This section will examine eastern Ontario under these parameters.

One method of examining the land, labour, capital and management factors is to determine the interactions between agricultural land use

systems and the socio-economic characteristics of farmers in each system. An inventory of agricultural land use systems which focuses on land use as an economic activity provides a relatively inexpensive and rapid method of depicting relationships among land, labour, capital, management and technology in basic production systems (Huffman and Dumanski, 1985). The concept of land use intensity is fundamental to the construction and interpretation of a map of agricultural land use systems (Huffman, 1983). Land use intensity is a reflection of the level of farmer inputs, and is an indication of the value of produce per unit of area. The Forestry Agricultural Resource Inventory in Eastern Ontario (FARINEO) is an example of such a land use study. While the FARINEO study did not include a socio-economic component, later studies by Huffman and Dumanski (1983) on Ottawa-Carleton used census information to describe each land use system in terms of its socio-economic characteristics. The result defines the physical characteristics, capital investment levels, income and expenses, labour inputs, operator characteristics and enterprise types typical of each intensity level. The summary statistics are presented in Table 3.2. The Ottawa-Carleton land use classification scheme was adopted for use with FARINEO since the agricultural activity in the FARINEO area was considered to be essentially the same as that in Ottawa-Carleton (OMAF and OMNR, 1982). It can likewise be assumed that the socio-economic characteristics of the farmers in the various land use systems for Ottawa-Carleton will be similar to the characteristics for the eastern Ontario region covered under the FARINEO study.

Table 3.2
 PHYSICAL AND SOCIO ECONOMIC DATA CHARACTERISTICS
 OF AGRICULTURAL LAND USE SYSTEMS IN THE OTTAWA-CARLETON AREA

PHYSICAL CHARACTERISTICS						
Land Use Systems	Number of Interviews	Farm Size (ha)	Rented Land (\$ of Farm Size)	Cultivated Land (\$ of Farm Size)	\$ CLI Classes 1 and 2	
					Owned	Rented
Monoculture - P	9	235.8	41.2	88.6	84.7	89.2
Corn	30	171.5	29.5	77.5	53.2	45.3
Mixed	48	104.8	25.3	75.1	38.6	33.0
Hay	29	75.0	10.5	77.1	41.8	28.6
Pasture	27	60.3	15.9	59.8	26.2	23.4
Grazing	5	41.5	0.0	39.2	28.2	-

ANNUAL FARM LABOUR			OPERATOR CHARACTERISTICS			
Land Use Systems	Total 4 (pd/ha/yr)	Hired (\$ of total)	Net Farm Return 2 (per total labour unit (P = 1.00))	Age (years)	Farming Experience (years)	Time in Current Enterprise (years)
Monoculture - P	4.8	47.9	1.00	46.2	23.1	11.3
Corn	8.3	18.6	1.36	44.0	26.1	18.1
Mixed	9.8	11.3	0.60	47.8	30.9	32.2
Hay	13.5	10.7	0.07	59.1	37.9	18.3
Pasture	9.8	9.7	-0.26	52.6	27.3	15.3
Grazing	12.9	0.0	-0.34	46.8	22.8	8.2

Table 3.2 (cont'd)

PHYSICAL AND SOCIO ECONOMIC DATA CHARACTERISTICS
OF AGRICULTURAL LAND USE SYSTEMS IN THE OTTAWA-CARLETON AREA

Total ² (P = 1.00)	CAPITAL INVESTMENT ¹			ANNUAL INCOME AND EXPENSES ¹				
	Land & Buildings (\$ of total)	Machinery (\$ of total)	Livestock (\$ of total)	Gross ² Income (P = 1.00)	Operating ³ Expenses (\$ of Gross)	Total ³ Expenses (\$ of Gross)	Gross ² Margin (P = 1.00)	Net ² Margin (P = 1.00)
1.00	64.6	25.0	10.4	1.00	72.2	86.9	1.00	1.00
1.31	66.7	18.6	14.7	0.97	59.8	75.8	1.77	2.23
1.41	70.5	16.6	12.9	0.73	61.7	80.7	1.21	1.36
1.45	79.0	11.7	9.3	0.30	103.2	119.11	0.24	0.17
1.61	85.7	7.6	6.7	0.18	230.7	237.7	-0.16	-0.46
1.94	89.5	4.7	5.9	0.14	104.4	104.4	-1.22	-2.35

OPERATOR CHARACTERISTICS

Education (years)	Off-farm work (\$ of 365 days)	Predominant Farm Enterprise
12.8	22.7	Cash crop and feeder operations (cattle, hogs)
12.0	2.5	Dairy
9.8	7.5	Dairy
10.8	22.2	Cow calf
11.3	40.7	Cow calf and hobby (horses, sheep)
13.2	45.6	Hobby (horses, sheep)

Notes

- 1) Data calculated per worked hectare. In monoculture, corn, mixed and hay system, this includes cultivated land plus improved pasture. In pasture and grazing systems it includes cultivated land plus improved and unimproved pasture.
- 2) Values in 1976 dollars for monoculture are total capital investment - \$3049.72/ha, gross income - \$736.72/ha, gross margin - \$175.02/ha, net margin - \$90.23/ha, net farm return per total labor unit - \$20.48/pd.
- 3) Operating expenses include all cash expenses such as feed, fuel, hired labor, repairs and interest payments, total expenses include operating expenses plus depreciation on buildings and machinery.
- 4) Total labour includes operator, partner, family and hired labour

McCuaig and Manning (1982) prepared a report on agricultural land use change in Canada in which they used the Saugeen Valley in Ontario as a case study. It is the author's view that the method of analysis and findings from this case study are applicable to eastern Ontario, and comparisons will be drawn between the two areas. There are a number of reasons for this assumption. The Saugeen Valley area was chosen because it exhibits the characteristics of most of the heartland use trends for eastern Canada. Additionally, the Saugeen Valley and eastern Ontario resemble each other in a number of ways: 70 percent of the Saugeen area has Class 1-3 agriculture land, while the figure for eastern Ontario is 60 percent; mixed farming predominates in both areas; recreational activities are offered in both regions but they are not prime tourist areas; a long standing history of forestry is common to both; a number of small towns provide the infrastructure to serve the agricultural community; and both regions are in the urban shadow.

1. Land

The extent of the land use change for eastern Ontario (PARINEO and Ottawa-Carleton regions), taken from 1971 to 1981 Canada Agriculture Census Data, is summarized in Table 3.3.

The region lost farms and total farm area during the 1971-1981 period. The loss of farms totalled 15 percent and the loss of farm area was 11 percent, indicating: (1) an increased abandonment of farming

TABLE 3.3: Canada Agriculture Census Data, 1971-1981

	1971	1976	1981	Change from 1971-1981	
				Absolute	%
No. of Farms	8,272	7,644	7,006	-1,266	-15
Total Farm Area (ha)	598,485	560,289	532,151	-66,334	-11
Total Cropland (ha)	282,336	302,852	307,623	25,741	9
Total Area in Improved (ha)	425,505	411,446	411,690	-13,815	-3
Total Area in Woodland (ha)	74,868	68,690	59,343	-15,525	-21
Total Area in Other Unimproved (ha)	98,112	80,153	61,113	-36,999	-38

properties, most of which are now lying fallow; and, (2) an increased dependence on higher levels of productivity from the land still being farmed in order to maintain production levels.

The change in quantity of improved land is usually a good indicator of how actively a farm is being managed. Gains in improved land indicate an intensification of agricultural activity, and for losses in improved land the opposite is true. Eastern Ontario showed losses in improved area. The Census also showed that improved land represented 71 percent of the land farmed in 1971, 73 percent in 1976 and 77 percent in 1981, indicating an intensification of farming on properties still in existence. Additionally, while improved land decreased slightly, the amount of cropland in the region increased by 9 percent. Since improved land is defined as consisting of cropland, improved pasture, summer

TABLE 3.4
AREA IN TOTAL IMPROVED
- in hectares -

	1971	1976	1981	CHANGE IN AREAS 1971-1981	
				Absolute	%
Improved Pasture	122,482	89,983	83,169	-39,313	-32
Summer Fallow	5,818	5,885	6,631	813	14
Other Improved	14,869	12,837	14,266	-603	-4
Cropland	282,336	306,852	307,623	25,287	9
	425,505	411,447	411,689	(13,816)	-3

fallow and other (which includes barnyards, lanes, roads, etc.), one or more of these categories must be decreasing substantially. A more detailed analysis of the Census data (Table 3.4) indicates that the improved pasture lost 39,313 hectares. Improved pasture includes all land which is being used for pasture or grazing land and which has had some improvements made to it in recent years. The loss of improved pasture can be attributed to two factors: one is the increase in cropping of these areas; the second is the abandonment of farms and farmland. As the Huffman and Dumanski study (Table 3.2 - Annual Income and Expenses) indicates, the pasture and grazing land use systems have negative net farm returns and would have a high potential for abandonment. These systems also have the lowest amounts of Class 1 and 2 land. Additionally, grazing operations had a smaller amount of

cultivated land as a percentage of farm size - 39 percent, as compared to monoculture systems, which had 89 percent.

Unimproved land, which consists of woodlands and other unimproved land, including native pasture or hay land that had not been cultivated, bush pasture, grazing and wasteland, has also been decreasing. The decrease has occurred in both absolute terms and in the percentage of farmland area. Most of this loss can be attributed to woodlands in higher quality soils being cleared for agriculture and to marginal farms, which would have a higher percentage of unimproved lands, being abandoned.

The data on land use changes discussed so far have been for the 1971-1981 period. A study by McCuaig and Manning (1982) examined the 1961-1976 period, and the changes were similar to the present findings but occurred on a more substantial scale. During this period, most of the heartland of eastern Canada lost between 15 percent to 25 percent of its farmland (McCuaig and Manning, 1982). For the PARINEO and Ottawa-Carleton regions, the number of farms and farmland declined by 32 percent and 19 percent respectively. The eastern heartland had a 9 percent decline in improved land, while the PARINEO and Ottawa-Carleton regions lost 14 percent of their improved land. The indication from this is that the changes are part of a long-term and steady trend in eastern Ontario and can be expected to continue along these same lines in the near future.

The next consideration is to determine what happened to the lost farm areas. McCuaig and Manning (1982) state that only about 10 percent of the loss of agricultural land in Ontario can be attributed to urban development. Even when hobby farms, extractive uses, etc., are considered, two thirds of the loss of agricultural land is still not accounted for. McCuaig and Manning found that while the overall amount of land classed as agricultural declined modestly, there were substantial changes in the location of land in agriculture and forest use. Nine and one-half percent of the land in agriculture in 1966 had been converted to other uses by 1976, while conversely, about 9 percent had been shifted from other uses to agriculture. The principal use of the land leaving agriculture was for forest and shrubland, with some going towards urban development. The land change was found to be occurring in fragmented parcels. Land going into agriculture was by the infilling of previously unused parcels of land in predominantly agricultural areas. There was also a major difference in the quality of land gained and lost from agriculture, with the land brought into agriculture being superior in capability to that leaving agriculture.

The land use trends and the effect they will have on agroforestry developments can be divided into two categories. One trend sees an intensification and consolidation in the farm operations that are continuing. They are increasing in size, increasing in cropland area, putting summer fallow and pasture land into intensive production and reducing woodland areas. Agroforestry systems have been put forward as

a soil conservation method, and could be a way of preventing the environmental and economic problems that will arise from the over intensive use of the land base.

The other trend for eastern Ontario has been the abandonment of marginal farms and their reversion to scrubland and brush. Again, agroforestry practices could be implemented productively. Those areas that are being abandoned and that have land quality capable of supporting agroforestry could have intensive forest plantations, forest grazing or tree crop operations introduced on to them. Some of the land, being lost from farming will have scattered areas of good quality land and the returns from an integrated agroforestry operation, e.g., black walnut farming combined with dual cropping or grazing operations, could provide good economic returns.

2. Labour

The changes in agricultural land use have been accompanied by changes in the farm labour characteristics. Following the trend of farmlands, the number of farmers has also been declining. For eastern Ontario, the farm population declined from 55,285 to 45,367 between 1976 and 1981. This loss of farm population is attributed to the out migration of young people unable to find suitable employment, the retirement of farmers and farmers who have abandoned their land.

There has also been an increase in the average age of farmers.

According to the 1976 census, 31 percent of Canadian farm operators were over 54 years of age compared to a 10 percent national labour force average (McCuaig and Manning, 1982). As farmers increase in age, the trend is toward less labour on the farm and less labour intensive farm use. The study by Huffman and Dumanski (1983) supports this.

Table 3.2 - Operator Characteristics shows that farmers in high intensity land use operations are younger than those in medium and low intensity land use systems.

Another change in labour characteristics is that an ever increasing segment of farm operators, squeezed by declining profits and rising input costs, are now responding by supplementing their farm income from off-farm sources (Centre for Resource Development, 1972). According to the 1981 Agriculture Census, the percentage of all farms reporting off-farm work in eastern Ontario went from 34 in 1971 to 37 in 1976 and to 41 in 1981. McCuaig and Manning found that most smaller farm units were part-time operations, and a similar situation was found in the Ottawa-Carleton study. Table 3.2 - Operator Characteristics and Physical Characteristics shows that the corn and mixed land use systems have low levels of off-farm work, the monoculture and hay systems have moderate levels and the low intensity systems have higher levels of off-farm work. Marginal regions have been found to have the highest incidences of farmers reporting off-farm work, and this is probably due to an inability to capitalize sufficiently for intensification or

expansion of their farming operations (McCuaig and Manning, 1982).

McCuaig and Manning reported that labour is becoming more difficult to obtain because of the out-migration of young people, the increased competition for the same labour pool from other sectors and the low pay and nature of farm employment. Most of the labour shortage problems were reported in the 40-120 hectare, single operator, mid-sized farms. Larger farms are able to hire a permanent labour force, and small farms do not have the manpower requirements for outside labour. Table 3.2 - Annual Farm Labour) shows that the lowest intensity land use (and smallest) farms had no outside labour, and the amount of hired labour increased as a percentage of total labour as land use intensity increased.

It is apparent that these labour characteristics will result in a decrease in the intensity in which some land areas in eastern Ontario are farmed. If a farmer has to reduce his labour input, either because of age, increased off-farm work or lack of labour, the less productive farm land areas will be left idle in order to concentrate on the higher quality soil. To avoid having these areas revert to scrubland, agroforestry practices could be implemented. Tree plantations could be developed without imposing any significant labour input demands on a farmer. For example, agri-crews, consisting of agricultural college students, are available to assist in the planting of seedlings. Additionally, conservation authorities are now involved in planting

trees as soil conservation measures. Thinning and other forest management activities that would be required during the rotation of the forest could be carried out at times when the demands on labour are low, such as in the winter. Harvesting could also be carried out by the farmer during the off-season, or logging companies could be contracted to cut the trees.

3. Capital

Total capital value comprises the value of three major investment areas: land and buildings, machinery and equipment, and livestock and poultry inventories. The total capital investment usually reflects the intensity of land use and will be directly related to a number of factors including type and value of crops, land capability, strength and stability of market conditions and proximity to large markets. Areas perceived as having higher, more stable or more reliable income potential will tend to have higher investments because of the expected higher returns for their efforts. The Huffman and Dumanski study (Table 3.2 - Capital Investment) found that: 1) the total capital investment per farm was highest for the monoculture system; and, 2) the portion of total capital value that comprises machinery and livestock was greater in the high intensity systems, while the low intensity systems were proportionately more highly capitalized in land and buildings.

The 1981 Agriculture Census shows that the average value of land and buildings has increased by a Canadian Price Index - adjusted 200 per-cent over the 1971-1981 period. The McCuaig and Manning study also shows that the values escalated over the 1961-1976 period. Since the value of farmland is dependent on the expected income from a farm operation, the increase in farmland values suggests an expectation of greater incomes for the area. Rising land demands have been one of the major factors in persuading farmers to contemplate changing the amount of land and/or intensifying the use of it (McCuaig and Manning, 1982).

The introduction of an agroforestry scheme could have a number of benefits in both the high and low land use intensity systems. In those farms that have large areas of abandoned or low intensity land uses, which are generating marginal returns on their farming activities, the availability of capital is a major limiting factor in initiating changes in farm activities to increase productivity. As indicated in a previous chapter, high intensity land use system farms are having cash flow problems but still have the requirement to increase returns on their agricultural production in order to survive. Raintree (1983) states that agroforestry schemes will be adopted if they satisfy the criterion that the implementation of a new technology will provide maximum returns to the most scarce production factor. Agroforestry would be a good alternative because of its low capital requirements. The equipment needed for tree planting, harvesting and processing is relatively inexpensive and could be integrated into existing farm

equipment such as the tractor. The operating costs for most agroforestry systems are low, meaning that economies of scale are not as important as in intensive crop production. Additionally, financial and technical assistance for implementing agroforestry systems is available through various federal and provincial government programs.

4. Management

Mixed farming operations are more likely to adopt an agroforestry approach than farms that are oriented toward the intensive management of monoculture crops. Three quarters of eastern Ontario farmers have mixed farm operations (Priest, 1986), and it can be expected that the integration of an agroforestry segment into these management systems will be relatively easier than in areas with more intensive monoculture agricultural practices.

A variety of external factors will affect the management of the rural land resource, and of these changing, economies of production have been considered the most significant by the majority of farmers (McCuaig and Manning, 1982). The rising costs of inputs such as fertilizer and labour, and a declining relative per-unit return for farm produce are resulting in a cost/price squeeze for the Canadian agricultural sector. When the costs of farm inputs outstrip net returns to farming, the farmer can respond in a number of ways: (1) enlarge the scale of the operation through farm consolidation; (2) achieve high production

through intensification; (3) adopt more efficient technology and management methods; (4) change to different crops; (5) seek off-farm work to bolster farm income; (6) abandon the farm; or, (7) subsist on a non-economic basis.

An agroforestry system could be part of these responses. Enlargement of the farm or intensification could lead to the land degradation problems cited earlier in this report, and the use of trees as a conservation measure has already been outlined. The adoption of more efficient management methods or a change to different crops could mean the introduction of an agroforestry management approach. The increase in part-time work or abandonment of farmland will create land that will be left idle, and with proper planning these areas could have a productive role through the introduction of agroforestry systems.

The information on the socio-economic characteristics of farmers in the different land use system supports the earlier conclusions from the analysis of physical characteristics on the implementation of agroforestry. Current trends have created an environment in which agroforestry could be implemented without any unsurmountable barriers. The next step in the process of determining the viability of agroforestry is to develop a strategy that will build on the existing agricultural and forestry practice in that area. The adoption of this technology will be discussed in the next chapter.

CHAPTER FOUR

ADOPTION OF TECHNOLOGY

A previous chapter has indicated the advantages agroforestry systems could bring to a farming operation. However, no new technological approach will have a significant impact as a land use system unless it is adopted by a significant percentage of land owners. The purpose of this chapter is to examine the factors which could enhance the adoptability of agroforestry systems in eastern Ontario. At a Canadian Forestry Association meeting of forestry extension specialists, held in November 1987, there was agreement that the keys to getting tree farming moving effectively in Canada are: suitable legislation; long term funding; markets, and education (Coats, 1987). These same factors would apply to the implementation of an agroforestry strategy.

Before examining these factors, two points need to be noted. First, agroforestry systems will not be implemented overnight. In order to have agroforestry established in eastern Ontario, a series of graduated steps will have to take place. The first phase of this approach will be to "fix up" the existing land use system, and then begin to make incremental improvements to it (Raintree, 1983). In order to maximize the compatibility and perceived advantage of agroforestry innovations, the approach of improving the existing forestry land use, then using the results as a base on which innovations can be grafted, will be an easier assimilation process than one which attempts the transformation

of a total system. These "discrete" technical interventions will be compatible with existing operations, will have a perceived advantage over the present system, and will probably be technically easier to implement, with the end results more readily observed and understood by local farmers. It must be stressed that this stage of development is not considered to be agroforestry, but rather is a means of developing an interest in the use of trees on the farm, which could lead to an agroforestry approach. Second, it is the author's belief that the farm sector should be the principal focus of an initial agroforestry strategy. Farmers are the largest occupational group of landowners with woodlots in Ontario; according to the 1981 Census, there are 82,448 farms in Ontario with 1.8 million acres of woodlands. In the southern half of Ontario, 53 percent of the landowners having properties 20 hectares or larger are farmers, and 79 percent of farmers have woodlands on their property (OMNR, 1982a). Farmers own 45 percent of the 153,000 tree farms in Ontario (Coats, 1987). Data for eastern Ontario given in Table 4.1 show that there are 202,129 hectares (499,259 acres) of woodland area on farms (Coons, 1985). Farmers also have equipment, such as tractors, sprayers, etc., that can easily be adapted to woodland operations, they are familiar with marketing products and would have the desire to manage their woodlots for a secondary income.

The next part of the chapter will discuss the keys to implementing agroforestry systems as they pertain to eastern Ontario.

Table 4.1
1981 CENSUS OF AGRICULTURE STATISTICS (CANADA) I

Location	No. of Census Farms	Total Area of Census Farms (Acres)	Area of Field Crops on Census Farms (Acres)	Woodland Crop Area on Census Farms (Acres)	Total Crop Area-Field Crops Plus Woodland (Acres)	Woodland Crop Area as a Percent of Total Crop Area	Woodland Crop Area as a Percent of Total Farm Area
Dundas	949	176,845	115,423	16,688	132,111	12.6	9.4
Frontenac	952	249,860	82,513	41,564	124,077	33.5	16.6
Glengarry	976	194,013	112,152	26,106	138,258	18.9	13.5
Greenville	720	129,301	56,320	25,180	81,500	31.0	19.5
Lanark	1,203	317,199	98,142	91,946	190,088	48.3	29.0
Leeds	1,134	274,369	97,549	48,439	145,988	33.2	18.0
Lennox & Addington	897	230,064	91,086	33,135	124,221	27.0	14.4
Ottawa	2,002	355,220	191,145	38,159	229,304	16.6	10.7
Carleton	973	206,073	127,987	15,446	143,433	10.8	7.5
Prescott	1,713	465,007	150,249	137,534	287,783	48.0	30.0
Renfrew	619	105,448	74,938	5,500	80,438	6.8	5.2
Russell	767	148,075	82,189	19,567	101,751	19.2	13.2
Stormont							
EASTERN ONTARIO	12,905	2,851,474 (1,154,443) hectares	1,229,693 (518,094) hectares	499,259 (202,129) hectares	1,778,952 (720,223) hectares	28.1	17.5

1 cited in Coors, 1985

Government Factors

The legislation and funding support recognized as being important in getting agroforestry established will for the most part be a government function.

To make farmers more aware of the benefits of forest management, government sponsored extension programs offering technical and financial woodlot management assistance will continue to be a necessity. A U.S. study found that a landowner's decision to reforest their woodland areas was based on three factors: 1) a belief that forest land should be kept in production; 2) anticipation of favourable economic returns on investment; and 3) the availability of advice or technical assistance (Pesco et al., 1981). Another study by the U.S. Department of Agriculture showed that between 1971 and 1981 public programs of financial and technical assistance were much more influential than markets or ownership characteristics in determining reforestation behaviour in non industrial private forest landowners (Page, 1985). The benefit of technical assistance is evidenced in a study done by Cubbage et al. (1985) who found that landowners receiving technical forestry assistance had stumpage prices 58 percent greater than those landowners making timber sales unassisted.

Conversations with those in federal and provincial governments, industry, farm and forestry associations, and others involved in agroforestry related activities indicate a maintaining of the status

quo in this area - no changes, i.e., increased funding support, tax or market incentives, etc., are being planned at any government level that will influence the decision of a landowner in eastern Ontario to get involved in agroforestry or forestry management practices. The main reason cited for this is that the contribution of forestry to the GPP in Ontario is low, approximately 2.5 percent, compared to around 30 percent for British Columbia (Coats, 1988). As a result of this small contribution, forestry does not get a high priority in the province. Additionally, of the small amount of attention paid to forestry, most is focused on the large forestry operations on Crown Lands in Northern Ontario. Private woodlands in the province get very little consideration.

An example of this from a policy viewpoint is evidenced in the implementation of the Southern Ontario Co-ordinated Program Strategy. This strategy was developed in 1982 in response to a recognized need on the part of OMNR for an integrated approach to resource management (OMNR, 1982b). Forestry and related issues played a significant role in this strategy. The objective for forestry was to produce an annual supply of 5.9 million cubic meters of wood for industrial purposes by the year 2020 and to make the maximum contribution from forest production to the achievement of provincial energy targets. The strategy paper noted that private land forests would be essential for the achievement of wood production targets because Crown lands would be able to provide no more than 40 percent of the anticipated demand. A

number of strategies for private land forests were put forward: maintain, improve and promote forest production through the Woodlands Improvement Act program; undertake a program of technology development with fast growing hardwoods and softwoods; advise landowners of any incentive programs to encourage the management of private land forests; and conduct an education program to promote the management of private land forests. OMNR was also going to direct greater effort to forest utilization by monitoring the development of, and assisting in the implementation of, effective marketing of forest products, including fuelwood and low grade material and by promoting the utilization of small diameter, low quality species. Since the announcement of this strategy in 1982, there has been no activity as was outlined in the forestry objectives. Considering the current climate of restraint, it is not expected that any new funds will become available to support the policies outlined in the strategy. Therefore, landowners wishing to get involved in an agroforestry strategy will have to do so within the existing policy framework.

The Ontario government does have a number of forest programs which private woodlot owners could access to facilitate this phased in approach for agroforestry. It should be noted that there are no programs specific to agroforestry. The Advisory Services Program is a forestry extension program that was established to make woodlands more profitable by better managing them for: products such as sawlogs, pulpwood, firewood, poles and fence posts; protection against floods

and soil erosion; and protection of water supplies. Landowners who properly manage their forests as a result of the program would also benefit from the Managed Forest Tax Reduction Program which provides 50 percent rebate on municipal property taxes to landowners who manage their woodlands productively.

For the next incremental step landowners could utilize the Woodland Improvement Act agreements to establish new woodlands. The WIA legislation and program was developed in response to a recognition that; i) large areas of abandoned submarginal agricultural lands in Ontario were suitable for reforestation, and ii) extensive areas of woodlands required precommercial thinning (OMNR, 1982a). Basic to this concern was the realization that: professional and technical advice must be provided in a regular and continuing manner; the owner must be given an incentive; and the property or woodlot must have sound forest management. Without assistance, there would be little incentive for the landowner to plant trees because there would be no immediate returns on investment. While most of the agreements have been, and will continue to be, for conventional reforestation projects, the WIA agreements could also include projects that are agroforestry in nature, such as intensive plantations or tree crop systems. For those landowners who would like to plant trees but do not want to become involved in a WIA agreement the ministry also provides nursery stock at a nominal charge.

Support is available for the establishment of trees to serve a protective function. OMNR and the federal government share the cost of a program to encourage rural landowners to plant windbreaks (OMNR, undated). Additionally, a \$22 million Ontario Soil Conservation and Environmental Protection Assistance Program (OSCEPAP) of OMAF is intended to provide assistance to farmers in controlling soil erosion, sustaining crop productivity and protecting water resources through such mechanisms as the planting of windbreaks (OMAF, undated). An OSCEPAP II program, introduced in 1986, is intended to protect highly erodible lands. The program will cover the costs incurred in protecting land unsuitable for cropping because of severe soil erosion, and includes the purchase and planting of trees. The Land Stewardship Program was established in 1987 to take fragile land out of traditional crop production, and part of the program will cover the costs of planting trees on this land (Coons, 1988).

The provincial government has also established programs specific to eastern Ontario. The Ontario government recognized that the forestry sector in the region was operating at a level below its potential (Anslow, 1977). This was due mainly to two factors; the poor quality of forests as a result of exploitation over the past 200 years and the reversion of agricultural land to forest land through natural regeneration, resulting in low quality forests. To strengthen the forestry sector, the "New Forests in Eastern Ontario" program was initiated (OMNR, 1978). The objective of the program was to provide

the technology which would permit the establishment of 100,000 hectares of fast growing hybrid poplar plantations in the area by the year 2000 (OMNR, 1980). These plantations would be capable of producing 1,250,000 oven dry tonnes of wood annually and provide eastern Ontario with 5 percent of its end use energy requirements, 60 percent of its fibre supply and 1 percent of its forage. In 1981, the Eastern Ontario Forestry Development Program (EOFDP) was initiated by the Ministry of Natural Resources under the Forestry Act. Its main purpose was to increase the volume of wood for forest mills in eastern Ontario. The program promotes the establishment of new forests, and the intensive management of existing young forests on private non-industrial land.

There is no doubt that these various forestry programs would provide a great deal of benefit to the farmer or landowner. The forestry extension services are free and, if the farmer follows the advice from OMNR staff, will provide immediate returns of firewood, construction material, fence posts and wood chips from the thinning operations. The long-term benefit of the forest management practices is that the trees will grow faster without the growth competition from other vegetation and will have a greater value when sold. There are also the aesthetic and recreational values to be accrued from better forest management.

The involvement of the farmer in these programs does not require a large commitment of capital or labour and would be an excellent way to introduce trees as part of the overall farm operation and increase farm income. A study by Appleby and Jones (1984) has shown that if a farmer

owns land which is idle, the implementation of a WIA would provide a number of economic benefits to the farmer including a reduction in land taxes, increased land value and income from the wood. The planting of intensive culture poplar plantations under the WIA program was also found to be economically attractive to the landowner in the Appleby and Jones study.

Domtar Model

An example of how this phased approach to the adoption of agroforestry has worked in eastern Ontario is demonstrated by the program Domtar Forest Products established in cooperation with the Ministry of Natural Resources, to provide wood to its Cornwall, Ontario mill (Velema, 1986). The program was initiated by the company because its supply of local wood was declining, necessitating the transportation of wood over greater distances at a time when transportation costs were rising sharply. These factors, coupled with the knowledge that the area close to the mill presented opportunities in terms of idle land and young hardwood woodlots, led the company to develop a long-term fibre supply strategy. The goals of the strategy were to: i) improve the forest productivity of the existing land base; ii) reduce transportation costs by increasing the volume of hardwood available close to the mill; and, iii) enhance the security of future wood supplies. Domtar realized that: 1) in order to fully address the wood supply problem the private landowners in the area would have to become directly involved; and, 2) woodlot owner would need assistance in managing woodlot and

idle lands for forestry purposes.

In 1980, Domtar developed a forestry extension program to assist private owners of mature woodlots to harvest and market their wood. The Woodlot Development Program (was set up to assist landowners in developing their mature woodlots into more productive forests. Domtar promoted the management of these woodlots, by providing technical assistance and using experienced and reliable contractors for the logging operations. Domtar's extension program was expanded with the initiation in 1981 of the Eastern Ontario Forestry Development Program (EOFDP) by OMNR, which made it possible for Domtar to provide two additional programs to the private landowner.

The company recognized that a far greater potential existed in the approximately 40,000 hectares of immature precommercial hardwood stands in the region, and under the Woodlot Management Agreement Program, Domtar would perform silvicultural precommercial thinning operations on these immature stands. The thinnings are removed, chipped and utilized by Domtar for paper production, and a stumpage fee is paid to the landowner for the wood removed. The program involves a ten year management agreement between the woodlot owner and Domtar in which the landowners commit their lands to intensive forest management.

The Tree Farm Agreement Program was designed to assist landowners in the establishment of commercial hybrid poplar plantations on cleared

land within a 20 mile radius of Cornwall. The program involves a ten year agreement between the landowner and Domtar in cooperation with OMNR. Under the agreement, Domtar pays an annual per hectare lease fee, prepares management and annual plans, prepares the land for planting, plants and tends trees and purchases the crop of trees from the landowner when it reaches a commercial age. The landowner, in exchange for dedicating land to forestry for ten years, gains a hybrid poplar plantation at no cost on formerly idle land, has guaranteed a market for the crop when it reaches a market size, receives free technical assistance and qualifies for the Managed Forest Tax Reduction rebate.

Markets

A major barrier to any increased interest in improving woodlot management will be the development of markets for the forest products. Markets are critical - farmers or other woodlot owners will have to be fairly certain that they will have an eventual market for their trees before they become involved in agroforestry operations.

A number of products such as sawlogs, veneer logs, fence posts, fuelwood, etc., have already been sold from woodlots. Table 4.2 gives the values of forest products which brought a cash income to the farms in Ontario. The total value of forest products is a very small portion of the total farm cash receipts, and would not seem to be worth the farmer's effort to exploit as an income source. However, the picture

Table 4.2

ONTARIO FARM CASH RECEIPTS FROM FOREST AND MAPLE PRODUCTS

1971 - 1980*

<u>Year</u>	<u>Forest Products</u>	<u>Total Farm Cash Receipts</u>	<u>Forest Products As Percent of Total</u>
1971	\$ 5,244,000	\$ 1,417,938,000	.4
1972	\$ 6,069,000	\$ 1,655,707,000	.4
1973	\$ 7,426,000	\$ 2,059,662,000	.4
1974	\$ 8,099,000	\$ 2,517,681,000	.3
1975	\$ 8,256,000	\$ 2,696,311,000	.3
1976	\$ 9,853,000	\$ 2,791,900,000	.4
1977	\$10,167,000	\$ 2,865,736,000	.4
1978	\$12,995,000	\$ 3,417,018,000	.4
1979	\$15,534,000	\$ 4,022,342,000	.4
1980	\$13,752,000	\$ 4,326,190,000	.3

* Statistics Canada Farm Income Catalogue 21-202P
as cited in Coons (1985)

of the contribution from forest products changes dramatically if one considers "income in kind," which is defined as the value of forest products harvested and used on farm. Table 4.3 gives these values, and it can be seen that the contribution from forest products is significant. These figures do not include the value for fuelwood used on the farm, which has an estimated value of \$25 million annually (Coons, 1985). The total farm income from forest products can be estimated from the above 1980 data to be:

Income in Kind	- \$12,684,000
Fuelwood	- \$25,000,000
Direct Income	- <u>\$13,752,000</u>
	\$51,436,000

In the initial phase of introducing trees as a farm product, markets will not be important because the farmer will use most of the product on the farm. It is when wood supplies from increased productivity on existing woodlots and new plantings have to be sold that markets will be crucial. These markets are expected to develop as forest industries are beginning to look to private woodlots for more of their wood supplies. With the expected reduced quality and quantity from Crown look to private woodlots for increasing quantities of wood. The demand for forest products is predicted to rise at a rate that will not be able to be met through the conventional means of the forest products industry. With the expected reduced quality and quantity from Crown forests, private forests are becoming critically important to the

Table 4.3

ONTARIO FARM INCOME IN KIND* FROM FOREST PRODUCTS¹

1971 - 1980**

<u>Year</u>	<u>Forest Products***</u>	<u>Total Farm Income</u>	<u>Forest Products As Percent of Total</u>
1971	\$ 4,595,000	\$29,305,000	15.7
1972	\$ 5,126,000	\$30,997,000	16.5
1973	\$ 6,903,000	\$43,584,000	15.8
1974	\$ 7,258,000	\$42,763,000	16.9
1975	\$ 7,366,000	\$43,587,000	16.9
1976	\$ 8,751,000	\$43,552,000	20.1
1977	\$ 8,808,000	\$45,445,000	19.4
1978	\$10,481,000	\$57,858,000	18.1
1979	\$13,575,000	\$72,133,000	18.8
1980	\$12,684,000	\$70,657,000	17.9

* Farm Income in Kind - relates to the value of forest products
harvested and used on the farm

** Source: Statistics Canada Farm Income Catalogue 21-202P

*** Forest Products - does not include Maple Syrup

1 - as cited in Coons (1985)

overall wood supply picture, especially in eastern Canada (Jones, 1984). The Southern Ontario Co-ordinated Strategy echoed this view (OMNR, 1982). Its targets for southern Ontario were to produce an annual continuous supply of 5.9 million cubic meters of wood for industrial purposes by the year 2020. It noted that Crown lands would only be able to supply 40 percent of this total. The total present southern Ontario harvest for industrial purposes is approximately 2.7 million cubic meters of wood annually and of this, approximately 1.3 million cubic meters have to be obtained from outside the region to meet the demand.

Looking first at the markets for softwoods, most of the industrial roundwood now sold from private woodlots is softwood, and the increased supply from better managed woodlots would find a ready market in the forest industry as pulpwood or sawlogs. It is difficult to determine what is now being sold because the market is not organized. Wood sales are done for the most part on an individual basis. A landowner contacts a local buyer from one of the wood processing industries in the eastern Ontario region who gives a price for the wood. OMNR provides a list of potential buyers in each regional district and an average price of wood recently sold. This price will vary because of a number of parameters including volume, species quality and accessibility. It should be noted, however, that farmers have looked on the sale of pulpwood as an uneconomic product (Jones, 1984). Stumpage prices are adequate to meet short-term requirements but do not

provide sufficient incentive to encourage more intensive management or plantings over the long run. In the absence of government or industry assistance and/or the lack of increases in stumpage prices, woodlots will deteriorate if pulpwood is the only market for the softwoods produced on private lands. As such, a successful strategy for the management of softwood stands would be to grow the trees for a sawlog market, and if possible, sell the thinnings and lower quality wood to the pulp market.

For hardwoods, Tables 4.4 and 4.5 show that a significant quantity and dollar value of hardwoods in the form of lumber, veneer and plywood are imported into Ontario which could potentially be replaced with wood from private woodlots. There is a significant amount of immature, pre-commercial, high value hardwood stands in eastern Ontario and it can safely be said that a market would be found for these trees if better forest management was practiced. Again, however, the market is not organized and the best way a woodlot owner can determine a value for his higher value hardwoods is to call in a buyer to inspect his woodlot.

In order for agroforestry to be adopted in this country, a major requirement will be the development of markets and new applications for fast growing hardwoods. These hardwoods are underutilized and have not provided any significant economic returns to the woodland owner. A market has always existed for the larger fast growing hardwoods as veneer or for sawlogs (Poplar Council of Canada, 1986b). This has

Table 4.4: IMPORTS OF FOREST PRODUCTS (VALUE) BY COMMODITY GROUP AND PROVINCE OR REGION OF CLEARANCE, 1984

Products	Nfld.	P.E.I.	N.S.	N.B.	Atlantic provinces	Que.	Ont.	Man.	Sask.	Alta.	British Columbia	Canada	
\$ 000													
A. Primary wood products	1 016	-	1 488	12 900	15 403	106 335	34 488	282	85	408	776	5 962	162 564
Logs and bolts	-	-	9	4 578	4 587	98 603	16 631	75	4	-	-	575	120 474
Pulpwood	-	-	-	82	82	808	11 027	1	-	-	1	835	12 753
Pulpwood chips	-	-	-	8 061	8 061	48	897	-	1	14	16	142	9 163
Other primary products	1 016	-	1 479	178	2 673	6 876	5 933	206	80	393	679	4 012	20 174
B. Wood fabricated materials	32	291	2 595	12 130	15 047	119 821	255 822	10 405	6 338	12 366	37 108	138 866	566 664
Lumber - Softwoods	5	180	135	6 943	7 264	15 854	33 992	2 564	488	1 598	4 650	46 710	108 469
- Hardwoods	-	-	980	1 157	2 138	53 714	90 549	8 640	3 202	3 176	15 018	11 631	173 049
Shingles and shakes	-	-	-	-	-	-	-	-	-	-	-	-	-
Veneer - Softwoods	-	-	23	-	23	1 418	530	-	31	5	36	9 650	11 658
- Hardwoods	-	-	-	2	2	8 458	16 002	3	385	378	766	783	26 011
Plywood - Softwoods	-	-	-	5	5	635	4 141	47	-	19	66	1 410	6 257
- Hardwoods	-	-	7	21	28	10 160	10 724	1	-	16	16	13 527	34 455
Other wood products	27	110	1 449	4 002	5 588	29 583	99 883	7 151	2 231	7 174	16 557	55 154	206 766
C. Wood pulp and paper products	3 087	102	5 439	40 430	49 057	260 685	737 952	44 230	2 983	29 570	76 783	111 315	1 235 791
Total wood pulp	-	45	73	5 444	5 562	30 358	71 695	-	-	6 046	6 046	15 592	129 253
Total paper products	3 087	56	5 366	34 986	43 495	230 327	666 257	44 230	2 983	23 524	70 737	95 722	1 106 539
Newsprint	-	-	-	-	-	-	-	-	-	-	-	-	-
Book and writing paper	37	-	44	22 093	22 174	46 373	88 269	11 738	244	2 835	12 818	14 725	106 359
Fine, tissue and sanitary	34	-	389	4 174	4 597	45 328	125 570	10 251	232	4 543	15 026	12 049	202 571
Wrapping and packaging	-	-	181	1 343	1 524	11 637	23 087	4 735	-	312	5 047	1 498	42 793
Paperboard	2 504	-	445	643	3 592	16 374	68 052	6 222	7	7 934	14 163	17 104	119 284
Building paper and board	51	-	47	303	401	12 864	18 911	1 457	871	392	2 720	6 965	41 861
Converted paper	138	1	1 600	1 639	3 379	37 880	111 819	1 862	594	1 274	3 730	12 929	169 737
Misc. paper products	322	55	2 659	4 791	7 828	59 870	230 549	7 965	1 035	6 233	15 233	50 451	343 931
Total forest products	4 134	392	9 521	65 460	79 507	486 841	1 028 262	62 917	9 406	42 343	114 667	255 743	1 985 019

* Including Alaska.

Source: Statistics Canada Special Compilation, International Trade Division.

Table 4.5: IMPORTS OF FOREST PRODUCTS (QUANTITY) BY COMMODITY GROUP AND PROVINCE OR REGION OF CLEARANCE, 1984

Products	Nfld.	P.E.I.	N.S.	N.B.	Atlantic provinces	Que.	Ont.	Man.	Sask.	Alta.	Prairies	B.C.*	Canada
A. Primary wood products													
Roundwood (1 000 m ³)	-	-	-	111	111	2 527	563	2	--	--	2	63	3 266
Logs and bolts (1 000 m ³)	-	-	-	108	108	2 502	172	1	--	--	2	23	2 807
Pulpwood (1 000 m ³)	-	-	-	3	3	25	391	--	-	-	--	40	459
Pulpwood chips (1 000+)	-	-	-	98	98	1	15	-	--	--	--	3	118
B. Wood fabricated materials													
Lumber (1 000 m ³)	-	-	-	-	-	-	-	-	-	-	-	-	-
Softwoods	-	-	1	58	59	97	153	13	2	9	25	294	628
Hardwoods	-	-	5	5	10	182	320	21	6	8	34	31	576
Shingles and shakes (1 000 m ²)	-	-	-	-	-	-	-	-	-	-	-	-	-
Veneer (1 000 m ³)	-	-	-	-	-	-	-	-	-	-	-	-	-
Softwoods	-	-	-	-	-	4	2	-	--	--	--	42	48
Hardwoods	-	-	-	-	-	9	16	-	--	--	--	1	26
Plywood (1 000 m ³)	-	-	-	-	-	2	14	-	-	-	-	2	20
Softwoods	-	-	-	-	-	26	21	-	-	-	-	28	75
Hardwoods	-	-	-	-	-	26	41	1	-	12	13	97	179
Other wood products (1 000 m ³)	-	-	-	1	1	-	-	-	-	-	-	-	-
C. Wood pulp and paper products (1 000 t)													
Wood pulp	-	-	-	10	10	49	109	-	-	8	8	24	200
Newsprint	-	-	-	-	-	-	-	-	-	-	-	-	-
Book and writing paper	-	-	-	20	20	48	79	12	-	-	-	-	-
Fine, tissue and sanitary	-	-	-	3	3	25	63	6	-	3	15	14	175
Wrapping and packaging paper	-	-	-	2	2	18	22	7	-	2	8	8	107
Paperboard	5	-	1	1	7	26	109	11	-	-	7	2	52
Building paper and board	-	-	-	-	-	18	20	2	-	10	21	29	191
Converted paper	-	-	-	1	1	12	42	-	-	-	4	12	54
	-	-	-	-	-	-	-	-	-	-	1	5	61

* Including Yukon.

Source: Statistics Canada Special Compilation, International Trade Division.

resulted in the highgrading of stands for these products and produced a low quality stand with no economic value.

The market situation for the fast growing hardwoods is now beginning to change. A study in Alberta on the opportunities of these underutilized species (Westergaard, 1985) noted that significant and yet unexplored markets exist for fast growing hardwoods in Canada, the U.S. and the Pacific Rim. Most of the promising development options were in the pulp and paper sector. New pulping methods which can utilize hardwoods are expected to be the mill processes of the future. A number of economic and technical factors such as lower wood costs, the availability of large local wood reserves, higher pulp yields and good paper quality will contribute to the rapid acceptance of these new processes, creating a significant demand for hardwoods. However, for the eastern Ontario area, it is not expected that any increase in demand will come from the pulp and paper sector. The Domtar mill in Cornwall is, and will continue to be, the only pulp mill in the area, and its wood supply from farms is not expected to increase significantly.

In the wood products area, the potential for the increased use of fast growing hardwoods exists for a number of applications. The building of new plants to produce waferboard and oriented strand board has created a new need for former "weed species" (Poplar Council of Canada, 1985). These two products have had the fastest growth in the wood composite

boards area, and their increasing use has been by far the major factor in stimulating the demand for aspen (Poplar Council of Canada, 1986a). The Alberta study referenced above also found good near term potential for specialty lumber (produced by slicing, drying and gluing wood) and hardwood plywood. Particleboard, medium density fibreboard and industrial handling lumber could also develop significant markets in the mid to long-term. The development of these types of products was put forward in the Southern Ontario Co-ordinated Strategy but, as was already stated, nothing has come out of that. There is still a possibility that these industries could be established in eastern Ontario but it will take a concerted effort on the part of government and strong lobbying on the part of private woodland owners. Markets are also developing for hardwoods based on specific demands created by a local economy. In southwestern Ontario farmers are selling poplar to local manufacturers which is being used to produce veneer and food baskets (Zsuffa, 1986). In eastern Ontario, poplar logs are required by Wilkinson Sword in Pembroke for the production of splints (Ottawa Citizen, 1987).

As a result of the new demand, the utilization of aspen has increased over the last decade from 0.9 million cubic metres in 1973-74 to 2.6 million cubic metres in 1984-85 in Ontario, and has increased rapidly since (Balatinecz and Morley, 1987). The Ministry of Natural Resources finds itself in some areas of the province having demands for poplar allotments which exceed the supply available (Poplar Council of Canada,

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1986b). Balatinecz and Morley found that while companies using poplar for pulp or reconstituted board had no immediate concerns about future supplies, those harvesting for lumber or veneer were concerned about the supply of quality logs. They found that these companies either had a program underway or were interested in getting one established. Private landowners in eastern Ontario could be involved with these forest companies in a poplar plantation program similar to the Domtar model to produce the required high quality veneer or sawlogs.

Another potentially large end use for the fast growing hardwoods will be as an energy source. In 1980, the Ontario Ministry of Energy announced a fifteen year program to develop energy from waste (OME, 1980). The target for 1995 is to produce 35 percent of Ontario's primary energy from indigenous sources, with biomass supplying 1.8 percent of the total primary energy demand. The target of a 0.7 percent primary energy demand contribution from energy plantations as part of this biomass supply will result in the production of 2.5 million dry tonnes of wood feedstock annually by 1995. The use of wood for energy in the non-industrial sector will be the major energy market for private woodlot owners. A study was undertaken by the Ontario Ministries of Energy and Natural Resources to determine the present, past and future consumption of fuelwood in Ontario (OME and OMNR, 1981). The survey estimated that 1,125,400 full cords of wood were consumed by Ontario residents in 1980, which is a significant increase from the 1972 total of 455,000 full cords. The findings of the survey

indicate that this consumption will increase, and since 75 percent of woodburners obtain their wood from private woodlands there will be an increased demand on these woodlots for wood supplies.

There is an additional advantage in having energy markets for the low value hardwood stands. A number of areas in eastern Ontario with good Canada Land Inventory production capacity for forests have poor quality forests growing on them. To take advantage of their growth potential the areas should be clear-cut and replanted. However, the low market value of the species available, their low quality and low volumes makes this option currently economically unattractive. If this wood could be converted to usable products such as fuel, the economics of carrying out this forest improvement option would be greatly improved. The low producing acreage which could then be converted to acreages which could produce the desirable wood species having good market values (Ellingsen, 1986).

In addition to the economics, there are a number of social factors that could establish a greater interest in managing woodlots and planting new areas. In eastern Canada in particular, farms have been handed down from one generation to another and most people living on these farms like living where they are and have no desire to move. If these people could be shown new farm practices such as agroforestry, which would allow them to continue to practice a lifestyle they enjoy, they will be interested. There is also the aesthetic value, recreational.

opportunities and wildlife production possibilities to consider in developing good forest management systems in an area.

Education

While the increasing demand for wood could ensure that the supply of wood from private woodlots will find markets, these markets will not materialize until a concerted effort is made to provide a reliable supply of the product. Despite the income received by farmers from their woodlots, there is still a large supply potential that goes unrealized by small woodlot owners. This is caused by two factors: poor forest management on the part of the woodland owner; and, a lack of awareness of the income that could be derived from trees. These are the issues that have to be addressed in the preliminary "fix-up of the existing land" phase. It is apparent that more emphasis on education and technical assistance to increase landowner awareness of the need for proper woodlot management and the benefits to be realized from this will result in an immediate payback. As stated by Joakim Hermelin, director of the N.B. Department of Natural Resources, Forest Extension Service, "The crucial issue is the education of the owner. An educated, informed owner is the cornerstone to all management development" (Hohol, 1984).

Despite the successful Domtar program, a major problem with the Ministry of Natural Resources programs has been that they have not had

an adequate uptake by landowners. It was estimated in 1965 that there were 8100 km² of land in southern Ontario requiring reforestation and a further 23,490 km² of existing woodlands needing improvement practices (OMNR, 1982a). From the inception of the WIA program in 1966 to March 31, 1981, a total of 51,754 hectares had been forested and 50,902 hectares had received improvement practices. This represents 6.4 percent and 2 percent respectively of the original areas designated as requiring reforestation or improvement practices. Another indication of the lack of success of the WIA is that the 1981 Ontario Rural Private Landowner Survey showed that in Ontario, 51 percent of the owners were unfamiliar with the WIA program but would like to know more about it (OMNR, 1982a). The farming community, which should be a major target for agroforestry, has also not been too involved with the WIA program, as is indicated in Table 4.6 (OMNR, 1982a).

Table 4.6

W.I.A. AGREEMENTS WITH FARMERS IN SOUTHERN ONTARIO

MNR Region	W.I.A. Agreements	W.I.A. Agreements with Farmers	Percentage of Farmers Owning Woodlands*	Percentage W.I.A. Agreements with Farmers
Algonquin	910	93	19.8	10.2
Eastern	2230	445	42.2	20.0
Central	2503	430	53.6	17.2
Southwestern	<u>2716</u>	<u>1431</u>	<u>71.0</u>	<u>52.7</u>
Total	8359	2399	52.6	28.7

* Ontario Rural Private Landowner Survey (1981)

There have been no official studies on the uptake of the WIA since the Private Land Forests study in 1982, but conversations with Ontario government officials indicate there has been a steady increase of landowners in ministry programs (Coons, 1988). The major problem now is that the WIA has not had any funding increases, except for inflation, since the late 1970s. Although landowner involvement is still not high in proportion to the total number of woodland owners, it is now taxing the WIA resources to the limit. Despite this, information on the government woodlot improvement programs still has to be disseminated more widely. Changes to the programs, such as increased funding, can only occur at the political level, and if a growing body of woodland owners starts to become vocal in their demands for more funding, changes will occur.

One way of getting the information out would be to follow the approach used by the Prairie Farm Rehabilitation Administration (PFRA) in promoting their activities. Each year, certain agricultural representative districts are chosen in which the PFRA concentrates their tree planning assistance program promotion. Letters are sent to farmers informing them of the program and the intent of the PFRA to promote tree planting activities in the area. This is followed up with direct contact and if required, visits to the landowners to outline the program. A similar approach could be implemented for eastern Ontario using the PARINEO survey (OMAF and OMNR, 1982) as a guide. To implement agroforestry in a "production" mode, regions, could be

reviewed, and low intensity agricultural land use systems, i.e., idle land, grazing or pasture areas, and areas with a significant forest cover, would be the places to concentrate extensive service efforts.

Information would be sent to the landowners in the area and followed up with visits by OMNR or OMAF representatives. This approach would be a cost-effective way of getting information out on the government programs and should result in a good uptake of the program. There are two major reasons to expect a good response from the landowner. First, a large amount of low agricultural intensity land is poorer class, and most of it is either not bringing any real income to the farmer or not bringing the income it has the potential to bring in. Farm forestry would be a natural adaptation to this land resource. Secondly, a large proportion of farmers in these low intensity land use areas are involved in mixed farming and would be aware of the importance of crop diversity in protecting farm income.

While the principal focus of agroforestry initially will be as a means of producing an income crop on low agricultural intensity marginal land, there is some potential for the early application of agroforestry on large scale, intensive, monoculture, cash cropping operations as a protective system. An earlier chapter has pointed out that soil degradation is a serious problem in all regions of Canada. It identified that changes to current agricultural practices will have to be implemented in order to prevent us from losing our agricultural capabilities. One major problem is that economic pressures on farmers

to produce as much as they can are preventing the application of conservation measures. The establishment of agroforestry systems for protection, e.g., windbreaks or shelterbelts, would be an effective conservation strategy that could be implemented at a low cost. The use of agroforestry in a production mode could also be implemented on these farm operations. The study by Huffman and Dumanski (1983) has shown that corn and mixed land use systems cultivate approximately 75 percent of their total farm area. Tree operations could be introduced on the remaining land area, require little labour input and provide an additional income source that could alleviate some of the economic pressures that force the overproduction on higher quality land. The approach of using the FARINEO study could also be applied here. High agricultural intensity land use systems with idle land could be identified. Specific information on the benefits of windbreaks to crop production, visits to the farm, and seminars could all be used as a means of increasing the uptake of government programs dealing specifically with windbreaks.

Infrastructure - Woodlot Owners Associations

In order to coordinate the supply of wood and ensure technical and marketing assistance can be provided to woodlot owners in eastern Ontario, some type of infrastructure will have to be established. A number of provinces have already addressed this issue and have successfully established marketing boards to help farmers sell their wood.

In New Brunswick, woodlot owners have been organized into seven regional forest product marketing boards since 1983. These organizations have the authority to negotiate prices and delivery schedules for wood from private woodlots. The marketing boards are financed by a levy on the wood sold. Woodlot owner associations are now helping develop markets and end products for their wood in the province; the New Brunswick Federation of Woodlot Owners owns part of Canada's first oriented strand board mill in Chatham, N.B. (Hohol, 1986). The Quebec Federation of Wood Producers and the Forest Owners Group are two organizations that help woodlot owners market their products. Woodlot owners in Quebec are also becoming active in the development of markets for their wood; a particleboard mill with an annual capacity of 250 million square feet has been planned in Lac St. Jean by Normick Perron Ltd. in partnership with two local woodlot owner associations (Silviculture, 1986).

In British Columbia, a woodland association is just beginning to develop. The Fraser Valley Woodland Owners Association now provides technical assistance in woodlot management and offers training and education in all aspects of silviculture, land use planning, forest equipment, etc. It also provides information on current prices for woodlot products and a list of those who are interested in buying the forest products. It does not yet have the infrastructure or financial capabilities to provide marketing services but is gradually developing them. (It is interesting to note that similar services in Ontario are

provided by the Ministry of Natural Resources.) The long-term objectives are to form an organization that will represent small woodland owners at the political level, ensure owners get a fair price for their produce, construct a wood processing plant and develop an education program for woodlot management.

Woodland owners associations and forest products marketing boards have been very limited in both eastern Ontario and Ontario generally (Coons, 1985). One of the problems has been that this area has culturally and historically been reluctant to adopt this approach (Coats, 1988). The Lanark Forest Cooperative was formed in 1950, and served as a marketing agency of pulpwood, sawlogs and veneer logs for its members. This cooperative, however, has not been active over the past ten years. Currently, the only active woodlot owners association in Ontario is the Huronia Woodlot Owners Association. The major objective of the organization is to promote better plantation and woodlot management and to assist in education on improved woodland management. The association is not involved in the marketing of wood products produced by its members.

A major emphasis for the near term should be the question of how to develop marketing boards for private woodland owners in Ontario. The associations developed in the Maritimes were initially financed by the provincial government. This degree of financial support is not expected to occur in Ontario and is another indication of the lack of

real commitment by the provincial government to private woodlands. Perhaps a better example of how to develop a woodlot association is that of the Fraser Valley Woodland Owners Association. They are starting off by offering technical assistance, with a strategy that as interest, finances and the infrastructure develop, they will begin to develop a marketing emphasis. The problem with this approach in Ontario is that most of these implementation stage services are already offered through provincial government programs such as the Advisory Services Program and Woodland Improvement Agreements. As a result of this, woodland associations could not start up by providing this assistance as an incentive to join because it is already available free of charge. As a means of promoting the development of associations, one initiative the government could adopt would be to transfer this type of responsibility to potential woodlot owner associations, as has been done with conservation authorities, and fund the associations to perform this task. This approach has worked in New Brunswick, where woodlot associations have administered government subsidy programs for forest management work on private woodlots and have undertaken a variety of educational and promotional activities in forest management (de Marsh, 1986). As the association grows, funding could then come from members through dues, sale of timber, etc. There is also the potential for these associations to become involved as did woodlot owner associations in New Brunswick and Quebec, in the development of manufacturing facilities to process wood. In eastern Ontario, the owners could, for example, become involved in supporting the.

establishment of short length log processing systems, which has been identified as a means of utilizing the subgrade wood in the area.

This chapter concludes the second phase of this paper which addressed the development of mechanisms for implementing an agroforestry scheme in eastern Ontario. The previous chapter examined the suitability of the physical and socio-economic characteristics of the area for the implementation of agroforestry and concluded there would not be any surmountable barriers. The present chapter examined the factors affecting the adoptability of agroforestry systems and developed an implementation strategy for eastern Ontario. The question posed at the beginning of this paper has been answered - agroforestry has an application in this country. The case study analysis of eastern Ontario developed a means of assessing the suitability of agroforestry in an area and established an adoption strategy. The next, and most difficult step, is to begin the further implementation of agroforestry systems, and this will be discussed in the concluding chapter.

CHAPTER FIVE

CONCLUSION

The overall objective of this paper was to examine the potential of agroforestry in the Canadian context. The Canadian agricultural and forestry sectors face problems similar to those in the developing world, which has successfully used this integrated land use system to address a number of their economic, environmental and social problems.

The first aim of the paper was to determine the extent to which agroforestry has been practiced in Canada and to examine other agroforestry systems which could be applied in Canada. An initial reaction would be that there would be little chance that agroforestry, which has been practiced largely at a subsistence level by farmers in the Third World, could be applied to the industrialized farming and forestry practices in Canada. However, it was determined that there were significant applications and potential applications for agroforestry.

A major contribution of trees to agricultural operations in Canada has been as windbreaks or shelterbelts, and as a result of increasing soil degradation problems and government programs to inform farmers about the economic and agronomic benefits of tree planting and to provide technical and financial assistance for these activities, the use of windbreaks is expected to increase in the future. Looking at pioneer tree species, the use of trees as a nurse crop has been applied extensively in Canada and is expected to continue at a similar level in the future. The increased

awareness and concern about soil degradation and government programs to encourage the use of trees to protect erodible soils and to rehabilitate degraded land is expected to result in an increase in this agroforestry system. There is also a good possibility that as forest management practices improve in response to a declining wood supply, the use of nitrogen fixing trees to add a fertilizer value to the soil will also increase. The growing of large quantities of biomass under intensive cultivation is one agroforestry system that is expected to increase over the mid term and this will be discussed in greater depth later in the chapter. While forest grazing in natural forests has peaked in western Canada, there is a good possibility that grazing on intensive culture plantations could receive greater interest in eastern Canada. Tree crops, especially black walnut, could provide a good economic return to the farmer, but this practice has the least potential to be implemented in Canada at this time. Dual cropping systems are the most intensively managed of the agroforestry systems and have a good economic potential. However, the practice will not be accepted until one of the other agroforestry systems gets implemented on a large scale, demonstrating the benefits of agroforestry.

Knowing that agroforestry had a potential in Canada, the issue to be addressed was the development of an agroforestry implementation strategy. An analysis of the factors involved in the implementation of agroforestry was performed on eastern Ontario in order to develop a strategy that was functional. The physical resource parameters of climate, soil and topography and the socio-economic characteristics of land, labour, capital and management were examined and found to be suitable to the establishment of agroforestry practices.

The next step in the process of examining the viability of agroforestry was to develop an implementation strategy and determine whether it could enhance the adoptability of agroforestry system in eastern Ontario. The keys to getting agroforestry moving effectively are suitable legislation, long term funding, markets and education. These factors were examined under the context that the best method of establishing agroforestry would be through a series of graduated steps and that farmers would be the best group to focus attention on. A strategy beginning with a "fixing up" of the existing land base and proceeding to the introduction of trees as a significant part of the farming operation was put forward as the most effective way of introducing the agroforestry concept.

The question that now has to be answered in the introduction of an agroforestry strategy is what is next? - where do we go from here? It is difficult to assess what impact agroforestry will have in Canada because there are too many uncertainties at this point in time which could affect the outcome. The best that can be done is to examine developments over the mid term to determine what the next step will be.

It is the view of the author that the agroforestry system which will next be implemented on a large scale is short rotation forestry. There are a number of reasons for this: the technological knowledge base is there; a great deal of research has been done on fast growing hardwoods and yields of 15 oven dry tons per hectare per year can easily be achieved (Anderson and Zsuffa, 1983); information on how to maximize biomass production through proper clonal selection, site preparation and management is well established and is available to landowners; mechanization of the

plantations has been achieved with the development of equipment for planting, harvesting, and handling; processes for the conversion of wood to fuel, fiber or feed are available, and the technology has been demonstrated in other parts of the world, such as Sweden, Finland and eastern Europe, where viable short rotation plantations have been established (OMNR, 1986).

The economics of short rotation forestry and market potential are also good. An economic analysis has shown that the cost of wood chips from SRF plantations, calculated at \$30 - \$35 per oven dry tonne, could compete with the current price of \$49 per oven dry tonne for pulpmill chips from conventional forest operations (Golob, 1986). Results from an analysis conducted by the Alternative Energy Division of the Minnesota Department of Energy and Economic Development indicated that a five year, hybrid poplar, biomass production system could be financially competitive with other farm investments (Jorgens et al., 1986). A previous section on markets has described the rapidly increasing demand for fast growing hardwoods in the pulp and paper and wood products sectors and as an energy source. The use of fast growing trees as an alternative use of farmland is being seriously examined by the European Economic Community as a way of dealing with its large agricultural surpluses (Commission of European Communities, 1985).

The SRF system also has a good on farm adoptability and end use application potential. The trees can be planted on land which is too wet for other uses, where drainage is too poor for field crops, in areas that are too stony for conventional agriculture, etc. The farmer has the equipment - tractor, cultivator, forage harvester, to manage the crop.

The harvested wood can be used on farm and would be especially suitable to farmers who grow grain crops (Barkley, 1986). The present agricultural practice, particularly with grain corn, is to dry the crops in drying bins fired by oil or gas. As an alternative, farms could set aside part of their land to grow their own fuel to dry the crops. An agroforestry plantation has been established at a corn-greenhouse operation to supply energy for the farm needs. A three hectare hybrid poplar plantation will be harvested in alternate years and is expected to yield 25 tonnes per hectare per year (OMNR, 1985). Farmers who do not have an on farm demand could sell the wood to farmers in the area who have corn dryers or greenhouse operations.

The overall conclusion of this chapter is that agroforestry is gradually being recognized as a productive and sustainable system in its own right, separate from agriculture and forestry practices. It is predicted that such agroforestry applications as windbreaks and pioneer species will continue to increase at a constant rate, while relatively new systems such as short rotation intensive culture (SRIC) plantations and dual cropping will begin to receive wider acceptance as their benefits become realized. It is the author's belief that SRIC plantations are poised to make a significant impact on the agricultural and forestry sectors, driven by factors such as the anticipated need for large quantities of wood for fibre and energy and the recognition of the productive capability of SRIC plantations.

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APPENDICES

APPENDIX 1

AGRICULTURAL LAND USE SYSTEMS

MOUNTAIN TOWNSHIP

DUNDAS COUNTY

ONTARIO

APPENDIX 1 (cont'd)

AGRICULTURAL LAND USE SYSTEMS

<u>SYMBOL</u>	<u>LAND USE SYSTEMS, TYPE</u>	<u>DESCRIPTION</u>
P	MONOCULTURE	A contiguous arrangement of four or more fields, or a minimum of 16 hectares of corn or small grains.
C	CORN SYSTEM	A contiguous arrangement of four or more fields of uniform size. 40 - 75% of the area is corn, the remainder is a mixture of hay, pasture, and sometimes grain.
M	MIXED SYSTEM	A contiguous arrangement of four or more fields of uniform size. There must be some corn, but less than 40% of the area. The remainder is a mixture of hay, grain and pasture.
H	HAY SYSTEM	A contiguous arrangement of four or more fields with a mixture of hay, grain, and pasture, the largest portion being hay.
HC	PASTURE SYSTEM	A contiguous arrangement of two or more fields with a mixture of hay and pasture, about equal quantities of each.
G	GRAZING SYSTEM	A contiguous arrangement of four or more fields or a minimum of 16 hectares with no field separation of either permanent pasture or native grass pasture, or a combination. It may have minor amounts (10%) of hay.

APPENDIX 1 (cont'd)

NON-AGRICULTURAL LAND USE SYSTEMS

<u>SYMBOL</u>	<u>LAND USE SYSTEMS, TYPE</u>	<u>DESCRIPTION</u>
A1	IDLE AGRICULTURAL LAND	Land idle for 1-10 years and in a state of reversion to natural vegetation.
A2	IDLE AGRICULTURAL LAND	Land idle for more than 10 years and supporting native vegetation.
Z	WOODLAND	Forest cover with a minimum of 45% crown closure density and not less than half a hectare in area.
Zp	PASTURED WOODLAND	Woodlands that are grazed by livestock.
Zr	REFORESTATION	Land supporting a stand of artificially stocked trees.
B	BUILT UP	Urban related uses.
X	SWAMP, MARSH	Supports vegetation characteristic of a depressed and poorly drained area.
E1	EXTRACTION	Sand and gravel pits and quarries
E2	EXTRACTION	Topsoil removal
T	SOD FARMS	Public or commercial sales
R	RECREATION	Parks, golf courses, campgrounds, etc.
K	SPECIALTY AGRICULTURE	Orchards, market gardens, etc.
W	WATER	Rivers, streams, etc.

APPENDIX 2

FARINEO LAND USE HECTARAGES BY TOWNSHIP

	MONOC		CORN		MIXED		HAY		INTENSIVE		PASTURE	
		%		%		%		%	AGRICULTURE	%		%
Dundas												
Matilda	559	2.11	3,047	11.47	3,491	13.14	6,755	25.43	13,852	52.15	2,494	9.39
Mountain	775	3.09	2,677	10.69	6,734	26.89	6,901	27.56	17,087	68.23	719	2.88
Williamsburgh	45	0.17	2,080	7.97	4,205	16.12	2,445	9.37	8,775	33.63	2,286	8.76
Winchester	1,064	4.22	4,692	18.63	9,713	38.56	5,740	22.79	21,209	84.20	753	2.99
Glengarry												
Charlottenburgh	791	2.23	1,643	4.64	7,097	20.02	8,799	24.83	18,330	51.72	2,030	5.74
Kenyon	596	1.78	126	0.38	6,044	18.05	7,198	21.49	13,964	41.70	1,501	4.48
Lancaster	3,779	15.17	3,898	15.65	4,176	16.77	5,534	22.22	17,387	69.81	976	3.92
Lochiel	—	—	1,355	4.36	4,683	15.07	13,737	44.22	19,775	63.65	3,143	10.12
Grenville												
Augusta	77	0.24	2,082	6.58	4,515	14.28	1,542	4.88	8,216	25.98	1,866	5.90
Edwardsburgh	250	0.81	2,122	6.85	2,918	9.42	1,490	4.81	6,780	21.89	4,105	13.26
South Gower	140	1.56	1,625	18.13	548	6.12	1,256	14.02	3,569	39.83	113	1.26
Oxford	94	0.36	1,805	6.87	2,065	7.86	4,981	18.96	8,945	34.05	754	2.87
Wolford	75	0.34	1,471	6.62	84	0.38	3,033	13.64	4,663	20.98	964	4.34
Prescott												
Alfred	—	—	81	0.44	1,899	10.36	8,016	43.73	9,996	54.53	3,366	18.36
Caledonia	305	4.61	809	4.26	3,911	20.60	6,531	34.40	11,556	60.87	1,539	8.11
E. Hawkesbury	—	—	761	3.24	6,617	28.16	6,362	27.08	13,740	58.48	2,357	10.03
W. Hawkesbury	23	0.18	316	2.43	2,533	19.48	1,846	14.20	4,718	36.29	2,141	16.24
Longueuil	58	0.63	751	8.15	1,379	14.97	3,876	42.08	6,064	65.83	740	8.03
N. Plantagenet	367	1.75	336	1.60	1,276	6.07	7,562	36.00	9,541	45.42	1,365	6.50
S. Plantagenet	739	3.59	1,428	6.94	5,431	26.38	6,405	31.11	14,003	68.02	888	4.31
Russell												
Cambridge	399	1.49	4,682	17.45	5,126	19.10	3,051	11.37	13,258	49.41	402	1.50
Clarence	123	0.41	1,563	5.26	4,852	16.33	6,867	23.11	13,405	45.11	2,332	7.85
Russell	1,296	6.51	3,002	15.08	7,843	39.40	2,500	12.56	14,641	73.55	517	2.60
Stormont												
Cornwall	12	0.04	927	3.34	2,321	8.36	1,767	6.36	5,027	18.10	3,226	11.62
Finch	733	3.41	4,480	20.79	8,929	41.44	1,117	5.18	15,259	70.82	2,204	10.23
Osnabruck	—	—	941	3.95	5,175	21.75	1,401	5.89	7,517	31.59	3,354	14.09
Roxborough	903	3.03	4,599	15.42	5,599	18.78	3,578	12.00	14,679	49.23	1,080	3.62
By County												
Dundas	2,443	2.37	12,496	12.15	24,143	23.47	21,841	21.23	60,923	59.22	6,252	6.08
Glengarry	5,166	4.14	7,022	5.62	22,000	17.67	26,268	28.24	69,456	55.61	7,650	6.12
Grenville	636	0.53	9,105	7.58	10,130	8.44	12,302	10.25	32,173	26.80	7,802	6.50
Prescott	1,492	1.20	4,482	3.60	23,046	18.49	40,598	32.58	69,618	55.87	12,366	9.92
Russell	1,818	2.38	9,247	12.09	17,821	23.31	12,418	16.24	41,304	54.02	3,251	4.25
Stormont	1,648	1.60	10,947	10.64	22,024	21.40	7,863	7.64	42,482	41.28	9,864	9.58
FARINEO Total	13,203	2.03	53,299	8.18	119,164	18.28	130,290	19.99	315,956	48.48	47,185	7.24

APPENDIX 2 (cont'd)

FARINEO LAND USE HECTARAGES BY TOWNSHIP

GRAZING	%	SPECIAL AGRICULTURE	%	TOTAL AGRICULTURE	%	IDLE 1	%	IDLE 2	%	FOREST	%	PASTURED FOREST	%
676	2.54	145	0.55	17,167	64.63	1,487	5.60	2,368	8.91	4,985	18.77	—	—
—	—	38	0.15	17,844	71.26	780	3.11	1,259	5.03	2,484	9.92	34	0.14
546	2.09	4	0.02	11,611	44.50	1,031	3.96	2,797	10.72	8,740	33.50	18	0.08
—	—	3	0.01	21,965	87.20	461	1.83	307	1.22	1,808	7.18	101	0.40
32	0.09	12	0.03	20,404	57.58	386	1.09	1,035	2.92	12,428	35.06	—	—
—	—	13	0.04	15,478	46.22	461	1.38	881	2.63	15,279	45.62	16	0.05
—	—	29	0.12	18,392	73.85	788	3.16	485	1.95	4,886	19.62	10	0.04
75	0.24	9	0.03	23,002	74.04	294	0.95	602	1.94	6,749	21.72	13	0.04
508	1.61	62	0.20	10,652	33.69	2,346	7.82	5,072	16.04	10,544	33.34	89	0.28
416	1.34	13	0.04	11,314	36.53	1,012	3.27	3,088	9.96	13,476	43.52	—	—
143	1.60	48	0.54	3,873	43.23	610	6.81	800	8.93	2,888	32.23	20	0.22
646	2.46	323	1.23	10,668	40.61	1,820	6.93	2,857	10.88	8,122	30.92	48	0.18
1,105	4.97	68	0.30	6,800	30.59	684	3.08	2,507	11.28	7,439	33.47	—	—
—	—	3	0.02	13,365	72.91	382	2.08	202	1.10	2,390	13.04	—	—
—	—	—	—	13,095	68.98	339	1.79	372	1.96	1,778	9.36	76	0.40
142	0.60	2	0.01	16,241	69.12	813	3.46	426	1.81	4,779	20.34	80	0.34
—	—	—	—	6,829	52.53	434	3.34	870	6.69	3,645	28.03	189	1.45
—	—	3	0.03	6,807	73.89	176	1.91	149	1.62	1,447	15.71	80	0.87
27	0.13	—	—	10,933	52.05	685	3.26	630	3.00	7,572	36.05	72	0.34
—	—	27	0.13	14,918	72.46	457	2.22	632	3.07	3,894	18.91	37	0.18
508	1.89	—	—	14,168	52.80	625	2.33	946	3.52	8,753	32.62	—	—
37	0.12	13	0.04	15,787	53.12	1001	3.37	783	2.64	10,973	36.93	101	0.34
168	0.84	—	—	15,326	76.99	993	4.99	574	2.88	2,162	10.86	76	0.38
—	—	19	0.07	8,272	29.79	1,535	5.53	4,035	14.53	10,335	37.23	102	0.37
160	0.74	—	—	17,623	81.79	521	2.42	870	4.04	1,606	7.45	58	0.27
283	1.19	—	—	11,154	46.87	1,818	7.64	2,239	9.41	7,098	29.83	15	0.06
—	—	1	0.00	15,760	52.85	1,398	4.69	1,170	3.92	9,705	32.55	270	0.91
1,222	1.19	190	0.18	68,587	66.67	3,759	3.65	6,731	6.54	18,017	17.51	153	0.15
107	0.09	63	0.05	77,276	61.87	1,929	1.54	3,003	2.40	39,342	31.50	39	0.03
2,818	2.35	514	0.43	43,307	36.08	6,472	5.39	14,319	11.93	42,469	35.38	157	0.13
169	0.14	35	0.03	82,188	65.95	3,286	2.64	3,281	2.63	25,105	20.47	534	0.43
713	0.93	13	0.02	45,281	59.22	2,619	3.43	2,303	3.01	21,888	28.63	177	0.23
443	0.43	20	0.02	52,809	51.31	5,272	5.12	8,314	8.08	28,744	27.93	445	0.43
5,472	0.84	835	0.13	369,448	56.69	23,337	3.58	37,951	5.82	175,965	26.99	1,505	0.23

APPENDIX 2 (cont'd)

FARINEO LAND USE HECTARAGES BY TOWNSHIP

	REFORESTATION		BUILT-UP		SWAMP/ MARSH		PITS & QUARRIES		TOPSOIL EXTRACTION		SOD FARMS	
		%		%		%		%		%		%
Dundas												
Matilda	155	0.58	161	0.61	10	0.04	27	0.10	—	—	122	0.46
Mountain	31	0.12	112	0.45	2,329	9.30	73	0.29	—	—	73	0.29
Williamsburgh	6	0.02	369	1.41	352	1.35	24	0.09	—	—	—	—
Winchester	55	0.22	370	1.47	35	0.14	86	0.34	—	—	—	—
Glengarry												
Charlottenburgh	228	0.64	533	1.50	331	0.93	21	0.06	—	—	—	—
Kenyon	192	0.57	106	0.32	442	1.32	87	0.25	—	—	—	—
Lancaster	37	0.15	232	0.93	3	0.01	18	0.08	—	—	—	—
Lochiel	86	0.28	288	0.93	—	—	25	0.08	—	—	—	—
Grenville												
Augusta	137	0.43	1,135	3.59	1,409	4.46	238	0.75	—	—	—	—
Edwardsburgh	146	0.47	443	1.43	1,248	4.03	35	0.11	11	0.04	101	0.33
South Gower	9	0.10	97	1.08	297	3.30	109	1.22	—	—	247	2.76
Oxford	282	1.07	439	1.67	1,741	6.63	99	0.38	—	—	—	—
Wolford	220	0.98	128	0.58	3,239	14.57	44	0.20	—	—	—	—
Prescott												
Alfred	78	0.43	200	1.09	1,006	5.49	44	0.24	4	0.02	488	2.66
Caledonia	272	1.43	35	0.18	3,009	15.85	4	0.02	8	0.03	—	—
E. Hawkesbury	64	0.27	196	0.83	2	0.01	32	0.14	12	0.05	—	—
W. Hawkesbury	18	0.14	845	6.50	24	0.18	91	0.71	38	0.29	—	—
Longueuil	2	0.02	485	5.27	6	0.08	58	0.63	—	—	—	—
N. Plantagenet	258	1.23	428	2.04	46	0.22	70	0.33	—	—	—	—
S. Plantagenet	280	1.36	145	0.70	20	0.10	18	0.09	—	—	—	—
Russell												
Cambridge	356	1.33	484	1.80	1,116	4.16	111	0.41	2	0.01	—	—
Clarence	171	0.58	515	1.73	230	0.77	65	0.22	12	0.05	—	—
Russell	38	0.19	468	2.35	—	—	110	0.55	20	0.10	—	—
Stormont												
Cornwall	43	0.15	2,585	9.31	189	0.68	361	1.30	16	0.06	19	0.07
Finch	565	2.62	135	0.63	—	—	82	0.38	5	0.02	—	—
Osnabruck	245	1.03	373	1.57	388	1.63	91	0.38	3	0.01	—	—
Roxborough	312	0.15	145	0.49	753	2.53	173	0.58	129	0.40	—	—
By County												
Dundas	247	0.24	1,012	0.98	2,726	2.66	210	0.20	—	—	195	0.19
Glengarry	543	0.43	1,159	0.93	776	0.62	151	0.12	—	—	—	—
Grenville	794	0.66	2,242	1.87	7,934	6.61	525	0.44	11	0.01	348	0.29
Prescott	972	0.78	2,334	1.87	4,113	3.30	317	0.25	62	0.05	488	0.39
Russell	565	0.74	1,467	1.92	1,346	1.76	286	0.37	34	0.04	—	—
Stormont	1,165	1.13	3,238	3.15	1,330	1.29	707	0.69	153	0.15	19	0.02
FARINEO Total	4,286	0.65	11,452	1.75	18,225	2.80	2,196	0.34	260	0.04	1,050	0.16

APPENDIX 2 (cont'd)
FARINEO LAND USE HECTARAGES BY TOWNSHIP

RECREATION	%	WATER	%	GRAND TOTAL	%
81	0.30	—	—	26,563	100.00
23	0.09	—	—	25,042	100.00
1,119	4.29	22	0.08	26,089	100.00
—	—	—	—	25,188	100.00
79	0.22	—	—	35,445	100.00
23	0.07	526	1.57	33,491	100.00
52	0.21	—	—	24,903	100.00
7	0.02	—	—	31,066	100.00
—	—	—	—	31,622	100.00
70	0.23	25	0.08	30,964	100.00
11	0.12	—	—	8,961	100.00
16	0.06	176	0.67	26,268	100.00
8	0.04	1,160	5.21	22,229	100.00
41	0.22	130	0.72	18,330	100.00
—	—	—	—	18,988	100.00
850	3.63	1	0.00	23,496	100.00
8	0.06	11	0.08	13,002	100.00
—	—	—	—	9,810	100.00
32	0.15	279	1.33	21,085	100.00
4	0.02	183	0.89	20,588	100.00
3	0.01	273	1.01	26,837	100.00
74	0.25	—	—	29,712	100.00
32	0.16	109	0.55	19,908	100.00
271	0.98	—	—	27,763	100.00
—	—	82	0.38	21,547	100.00
374	1.57	—	—	23,798	100.00
2	0.01	—	—	29,817	100.00
1,223	1.19	22	0.02	102,882	100.00
161	0.13	526	0.43	124,905	100.00
105	0.09	1,361	1.12	120,044	100.00
935	0.75	604	0.48	124,619	100.00
109	0.15	382	0.50	76,457	100.00
647	0.63	82	0.07	102,925	100.00
3,259	0.50	2,977	0.45	651,911	100.00

APPENDIX 2 (cont'd)

OTTAWA CARLETON LAND USE SYSTEM

Monoculture System	10,500 hectares
Corn System	23,500 hectares
Mixed System	26,700 hectares
Hay System	34,400 hectares
Pasture System	12,000 hectares
Grazing System	<u>22,300 hectares</u>
Total Land Under Agricultural Use	129,400 hectares
Abandoned (A1) and Scrublands (A2)	28,300 hectares
Forest Cover	59,000 hectares

APPENDIX 2

Forestry Agricultural Resource Inventory in Eastern Ontario

The FARINEO legend is as follows:

Monoculture System

a single intensive or cash crop type, usually corn. Fields have been in continuous corn or continuous grain. Very large fields, no fencerows. This system is associated with cash crop operations, beef or hog feeder enterprises and in some cases, dairy farms. This system requires CLI Class 4 or better soils, but it is usually found on Class 1 soils or Class 2 soils which have been improved with tile drainage.

Corn System

corn, grain and hay combination, with corn 40-75%. Some pasture is allowed. The corn system is spatially associated with monoculture systems but is far more widespread. It is almost exclusively related to dairy enterprises on CLI Class 1-4 soils, with more Class 3 and 4 soils being utilized.

Mixed System

grain, corn and hay combination, with no dominant crop. Corn should be less than 40%, some pasture is allowed. This system is widespread and fairly

evenly distributed over the Class 1-4 soil areas, but is most common on Class 3 soils. It is mainly related to dairy farms and, to a limited extent, beef operations.

Hay System

hay and grain combination, with hay (usually a mixture of legumes and grass) dominant. Some pasture and less than 10% corn is allowed. This system occupies the greatest area in the region. It is found on Class 1-4 soils but has greater representation on Class 3 or 4 soils. It is the most intensive system that can utilize parcels containing only Class 4 soil, and it relates primarily to cow-calf beef enterprises. Approximately 40% of these farms are operated on a part-time basis.

Pasture System

hay and pasture system with improved (cultivated) pasture. This is a low intensity cropping system which makes use of relatively permanent stands of improved grass for hay and pasture. The reseeding of grasses such as timothy, brome or orchard is done only sporadically. The system occurs primarily on Class 4-6 soils, and beef, horses and sheep are the main types of enterprises, and about 60% are part-time or hobby farms.

Grazing System

grazing land of natural grasses. Low intensity use, usually on poorer land. This category is fairly widespread, particularly on Class 4, 5, and 6 soils, and is the only feasible agricultural use for Class 6 land. Most of the grazing parcels of land constitute an adjunct to a more intensive system.

"Special agriculture" was used to classify activities such as orchards, market gardens, nurseries and greenhouses.

The non-agricultural land uses designated by FARINEO were adopted from the Ottawa-Carleton land use survey with no changes as follows:

Idle Agricultural Land (A1)

Land idle for 1-10 years. Fields are overgrown with weeds and native grasses with an understory of similar material in a state of decay. Fencelines may be in poor condition or not visible. In advanced stages there may be scattered clumps of willows or small poplars or alders. Most woody growth has spread out from the fencelines and occurs in depressions, leaving central, higher areas covered with weeds. This land could be returned to agriculture with a minimum of capital input.

Idle Agricultural Land (A2)

Land idle for more than 10 years, characterized by brush, shrubs and poplar growth between five and

twenty-five feet high over more than thirty percent of the total area. Slower growing trees such as cedar, elm, cherry, apple or maple may be scattered but well-established. The presence of even a few of these species indicates that the land has been left undisturbed for a lengthy period of time. Later stages evidence the plant community conforming to natural landform and soil conditions, covering fences and ditches. Substantial investment and equipment would be required to return the land to agriculture.

Woodland

Continuous forest cover, with trees more than twenty-five feet high and with a minimum of forty-five percent crown closure density. Area not to be less than half a hectare.

Pasture Woodland

Woodlands used for grazing livestock.

Reforestation

Land supporting a stand of artificially stocked trees, either by hand or machine.

Swamp or Marsh

Natural depressional areas which are waterlogged for most of the year and may encompass small ponds of standing

water. Early successional stage species such as cattails, reeds, sedges and willows are prevalent. These areas have no recognizable active use.

- Built-up Urban related uses including continuous ribbon development. Single rural residential lots were not identified unless in groups of five or six located adjacent to each other.
- Extraction 1) Sand and gravel pits and quarries, or
 2) Topsoil removal including areas where topsoil is stock-piled in windrows.
- Sod Farms Public and commercial sales of sod.
- Recreation Facilities open for recreational use (playgrounds, playing fields, parks, golf courses). Recreation areas within built-up areas were not designated.

END

0|6|0|7|8|9

FIN