

**SEVEN CASE STUDIES IN  
SUSTAINABLE AGRICULTURE**

**David Patriquin**  
Dalhousie University  
(Coordinator and Regional Researcher)

and

**Linda Edwards, Mark Gimby,  
Pierre Jobin and Roger Samson**  
(Regional Researchers)

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SUSTAINABLE AGRICULTURE**

**A report to the Science Council of Canada**

by

**David Patriquin**

Biology Department, Dalhousie University  
Halifax, Nova Scotia B3H 4J1  
(Coordinator and Regional Researcher)

&

**Linda Edwards**

Integrated Crop Management Inc.  
Box 164, Okanagan Centre, B.C. VOH 1P0

**Mark Gimby**

Saskatchewan Research Council  
15 Innovation Blvd., Saskatoon, Sask. S7N 2X8

**Pierre Jobin**

Centre de Développement D' Agrobiologie  
244, rue Principale, Sainte-Elizabeth-de-Warwick  
Quebec JOA 1M0

**Roger Samson**

REAP-Canada  
Box 125, Glenaladale House  
Ste. Anne de Bellevue, Quebec H9X 1C0

(Regional Researchers)

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## INTRODUCTION

These case studies of SA (sustainable agriculture) in Canada were conducted in the late fall/early winter of 1990/91. Each case was investigated by a regional researcher who had some familiarity with the region and with SA. Short biographies of the regional researchers are given in Appendix A. A list of 28 questions (Appendix B) provided a guideline for interviews with the farmers and their families, but researchers were encouraged to develop the case studies as they, in consultation with the farmers, felt appropriate.

The farms are:

- I. A market garden in Nova Scotia
- II. A potato farm in New Brunswick
- III. A dairy farm in Quebec
- IV. A mixed livestock/crop/vegetable farm in Ontario
- V. A cash crop farm (soybean, corn, wheat) in Ontario
- VI. A grain/hog farm in Saskatchewan
- VII. An orchard in British Columbia

The primary objective was to provide examples of innovative SA practices that have been implemented by farmers. The farms were not selected as the longest standing, most complete or "best" examples of sustainable farming. Rather it was sought in the total selection to represent varying degrees of or stages in, implementation of SA practices. It was also wished to include representatives of the major types of farm operations in Canada and the Science Council requested that there be at least one farm from each of the 5 major regions of Canada.

The most common question relating to SA is not whether it can be done in ecological terms, but whether it is affordable, i.e. can ecologically sustainable systems also be "economically sustainable"? This invites definition of the term "sustainable" which inevitably generates a lot of debate.<sup>a</sup> In terms of the land and soil considered on their own, the definition need not be equivocal; sustainability clearly implies maintaining or improving the inherent productivity for the next generation. It is when we move into the economic and social spheres, which have a bearing on the ability to sustain the land, that the term becomes more difficult to define. An overriding trend since the 50s has been a continuing decline in the number of farms, with a concurrent increase in the size of individual farms. Sustainability of the farmer's livelihood has meant getting bigger, but even that has not been sufficient to keep up with the non-farm sector, and the proportion of the farm family income derived from the farm has continued to decline. According to a Statistics Canada bulletin, income from farm activities represented on average just 23% of total farm family income in 1985.<sup>1</sup> Further, there is the complicated issue of subsidies, transfer

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<sup>a</sup> The Nova Scotia Agricultural College uses the following definition: "A sustainable agriculture is one that, over the long term, conserves or enhances environmental quality and the resource base on which agriculture and society depend. It also provides for basic human food fibre needs, is economically viable, and enhances the quality of life for farmers and society as a whole." An older, more familiar term for this type of farming is "organic". Within the last few years, this term has taken on a more specialized and legalistic meaning as a result of its use in marketing, and the introduction of "certification" codes to guarantee produce as organic. These codes define what practices or materials may and may not be used, require auditable records of production and handling, and require third party inspections. Use of synthetic chemicals (e.g. ammonium nitrate) or secondarily processed chemicals (e.g. superphosphate) and biochemicals (e.g. antibiotics) is prohibited. Otherwise, the practices promoted by organic agriculturalists are largely the same as those now considered to be part of "sustainable agriculture", e.g. cover cropping, composting, conservation tillage, use of legumes to provide nitrogen.

payments et cetera which according to one report, now make up about 75% of farmers realized net income, up from about 30% in 1981. <sup>2</sup>

Thus while the question of economic sustainability is an important one, it was not attempted to document the precise financial status of each farm as this would entail intrusion on personal matters which are not really pertinent to the question. Instead, holdings and operation of the farms were documented in detail which will allow their economic status to be assessed by making reasonable assumptions about interest rates, cost of equipment et cetera. Alternatively, it could be considered in the light of different assumptions, for example different subsidies. Financial data that were available and offered were incorporated in the report.

Many of the SA practices that have been implemented on these farms were well known beforehand, e.g. planting of windbreaks, but they were not commonly practiced in the region. In documenting the SA practices, we wanted to illustrate for non-farmers, the kinds of factors affecting the farmers' decisions or abilities to implement them. We asked what were the incentives, where did the ideas come from, was there technical or financial assistance, what were the impediments and what would the farmer like to do but can't and why can't it be done? Some of the factors are matters of constraints or practicality. Almost always, there is more than one consideration involved - the farmers of necessity deal with whole systems.

Other factors may involve some logical thinking about the underlying biological processes, based on some kinds of general principles. The farmers' test of their concepts is the success or not of innovations in maintaining or improving the system with the same or fewer inputs. In some cases, the concepts and practices are ones that have been developed scientifically and adopted or adapted by the farmer. In other cases, it remains for science to document and explain the farmers' innovations.

## **SUMMARIES OF THE CASE STUDIES**

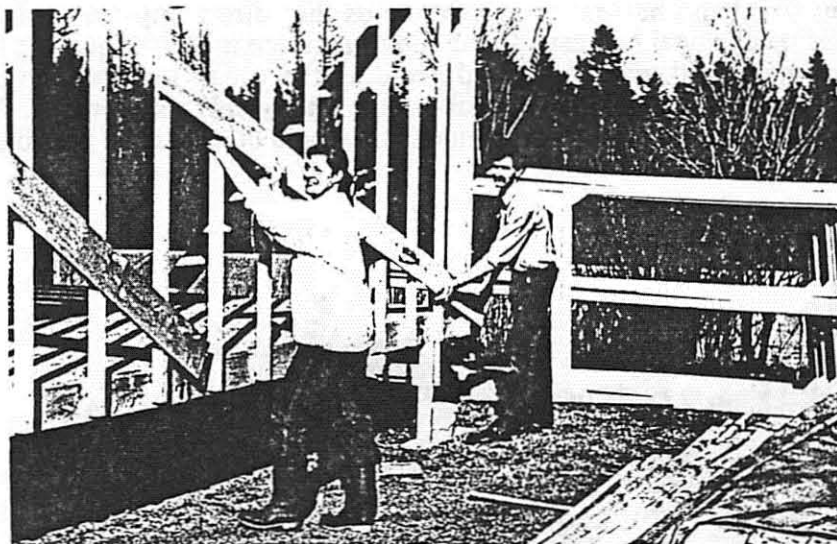
### **I. Small Scale, Intensive Organic Vegetable Production in Nova Scotia: The Kungl Farm.**

**(Regional Researcher: David Patriquin)**

Probably every Canadian city has a complement of health food stores, food co-ops, restaurants and individual families which buy "organically grown" food from local producers. Within the last few years, some of the larger supermarkets have begun to market organic produce. This development has created a new marketing niche for farmers, and the farmers involved are often the first to try or develop techniques that later have proven to have wider application in sustainable agriculture.

Norbert Kungl, a graduate of an agricultural college in Germany, immigrated to Canada with his spouse Uta in 1982. While working full time on other jobs for most of the period since then, they cleared long abandoned farmland on the Minas basin and began to grow vegetables organically. In 1990, they sold \$34,000 of vegetables produced on 6 acres and 5000 square feet of greenhouse space including 1.5 acres of cole crops lost because of drought. While the Kungls have been successful in establishing supermarket outlets for their and other farmers' produce, they prefer to market directly to consumers, which they do at Farmers' Markets, and by organizing consumer buying groups. To cater to a demand of their customers, they are beginning production of eggs from free-ranging hens for which they have built a movable hen house and fencing system.





**New Market Niches:** Norbert and Uta Kungl building a mobile chicken coop and fencing system to produce eggs from free-ranging hens. The eggs are being produced to cater to a demand from customers who are organized in buyer groups to purchase organically grown produce.

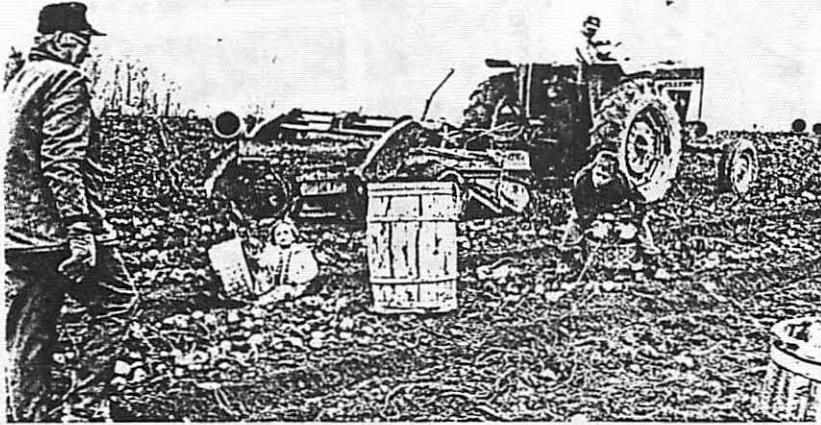
Soil fertility is maintained through cover cropping, rotation of the vegetable ground with land kept in leguminous sod for several years, and applications of lime, aged cattle manure, and crab meal. They experiment continuously with new varieties and new methods for controlling pests and weeds. A formal, replicated experiment set up in 1988 to compare several techniques for controlling cabbage root maggot confirmed Norbert's suspicion that rotenone, a botanical pesticide often used by organic producers, was not very effective; floating row covers and tar paper discs significantly reduced pest infestation. Norbert feels that much of the need for weeding, which takes up a lot of labor in most organic vegetable operations, can be reduced through use of cover crops. In 1989/90, an experimental mustard cover crop-to-carrot sequence reduced the weed pressure very substantially in the carrot crop.

## II. Potatoes in New Brunswick: the McLaughlin Farm (Regional Researcher: David Patriquin)

Potatoes are New Brunswick's principal agricultural product. Since the 1950s, potato production has been transformed from being one of a number of products on more than 20,000 mixed farms to being the principal or only product on fewer than 500 farms. These highly specialized systems are dependent on heavy machinery and intensive use of fertilizers, growth regulators and pesticides, which has led to some critical environmental problems. At the same time, low prices for potatoes has made it a tough industry to survive in, and for most farmers, there is little latitude to experiment with SA practices.

The McLaughlins began to implement more sustainable practices in the mid-70s. The case study illustrates that one of the benefits of adopting more sustainable farming practices for potatoes is improved yield, aesthetic quality, and keeping quality. Some of the key factors in developing more sustainable practices were (i) including a small livestock component in the farm operation which gives more cropping options for management of erosion-prone land, provides an on-farm use for culls (which recycles nutrients and gives better monetary value for the culls) and produces compost which can be applied selectively to improve areas of low fertility; (ii) the province's insect

monitoring program; (iii) hand harvesting which avoids the direct physical soil degradation associated with use of mechanical harvesters, and allows more control over quality; (iv) keeping costs down by recycling of old machinery, and avoiding the usual debt burden assumed on intergenerational transfer of farms. With lower costs and higher yields per unit area, they are able to maintain on average, longer rotations with potatoes than would otherwise be possible.



**Hand harvest of Potatoes in New Brunswick:** Many farms still harvest potatoes by hand, a practice that is highly dependent on a school potato break. Other family members often accompany the school age children. Here, a potato digger removes potatoes from the ground, while a student, a preschooler and an adult put potatoes in baskets which they empty into the barrels. Hand harvesting is more gentle on the soil than mechanical harvesting, and patches of diseased potatoes can be avoided, thereby increasing storage quality.

Most of the McLaughlins' practices could in principle be adopted by other farmers save one: the hand harvest which is dependent on a school "potato break". The break could soon disappear because it is not compatible with the life style of the majority of today's rural residents or with academic demands on high school students.

### III. Dairy in Quebec: Ferme Fleuralic (Regional Investigator: Pierre Jobin)

Quebec has long had a reputation for strong support of its farming community, and more recently for introducing strict environmental legislation. The demand for organic food has grown faster in Quebec than elsewhere in Canada and the province has the highest concentration of organic farms.

Louis Fleurent, began converting his dairy farm to organic management in 1988. A new rotation of crops has been implemented: Years 1-3: alfalfa hay; Year 4 : hay turned under in mid-summer, soil fallowed 2-3 weeks and a brassica catch/green manure crop seeded; Year 5: cereals/brassica catch crop; Year 6: cereals followed by a short fallow and direct seeding of hay in late summer. A shortened interval under alfalfa hay reduces invasion by couch that occurs in older stands. The mid-summer cultivations in years 4-6 followed by fall crops control couch that gets established in the hay. The direct seeding of hay in late summer is an innovation of Mr. Fleurent that allows for better control of weeds than spring seeding or undersowing in cereals. A finger weeder is used for harrowing of weeds, and he plants cereals deeper than before so that they resist the harrowing better. He intends to implement rotational grazing on pastures to control weeds and increase productivity. He has eliminated use of synthetic fertilizers with little or no loss in production to

date. The quantity of bedding has been increased to conserve more of the liquids, and to improve the manure/bedding mix for making compost. There is a limit to how much liquid that straw will absorb; use of supplementary materials is being examined to determine if manure can be handled entirely in solid form with only small liquid losses. All of the innovations are subjected to critical economic evaluation which he is able to do through participation in a government subsidized program which enables farmers to hire economic consultants. A similar program enabled a group to which he belongs to hire a consultant to assist in them in conversion to organic agriculture.



**Canola used as a catch crop/green manure on Ferme Fleuralic, late October, 1989.** Hay ground was cultivated in late July with a chisel plow and fallowed for 2 weeks; then compost was added and canola sown. An adjacent strip was conventionally managed with application of fresh manure and late plowing in October. Mixed grain was planted in 1990. There was much less weed pressure in the catch crop strip, especially from couch grass (*Agropyron repens*); and the yield was about 25% higher than in the conventionally managed strip.

#### **IV. A Diversified Mixed Farm : The Jeffray Farm in Ontario (Regional Researcher: Roger Samson)**

The Jeffrays operate a diversified mixed livestock farm which they began to convert to a "certified organic" operation in 1988. The main enterprise is a 40 cow milking herd which processes most of the farm's field production. There are also sheep, laying hens, Muscovy ducks, a cereal cash crop (spelt) and vegetables which are complementary to the dairy operation. The major change made was to eliminate most of the corn from the cows' ration. Corn silage was replaced with an increased amount of mixed alfalfa and grass silage, and corn grain by cereal grain. Milk production dropped initially but has again reached 50-55 l=lbs/day. They found that they had to provide some soybean (which had been dropped) to high producing cows, and that cows had to get in better body condition so that they could draw on body fat and tissue reserves during the period of peak energy requirements. A computerized system is used for the grain ration and roasted soybeans. Changes were also made in the dairy herd health practices and dairy cleaning system. Sheep would not on their own be profitable, but in the total system improve forage utilization, consume waste vegetables and help to keep pastures clean of weeds. Complex seed mixtures are used to establish hay and pastures. A new rotation ensures that land is always covered in the winter. Vegetables are planted on different fields of the rotation according to their fertility requirements. To work towards

better genetic adaptation of crops and livestock to their farm, the Jeffrays keep their own seed and bulls.



**Sheep graze weeds and natural regrowth of cereal in the fall after harvesting winter rye.** The principal product of the Jeffray farm is milk from dairy cows. Sheep, laying hens, Muscovy ducks and geese provide some additional income but they are kept primarily for functions that are complementary to the main operation, such as processing of wastes, control of weeds and flies, and providing roles on the farm for children.

The transition to organic farming has taken place fairly smoothly, thanks to advice offered by farmers in the Ecological Farmers Association of Ontario who had made similar transitions previously. Economic benefits have been realized both in reducing costs and in developing high value crops for off-farm sale.

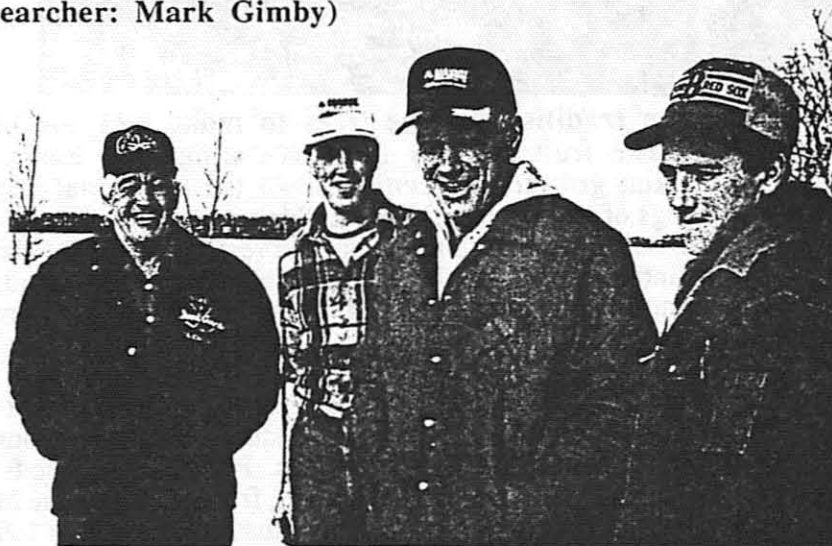
#### **V. Cash Crops in Ontario: The Smith Farm (Regional Researcher: Roger Samson)**

Doug Smith has implemented a number of practices that provide more protection for the soil and significantly reduce expenditures on chemical inputs and machinery, while maintaining or increasing yields. In 1984, he changed over from a continuous corn/mouldboard plowing system to growing corn and soybean on ridges. In 1988, he introduced strip-intercropping of corn, soybeans and winter wheat in side by side 15 foot strips. He reduced herbicide use by two thirds through banding the herbicide on rows and cultivating between rows. Corn yields were increased by increased sunlight exposure and by increasing the density of planting in the outside rows of the corn strips. Rotating the crops greatly reduced infestation by corn rootworm. Soybean yields in the outside rows were suppressed in the corn/soybean system by shading but by introducing a third crop, winter wheat, this differential was eliminated. He has started to relay crop soybeans into winter wheat at heading to take advantage of sunlight that would otherwise be wasted. He is experimenting with planting a vetch cover crop after the winter wheat, to make more use of solar energy and to reduce N requirements for the succeeding corn crop. A major benefit of the changes is lower machinery costs, and reduced machinery storage area.



**STRIP-INTERCROPPING OF CASH CROPS:** Doug Smith plants his cash crops on ridges in alternating 15 foot strips; photo shows left to right, winter wheat, corn, and soybean.

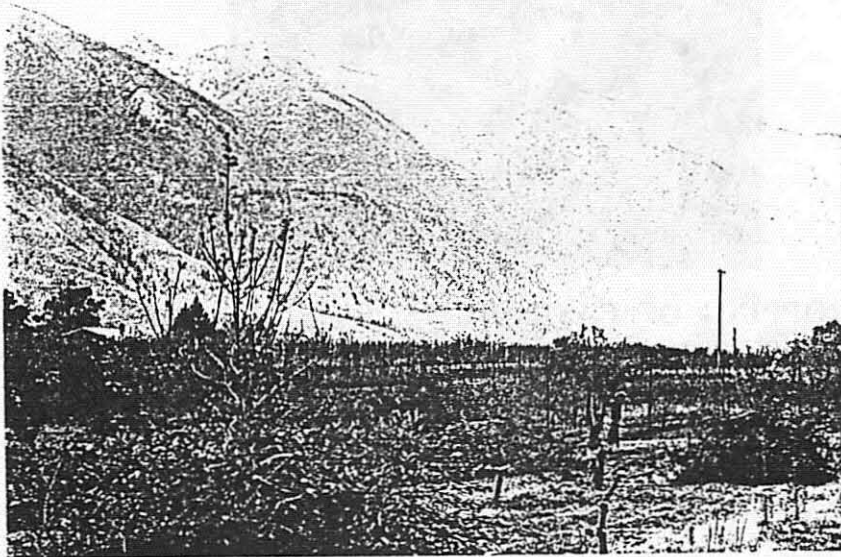
**VI. Grains and Hogs on the Prairies: The Baumls**  
(Regional Researcher: Mark Gimby)



**Four families and three generations of Baumls (from left to right: Ray, Rob, Clarence, and David) farm 13 quarters of Prairie land. The Baumls believe that the idea of growing grain for export has had its day. "We will have to look at new crops and possibly new markets if we want the family farm to survive" says Ray. "We will probably have to go back to a more mixed kind of farming with different kinds of livestock, possibly silviculture."**

The Bauml farm is a four family unit of 2080 acres situated in the Black soil zone. On-farm income is derived from hogs and cash crops. They have 6-7 miles of treed shelterbelts which they began planting in 1970. In the last few years they began to cut chemical inputs, and change the crop rotation. One of the seven quarters was certified as organic in 1990. On half of the fields, sweet clover is plowed down in a partial fallow or there is a straight summer fallow; half of the fields are seeded to spring wheat, durum, peas, lentils, barley, buckwheat, oats, rye and red clover. Delayed seeding and post-emergent harrowing is practiced to control weeds; some herbicide is still used. No synthetic fertilizers are used; instead they rely on legume plowdowns, and pig manure. Most of the feed for pigs is grown on the farm. They experiment with different field practices in side by side strips, e.g. for mechanical control of weeds, and use of rock phosphate and PB 50, a biological seed treatment for phosphorus enhancement.

**VII. Tree fruit farming in British Columbia: Wayne Still's Vialo Orchard and Apiary**  
(Regional Researcher: Linda Edwards)



An orchardist cuts down the traditional large trees to make way for high density plantings of smaller trees. The fruit industry is experiencing hard times. To remain competitive in the global market, growers are cutting down the traditional large trees and establishing high density plantings of smaller trees. The smaller trees fruit earlier allowing a more rapid turnover of varieties, and they are easier to prune and harvest. Since 1981, Wayne Still has used organic techniques to maintain a traditional, large tree orchard. With the introduction of effective controls for codling moth, and good prices for organic produce, more orchardists are adopting organic techniques.

There is pressure to reduce the use of pesticides on fruits because of the development of resistance by pests, a decline in the rate of production of new pesticides, concern by consumers over pesticides, and pressures from urban people living in rural areas. Prices for organic fruit produced in B.C. have averaged 4-5 times those of conventionally grown fruits, but because of high losses to pests, these operations have not been very profitable. This situation changed in 1990 due to the development of effective non-chemical controls for codling moth, the major pest of apples in organic orchards.

Wayne Still has operated a 4.5 acre organic orchard in the Similkameen Valley since 1979; it has been managed organically since 1981. He regards it as a heritage orchard preserving old strains. He manages it as a woodlot with trees of different ages and a minimum of intervention. (In

contrast, in other orchards, conventional and organic, there is a lot of replanting of new varieties in high density regimes). Modest use is made of turkey manure mixed with sawdust and of fish products as fertilizer. The understory, which includes a number of herbs, grasses, clovers and alfalfa, is mowed until mid-July when plants are left to flower and seed and help with hardening off of trees; a strip is left unmowed as habitat for beneficial insects, and ground is hand weeded around the base of trees. Production has declined since 1982. Rather than replant, Mr. Still is renovating by removing older branches and by tying down branches to stimulate fruiting buds and by pruning to generate buds. In 1990, his pest control program consisted of 2 dormant oil sprays for San Jose scale, sulphur at petal fall for mildew and putting out pheromone dispensers to disrupt codling moth mating. Checks of fruits in bins revealed an average loss to insects of 3.3% which is equivalent to losses in conventionally sprayed orchards.

In the past, codling moth had caused large losses in organic apple orchards. A pilot sterile insect release program conducted in the region from 1976 to 1978 was highly successful but prohibitively expensive compared to chemical control. The area remained free of codling moth until 1983 after which the damage increased annually, causing losses of the order of 50% in 1988. There is agreement now to reestablish the sterile release program or to use the pheromone technique (which is much cheaper), if it continues to prove effective. This promises to make organic production much more feasible for more growers and acreage under organic management is expected to expand rapidly. Unless the market expands at the same time, organic growers could face the same problems of oversupply as are currently faced by conventional growers. Melding of organic growing methods with new the new high density systems and new varieties may be the key to economic sustainability in the future.

## CONCLUSIONS

The data base for the case studies alone is limited. Nevertheless, there are some trends or common themes that apply to SA more broadly.

### Economics

On the 5 farms that had been following mainstream practices at one time, implementation of SA practices has been financially beneficial or at least paid for itself through reduced expenditures for fertilizer, pesticide and feed (dairy, mixed, cash crop and grain/hog farms), reduced machinery costs (cash crops) or higher returns as a result of better quality of produce (potatoes) and higher yields (cash crops, potatoes). However, these farmers like others are suffering from the malaise of generally low commodity prices and are not immune from the vagaries of the market place and international trade wars for crops such as potatoes and grains.

The implementation of certification programs has helped to establish a market niche in supermarkets for organic produce by ensuring high quality of marketed produce and by helping the producers to explain precisely what is meant by "organic". However, the premiums on organic produce - if any - are not a panacea for farmers' financial or marketing woes. Most existing organic farms are still relatively small, and in most regions, total production is still a small proportion of the total market. When prices for certified organic produce are high, larger farms move into the market and it is quickly saturated. Many prairie farmers who moved into organic grain production when prices were high now find they can't get a premium for the grain. Organic apple producers in B.C. are currently receiving very high premiums, but production will likely increase rapidly because of the introduction of non-chemical controls for codling moth, and because there is a large acreage in transition. Researcher Linda Edwards considers that the key to survival of BC orchardists in a highly competitive international market lies in a melding of organic techniques - particularly elimination of pesticide use - and growing of new varieties in high density

plantings. There is a large premium for organic potatoes in the east, but the acreage under organic production is very small (28 acres in New Brunswick) and the market would probably be saturated very quickly. So far, however, it has proven very difficult to produce potatoes organically on a large scale.

Amongst small organic producers such as the Kungls in Nova Scotia, one trend has been to focus on direct marketing at farmers' markets and to organized consumer groups, emphasizing consistency of the market rather than on high premiums for organic produce. On larger, mixed farms in which milk or meat are the principal product, the field production is often certified as organic, but the meat or milk are not. In this case, the economic incentive lies in reduced production costs, and there is always an option for producing an organic cash crop such as spelt when there is a good market for it. Generally it appears that in economic terms, organic production is neither better nor worse than "conventional" production, and farmers go into it or stay in it for other reasons.

A major cause of financial difficulty, and a significant impediment to adopting SA practices is the high capital value of typical family farm units. Large debts are often assumed by the new generation on intergenerational transfer of the farms, or when the farms are purchased by non-family members. The assumed debt puts a lot of pressure on the farmer to realize immediate profits, and often precludes investment in SA practices for which the benefits are not realized for several years. The McLaughlin brothers in New Brunswick cited the lack of a large debt transfer as important in their ability to survive financially. Other factors that contribute to reducing their debt are the collaboration of three families in farming, growing much of their food and energy and fibre on the farm, and fixing up and maintaining used equipment rather than buying new equipment. These features are shared to some extent by the other farms. Interestingly, all of the larger farms in this study - potatoes in New Brunswick, dairy in Quebec, mixed farm and cash crops in Ontario, and grain and hogs in Saskatchewan - are farms operated by at least a second generation of farmers in the same community if not on the same farm. The new farmers in the study began with very modest operations and remained small (organic orchard in B.C.) or built their operations up very gradually (market garden in Nova Scotia).

#### Sustainability of the Farm Community

Adoption of more SA practices is seen as improving the viability of individual farms, but farmers' concerns extend beyond their own farms. In all of the case study regions, except for the B.C. orchards where most orchards remain relatively small in area, farmers were concerned over the shrinkage of the farm community that had occurred and is still occurring as a result of farms becoming more specialized and larger but fewer in number.

In many rural communities, farmers have become a small minority, which has impacts on education, the availability of skilled (experienced) farm labor - especially for mixed farming systems - and more generally, on the attractiveness of farming as a livelihood to the next generation. Ray Bauml (Saskatchewan) says "we have lost a generation of farmers.". In his generation, 8 of 10 of his colleagues in school were from farm families, while for his grandchildren who are now farming, it was about 1 in ten.

In New Brunswick, teenagers in the McLaughlin family said only 1 of 25 class mates in Grade 9 and only 4 classmates in a graduating class of about 100 were from a full-time farm family. Each year, the question of whether the traditional potato break, in which schools are closed for three weeks to allow students to participate in the potato harvest, comes up for consideration. The students generally are in favor of it, but it is becoming less compatible with the life style of the majority of the rural residents, and with the academic demands on high school students. Dropping it would result in many of the hand-picking operations being replaced by mechanical harvesters, which are very hard on the soil; and in more money leaving the community.



A number of factors can combine to make farming an inaccessible or unattractive career option for young people: the high capital cost of farms, long hours, lack of regular vacations, persistent financial stress, the diminishing numbers of farmers, and a feeling that society does not value their labor, and regards them as unskilled. A strong motivating factor for many of the farmers to move into more SA was that it could help to make farming a more attractive way of life for their offspring, and ultimately contribute to revitalization of the farm community, for example by stopping or reversing the trend towards larger and larger units, using more of the resources within the community, making the farm a safer place for children, and by providing more options for employment of family members.

There is not, however, a simple relationship between farm size and adoption of SA practices, which is illustrated by the case study of potatoes in New Brunswick. The very large, consolidated farm units owned by processors have been able to adopt SA practices more readily than most independent potato producers (most of whom are specialized for potato production rather than mixed farming). The processors have the financial resources and diversity of operations to better withstand year to year fluctuations in commodity prices and vagaries of climate that can cause debt laden independent producers to go out of business. The processors now recognize the necessity of certain SA practices for the long term maintenance of yields and quality. They have their own expertise to keep them abreast of the latest innovations and to interact with government experts, and they maintain their own experimental farm where new techniques can be tested. Once a new strategy is adopted, e.g. longer rotations, it can be applied immediately over large areas. An additional factor favoring large units is that conservation practices that have to be applied to topographically contiguous units, e.g. terracing, are more readily applied to consolidated units than to the original farms - those were granted during early land settlement in ways to allow easy access to the land for mixed farming rather than to maintain topographic continuity.

There can be little doubt that the smaller mixed farming systems of the past were more sustainable ecologically. For example, structural controls were not needed for control of erosion because potatoes were grown on much smaller acreages, and much less frequently in the rotations, higher levels of organic matter were maintained and the most erosion-prone land could be kept under permanent cover. Whether mixed farming systems can be made economically viable today is probably dependent on drastically reducing the costs of production, and on the development of marketing systems that could cater to mixed farm production. The case study of McLaughlin potato farm illustrates some ways (cited above) in which costs have been kept down. Further it illustrates how a modest degree of diversification, in this case keeping of small herd of beef, greatly increases the options for SA practices in production of a cash crop. Another way that diversification of potato production on a local scale is occurring is through farmers exchanging resources or land between specialized farms, for example a potato grower buying manure from a beef producer and renting land that had been in soil building crops to grow potatoes, and livestock producers using potato culls as feed, and growing hay on potato farms.

There are a number of factors that are improving or could improve prospects in the future for smaller scale, mixed farming systems and of a more locally diversified, interdependent agriculture. There is an increasing demand for fresh produce, organic produce, and a greater diversity of foods. A sharp increase in transportation costs due to fuel shortages would greatly increase the relative cost efficiency of producing more food locally. Global climatic instability is making the concentration of certain crops in certain regions for economic reasons alone, more risky. The phenomenon of cross-the-border buying and chronic economic problems in rural communities have also generated some awareness of the benefits to the community of buying locally, and of growing more food locally.

### Ecological/Agronomic Factors

**Livestock** Livestock are components of all farms except for the cash crop system in Ontario. Brian Jeffray (mixed farm, Ontario) considers that changing the diet of his cows to reduce dependence on corn in favor of crops that can be grown more efficiently on the farm (haylage, pasture cereals) was a bigger change than changing the field crop production from conventional to organic. One limitation is the genetic stock, which has been selected to use high proportions of concentrates in the diet. Over time, Brian will attempt to switch away from narrow bodied "grain type" cows to full bodied "forage type" cows.

Several of the case studies illustrate that livestock that do not contribute a large cash income directly can play an important role in developing more sustainable systems. On the New Brunswick potato farm for example, a small herd of beef cattle provides food for several families and occasional supplementary income, produces compost which is applied selectively to areas of low fertility or poor soil quality, consumes potato culls, and provides for some diversification in the cropping system. The diversification allows longer rotations of potatoes with soil conserving, hay crops on the most erosion-prone land. On the mixed farm in Ontario in which the principal product is milk, sheep are used to graze weeds and regrowth after cereal harvests, ducks and geese clean up spilled grain and keep flies down in the barn, and laying hens provide a role in the day to day operation of the farm for children.

**Pests and diseases** Pests and diseases were cited as problems on the farms producing fruit and vegetables, but not on the farms in which grains or livestock were the principal products. Doug Smith's principal pest problem in his cash crop system- corn rootworm - became much less of a problem after he began rotating corn with soybeans and winter wheat.

In the cases of fruit trees and large scale potato production, controlling pests effectively with reduced or no use of chemicals requires some hi-tech input or other types of institutional or business support, for example to monitor pests, produce pheromones for control of codling moth, to develop bacterial insecticides to control potato beetle, or to introduce and propagate predators. The impact of technological innovation can be very high: losses of apples in the organic orchard (B.C.) dropped from around 50% to 3% in the first year of use of a pheromone to disrupt codling moth mating. It also reduced the labor requirement substantially. Site-specific management practices requiring considerable knowledge of pests, observational skill and patience on the part of the grower are also necessary.

A more exclusively farmer-dependent approach is utilized in the case of the organic market garden (N.S.). This includes selection of pest-resistant vegetable varieties, monitoring of pests and setting out crops to avoid peak pest periods, informal (just trying it) and formal (replicated plot) experiments to test controls reported in the informal literature, and to test new commercial products such as floating row covers. In both the market garden and the orchard, which are operated for certified organic production, large losses sometimes simply have to be accepted (as they do when chemical controls become ineffective due to resistance, or because of climatic conditions).

Some production of vegetables appears to fit nicely into a larger scale, mixed farming system such as the Jeffrays' mixed farm in Ontario. Vegetables are grown in different locations each year, minimizing infestations by pests which overwinter in the soil and in crop residues. The Jeffrays attempt to match the fertility demand of different crops with the fertility of the soil by growing the most demanding crops after plowing sod and the less demanding crops on ground that has been in

grains for a few years. They believe this helps to reduce pest infestations associated with excess fertility, for example worms in turnips.<sup>a</sup>

**Weeds** All of the Case Study farms reported reduced or no use of herbicides. Among the alternatives:

-Harrowing or cultivating with traditional implements or modern versions of those, e.g. new types of "finger weeders." Louis Fleurent (dairy farm, Quebec) plants cereals deeper than he did before in order to give crops more resistance to harrowing.

-Cover or catch cropping, especially with brassicas. The principle is to plant brassicas after mid-summer cultivation of early harvested crops such as winter cereals or peas or after cultivating sod. The brassicas grow rapidly in the cool temperatures of fall and are quite frost tolerant but are killed by freezing temperatures. They die when they are still succulent so the tissues decompose quickly in the spring, and a minimum of tillage is required to prepare the seedbed before the next crop. Farmers like to apply manures or liquid wastes to the brassicas which can take up a lot of soluble nutrients quickly and mid- to late summer is a convenient time to apply them. It is also considered better to apply organic fertilizers at this time rather than in spring, because it allows time for toxins in fresh manures to be metabolized, and for some of the nutrients in the more insoluble fractions to be metabolized by the soil. The tap roots open up the subsoil, and keep nitrates from leaching.<sup>5</sup> Farmers have found that some types (e.g. oilseed radish), will plug up tile drains so they use types (e.g. white mustard) with less vigorous tap roots.

This use of brassicas is not common practice in Canada, but the practice has been applied by organic farmers in Europe for some time.<sup>6</sup> It has been especially promoted by the Ecological Farmers Association of Ontario. It was being practiced or tested on four of the Case Study farms, variously using oilseed radish, canola, white mustard, yellow seeded mustard and fodder radish. Norbert Kungl (market garden, N.S.) found it a very effective way to reduce weed pressure in carrots, which is a notoriously weedy crop under organic management.

-Louis Fleurent's most difficult weed had been couch (*Agropyron repens*), a perennial, rhizomatous grass which invaded his hay and proliferated more under cereals planted after hay. Control of couch was an important factor in developing a new rotation. Elements in his weed control strategy are: (i) to shorten the interval under alfalfa hay thereby avoiding the die back of alfalfa and invasion by meadow grasses after longer intervals; (2) practicing mid- to late summer cultivation followed by catch cropping with brassicas or direct seeding of hay. Cultivation to control couch is more effective late in the season than early, and the catch crop competes with couch when it otherwise can be very prolific. The new rotation is: **Years 1,2,3:** hay; **Year 4:** hay plowed mid-summer followed by catch crop of brassicas; **Year 5:** cereals followed by brassicas; **Year 6:** cereals followed by cultivation and seeding of hay). Direct seeding of hay in late summer (versus early summer or undersowing cereals) was an innovation of Mr. Fleurent; it had not been practiced in the region previously.

-In pastures, farmers are introducing or have introduced Voisin Grazing Management and seeding down of complex mixtures (Case Studies III, IV). Under this intensive rotational grazing system, weeds essentially cease to be a problem.<sup>7</sup>

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<sup>a</sup> Organic practitioners have long maintained that pest problems are primarily due to imbalanced nutrition of crops, and that organic systems of crop production can reduce pest problems by providing a better balance of nutrients.<sup>3</sup> There is now considerable evidence to support this view.<sup>4</sup>

-The ridge tillage system adopted and adapted by cash crop farmer Doug Smith greatly reduces weed pressure and allows herbicides to be used more selectively; for example he bands herbicide on ridges in corn and soybeans, relying on cultivation alone between ridges, and he has added winter wheat to the corn-soybean rotation which provides a phase for spot spraying of problem weeds.

-In his organic orchard, Wayne Still (Case Study VII) encourages a diversified weed flora to provide habitat for natural enemies of pests. The weeds are removed only around the base of new trees.

**Fertility** All farms utilize legumes to provide some or all of the inputs of N to the farm. Hairy vetch was cited as a crop of particular interest for providing N and improving soil structure on three of the farms although there had not yet been much experience with it, nor have there been selections of winter hardy types in Canada. However, it is valuable as a winter-killed annual. The buildup of *Verticillium*, a pathogen of potatoes, in clovers and possibly vetches, limits the use of legumes in short rotations with potatoes.

On three of the farms (market garden in N.S., dairy in Quebec, and the mixed farm in Ontario), 2 to 4 year sequences of annually cultivated crops are regularly rotated with several years of leguminous hay or pasture sod. Aside from controlling couch, Louis Fleurent considers that a benefit of plowing alfalfa sod before the alfalfa dies out is that it will provide more N to the subsequent cereal crops. These types of rotations are more or less the same as "ley farming", which developed as a variant of the 18th century Norfolk rotation, and is a common feature of many organic systems in Europe<sup>6</sup>. The principle is to build up fertility - especially organic matter and nitrogen - under the sod, which is subsequently exploited by the annual crops.

Conserving nutrients is an important part of SA. On both of the farms with dairy cows, emphasis is given to increasing bedding to conserve nutrients, especially potassium. It also helps to make a better quality compost. The amount of straw available can be a limitation (especially with recent cereal selections which tend to have shorter straw). Also, there appears to be a limit to the amount of liquid that straw can absorb. Louis Fleurent in collaboration with CDAQ (Centre de Developpement d'Agrobiologie du Quebec) is looking at supplements to absorb liquids. One possible outcome is that manure could be handled almost entirely in a solid form, as opposed to the more usual (and expensive) strategy of building holding ponds for liquids. Such systems could help farmers more readily comply with impending environmental legislation to restrict runoff and leaching from manure. Louis added rock phosphate to gutters to activate the phosphorus and absorb ammonia, but because of the need to reduce labor, now adds it to the compost pile.

The timing of application of manures and composts to fields is considered especially important by the farmers moving into organic production, with late summer and fall application to catch or cover crops considered desirable. Brian Jeffray (mixed farm, Ontario) believes that use of compost rather than fresh manure reduces scab in potatoes.

On two of the farms (potatoes in N.B. and cash crops in Ontario), commercial fertilizers are used as needed to achieve maximum yields, but the farmers do some testing to determine the rates. On the two small scale, organic operations (market garden in N.S., orchard in B.C.) manure is imported. On the other three farms, which include large livestock components, commercial fertilizers had been used routinely until recently, but no synthetic fertilizers have been used for the last 1-3 years, with no drop in production apparent to the farmers. Nitrogen can probably be maintained by legumes. Lime and rock P are used; and there is some import of nutrients to the farms in purchased feed and mineral supplements. In the long term, however, it seems likely that

some deficiencies could develop, especially for potassium.<sup>a</sup> Researcher Pierre Jobin expressed the need to do whole farm nutrient budgeting for such systems.

### Information, Research, Policy

The farmers included in the case study have moved towards SA for a variety of reasons, and usually more than one. All were concerned about environmental issues; all see SA as ultimately if not in the short term, one that can bring better returns of the farmer by cutting down on inputs; several specifically singled out hazards of working with toxic materials as a motivating factor. The movement towards SA has been largely farmer driven; it is a grass roots movement as opposed to being institutionally led. The movement today is very different from the mostly urban-led and followed back to the land movement of the sixties and seventies.

The farmers make use of a variety of low and high technologies, and of both traditional concepts and recent scientific knowledge to develop SA practices and systems. They obtained their information and ideas mainly from other farmers, from magazines and books dealing with various types of "alternative" agriculture ("organic", regenerative", "ecological", "biodynamic"), and through non-governmental, farmer-oriented organizations. These organizations seek out scientific information pertinent to SA. Some of them have accumulated an extensive literature including a lot of literature not found in institutional libraries. They organize short courses, tours of farms and speaking engagements by farmers. Four of the case study farmers (Kungl, McLaughlin, Fleurent, Jeffray) referred to one farmer, Lawrence Andres in Ontario, as being particularly influential on them; they had visited his farm, or heard him speak locally.

The farmers use many government services (e.g. for monitoring pests, analyzing soils, forages and organic fertilizers) and make use of information bulletins but with a few exceptions (e.g. Saskatchewan Research Council), did not find government or educational institutions to be encouraging or to be of significant help to them in making a transition to SA. There is a consensus that attitudes are changing, however. One program cited as especially valuable is the Production Clubs in Quebec in which the Department of Agriculture provides 80% of the costs for groups of farmers to hire extension agents and technicians to work for them; a number have used the program to help them in making the transition to SA.

In all cases, a high degree of on-farm experimentation has been involved in the development of SA practices and systems. To some degree, that was necessary because the pertinent experimentation had not been done elsewhere, or the information was not very readily accessible. As the knowledge base for SA grows, less experimentation (and fewer failures) will probably be necessary for farmers to practice SA. However, it is recognized that a higher level of farm and farmer based experimentation is necessary for the practice of SA because of the greater importance of biological processes in these systems, and their sensitivity to site specific environmental and management factors. For example, the effectiveness of a leguminous green manure as an alternative to synthetic nitrogen fertilizer is affected by the green manure species, the soil type and biological activity, the type of equipment available for tillage and how it is used, and by the species or even the variety of crop using the N.

Most often the farmer's research consists simply of trying something on a small scale, or of side by side comparisons of a new and an old method. Several of the organizations working with the

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<sup>a</sup> Potassium was apparently a limiting nutrient for cereals in the double Norfolk rotation on the Wiltshire Downs (wheat-barley-grass-clover-wheat-barley-beans-roots). It was dealt with by grazing sheep on grass and clover, and folding sheep onto root crops; without that, it was impossible to obtain good crops of cereal.<sup>8</sup>

farmers conduct or organize some formal on-farm research. Involvement of farmers in the identification of problems to be researched is seen as particularly important: researchers often go to farmers after identifying problems for research to seek their support, but do not very often to ask, "what do you need researched?"

Some of the more specific areas of research identified by the case study were whole farm nutrient budgeting, different methods of composting, livestock nutrition on unconventional feedstocks, the identification of more types of green manure/cover crops and their characteristics, and the effects of different mixtures or sequences of crops on productivity, nutrient cycling, pests and weeds. The need for whole system thinking is stressed, but it is the tools to put their systems together that farmers require, not recipes for farm systems. It is up to the farmer to develop those because each farm is unique. Perhaps the most consistent comment was that farmers want to understand the underlying processes, to explain how existing systems that are functioning well, work. It was suggested that this could best be achieved by studying some of the best existing farms, rather than by setting up model farms which involve a lot of elements that farmers don't use. "There are so many things we are doing already that work, says Ted Zettel of the 700 member EFAO (Ecological Farmers Association of Ontario), "but there is not a good scientific base for them."

Generally the farmers were not enthusiastic about government subsidies to stimulate SA. They tend to discourage farmers from doing things on their own, and discriminate against farmers who are already practicing SA. "Farmer to farmer communication is the most important factor in the spread of SA" says Zettel, but there are so many farmers interested, OMAF (Ontario Ministry of Agriculture and Food), has to be involved. They have to at least be supportive, if not actively promoting the movement. We need to be given credit for what we are already doing successfully. When farmers make inquiries on practices for which they [OMAF] don't have a lot of data but which farmers are using successfully, they need to say, yes we know that some farmers are doing this and it works. It is a good idea." Zettel says that a lot of farmers are fence-sitting, waiting for the O.K. from the government. "They told us what to do in the 60s and 70s, to specialize and use more inputs. Now farmers are waiting to be given approval to move in the other direction." Steps in this direction have been taken: OMAF personnel attended a short course given by EFAO in April 1991, and a section on non-chemical control of weeds written by EFAO farmers is included in the 1991 Field Crop Guide. Much the same story is happening elsewhere in Canada.

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## **I. SMALL SCALE, INTENSIVE ORGANIC VEGETABLE PRODUCTION IN NOVA SCOTIA**

**(Regional Researcher: David Patriquin)**

### **I.1 Introduction**

Probably every Canadian city has a complement of health food stores, food co-ops, restaurants and individual families which buy "organically grown" food from local producers. Within the last few years, some of the larger supermarkets have begun to market organic produce. This development has created a new marketing niche for farmers, and the farmers involved are often the first to try or develop techniques that later have proven to have wider application in sustainable agriculture.

Norbert and Uta Kungl immigrated to Nova Scotia with their 2 year old daughter from Germany in 1982. Uta had been a lab technician, and Norbert had recently graduated from Agricultural College, majoring in animal science. From the beginning it was their intention to buy a farm which would be managed organically with vegetables as the principal product.

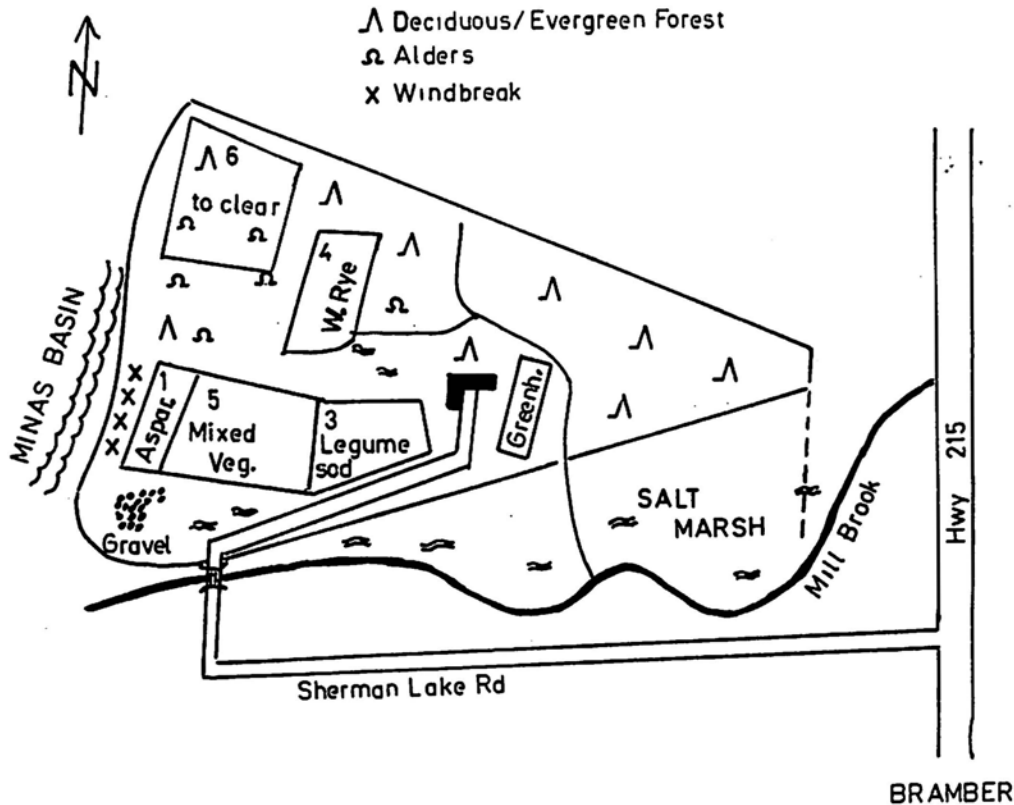
For the first 3 years, Norbert worked for a farmer practicing ICM (Intensive Cereal Management) in the Annapolis Valley where the best land and climate for agriculture in Nova Scotia is found. The Kungls undertook a systematic search for good but affordable land which they began by consulting soil and agroclimatic maps. They wanted a warmer area within marketing distance of the Halifax/Dartmouth urban region, but they did not look in the the Annapolis Valley because of the high cost of land and the widespread use of pesticides. Cheverie, where they finally purchased land, is just to the east of the valley, with almost as many heat units (2300-2400 versus 2500 in the warmest part of the valley), and class 2 soils. Locally, they looked for well drained land. In 1984, they purchased a 60 acre farm that abutted on the Minas Basin. The land had been settled by the Lake family circa 1850, and mixed farming including orcharding practiced until about 45 years ago when the land was abandoned, except for the occasional crops of hay or oats. There is little agriculture practiced in the region today, except for some beef production based on extensive pasturing and purchased grain.

In 1984, the Kungls cleared and plowed a portion of the land from rough sod and alders and planted Triple Mix (a common hay mix consisting of red and Alsike clovers and Timothy grass). More was ploughed in 1985, when Norbert worked part time at a hydroponic greenhouse operation in Falmouth, 40 minutes driving distance away. 1986 was the first year in which they depended solely on the farm for their income which came from vegetable production on 2.5 acres. In 1990, the sales from 6.5 acres of vegetables, excluding 1.5 acres of cole crops which were lost because of drought, amounted to \$34, 000.

### **I.2. Farm Description**

#### Land base, buildings and equipment

The farm is located on the Hansford Soil Series which consists mostly of a loamy sand over a thick layer of gravel. It is described as poor crop land with relatively low fertility and good to excessive drainage. Being located close to the Minas Basin, it has an extended growing season compared to the more inland areas; typically there is no frost after May 10-12 and not before October 10-12 and often the frost free period extends even into November. The winds off of the Minas Basin keep temperatures above freezing but somewhat cool in the early part of the growing season.



**Fig. 1.1: Diagrammatic map of Sunset Garden Farm. The numbers indicate areas of fields in acres.**

Of the 60 acres, 20 are readily arable. The remainder is salt marsh and mixed evergreen/deciduous forest on swampy or irregular terrain. Thirteen acres are now cultivated, which includes 4 acres cleared of alders in 1989/90 and seeded with winter rye in 1990. Another 6 acres is designated to be cleared (Fig. 1). A row of poplars was planted in 1986 and a row of pines in 1990 as a windbreak on the sea frontage.

There is a newly constructed but not completely finished house, with a large basement (1500 square feet), 600 square feet of which is used for washing vegetables and temporary storage, and in the early spring, for starting transplants under lights. A cold storage room (300 sq. meters) will be constructed in the basement in 1991.

There is a dome shaped greenhouse with steel supports, 25 x 200 feet basal area, enclosed with 2 layers of polyethylene plastic. It is wood heated and in operation from late March to early December. The basement facility is used to start the earliest transplants in order to save on heating costs.

Farm equipment includes a Massey Ferguson 45 horsepower tractor with front end loader, a small Farmall Cub tractor with a mid-mounted cultivator, a 10-foot spring tooth harrow, a 5-foot disk harrow, 3 Planet Junior Seeders, a crop (flail) chopper, a farm wagon, one rototiller, and a cube van for marketing.

Labor, sources of income, marketing.

From May to October, there is one full time employee, plus Norbert, Uta and seasonal help working on the farm. The seasonal help involves six to eight persons working two to three days



per week from July to October. In 1986, the Kungls received a business grant which enabled them to build a greenhouse. In the fall of 1988, Norbert took out a business loan to purchase the hydroponic greenhouse in Falmouth where he had worked previously, and operated it for 2 years (in addition to the home farm). He gave it up in the fall of 1990 and now works solely on the farm and at purchasing and marketing organic produce. The Kungls live modestly, completing their house and expanding the farm operation as they are able to without incurring a lot of debt. Their only debt is the mortgage on the farm. They had a second child in 1987 and a third is expected.

In 1986 and 1987, vegetables were sold out of the field, to a few private customers and at a Farmers' Market in Windsor, 35 minutes driving distance away. In 1988, Norbert began to sell his own and other farmers' "certified organic" vegetables through Sobey's, a Maritime supermarket chain. This was the first time organic produce had been sold through supermarkets in the Maritimes.

Norbert picked up produce once a week from farmers in the Annapolis Valley and took it to stores in Halifax/Dartmouth, the only large urban area in Nova Scotia (combined population approximately 250,000). While it was a breakthrough in terms of marketing, it was not very profitable to make the long trips (400 + kilometers) for what were sometimes only small quantities of produce. The hydroponic greenhouse operation, which he purchased in the fall of 1988, had an established market for lettuce in supermarkets to which he delivered produce twice weekly; this gave him regular and affordable access to the markets for the organic produce regardless of quantity. Over 1989 and 1990, Norbert and the growers for whom he marketed produce gained credibility for regular delivery and good quality. In 1990, he obtained a contract with Bolands (owners of IGA supermarkets) to make deliveries to 6 stores, while still being accepted as a supplier at the Sobey's stores, and making regular deliveries to 4 health food stores in the Halifax/Dartmouth region. The produce is certified as organic by OCIA-International (Organic Crop Improvement Association) through a local chapter, OCIA-Nova Scotia, which was formed in 1988. Typically, the premium for organic food is 15%. Norbert regards the introduction of the certification program in Nova Scotia (in 1988) as critical to the development of the storefront market as it allowed him to explain to produce managers precisely what was meant by "organic", and the organization was able to have some control over quality of produce which was being marketed as organic.

While the urban storefront market outlet continues to exist and could be expanded, it is an expensive way to market produce from small operations unless it is coupled to a larger volume system such as the hydroponics produce. In 1990/91, the Kungls began to organize private "buying groups". These consist of a minimum of 8 families who agree on a central distribution point to which Norbert makes deliveries once per week in season and biweekly in winter. When they pick up their produce, each family fills out an order for the next week according to what is available. Each family's order is delivered in precooled wooden boxes. In 1991, the Kungls will also be selling produce one day each week at Farmers' Markets in Halifax and Dartmouth. As they build up this clientele, sales to supermarkets will be reduced. Besides their own and other farmers' organic vegetables, the Kungls will market tree fruits and beef from other organic producers. In early 1991, the Kungls purchased 200 laying hens to serve demands of their customers for eggs produced by free-ranging hens.

#### Vegetable production.

Transplants are used in order to get early harvests from crops such as lettuce and coles or to establish long season crops that otherwise could not be grown, such as leeks. The transplant crops include lettuce and cole crops as the major items, plus Swiss chard, leeks, spanish onions, broadbeans, peppers, tomatoes, melons, chinese cabbage, oriental greens and a few herbs. Cucumbers, and some of the tomatoes and eggplants are grown to maturity in the greenhouse

during the summer. Crops seeded directly in the field include, peas, spinach, lettuce, radishes, coles, onions, beans, beets (grown for greens and tubers), broadbeans, and onions. There is one acre of asparagus (a perennial).

The earliest transplant crops are started in a germination chamber in the basement facility and are moved to the adjacent growing room which has natural lighting supplemented by fluorescent lamps. The greenhouse operation begins in late March. One quarter of the greenhouse is enclosed in an inner tent for starting transplants. The growing trays are set on benches which are on rails to allow the benches to be pulled out of doors for hardening off of transplants. The potting medium consists of a home-made mix of peat moss, sand, limestone, fish scale meal, Sulpomag (a natural mineral high in potassium), rock phosphate and a small amount of compost. Diluted fish emulsion is sprayed on plants if they begin to turn yellow because of insufficient N. The transplants are hand planted in the field.

Damping off is often a problem in transplant production. The planting medium and the trays are not sterilized, nor is seed treated, which are recommended precautions against damping off<sup>1</sup>, nor are fungicides applied to soil if damping off appears. Norbert finds that damping off can be a problem in the spring; when it appears, he tries to water plants only early on sunny days so that the soil dries significantly by evening.

Variety trials are conducted every year. In 1990, for example, 11 varieties of green and yellow beans were tested.

#### Rotations, fertility management

Fertility is maintained by rotation with legume sod, growing of cover crops, and use of lime, imported manure, and fish scale meal. "Aged" manure (several years old) is obtained from part time beef operations; Norbert pays only trucking costs (about \$75 per 12 cubic yard load). It is dumped in windrows and turned once or twice in the summer with a front end loader. The fish scale meal, containing approximately 10% nitrogen, comes from Cap Pele, New Brunswick. Approximately 1 ton is used on the total acreage (6 acres).

The main field has been divided into two large sections (Fig. 1) which are rotated, one with biennial and perennial legumes (red, Alsike and sweet clovers and alfalfa) to rebuild soil fertility, and one with the cultivated crops. It is difficult to follow a precise rotation of the different vegetables, because of the large variety of vegetables grown, the constant testing of new species and varieties, and because of year to year fluctuations in demand for individual vegetables. Generally, they have applied most of the manure to cole crops, (20-25 tons/acre), somewhat less to greens (15 tons), and they rotate this ground into carrots, peas, beans and other crops. Winter rye is sown into the cole crops after canopy closure, just before the last cultivation for weeds. After 4 seasons, the entire vegetable ground is rotated into perennial legumes and the existing legume sod is broken to grow vegetables.

In 1989/90, Norbert experimented with a mustard catch crop-to-carrot sequence. Following the main crop in 1989, the ground was cultivated, manure incorporated and yellow seeded mustard planted in early September. The mustard grew well in the fall providing good ground cover, but was killed over winter. It effected good weed control by stimulating annual weeds to germinate out of season so that they would be subsequently killed by winter cold, and by smothering perennials. Carrots were planted in 1990 with only surface tillage. This resulted in a carrot bed with very few weeds - previously they had required a great deal of hand weeding. Another advantage of this system is that manure is applied in late summer or fall rather than in the spring when ground is often wet, and using the manure spreader causes a lot of compaction.

Norbert plans to implement a new rotation in 1991. The annual vegetable land and legume sod land will be divided into 10 meter strips, each planted with one of 3 categories of vegetables or in legume sod. The vegetable categories are:

1. Early seeded or transplanted crops (April 20 on) that will be harvested before early August, e.g. peas, lettuce, spinach, early cole crops.
2. Crops that are late seeded or transplanted, that is not before June 20, e.g. beans, late coles, lettuce, spinach.
3. Crops requiring a long growing season (early seeded and late harvested), e.g. leeks, onions, storage carrots, parsnips.

The early seeded crops will allow subsequent soil preparation to be done at the best possible time, which is in August. It will then be seeded with a legume-grass mix which will include a large component of hairy vetch, and some longer lasting clovers. (He is trying to find a winter hardy variety of vetch for this purpose; hairy vetches tested in the area to date do not usually survive over winter.) This land will then go into the legume sod for 3 years. On the third year, it will be broken in August and a mustard cover crop established, or it will be broken in the following spring, prior to establishing group 2 crops.

*Phacelia*, a soil-improving crop recently registered for use in Canada, will be planted in spring prior to planting the late seeded crops. Manure may be spread at the time the ground is prepared. Two weeks before seeding the cash crops, the *Phacelia* will be mulched and disced or just disced. Buckwheat may also be used in this way- the requirement is for a fast-growing crop which is neutral towards common pests of vegetables. Whenever possible, winter rye will be interseeded in cole crops at the last cultivation.

The third crop group will not allow a cover crop before or after the crop, but some interseeding with rye may be possible.

With this degree of regularity in rotation of vegetable crops, Norbert feels that it will be easier to follow better cropping practices. There will be 22 or 23 strips on the existing vegetable/legume sod field, and 16 on the adjacent, recently cleared 4 acre field (Fig. 1).

#### Weed control

The principal weeds are lambsquarter, chickweed, corn spurry, ground sorrel, red root pigweed and some grasses. There is a small amount of thistle in the asparagus. There had been a lot of couch grass (*Agropyron repens*), but it has been largely eliminated by intensive cultivation.

Weeds are controlled by hand weeding in rows, use of the mid-mounted cultivator between rows, and by cultural practices such as cover cropping. Weed control requires a lot of the labor in May, June and early July. Weeds in asparagus are controlled by several harrowings over the entire field including rows in early spring (asparagus crowns are 6 to 8 inches below the surface so are not affected), harrowing once again after harvest is completed (about June 10), and then cultivation between rows and hand hoed in rows. Norbert believes that more intensive use of cover, green manure and catch crops will reduce the weed pressure considerably, as it did in his experimental mustard-carrot sequence. In 1991, he will experiment with an annual vetch in asparagus, seeding it after the harrowing in early June.

#### Pests

Major insect pests are flea beetles, root maggots and carrot rust fly. In conventional operations, these pests are controlled by use of synthetic pesticides which are not allowed in certified organic production. They have used rotenone, a botanical pesticide, against flea beetle in the past, but did

not use it in 1990 and do not intend use it in the future. The rotenone was not very effective; it kills flea beetles but keeps them back for 2 to 3 days only, and with coles it is necessary to spray 2 to 3 times in the early summer. Norbert doesn't like using it because it is non-selective and kills beneficial as well as harmful insects. In 1990, Norbert put susceptible early crops under a spun polyester floating row cover which he first experimented with in 1988. Flea beetles like open and dry ground. Norbert is building an implement to chop the legume grass mix and spread it between rows. He hopes this will encourage predators and reduce the rate of reproduction by flea beetles.

Cabbage root maggots (*Hylemya brassica*) are serious pests in some years. In the first year that the Kungls worked the farm (1986), about 30% of first and second batches of broccoli and early cabbage died after a short dry spell in June. With help from provincial and federal entomologists, Norbert searched the literature for information on the pest. There was little information available in the extension bulletins or entomological handbooks, apparently because the pest is relatively easy to control with systemic insecticides. One difficulty was that of positive identification of the adults. The most complete description was found in a 1927 publication<sup>2</sup> which included a detailed description of the life cycle, sketches of male and female flies and results of more than ten years of research on control of the pest. The informal organic gardening literature suggested several remedies for the pest.

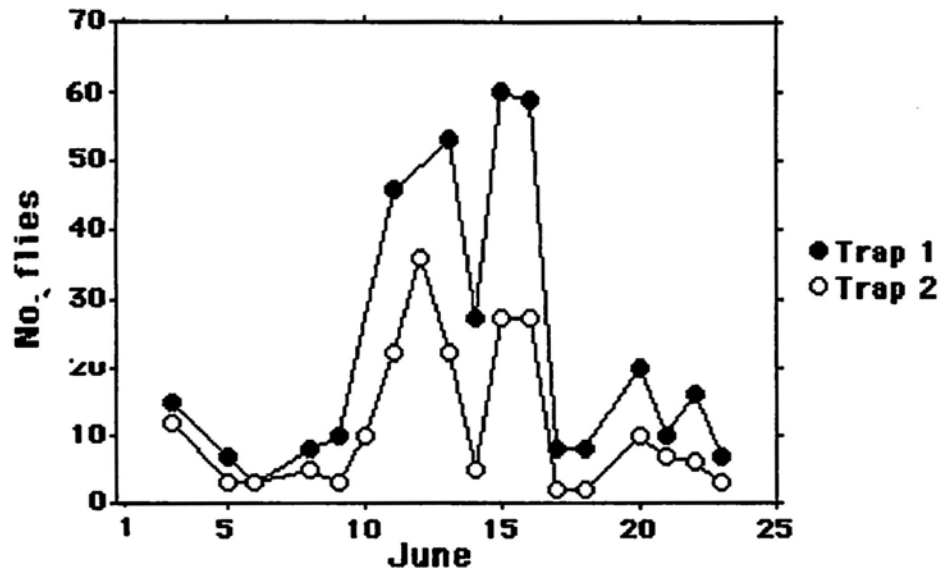
In 1988, Norbert and Rupert Jannasch, a university student working on the farm for the summer, set up a formal replicated experiment to test effectiveness of several controls for the pest, with Chinese Cabbage as the host. They also monitored the fly populations. There were four treatments (Table I.1) with 4 replicate plots (22 plants in each) set out in a randomized complete block design. The treatments were a control, tar paper discs at bases of plants, a floating row cover and rotenone. The floating row cover, a new commercial product, was provided by a provincial vegetable specialist. At harvest, plants were cut just below soil level and damage in the form of tunneling of roots rated on a scale of 1-5 (1=0, 5= plant destroyed). The results (Table I.1) indicated some benefit from use of discs and floating row cover, but not from rotenone, confirming Norbert's suspicion that rotenone was not very effective. Overall, damage was light and all plants produced marketable heads. The floating row cover provided good protection against flea beetles as well as the root maggots; a disadvantage of its use was that it contributed to some undesirable soft tissue in the Chinese cabbage. It is also very expensive.

**Table I.1 Effects of different control measures on severity of root maggot damage to Chinese Cabbage.**

	Average ranking of damage	Range
1. Control	1.82	(1.45-2.27)
2. 10 inch tar paper discs around the base of each plant	1.23*	(1.01-1.36)
3. Floating row cover over the entire plot	1.25*	(1.01- 1.45)
4. Rotenone in weekly intervals.	1.69	(1.55- 1.91)

\*Values were significantly different from control at 0.01 level of probability as assessed by two way ANOVA and Dunnett one-tailed test for mean less than control.

The seasonal abundance of the flies was monitored using two yellow plates smeared with tanglefoot ("yellow sticky traps"). One was better protected from the wind than the other and consistently caught higher numbers of the pest (Fig. 1.2). In general, wind conditions had a major effect on the number caught. Information of the seasonality of the pest helps Norbert to decide when he can most effectively use the floating row cover.



**Figure 1.2** Numbers of root maggot adults caught on yellow sticky traps in June 1988. Trap 1 was less exposed to the wind than Trap 2.

In 1990, Norbert tested another remedy reported by organic gardeners, which is to sprinkle diatomaceous earth on flats just before planting; the plants are brushed lightly by hand so that some of the dust collects around the stems of the plants. This was tried with broccoli and there was no serious damage; however there were no controls, and the dry weather may have been a factor in limiting hatching. In 1991, he will experiment again with the diatomaceous earth and include some replicates and controls.

For carrot rust fly, the principal control Norbert uses is that recommended by the N.S. Dept. Agriculture, which is to harvest carrots before the end of September in order to avoid the second generation of flies. Use of a floating row cover can prevent most damage in early carrots by the first generation. Norbert considers the second generation to be more of a problem.

Norbert has not had problems with wireworms or grubs, which are sometimes numerous following sod.

#### Livestock

The Kungls have kept a few sheep in the past but found that the damage they do to vegetables when they get loose made it not worthwhile. At one time, they had considered keeping beef cattle, but with an assured supply of manure locally and other farmers producing organic beef, they feel there is no need to keep beef at the moment. To serve a demand of their private customers for eggs produced from free-ranging hens, they purchased 200 Golden Comet laying hens in the spring of 1991, and are building a mobile coop and 500 feet of movable fence. The system will be moved around grassland, and possibly some of the legume sod. It will be moved frequently enough to ensure that the soil is not overfertilized or the vegetation completely routed out. Some grain

will be given also. They expect to produce 14 dozen eggs a day with this system. Ideally sheep should graze the soil before chickens, but for convenience, their 2 remaining sheep will be pastured with the hens. In winter, the birds are fed sprouted grains and laying hen ration. The sprouted grains are considered by organic practitioners to have better feed value than unsprouted grains and to reduce mortality rates.

### **I.3 Incentives, Limitations and Outlook**

The range of techniques and materials that can be used in production of "certified organic" produce are defined by the standards of the certifying organization, in this case a Nova Scotian chapter of OCIA-International which has been in existence since the fall of 1984. OCIA is the largest of a number of certifying organizations in North America. The Nova Scotian chapter was set up in 1988. It remains relatively small in Nova Scotia, with a total of 10 farms and 275 acres certified in 1990, 35 of those for vegetables, or vegetables and apples, 20 for grain, 90 for hay and the rest pasture. In total there are approximately 12,000 acres (5000 ha) of vegetables produced in Nova Scotia; 31% of the market is direct to retail stores, roadside marketing and farmer's markets.<sup>3</sup> There is no certified organic livestock production in Nova Scotia because most organic producers have to resort to use of a small amount of purchased grain or hay at some point which is not allowed by the standards. Norbert was on the executive of the organization for two years. Monthly meetings are held to which speakers are invited, or at which they carry on their own discussions of organic production techniques. The current president is "quite comfortable with OCIA's relationship with the provincial department of Agriculture. Government is becoming more aware of organics and some people in the Department are quite supportive. They have also put on conferences on sustainability.... it's up to growers to show that organic agriculture can work."<sup>4</sup>

Provincial specialists have been helpful to the Kungls by providing seed for variety tests, responding to requests for information on certain pests and suggesting trials, e.g. of the floating row cover. For ideas on organic growing methods, Norbert has relied on books, magazines and coffee break talk at conferences. Within the last 2 years, the Nova Scotia Agricultural College at Truro has begun to sponsor conferences and some courses in sustainable agriculture, and Norbert has on several occasions been an invited speaker. He was invited to speak at a conference on Sustainable Vegetable production held in Montreal in 1990, and in 1989, was invited to talk to the New England Governors and Maritime Premiers Conference. In the spring of 1991, Norbert made a trip to Germany, the first in 6 years, to update himself on developments in organic agriculture there.

Norbert feels that the institutions could do more in the way of research for organic/sustainable farming, and expects they will do so in the future. While a systems approach is required to practice organic agriculture, he considers that the systems aspect of it is up to the farmer to develop because each farm system differs according to climate, soil, products, market etc. The institutions can help by identifying and researching components of the total system that need research, e.g. to find winter hardy varieties of hairy vetch for local use, or to research use of different cover crops in weed control.

The Kungls are excited about what they are doing, and feel they have a bright future especially if they can keep costs down for machinery and marketing.

### **I.4 Literature Cited**

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## II. POTATOES IN NEW BRUNSWICK (Regional Researcher: David Patriquin)

### II.1 Background

Potatoes are the most important agricultural commodity in New Brunswick. The province accounted for 20.6% of Canadian production in 1989, second only to P.E.I. which accounted for 28.8%. In total Canadian imports of potatoes approximately balance exports, but there are regional variations - production is mainly in the east, imports are mainly in the west.<sup>1</sup>

In N.B., more than half of the crop goes into processing plants at Florenceville and Grand Falls for fries, and a small amount, about 5% of the processing potatoes<sup>2</sup>, to a processing plant for potato chips. New Brunswickers are said to eat 1 barrel of potatoes per year<sup>2</sup>, the equivalent to approximately 12% of the provinces marketed production. (1 barrel = 165 lbs or 75 kg). Disposition of potatoes 1979-1985 was 57% to processing; 9.3% seed potatoes for next crop, 13.6% domestic table potatoes, 14.5% exported to U.S. and 5.6% offshore. Cullage and losses 1981 to 1989 varied between 13 and 32 % of total production<sup>1,3,4</sup>.

#### Changes in potato production since the 1950s

The total acreage under potatoes in New Brunswick has not changed much since the 1950's. However, the methods of producing potatoes have changed radically, as have the economics of potato production, the structure of rural communities, and the impact of potato production on the environment.

In 1951, potatoes were produced on mixed farms distributed through most of the province's agricultural area. The average area in potatoes on any one farm was 1.9 acres. Only 3% of all farms with potatoes had more than 12.3 acres, 1% greater than 22.4 acres. Potatoes were typically grown 1 year out of 5 to 7. A typical rotation for farms with cattle was Potatoes-Grain-Hay-Hay-Grain, with 2000 lbs/acre of 4-6-10 or 5-8-10 fertilizer applied to potatoes and 200-250 lbs/acre of 4-6-10/2-12-6 to grain/hay (or none)<sup>5</sup>. With holdings of under 20-30 acres, most of the work of the potato crop could be handled by individual farm families with the exception of harvesting which for more than a few acres required outside help. In Carleton and Victoria counties, school was begun early so that students could be excused for potato harvesting in late September, a practice which still exists in most school districts of those counties. The requirement for labor assistance during harvest put a practical limit on the maximum size of individual potato holdings.<sup>6</sup>

In 1957, the first french fry processing plant was built in the province at Florenceville. Mechanical harvesters were introduced in the mid-60's which relieved the major short term constraint (labor at harvest) on the size of potato holdings. Stimulated by government policies promoting specialization and expansion, a rapidly growing market for processing potatoes, and mechanical and chemical technologies which allowed fewer people to do more and relieved biological constraints to monoculture, farmers began to specialize in potatoes and there was a sharp increase in the average number of acres under potatoes per farm. Concurrently, there was a sharp decline in the number of farms on which potatoes were grown, and most of the production became concentrated in the the potato belt (Table II.1).

There was a marked reduction in the length of rotations. In 1986, the average potato producer had 115 acres of potatoes on an average cultivated land base of 162 acres<sup>5</sup>, implying on average 2 years of potatoes for one of alternate crops, except where land is rented for rotation purposes. (Data extracted from Statistics Canada 1986 census<sup>1</sup> suggests 122 acres of potatoes per farm with a total 206 acres under crops, or roughly an average of one year of potatoes for one of an alternate



crop.) Common rotations today are P-G, P-P-G, P-P-G/Rc-Rc (P=potatoes, G=grain, Rc=red clover). Peas are grown on contract and harvested by McCain Foods Ltd. but can be grown only once in 5 years due to disease problems. Production of potatoes has become concentrated almost exclusively in the "potato belt" in Madawaska, Carleton and Victoria counties in the upper St. John River valley. Overall total farm acreage in New Brunswick has decreased by about three fold, but the acreage of potatoes has increased slightly (Table II.1).

**Table II.1. Some statistics related to potato production in New Brunswick  
Figures provided by Statistics Canada, Truro, N.S.**

	1951	1961	1976	1986
Total no. farms in N.B.	26431	11786	4551	3554
Total no. farms in potato belt (Madawaska, Carleton Victoria counties)	4735	2923	1212	1050
Total area farms in N.B. ('000 acres)	3470	2200	994	1010
Total area farms in potato belt	763	593	376	351
Total no. farms in N.B. with potatoes	20004	8190	892	547
Total no. farms in potato belt with potatoes <sup>a</sup>	2775	1746	640	397
Total area of potatoes in N.B. (acres)	38123	54165	55125	48466
Total area of potatoes in potato belt	23057	45374	53107	45729
Total production ('000 cwt)	5715	10162	11143	11399
Total marketed production	NIA	8711	9957	9252
Farm value of crop ('000\$)	19050	9044	39330	63110

<sup>a</sup> Definition change occurred between 1951 and 1961

Today, potato farming is essentially a plantation operation. An immense amount of material is handled: for a 100 acre potato holding, about 185,000 pounds of seed has to be assembled and cut for planting, and over two million pounds of potatoes are harvested. The operation requires a variety of light and heavy, specialized and non-specialized equipment, many chemical inputs, storage and grading facilities and a high level of business and farm management skills. The capital expenditure for a 100 acre farm was estimated as \$360,000 in 1986.<sup>7</sup>

Seven classes of chemicals are commonly used for weed and pest control including one to several insecticides, one to several herbicides, a fungicide for seed pieces, a sprout inhibitor (applied to the growing plant or in storage), a topkiller, one or more foliar fungicides, and a post-harvest fungicide (used for seed potatoes). The 1990 Potato Crop recommendations for the Atlantic

Provinces (Agdex 267) lists 50 different chemical compounds for weed and pest control. Rotation of chemicals is recommended because of resistance problems; for many or most, timing of application is critical, and attention has to be given to avoiding incompatible combinations of chemicals. Yields are high - potatoes are one of the the most productive crop per unit area in northern regions<sup>8</sup>- and so are fertilizer applications. Recommended rates for processing potatoes are generally in the range 800-1200 kg 15-15-15 per hectare (712-1068 lbs/ac) depending on the variety, but up to 2000 kg are used.

#### Hazards of Intensive Potato production

The potato belt provides near ideal conditions for potato production with generally light soils which facilitates harvesting, good drainage which minimizes pathogen problems, relatively high rainfall which is needed to support high yields, and soils which are naturally somewhat acidic, which minimizes scab problems. However there are tradeoffs, particularly under intensive production. It is difficult to maintain high levels of organic matter in the light soils. Low organic matter makes them more prone to compaction by the heavy machinery. The soils, mostly formed on glacial till, are relatively shallow. Where excessive drainage and erosion exist, there is a potential for chemicals to move quickly into ground and surface water. High intensity rainstorms, and frequent freeze-thaw cycles combined with complex topography, slopes of 5-15% and the traditional practice of cultivating row crops up and down the slope makes the land erosion prone.<sup>9</sup> (Up and down hill cultivation is done to encourage quick drainage of excess water which otherwise makes the crop prone to blight; it also reduces gully erosion hazards but increases rill and sheet erosion drastically). Modern mechanization, especially of harvesting has encouraged farmers to increase field size by removing fence lines and windbreaks which increases the erosion potential. Removal of stones to facilitate harvesting operations increases erosion.<sup>9</sup> To justify the high cost of mechanization, rotations have been shortened. The growing of longer season potato varieties used in processing in a short season combined with use of the heavy harvesting equipment under wet conditions increase soil compaction and degradation. 1990 was a particularly bad year: heavy rains in the fall slowed down harvesting and 120 out of 400 farmers left a total of 2000 acres (810 ha) of potatoes in the ground.<sup>10</sup>

That these conditions are resulting in high and non-sustainable rates of erosion is well documented. Daigle<sup>11</sup> cites studies indicating that since 1945, soil erosion rates have increased at least 5.3 times where poor soil and crop management and no soil conservation or terracing systems exist.<sup>10</sup> In the potato belt, 28% of land rotated through potatoes is considered to have acceptable annual soil losses (3-4 tons/acre), 37% moderate losses (4 to 10-12 tons/acre), and 35%, moderate to severe loss (>10-12 and up to 50-100 tons/acre) (1 ton/acre = 2.24 tonnes/hectare). With the help of government programs and technical assistance, erosion control measures with terracing and strip cropping systems are being implemented on approximately 300 to 700 additional hectares annually.<sup>12</sup> There has been progress: fifty percent of potato acreage was continuous potatoes 12 years ago, that's down to 8% now.<sup>11</sup>

As in other sectors of agriculture, awareness of potential or actual pollution from chemicals used in farming is more recent, more controversial, and no programs comparable to those promoting soil conservation have been introduced to encourage reduced chemical use. In 1983, a task force was initiated to examine possible connections between birth disorders and use of chemicals. A connection with chemical agents used in the Provinces' forest budworm control program had been suspected, but instead the evidence suggested a connection with exposure to agricultural chemicals.<sup>12</sup> A well-water testing program conducted in 1984-5 revealed elevated levels of nitrate and traces of pesticides including Aldicarb (systemic insecticide) and ethylene thiourea (fungicide) in wells of the potato belt.<sup>13</sup> Concern continues. One response was the formation in 1985 of SAVE- Save the [St. John River] Valley Eco-system - an organization of farmers looking for

means to farm more sustainably and with less use of chemicals. Two years later, an organic farmer's association began to certify farms in New Brunswick for organic production.

#### Economics of growing processing potatoes

There are 2 pricing systems for processing potatoes; one is a preset contract price, and the other is the open market price. The former is set by the N.B. Potato Marketing Agency taking into account interests of the processors and of the producers. It is calculated to give cost of production (Table II.2) plus a small profit margin. The calculations assume a certain yield, so to realize a profit on contract potatoes, yields must equal or exceed that, or the producer's production costs must be less than those assumed. If they don't, the farmers lose. Penalties or bonuses are included to take into account quality factors such as color (affects chip color), specific gravity and size (fast food operations wants long chips; this requires getting the potatoes in early). Processors decide what proportion of their requirements that they will buy on contract, and what portion on the open market. About 20% of potatoes processed by McCain Foods Ltd. are produced on company farms. The open market price varies according to supply and demand, and the N.B. potato producers compete directly with those in the NE United States. The prices vary for different grades and seasonally; generally the better the quality and the longer farmers can keep their potatoes, the better is the price paid to farmers, but the relationship is complicated by market factors.

**Table II.2. Cost of producing processing potatoes in 1989/90 Data are for 23 farms, where each farm value was weighted according to its acreage of potatoes.<sup>1</sup>**

Item	Cash <sup>a</sup>	Non Cash <sup>a</sup>	Other
<u>Variable Costs<sup>a</sup></u>			
Soil prep.	25.65	3.22	
Buildings	9.34	0.33	
Lime	7.15	0.00	
Planting prep.	13.04	2.27	
Seed	135.58	0.00	
Fertilizer	140.40	0.02	
Planting	18.22	3.52	
Planting labor	4.14	0.72	
Rock hand pick	7.09	1.13	
Crop insurance	20.86	0.00	
Spraying herbicide	1.66	0.61	
Herbicide	15.11	0.00	
Cultivation	11.51	3.93	
Nutrient-spray	0.22	0.00	
Spraying	19.33	3.97	
Fungicide	48.30	0.00	
Insecticide	14.36	0.00	
Mowing	1.40	0.68	
Road grading	1.35	0.73	
Sprout inhibitor	13.97	0.00	
Pre-harvest prep.	2.01	1.66	
Top kill	25.72	0.05	
Harvest	63.63	8.78	
Harvest labor	40.69	1.79	
Storage	26.26	1.44	
Storage Labor	10.28	0.84	

Table II.2 concluded

Item	Cash <sup>a</sup>	Non Cash <sup>a</sup>	Other
Marketing	28.32	3.19	
Marketing Labor	7.94	12.00	
Acct/legal	4.69	0.00	
Owner manage	0.00	27.62	
Return manage	0.00	50.00	
Snow removal	2.32	1.54	
Vehicles	15.24	0.43	
Utilities	7.23	0.00	
Misc.	26.63	2.75	
Interest-OC Borrowed	42.55	0.00	
Interest-OC equity	0.00	17.52	
a. TOTAL VARIABLE CASH COST	811.72	0.00	
b. TOTAL VARIABLE NON CASH COST	0.00	150.74	
c. TOTAL VARIABLE COST			962.45
<b>Fixed Cost<sup>a</sup></b>			
Annual-lease	21.76	0.00	
Insurance	22.01	0.00	
Interest-IT borrowed	93.01	0.00	
Annual-taxes	7.81	0.00	
d. TOTAL FIXED CASH COST	144.58	0.00	
Depreciation	0.00	113.28	
Interest-IT equity	0.00	139.04	
e. TOTAL FIXED NON CASH COST	144.58	0.00	
f. TOTAL FIXED COST			396.91
g. TOTAL OVERALL CASH COST	956.30		
h. TOTAL OVERALL ON CASH COST		403.06	
i. TOTAL OF ALL COSTS PER ACRE			1359.36
Cost per barrel @ 90 bbl/acre	10.63	4.43	15.10
Cost per barrel @ 140 bbl/acre	6.83	2.88	9.71
Cost per barrel @ 180 bbl/acre	5.71	2.40	8.10

a. Variable cash costs include all cash input costs plus operating capital interest. Variable non-cash costs include owner time plus return to management (\$50.00/acre) plus interest on owner operating capital. Fixed cash costs include taxes, leases, insurance plus interest on term loans linked to potato production. Fixed non-cash costs include depreciation plus interest on owners investment (term equity).

Given an average production cost of \$9.71/barrel (at 140 barrels/acre) in 1989/90, the contract prices received in 1989 (Table II. 3) approximately covered production costs only, while the open market prices were apparently much better. For the previous 4 years, contract prices were in line with the 1989 values. In two of the last 5 years, contract prices were better than the average price and in three years lower; yields were low in the two of the three years of highest average prices (1986, 1988) and average prices appear to have been well below production costs in the other two years (1985, 1987). 1990 was a bad harvest year because of wet weather in the fall. The appearance of PVYn virus in some potatoes from P.E.I. and New Brunswick resulted in restrictions on exports and in depression of prices generally in early 1991. For the most part, the

farming end of the potato-processing industry in recent years has not been a financial success - or at least one that many farmers could share in.

**Table II.3 Average yields of marketed potatoes in N.B., and average prices for processing potatoes purchased on contracts, and for all potatoes (seed, table, processing/contract and non-contract).<sup>1, 4</sup>**

Year	Avg. Yield of Marketed potatoes (barrels/acre)	Contract Price			Avg. price paid for all potatoes
		Fall (Sept./Oct.) (dollars per barrel)	Jan 1-15 (Sprout inhibited)	Jun 1-15	
1985/86	140	7.03	8.28	9.84	5.03
1986/87	116	7.03	8.28	9.84	11.25
1987/88	139	7.03	8.28	9.84	7.70
1988/89	132	7.13	8.38	9.94	12.30
1989/90	140	7.26	8.82	10.38	13.20
1990/91	138	7.92	9.32	10.88	10.03

<sup>a</sup> Total weight of marketed potatoes over total area planted

The financial precariousness of potato producers in eastern Canada was summed up in the Report of the Royal Commission of the P.E.I. Potato Industry (1987)<sup>14</sup>: "a 200 acre potato farm with a yield of 250 cwt per acre would achieve an average profit of \$12000, which can hardly be considered an adequate return on the farmer's labour or investment. Such investment would be in excess of \$500,000 on a potato farm of his size. In fact, a farmer with a family in all likelihood would have to erode away his or her equity position in the farm in order to meet living expenses."

The financial stress borne by potato producers is a major limitation to the practice of SA: "When potato prices are bad there is a great tendency to plant more potatoes to spread the debt load over more acres. Our observations are that this very often pushes the land, buildings and equipment to the limit. The yield suffers because of lack of rotation, the machinery being pushed to the limit has many breakdowns, harvesting time is stretched out and a good deal of frost damage occurs. Thus this increase of production did not lower risk in many cases but increased it. The observation when dealing with potato producers is that when there is a favorable price potato year, producers tend to pay their bills, year two they buy machinery, year three they jump on their new tractors and plant potatoes to beat hell and the price goes down."<sup>7</sup>

## II.2 Farm Description

The McLaughlin farm, run by brothers Dale and Darrel and families, with some input from their father until recently, is located in California Settlement, Victoria Co. a few miles off the trans-Canada from Aroostik. The 225 cleared acres is fairly typical of potato farms in New Brunswick, but the portion of it devoted to potatoes - 85 acres in 1990 - is not. As a rule of thumb, it's said 100 acres is required to produce a reasonable income for one family. The McLaughlins have managed to stay in business, substantially reduce their debt, to increase potato yields, improve quality, reduce the inputs of chemicals, and to reduce the erosion potential. They have done so through a combination of SA practices, maintaining a close family unit, growing as much of their food, heating fuel and timber needs on the farm as possible, and by fixing up and maintaining old rather than buying new, equipment.

### Sources of income, and means of reducing living costs

The McLaughlin farm supports two brothers and their families, and provides a small amount of income in support of their parents, Phyllis and Arthur McLaughlin, almost all from potatoes. Dale

and spouse Stella have 3 boys ages 11 to 18; Darrel and spouse Floranne, 4 children of ages 8 To 16. Currently, Darrel attends the University of New Brunswick where he is studying Rural Sociology. He returns on weekends and for all of the spring and summer when he works full time on the farm. Floranne works full time as a receptionist. Phyllis is a school teacher. None of the mothers worked outside of the farm when there were children in pre-school stages. The families live comfortably in nicely finished dwellings with no lack of modern amenities. They harvest about 20 cords of wood from their woodland each year which provides most of the heating for the houses and work areas.

Until 1990, sheep were kept at the parent's farm at Limestone Siding, seven miles away. In 1989 there were 115 ewes producing approximately 150 lambs which brought in \$7-8000. They gave those up in 1990 because it was proving too much for Arthur McLaughlin to help with. As well, they wanted to rest the land for a few years to rid it of parasites.

At California Settlement, the McLaughlins keep 15-20 cattle which provide beef for the 3 families, consume potato culls and crops grown in rotation with potatoes, and produce manure for composting. They often have 2 or 3 extra to sell. The cattle are Solaire (bull) x Hereford/Holstein crosses. The Solaire, not a common breed but the McLaughlins say, an up and coming one, produces a small animal with good flavor. They like the Solaire because it throws a small calf (55-75 lbs) without the need of assistance at birth. They are not fussy feeders, and the crosses do reasonably well on hay and they chew out old alders. Typically, the cattle are on pasture from the beginning of May until the end of October.

Off season, the cattle are fed hay, grain and potato culls, all from the farm. Four or five bushels of cull potatoes plus some calcium, phosphorus and vitamins substitute for 1 bushel of grain. They feed about 2400-2500 square bales of hay, but like to take in 3000 as insurance for use in a longer winter. Waste hay is used for bedding; they use only about 200 bales of straw in a year and never buy any.

Gardens provide about half of the families' vegetables.

#### Potatoes

Potatoes for the the fresh table, seed and processing markets are the mainstay of the cash income. Some years 25% may be sold as seed potatoes, but if they don't wish to keep them or there is not a demand, most will be sold as Table potatoes. They do not sell directly to processors but sometimes their potatoes are bought by buyers who in turn sell to processors.

The McLaughlins used to plant half of the cultivated land (225 acres) in potatoes, the rest in grain, pasture and hay. Last year they had 50 acres in potatoes and in 1990, 85 acres (Figure II.1, Table II. 4).

The keys to the profitable production on this farm are high yields and quality, which bring good prices, and relatively low input costs. SA practices are critical to all three. Yields on the McLaughlin farm are generally in the range 150 to 225 barrels/acre; averages for the industry are generally in the range 118-170.<sup>1</sup>

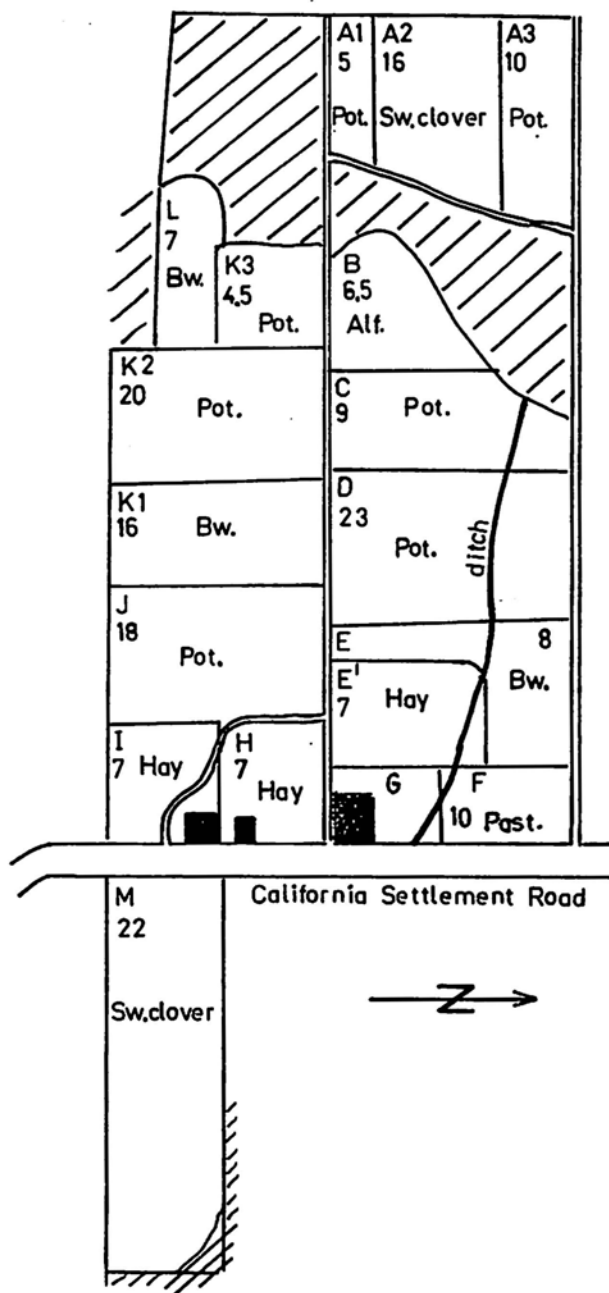


Figure II.1. Diagrammatic map of McLaughlin farm. Letters indicate field designations; numbers below those give approximate areas in acres.

**Table II. 4. Yields and crop sequences. Slopes go from 0 (no slope) to +++ strongly sloping; Crops are P (potatoes), SC (sweet clover), BW (buckwheat), V (vetch), M (millet), O (oats), A (alfalfa), H (hay), Ps (pasture). (S) and (R) refer to potato varieties Superior and Russet Burbank.**

Field	Area	Slope	Crop 1990 Yield (bbl/ac)	Crop 89-88-87
A1	5	+	P(S) 165	SC-P-BW
A2	31	+	SC/A	SC/A-P-P
A3	9-10	++	P(S) 180	SC-P-SC
B	6.5	+++	A	A-A-A
C	9	+ /+++ /+++	P(R) 180	BW-BW-BW
D1	11	+	P(R) 195	P-BW-BW
D2	5	+	P(S) 115	P-H-H
D3	7	+	P(S) 150	P-BW-BW
E	8	+ /++	BW	H-H-H
E'	7	++	H	H-H-H
F,G	10	+++	Ps	Ps-Ps-Ps
H	7	++	H	H-H-H
I	7	++	H	H-
J	18	0/+	P(R) 204	BW-P-P
K1	16	0/+	BW	BW-P-P
K2	20	0/+	P(S)*	V/M/O-P-P
K3	4.5	++	P(S) 180	P-A-A
L	7	++	BW	P-P-H
M	22	0	SC	SC-P-P

\*In 1989, 3 green manures were planted; in 1990 yields were 225 barrels after vetch, 195 after millet and 175 barrels after oats

#### Varieties: Yield versus Blight

Variety is an important factor in yields. The Superior variety which came in during the last 15 years has made the difference, Dale remarks, between surviving or not on many farms. It is a mid-season cultivar, early sizing and a good yielder. Kennebec was the principal variety before; it yielded 2/3 of Superior and had a cull rate of about 25 to 30%. Superior gives 50 barrels more per acre in yield with a remarkably low cull rate, about 3%.

The other principal variety grown is Russet Burbank (Netted Gems), a late season type which can be stored later to bring a better price, and they are wanted by processors year round. If they sprout, the sprouts are removed easily by rubber rollers. They are also good for baking and boiling. The processors have promoted this variety because it is good for golden fries. Disadvantages are its late maturation which requires harvesting into the late fall when conditions may not be good for harvesting, moderate yields, relatively high requirements for fertilizer, its susceptibility to leaf roll, mosaic viruses and *Verticillium* wilt, and that it is quite sensitive to wet and dry spell weather conditions characteristic of N.B. summers. (In 1982, such conditions resulted in knobby potatoes unacceptable to the processors, and half of the N.B. crop had to be discarded).

Superior yields well, but is blight susceptible which means that it is difficult to grow on a large scale without using fungicides - a tradeoff they don't particularly like but have to accept. Two or three different fungicides are used. The frequency of spraying is a function of the weather. If it's sunny and dry, they may not spray for 2-3 weeks, but if the blight index is high, they'll spray weekly. They keep their ears to the ground for blight in surrounding areas.



Blight is the difficulty most often cited as the principal fear farmers have of attempting organic production in this area. The McLaughlins have experimented with organic production. Good aeration is critical to avoiding blight; they notice blight at the edge of hedges where the air is dead or where it is shaded and dries off late in the day. The trial organic potatoes are planted in better aerated areas. In 1988, they planted twenty 100 foot rows of Pontiacs which were raised totally organically. They sprayed two times with horsetail tea which they had heard about from a lady in Maine.<sup>15</sup> There was no blight. They planted bush beans in offset rows through the potatoes at intervals of 4-6 feet to act as a trap crop for potato beetles, a technique they had heard from an organic gardener. They didn't have any problems with potato beetles. Another trial was conducted with Superiors in 1990 using fish scale meal as fertilizer. They were harvested late because of wet weather; tubers had about 25% blight damage. (Superiors are blight susceptible). The crop would have been a write-off had it been done on a commercial scale.

#### Other chemicals

Other chemicals used in raising the potatoes are herbicides, occasional insecticides, a sprout inhibitor, and some top killer. Some top-killing is done by flailing and allowing the frost to complete the process. It is difficult in a large operation to top-kill entirely by mechanical means because earlier in the season when the blight is more active, flailing may help to disperse the blight. Herbicides are used for spot spraying of barnyard grass and couch grass. Some fields may be totally sprayed to control broadleaf weeds (mustard, lambsquarter, pigweed, hemp nettle); however, if there is no history of weed problems, they don't spray. They also cultivate and hill up potatoes for weed control. Wild mustard is a common potato field weed, and once it gets into a system, it is difficult to get out. Its bright yellow flowers make it an easy target for hand control to prevent it spreading. Stella says they used to do that when they were kids, but not now, there's too much area to cover on one farm and not enough labor.<sup>16</sup>

The McLaughlins spray for insects according to needs identified by the Province's Pest Management Alert Program which involves twice weekly sampling by government employees, and their own observations. The program tells them what is in the area. The decision to spray for flea beetles and Colorado potato beetle is based on their own observations of leaf damage. For aphids, the judgement is based on where the aphids are in the region, rather than the level in the fields. They receive a computer readout of the county which tells them where they are, and if they are in a migratory stage; if the aphids are migratory and upwind, they spray.

#### Crop rotation:

The McLaughlins moved into rotation of potatoes with soil improving crops about 15 years ago, well ahead of the industry at large and the research and extension services. They are still experimenting.

They began with red and Alsike clovers about 1975. It had been said locally that plowing in clovers would make the soil hot enough (through respiration of the microbes) to burn the seed up. The McLaughlins planted one piece with red/Alsike, turned it in the next spring and got a bumper yield: 225 barrels (375 cwt)/acre. They planted 5-6 acres the next year and 20 acres the year following with good results. The clovers are plowed in late May or early June, about one week before planting potatoes. They like to undersow red/Alsike clover into grains (of which they have had up to 100 acres in the past), but there are limitations. Lodging of oats creates problems for the undersown crop. The clover tends to hold moisture which makes it difficult to get wheat dry enough for harvest. Barley is best; it is shorter which allows more light to go to the clovers but the straw is not the best for bedding (it cannot be used for pigs because it itches; it's not too bad for cattle). Barley fits into the workload better than other cereals because it is normally harvested before potatoes.

Sweet clover was introduced 4 or 5 years ago. New Brunswick farmer Max van Zingel had started using it long before then to improve ground for potatoes. The McLaughlins learned about it at a SAVE meeting at which van Zingel spoke. They tried it on a field that had compacted severely. The sweet clover penetrated the hardpan, and when the residue was worked in, this encouraged water to percolate through the hardpan. The Sweet clover produces the most biomass of any of the rotation crops, growing to 6 feet high, and can be difficult to work in; it has to be rotary mowed first. It makes the ground very retentive of water, which can make it difficult to dig especially if wet; it tends to be pasty and doesn't feed easily through the digger. But it does result in good yields and quality of potatoes grown after it.

Crimson clover (a rarity today, but a common undersown crop in the pre-chemical era) was tried, but potatoes did poorly after it, possibly because of *Verticillium*.

In 1989 vetch was tried for the first time with very good results; the best yields in 1990 followed the vetch. They couldn't get seed in 1990. It's hard to plow and has to be disced a few times to get it under, but they like it. They tried vetch after reading about it in New Farm, and hearing about it in conferences.

Alfalfa hay is a good soil improver, but because of its high pH requirements, can be used only before Russets which are tolerant of high pH. Superior is more tolerant of scab (which is encouraged by high pH) than a lot of varieties. Alsike and red clover are reasonably tolerant of low pH. Kennebecs have a low optimum pH (circa 5.5), making them difficult to grow in rotation with wheat or alfalfa. The McLaughlins focussed on legumes because they wanted the inputs of nitrogen from N<sub>2</sub> fixation. Difficulties with *Verticillium* which grows on legumes as alternate hosts, prevent exclusive use of legumes. Where they begin to see *Verticillium* problems, non-legumes are used. They started using buckwheat 10-12 years ago; at one time they took a crop of grain from it, but today they use it only as a soil-improving crop. Millet has been used successfully, and they plan to use more of it in the future.

Rye is another possible non-legume for cover cropping that has been researched in the Maritimes. One use is to broadcast it into the potatoes before harvesting; it is packed down during harvesting, and germinates in fall to provide a winter cover. It's not a good choice, however, for longer season potatoes and it tends to be very spotty where ground is hard packed; it's not a good way to get a cover crop Dale says, and few do it. They are going to try rye after disking buckwheat.

The McLaughlins attempt never to have more than 2 years of potatoes in a row, and any place where there is a concern for erosion, not more than 1 year. On the most level land (Fields J, K), potatoes are planted in 1 year out of two (or 2 years of green manure followed by two years of potatoes); on the more sloping land, potatoes are planted 1 year out of 3 or 1 out of 4 (Table II.4). For truly sustainable production, they feel they shouldn't have potatoes on more than 50 of their 225 acres, perhaps only on 35 acres, i.e. potatoes should not be grown in more than 1 year out of 4 to 7, which is about what it was in the 1950s. They notice that where fertilizers are used two years in succession, there is a marked decline in earthworms, but where they are used only 1 year in 3 or 4, there are more earthworms in spring or even in the fall after fertilizer use.

#### Fertilizer compost

Beginning 4 years ago, manure from the cattle operation has been composted. It's put out in July, turned over in August and once again in the fall if there is heavy weed growth (lambquarter, couch grass) on it. The compost is put on potato land or on green manure crops in places of low fertility. The stimulus to compost came from reading New Farm, and hearing talks by Lawrence Andres and David Reibling (organic farmers from Ontario) at the MARSAN conference held in Nova Scotia in 1984. (MARSAN refers to the Maritime Sustainable Agriculture Network, it has since given way to the Organic Crop Improvement Association which has chapters in

the 3 Maritime provinces). A limitation in making good compost is the amount of straw required - Lawrence Andres advises 80 square bales per head (as bedding); they don't have that much available, and it's a shortfall in the system. They would like to go to round baling to get more straw (there is less labor required to get it than for square bales).

Lime is put on fields every 2nd or 3rd year. It is applied to soil before planting green manure crops or grain to bring pH up to about 6. 120 tons were put on in 1990, 80 tons in 1989.

Soil analyses were done yearly for about the first 10 years on the farm but now are taken only every 3 to 4 years to determine lime needs and to qualify for lime subsidies. They say the recommendations are always the same for P and K which register High to Very High.

Fertilizer rates are 100-200 lbs/acre of 15-15-15 on grain, and 800-1100 lbs on potatoes, never more. They have tried less; when there is not enough, yields drop 20-25% and plants die prematurely. If potatoes follow barley, 20 to 40 lbs/acre additional N may be added to compensate for immobilization by straw. These rates are on the lower side of typical application rates for processing and table potatoes.

### Harvesting

The McLaughlins had a potato harvester but stopped using it 14 years ago in favor of hand picking. The principal reasons for doing so were concerns about quality of the potatoes and the quality of the soil. With a harvester you can't avoid bad spots; with handpicking, the bad ones can be picked up separately and stored separately.

In addition to the weight of harvesters, 10-14 tons, there is a lot of vibration and together they cause tremendous compaction especially when used on wet soils. The problem is particularly bad with long season, processing potatoes which offer little leeway for harvesting; in 1990, harvesters were on the field in the wettest possible conditions. It was a matter of doing that or losing the crop. The compaction leads to poorer quality potatoes, more energy required for tillage and increased erosion. The erosion is enhanced also by the fact that rocks are more of a nuisance with mechanical harvesting and are removed. They are collected by the harvesters and dumped in little piles which are then picked up by another vehicle. Rocks are all that's anchoring the soil in a lot of these places<sup>8</sup>, the McLaughlins say; they also act as a heat sink and the soil is colder without them.

Hand harvesting is a community and social affair. In most of Carlton and Victoria counties, there is still a "potato break" in which schools are closed from 3 weeks before Thanksgiving. There is a 25-30% participation rate of children 8 to 18 years; the median age is about 14 years. Parents, grandparents and preschoolers often come out with the students. The McLaughlins employed 54 pickers in 1990, 80% of them school age children and their parents. A potato digger which can be run off a small tractor works up and down rows to expose the potatoes; then barrels are put out by a truck for several rows ahead of the pickers who move transversely across the rows. The width of row assigned to each picker varies according to the ability of the picker so the whole line of pickers moves across the field together. As a barrel is filled, the picker makes out a tag which is collected and used to calculate the wage; finally barrels are picked up by a truck with a boom. In 1990, wages averaged about \$0.75/barrel. A typical adult picker will fill 80 barrels in a day. A 5 a.m. radio broadcast from across the border (Maine) matches workers and farmers who phone in their needs. There are typically 50 to 65 workers at a time. They bring lunch. McLaughlins give them fruit.

The McLaughlins are afraid that the hand harvest will not last much longer. It depends greatly on the school break, and with a largely non-farming population even in rural areas, the lifestyles no longer match the needs of the farmers. To have or not to have a break comes up for a vote each year by local school boards, and the odds are not good: in Blair's Grade 9 class of 25, there is only

one other student who comes from a full time farm family; in Ivan's graduating class, there are 5 out of about 100.

A Potato harvest survey (1988) by the Board of School Trustees, District 31 (Andover) where the McLaughlins are located revealed:<sup>17</sup>

- 59/69 farmers with handpicking operations considered the break necessary for their operation;
- 30 out of 66 indicated they would use potato harvesters if schools were not closed for the harvest break;
- Of 1976 students surveyed (93.6% of the total), 37.9% were involved in the 1988 harvest; they averaged 11.9 man days work and \$233.63 earnings per student;
- 582/922 parents said they would prefer to see the harvest continue;
- amongst high school students, 26% felt the break had a positive effect on school work, 11% a negative effect and 63% no effect (776 students surveyed)
- teachers felt that the break did not create problems for students in elementary school, except possibly in upper elementary grades, whereas it did create problems due to more absenteeisms, difficulties starting over again etc. in secondary grades (8-12); however, a majority of parents felt that only senior high students should be involved in the harvest.

In a 1989 Survey of District 31 (Andover) potato growers,<sup>18</sup> it was found that 97 of the 108 potato growers listed by N.B. Dept. Agriculture, grew potatoes in 1989; amongst those, there were 29 harvester operations (51 partners), employing 217 adults, 91 students for harvest; and 31 hand-picking operations (46 partners), employing 320 adults, 805 students at harvest.

#### Storage and marketing

The McLaughlins used to sell directly to processors, but stopped doing so and diversified their marketing in order to have more control over prices. Most are now sold as table stock, some as seed and some to dealers who may sell them to processors. (If they sell seed potatoes, they need to avoid trucking to processing plants because of the possibility of picking up diseases). Generally, the longer potatoes can be stored the better the price - or at least the more options there are for dealing with the market. "It's a gamble we often take", says Dale "if the price is bad in the fall there is no sense selling them so we sit on them." The best price is often in the final month when their "old crop potatoes" are sold along side of new crop potatoes coming in from the south. The old crop potatoes are better for potato salads. Variety, quality and use of a sprout inhibitor affect storage. Russet Burbank is best for storage, but it is a long season variety -140 days while there are only 126 frost free days on average in the area - which means often that it is harvested regardless of conditions, and it is not possible to cover crop after it. The McLaughlins keep potatoes for up to 11 months, which is not common except with high tech storage facilities. Their low tech, long term storage facility is better than average: an old potato storage shed with rock walls buried in the soil on which there is a concrete ceiling with a metal hip roof. Use of a sprout inhibitor is a must for 11 month storage which adds to the chemical load. (The sprout inhibitor, MH-60 is applied to the growing plant; timing is critical). Modest use of fertilizer is important. If they go over 120-150 pounds of nitrogen per acre (134-168 kg/ha) on the fertilizer, the tissues get more succulent and there is a significant decline in how well they store. With the use of green manures, the McLaughlins get enough N in total for maximum yield with not more than 150 lbs N, but still have good keeping quality.

Being able to separate out poor potato spots during harvesting is important. Soil compaction also reduces keeping quality. Appearance is another quality factor of concern; with over-fertility, stress, sudden growth spurts and compaction, potatoes tend to get knobby. The McLaughlins's potatoes are reasonably smooth and tend to be consistent in quality from year to year. They believe that rotations with soil improving crops are especially important in this regard. The McLaughlins generally fetch better than average prices for their potatoes through a combination of high quality

and waiting to sell. Quality advertises itself: they have had calls from as far as New Jersey from producers who want more potatoes to meet obligations and had seen the McLaughlins potatoes in the market (their phone number is on the bag).

But a reputation for high quality doesn't insulate them from the year to year market surges (Table II.5), or vagaries of disease and market place: identification of PVYn (mosaic) virus in some PEI and N.B. potatoes in early 1990 resulted in a ban on imports of potatoes to the U.S. from both provinces. The ban on N.B. potatoes was on and off again; table potatoes were finally allowed through provided they were treated with a specific sprout inhibitor which was not the same as that which the McLaughlins had applied.

**Table II.5. Prices received by the McLaughlins 1985-1990. Most were sold as Table stock.**

Crop Year	Time sold	Price (per barrel)
1985	Spring 1986	\$2.50-\$5.50
1986	Fall 1986	\$12-\$18
	Spring 1987	\$15-\$21
1987	Spring 1988	\$6.50-\$7.00 (Foundation Seed Price) \$6.50-\$9.00 (Table stock)
1988	Oct 1988	\$12-\$15
	Nov 1988	\$13.25-\$16.25
	Spring 1989	\$24-\$25 for round white Superiors \$21.50-22 for Russets, not graded
1989	Fall 1989	\$12-\$14 Table Stock \$15 for large grade
	Spring 1990	\$17 \$22-\$23 for large grade

They prefer to feed potato culls to cattle rather than put them on the market. One reason is that when processors buy culls, it reduces the demand and lowers the price paid for good quality potatoes. To protect their own market, farmers should avoid selling culls, says Dale. A good alternative is to use them as cattle feed. Culls are worth \$2-3 per barrel as a substitute for grain, while they fetch only \$0.75 to \$1 per barrel from the processors.

#### Traditional Rural Competency and Family Values

In terms of overall financial solvency, there is an additional factor that is critical to McLaughlins ability to sustain their livelihood - and hence their ability to experiment with SA practices: relatively low capitalization costs. This has been achieved mainly by (i) avoiding the usual costs of intergenerational transfer, and (ii) fixing up and maintaining old equipment rather than buying new equipment. The California Settlement farm was purchased in 1971 with a 30 year mortgage at 5%. Arthur McLaughlin worked with the boys until 10 years ago. When the boys took over, there was no buyout, no remortgaging of the next generation. Part of the reason this was possible was that Phyllis McLaughlin has worked as a teacher in later years, (but none of the mothers worked away from the farm when the children were small).

The McLaughlins don't need a lot of money for either buildings or equipment. Arthur McLaughlin has a small sawmill. When a new structure is being built, they pour the concrete, saw the timbre, frame, board it in and shingle themselves. They never buy new machinery (Table II.6). They buy from auctions, people retiring, and repair constantly. There are 5 cars in the expanded family, one "good one" (a 1977) for when it's needed.

In summary, the case study illustrates that one of the main benefits of adopting more sustainable farming practices for potatoes is improved yield, aesthetic quality, and keeping quality. On the McLaughlin farm, some of the key factors in developing more sustainable practices are (i) including a livestock component in the farm operation which gives more options for management of erosion-prone land, provides an on-farm use for culls (so nutrients are recycled), and produces compost which can be applied selectively to improve areas of low fertility; (ii) the province's insect monitoring program; (iii) hand harvesting which avoids the direct physical degradation of soil associated with use of mechanical harvesters, and allows more control over quality; (iv) keeping costs down by recycling of old machinery, and avoiding the debt burden of intergenerational transfer; with lower costs and higher yields per unit area, they are able to maintain on average longer rotations with potatoes than would otherwise be possible.

**Table II. 6. Partial list of structures and equipment on the McLaughlin farm**

Structures:	1 barn with livestock 3 potato houses 1 machine shed 1 repair shop 1 granary (wooden) 1 bunkhouse for 12-15 pickers, with cooking facilities; outhouse
Vehicles:	5 old tractors, 30, 45, 55, and two 96 hp (newest is 1971 model) 3 four ton trucks for hauling 2 old trucks; used to haul water for sprayer & hold potatoes while racking
Field equipment	4 bottom plow 14 foot disc spring tooth harrow vibrashank, 14 feet tool bar and old cultivators and hoes manure spreader PTO grain seeder, 12 feet sprayer baler haybine forage harvester rake Combine Massey Harris 1960 Electric shoveller Skidsteer loader 4 diggers, 2 with transmissions; use 2 at any one time 450 barrels

### II.3 Adoption of SA practices within the industry at large

#### Erosion control

Awareness of the erosion/soil degradation problem has increased a lot in the potato industry at large beginning in the early 80s especially in the northern part of the potato belt. According to J.P. Daigle, a Soil Conservation Engineer with the N.B. department of Agriculture, the formation of a SCIA (Soil Crop Improvement Association) by farmers was a significant factor in increasing awareness. Technology demonstration projects were set up on some local innovative farms in highly visible locations, and demonstrated that good soil management can increase yields and quality. Currently, protection measures are implemented on approximately 300 to 700 additional

hectares a year. The amount brought under protection each year goes through 4-5 year cycles which correspond to the life spans of government land improvement programs under successive Federal/Provincial assistance agreements. Daigle says that less than 15% of land is adequately protected now. He considers there is much more commitment to soil conservation in the U.S. such as in the state of Maine where approximately 40% of the land is protected by conservation practices. The US Soil Conservation Service provides technical on-farm services to assist land owners in the preparation of farm conservation plans. They operate on a longer time frame than in Canada. Daigle notes also that they have made much more effort in the past twenty years to popularize soil conservation concepts, e.g. in schools,<sup>19</sup> and through the media.

Cropping measures (cover cropping, crop rotations and green manuring) and conservation tillage constitute the first basic measure of reducing soil erosion and improving soil productivity. On-farm conservation practices such as contouring, strip cropping, terracing, runoff control structures and watershed management are required to protect the land resource on approximately 40-50% of the crop land in the potato belt. Projects involving contouring, strip cropping and erosion control structures are often difficult to implement because most farms were granted land during early settlement in ways to allow easy access to the land for mixed farming systems rather than to maintain topographical continuity in the land grant. The result is often that one farmer alone cannot implement effective conservation measures unless the neighbor(s) cooperates with the project or unless major field consolidation efforts can occur. With more mixed, traditional cropping systems, this was not a problem - as at the McLaughlins, more extended rotations or permanent cover could be established on the more erosion-prone land. But without these options, effective conservation measures are much more readily implemented on larger farms than on small farms. Further, because of the greater long term security and greater capital, they are also more readily implemented on the large corporate farms than on the smaller family operations. "I am a farmer. We owe thousands of dollars. I hear people talk about soil conservation, but how can I conserve the soil when I owe so much money? How can I afford to put in a cover crop that I cannot sell for money? How can I afford to do this for the prices we get for our potatoes?"<sup>20</sup>

#### The Corporate Farms

Gilles Moreau, an agronomist working for McCain Foods Ltd. described practices that have been implemented or that he is promoting for company holdings. Within the last 2 years, they have moved from a rotation of 2 years in potatoes - 1 year in an alternate crop to 1 year in potatoes-1 year in an alternate crop. The alternate crop is grain, one of 3 cole crops (broccoli, brussels sprouts, cauliflower) or peas followed by a ryegrass cover crop, a practice introduced by McCain Foods Ltd. agronomists. The cole crop can be grown only once in every 6 years because of clubroot, a soil borne disease which otherwise becomes problematical. He feels this is still not sufficient to maintain a good level of soil organic matter, and he would like to see one year of potatoes, one year alternate cash crop, and one year of a residue-producing crop such as Japanese millet, or sudan grass. The company began some compost operations one year ago at their feedlot in Florenceville where 100-200 beef are kept to consume wastes; he feels that the compost could be applied in the fall of the second year or spring of the third year in the 1:2 rotation.

In the last 10 years there has been a lot of implementation of erosion control structures and measures including waterways, terraces and contour tillage. Plowing has been largely replaced by chisel plowing, leaving 25-40% of residues on the surface.

They are experimenting with biological controls and pesticides, e.g. M1 and TRIDENT (commercial *Bacillus thuringiensis* products) for control of Colorado Potato beetle. The equipment subsidiary of McCain Foods Limited manufactured a prototype "Beetle Eater" which underwent field evaluations in 1990. There is much less use of herbicides, more spot spraying. There is no alternative to fungicides to control blight.

McCain Foods Ltd. agronomists keep in close touch with and work closely with government researchers throughout eastern Canada.

Others in the industry acknowledged that McCain Foods Ltd. has implemented some good practices on their land. However one limitation cited is the very large size of many of the potato fields (several hundred acres and more) which poses a significant limit on the effectiveness of erosion control measures. (According to the Universal Soil Loss Equation, erosion increases as slope length increases).

#### Corporate Competition

The Irving and McCain enterprises dominate the potato processing industry in P.E.I. and N.B. respectively. Within the last two years, each has moved into what had been the other's exclusive territory. McCain Foods Ltd. is completing a large processing plant in P.E.I., and Irving has announced plans for a \$50-million French-fry plant across the highway from the McCain Foods Ltd. plant in Grand Falls. The reasons for these developments have apparently more to do with family rivalries, complicated arguments concerning free trade and political pressure to create more jobs than with any immediate demand for potatoes. The McCain Foods Ltd. processing plant is currently operating at 63% capacity, and the french fry market is growing at only 2-3% per year.<sup>21</sup> Opinions vary on the economic and ecological impact. There is little information available on where the potatoes would come from - the U.S., from land currently being cleared of forest or by direct competition with McCain Foods Ltd. for existing production. A need for an additional 12,000 acres of potatoes has been cited. Opinions even amongst provincial government personnel vary widely on whether "the land could take it", in part because it is not known what kind of demands are going to be put on the land. Some farmers express concern that the benefits for local economy will be minimal because they say, the Irving operations have their own sources of supplies, machinery etc. and do not patronize independent businesses.

There is continuous nervousness within the industry concerning trade with the U.S. The area under Potato cultivation in eastern Canada has increased in the last decade while that in Maine has decreased, and Maine farmers blame this on unfair (government subsidized) competition from Canadian producers and processors. (A few years ago they demonstrated their anger by dumping potatoes at the border). The Irving plant at Grand Falls will be given a \$4-million grant for job training and marketing programs, a \$14.5-million waste water plant and a \$10.5- tax credit, subsidies which the McCain Foods Ltd. interests contend will result in countervailing action. The producers wonder whether these developments will result in more markets and better prices, or in more competition and lower prices. In spite of free trade, free flow of potatoes is often restricted by non-tariff barriers, which farmers feel are trade barriers in disguise. In the fall of 1990, potatoes were being held up at the border for pesticide residue testing. In the spring of 1991, the discovery of mosaic virus in seed potatoes from Prince Edward Island resulted in drastic measures by the Americans to restrict flow of potatoes from the entire eastern Canadian region.

Opinions vary as to whether McCain Foods Ltd. control of the market for processing potatoes is helping or hindering the independent potato producers. A big potato producer selling to McCain Foods Ltd. can make a good living it is said, although it is universally acknowledged that you cannot get into the business today without a lot of money, and the trend of reduction in numbers of producers continues.

Darrell McLaughlin and others<sup>6</sup> maintain that the industry is structured to give the processors unfair advantages over producers, and these will ultimately do the independent producer in. Thus while the contract price for potatoes is set by the Potato Marketing Agency and it could in principle set a fair price, the producers set the amount of potatoes they buy on contract.

Farmers who borrow money are often required to offer as collateral a contract with a processor; the same processor also sells seed, fertilizer and equipment and other inputs need to meet



contract requirements. Their own holdings allow them to compete with independent producers, and since they can buy the same inputs at reduced rates, they have a competitive advantage.

### Organic Potatoes

An organic certification organization (OCIA-NB) was formed in 1987 within a year or two of when the first organizations appeared in other provinces or states. In 1990, 28 acres of potatoes were certified on 10 farms. Eight of the farms with organic potatoes are mixed vegetable or crop-livestock farms. Seventeen of the acres occur on 2 farms which are conventional potato farms in the process of transition of transition to organic agriculture.<sup>22</sup> The mixed farmers do not report much difficulty in growing a small acreage of potatoes organically. They generally select cultivars that are less disease and pest-prone, and the potatoes are sold on the fresh table market at a good price (in the fall of 1990, \$0.40 per pound versus \$0.06 to \$0.10 for conventionally grown potatoes). The Provincial department of agriculture did some testing in 1988 of different organic fertilizers, and in 1989 of the performance of different cultivars under organic production. Only one of the top 5 performing varieties in the organic trials was amongst the top 5 performing varieties in conventional production.<sup>23</sup> In the variety trials, 10 tons/acre composted manure was applied, and 23 varieties tested. The yield varied from from less than 50 cwt/acre to >200 (versus 150 to >300 in conventional trials). The top 5 varieties differed from the top 5 in conventional trials except for one. The top variety in the organic trial had the highest proportion of severe scab.

The large potato growers generally section off part of their land for organic production, which they will put on a longer rotation with soil improving crops. They purchase large amounts of manure, or fish scale meal or crab meal to replace the inputs of synthetic fertilizer inputs. Some are using the new types of *Bacillus thuringensis*, a bacterial pathogen of certain insects, to control Colorado potato beetle. The principal concern of the transitional growers in N.B. is blight. Use of bluestone (copper sulfate) as an alternative to organic fungicides for blight control is permitted by the International base standards of OCIA, but not by OCIA-NB. The transitional growers are not so much worried about blight on their own limited organic acreage as they are about it serving as a source of blight for their own and neighbors' conventional fields. The fear of blight, and stringent certification requirements for transitional potato growers- such as the need for barriers between conventional and organic crops, separate sprayers, and separate storage facilities - are cited by some conventional growers as impediments to their trying to grow organic potatoes. Another impediment may be the requirement that farmers must have plans to convert their entire farm to organic production. Conventional growers who are growing some organic potatoes report that more than the premium price they might get for their potatoes, the experience gained in growing organic potatoes has resulted in their implementing better practices in their conventional operations, such as reduced use of pesticides, and use of legumes in rotations to provide N and improve soil quality.

## **II.4. Conclusions**

Since the 1950s, potato production has undergone what can be described as a change in state, and the conditions for stability or quasistability in the the new state or systems are very different from those for the old state. The concept that there can be alternate stable or quasi-stable states of complex, living systems is a recently established but generally accepted principle in ecology.<sup>24</sup> The transition from one state to another can be driven by gradual but persistent change in a particular condition (variable), which at some point leads to a sudden shift in the stable state of the system.

The old potato production system consisted mostly of modest sized, crop-livestock farms. Most of the inputs originated on the farm, capital expenditures were low, and there were not a lot of financial barriers to farmers' passing their farms on to their offspring. Erosion and soil degradation were minimized by crop rotation and by use of soil-conserving crops on the most erosion prone

land. There was less need for pesticides and fertilizers, and because acreages of potatoes were small, they could be dealt with using lighter machinery.

The new potato production system consists of highly specialized, capital intensive units. They are for the most part one-commodity systems, most inputs are purchased from off the farm and they are not transferrable to individuals without the assumption of a lot of debt. Because potatoes are the only commodity on most of the farms, there is a limit to the length of rotations, and little possibility in most cases of not growing potatoes at all on the most erosion-prone land. Thus there is more need to employ structural controls such as strip cropping and drainage ditches as opposed to growing less erosion-prone crops. For structural controls, bigger is better because of the need to implement them over topographically contiguous regions. Because of the high capitalization costs and heavy debt burden borne by large independent growers, they are less able to afford SA practices than are the even larger processor-farms. Further, the processors know they are in the business to stay, so have more incentive to practice SA than the independent producers whose first priority is simply to survive. The larger processor-farms may have more options to diversify because they process other products (e.g. peas, brassicas), and keep cattle to consume potato processing wastes.

The very large, processor-farms also have better prospects for survival than many or most of the independent farms because of fewer debt problems and because there is not an equivalent shortage of labor. The prospect of regular hours and a regular pay cheque is more attractive than the long hours and chronic debt borne by many or most of the independent producers.

The research required to improve SA in the large, specialized systems is more of a high tech nature than it might have been for the old systems, e.g. designing harvesting equipment that is more gentle on the land, genetic engineering to develop biological pesticides for pests that are inevitable given short rotations and the concentration of potatoes in certain regions. How fast and to what degree the new systems move towards SA practices that maintain soil quality is likely to be determined mostly by the rate at which potato yields and quality fall due to declining soil quality; the driving force for diversification of the continuous potato rotations was the demonstration that the diversified systems could improve yields and quality. Innovations or varieties that result in the production and quality being less sensitive to soil quality would slow down the rate of adoption of soil-conserving practices.

Given the continuing concern of consumers about chemicals, how fast the new systems move towards SA practices that entail less use of toxic chemicals is likely to be determined by how fast economic hi-tech alternatives are developed, e.g. the potato-bug suction machines or *Bacillus thuringiensis* products.

The trend currently is clearly towards further reduction in the number of independent producers, and an increase in the size of single potato holdings. The McLaughlin farm illustrates an economically viable means of surviving at current size, and of increasing the ecological sustainability of the system. Most of those options would be available to other producers, save one: the hand harvest of potatoes, which will probably disappear. This would be a serious impediment to the McLaughlins' sort of operation, given the significance of hand harvesting for quality. To increase adoption of the McLaughlins' practices is probably more a matter of social/economic policy (e.g. giving incentives to maintain or recycle old equipment) than it is of technical innovation; the research required is of the more traditional agronomic type rather than hi-tech research.

There is a significant demand for organic potatoes which will probably continue to grow. It appears doubtful that the larger potato farms could be converted in total to organic production, although growing some organic potatoes has been found to benefit the total operation. Organic production on a small scale in mixed operations is feasible, and profitable.

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### **III. Dairy in Quebec (Regional Researcher: Pierre Jobin)**

#### **III. 1 Introduction**

The Fleuralic dairy farm is located on the south shore of the St. Lawrence River, next to Lac St-Pierre, a little down-river from the city of Trois Rivieres. Owned by Lorraine Lemire and Louis Fleurent since 1984, and the 5th generation of Fleurents on the farm (it has been in the family since 1836), the farm is fairly representative of Quebec's family dairy farms, in terms of cultivated acreage and herd size.

The large Nicolet area has long been recognized as highly developed in agricultural terms. The region enjoys relatively mild climatic conditions for Quebec, with nearly 2,600 degree-days by virtue of its geographic situation near the St. Lawrence River. The soils are variable, but a majority rest on ancient marine deposits from the Champlain Sea, which are naturally fertile, particularly in dairy production. A high percentage of Quebec's dairy farms is concentrated there. For the past few years, the Nicolet and Bois-Francs region has seemed the location of choice for a substantial number of farmers, principally dairy farmers, who have serious concerns about the effectiveness of current agricultural practices. They are showing increasing interest in low input/organic farming practices, out of concern for making better use of their agricultural resources, reducing farm inputs, reducing their production costs and, finally, reducing the negative impact of their farming practices on the environment. The vitality and the positive results achieved by certain farms, such as the Fleuralic farm, in organic farming, in the last three years, has generated growing interest among the region's farmers, and among MAPAQ (Ministere de l'Agriculture, des Pecheries et de l'Alimentation du Quebec) regional and provincial consultants.

#### **III. 2 Farm Description**

##### The land base

The Fleuralic farm is 61 ha in size, of which the majority is cultivated, i.e. more than 57 ha (Fig. III.1; Table III.1) The topography varies little (mostly flatlands). There are no woodlands or major waterways. The soils are principally loams, with a few sandier strips of land.

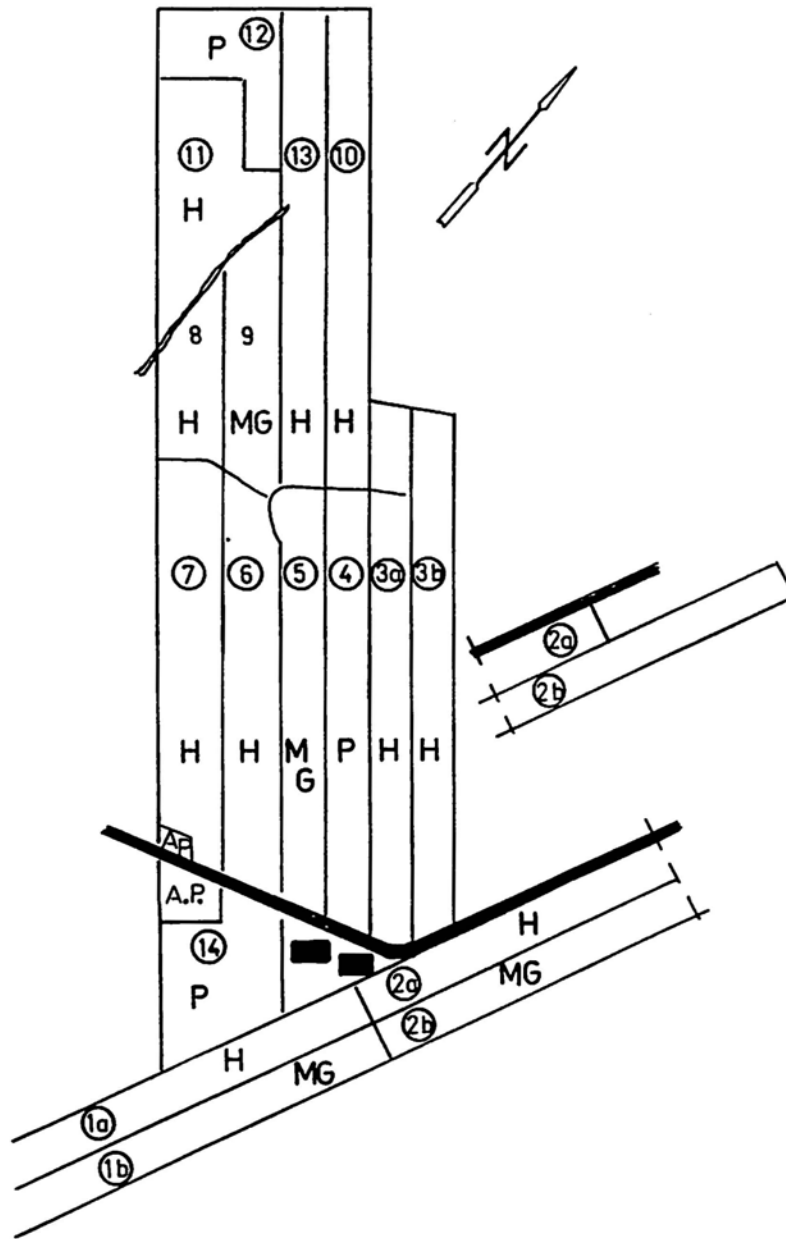


Figure III.1 Map of Fleuralic Farm. Numbers in circles are field numbers. Areas are given in Table III. 1. Crops are shown for 1990. H = hay, MG = mixed grain, P = pasture.

	SOLE # 1		SOLE # 2		SOLE # 3	SOLE# 4		SOLE # 5			SOLE # 6		SOLE # 7	
FIELDS	1A & 1B		2A & 2B		3A & 3B	6 & 7		8 & 9 & 10			10 & 13		4 & 5	
AREA:	6.5 ha		8.5 ha		9.1 ha	8.7 ha		7.5 ha			7.0 ha		7.1 ha	
1987	HAY	HAY	HAY	HAY	MIXED GRAINS	HAY	HAY	HAY	HAY	HAY	HAY	HAY	PAST	PAST
1988	HAY	MG	MG	HAY	HAY	MG	HAY	HAY	MG	HAY	HAY	MG	PAST	PAST
1989	MG	HAY	HAY		HAY	HAY	HAY	HAY	MG	MG	HAY	MG	MG	PAST
			FA/GMAN											FA
1990	HAY	HAY	MG		HAY	HAY		HAY	MG	HAY	HAY	HAY	PAST	MG
			GMAN			FA/GMAN								
1991	HAY	HAY	MG	HAY		MG		HAY	HAY	HAY	HAY	HAY	PAST	PAST
				FA/GMAN		GMAN								
1992	HAY		HAY	MG		MG	MG		HAY	HAY	HAY	HAY	PAST	PAST
	FA/GMAN			GMAN										
1993	MG	HAY	HAY	MG		MG	HAY		HAY	HAY	HAY	HAY	PAST	PAST
				FA/GMAN			FA/GMAN							
1994	PAST	HAY	HAY	HAY		HAY	HAY		MG	MG	HAY	HAY	MG	MG
				FA/GMAN			GMAN							
1995	PAST	HAY	HAY		HAY	HAY		HAY	HAY	HAY	MG	MG	MG	MG
			FA/GMAN			GMAN								

**Figure III. 1** Rotation over 10 years. MG = mixed grain, PAST = pasture, FA = fallow, GMAN = green manure. Note pasture in Sole 7 is being switched to Sole 1 so cows will not have to cross the road, and to facilitate a more intensive grazing system in those fields.

#### Livestock

The herd of 32 milking cows, 19 Heifers and calves produces 200,000 kg of milk annually, and uses the bulk of the farm production, which makes the enterprise almost entirely self-sufficient in terms of the feed requirements of the herd (Table III.1).

**Table III. 1 Herd and Feed Statistics**

<u>Animal Inventory:</u>	<u>No.</u>	<u>Value (\$)</u>	
Milking cows	32	32800	
Mated Heifers	8	6560	
Heifers	7	3591	
Young heifers	2	616	
Bull calves	2	196	

Annual Feed requirements and Supply (metric tonnes):

<u>Component</u>	<u>Utilized</u>	<u>Produced On-Farm</u>	<u>Purchased</u>
Fresh Hay	210	200	10
Feed (12% protein, 1.65 Mcal/kg)	61.7	40 (mixed grain)	18 (corn)
			4 (other)
Pasture area	6.4 ha		
Pasture production	200 tonnes		
Straw	25 tonnes	24 tonnes	1 tonne
Old Leaves <sup>a</sup>	3 tonnes		3 tonnes

<sup>a</sup> Old leaves from municipality used for bedding. The only disadvantage is having to remove them from plastic bags.

#### Manure Management

For Mr. Louis Fleurent, sound manure management is a vital characteristic of his enterprise. The farm is equipped with a manure transport system that uses troughs and chains, as well as a 75-foot exterior slope. The manure is stored directly on the soil, without a cover. The litter is composed mainly of straw, of which roughly 45 tonnes is required per year, i.e. nearly 3.0 kg/LAU per day<sup>a</sup>. About 500 tonnes of manure are stored each year.

Twice a year, i.e. in early June and in October, the manure is placed in a windrow to compost. It will be turned over as needed, to optimize the quality of the compost produced. At present, all manipulation of the compost is done with the front end of the tractor, and the manure spreader. For 1991, the purchase of a compost turner is planned to facilitate the turning of the windrows. The compost is spread on the fields at various stages of maturity, and in various doses, according to crop needs and soils. In general 10-15 tonnes of compost/ha are applied in the case of mixed-grain crops, and 5 tonnes in the case of hay.

Evolution of the composting system Louis Fleurent began his experiments with the composting of farm manure in 1988, but has modified his practice considerably over the years. In order to reduce liquid losses in the barn and on the storage site, Mr. Fleurent increased the quantity of straw litter under the animals more than twofold, from approximately 1.5 kg/AU/day to nearly 3.25 kg/AU/day. Owing to these quantities, he had to begin to make two removals per day, i.e. one after each milking.

<sup>a</sup> LAU = large animal unit (roughly 500 kg). There are approximately 42 LAU which represents a livestock loading of 0.76 LAU/ha.

better texture within the mass of manure to be composted, and assuring a better balance between carbon and nitrogen. Mr. Fleurent considers it essential to add massive quantities of litter to his manure to further promote the formation of high quality humus, and to ensure that an adequate amount of humus is maintained in the fields.

For the spreading of compost in small amount ( 5 tonnes per hectare) Mr. Fleurent purchased a hydraulic manure spreader that improves precision of spreading. The spreader is also used to make compost windrows and to turn them, and can be operated faster than a chain operated manure spreader. The compost is turned one or two times with the consistent aim of optimizing the quality of the product.

For the 1991 season, Mr. Fleurent plans to purchase, through a small machinery pool, a compost windrow turner, which will save him an enormous amount of time, both in stacking, which could then be done by means of a dump truck, and in the turning over of the compost.

The turner in question, which can be acquired at a very advantageous price (around \$7,500), is capable of turning 600 to 800 tonnes of manure per hour, and should reduce considerably the wear and tear currently associated with intensive use of the spreader. Mr. Fleurent believes he can take advantage of financial assistance to purchase the turner, through a Quebec program for making better use of farm manure.

Strategies to further reduce liquid losses A major improvement that Mr. Fleurent wants to make in his manure management system during the coming season is to totally eliminate liquid losses encountered when the manure leaves the barn, and during the prolonged accumulation of the manure outside.

Despite the substantial increase in the past three years in the quantity of straw litter under the animals, significant liquid losses still occur. He is still concerned that there is loss of a high percentage of the total potassium and nitrogen in the manure; not only are they lost from the system, but they may also have negative impacts on the groundwater.

Particularly under conditions of conventional housing, a massive addition of chopped-straw litter (more than 3.0 kg/AU/day) reaches a certain limit in the capacity for absorbing the liquid portion of animal excreta because:

- the straw absorbs the liquids slowly owing to its physical structure;
- it is difficult to bring the liquids in contact with the straw in the trough.
- the contact time with the liquids is very short, given the frequent manure removals required when such a quantity of litter is used (twice a day).

Very little practical information exists on the subject. For Louis Fleurent, therefore, it is of prime importance that he evaluate *on his farm* the effectiveness of other absorbent materials (e.g. peat moss) which could possibly be added to the straw litter, in small quantities, to maximize the absorption of liquid manure and minimize losses to the environment. Thus, even before thinking about investing in an outdoor manure storage and management system, Mr. Fleurent wants to experiment with a number of different absorbents during the winter, to reduce to the maximum liquid losses before the manure reaches the storage site. These tests will be conducted in collaboration with CDAQ (Centre de Développement d'Agrobiologie du Québec, located at Ste. Elisabeth de Warwick) in 1991.

Based on those results, it will then be appropriate to evaluate which is the better outdoor manure management system between the following two alternatives:

- an open-air system, using a concrete slab large enough to allow for an initial composting phase for the solid manure, and a holding basin for the recovery of liquids and rainwater;



-a covered system, which would prevent any accumulation of rainwater, in which the manure could possibly be managed entirely in solid form, with only small liquid losses. If necessary, a small holding basin for liquids could be added to the structure.

Louis Fleurent anticipates a major investment, though he considers such an investment essential in terms of the orientation which he is currently giving to his farm, and to reduce the negative impact of his farming practices on the regional ecosystem.

### Crop Rotation

The Fleuralic farm has always grown mainly hay crops, in rotation. Historically, of the 140 acres of cultivated land, nearly 80 to 90 acres were in alfalfa-grass meadow for the harvest of dry hay, 30 to 40 acres in grain, and approximately 20 acres in rough pasture.

**New rotation with a shorter interval in hay** Since 1988, the Fleuralic farm has been trying to re-orient its rotation to make better use of the fertility of its meadows, increase its self-sufficiency in grain, and to reduce the risk of perennial grasses becoming established in the meadow. Thus, the present rotation tends to integrate 2 years of cereal crops with 4 years of mixed hay crops. The following plan and Fig. III.2 illustrate the present rotation:

- Year 1: mixed hay
- Year 2: mixed hay
- Year 3: mixed hay
- Year 4: mixed hay - fallow - green manure
- Year 5: cereals - green manure
- Year 6: cereals - fall seeding of mixed hay crops

When the hay crops were kept longer than 5 years, the alfalfa often tended to disappear from the mix, which greatly reduced the competition against couch grass in the meadow flora, and resulted in the use of herbicides to counter this weed.

Though the new system sometimes involves the ploughing under of flora still extremely abundant in alfalfa, Mr. Fleurent considers the practice particularly beneficial in terms of the cereal crop cultivation which will follow. He believes that this practice will enable him to maintain, and even increase, his production of hay and grain, even though synthetic fertilizers have been eliminated completely from the farm for the past three years.

Eventually, Mr. Fleurent hopes to be able to integrate into his rotation a third crop year, in this case a cereal crop for human or non-human consumption, for off-farm export.

Increasingly, varied mixtures are encouraged in hay seedings, i.e. 13.5 kg/ha of a mixture of 40% alfalfa, 20% Alsike clover, 40% Timothy, and 3.4 kg/ha of a mixture of 50% orchard grass, 50% brome grass.

**Fall seeding of meadows** Since 1987 the meadows have been seeded in the fall, which is definitely not a common practice in the region. For Mr. Fleurent, the fall seeding provides several advantages for his enterprise. First, it allows for a better distribution of tasks over the entire season. Second, the pressure from annual weeds is greatly diminished in the fall compared to the spring, which allows the hay crop to become established more easily, with no need for herbicide. Finally, since it does not require using a cereal crop as a nurse crop for the hay mixture, this practice also allows for mechanical weeding (prior to establishing the crop), an operation performed on the farm for the past two years, and providing excellent control over annual weeds in cereal crops without the use of herbicides. For three years now there has been no use of herbicides on the Fleuralic farm.

For Mr. Fleurent, however, it is important not to leave the fall seedings too late. The ideal seeding date for the Nicolet region falls between August 8 and August 20. Delaying the seeding beyond that date greatly reduces the chances for success. Moreover, a very dry period sometimes makes it difficult for a hay crop to become quickly established. Since 1987, the success rate for fall seedings on the Fleuralic farm has been excellent, while on only one occasion did they have to re-seed a portion of the fields seeded the previous year.

**Green manure crops** The growing of green manure<sup>a</sup> crops in the rotation has been common practice since 1989. The species favoured are white mustard, canola and/or fodder radish, owing to their strong growing capacity in a cool climate. Preferably, the fall green manure is seeded following an early turning of the meadow (after the second cutting, in mid-July). It is, if necessary, preceded by a short fallow, to help control couch grass. Also, the green manure is seeded concurrently with the spontaneous regrowth of grain (which then contributes to the green manure), in the first year of rotation in cereal cropping. For Mr. Fleurent, it is important that the rotation never leave soil bare for too long a period, particularly in a climate with heavy precipitation like that of Quebec.

With more than 50% of the crops in legume-grass meadow, and low exports of nutrients off the farm, Mr. Fleurent considers that this rotation is not likely to result in deterioration in the fertility of the farm's soils, and in the farm's production capacity, even though all purchases of synthetic fertilizers were eliminated more than three years ago. Indeed, Mr. Fleurent seems convinced that export crops should be integrated into his enterprise, since he is far more fearful of a surplus of fertility, and hence losses to the environment (mainly in nitrogen) than of an impoverishment of his lands.

#### Use of Fertilizers

Purchases of synthetic fertilizer were gradually reduced beginning in 1988. None were used in 1990. This enterprise was never a large importer of fertilizer from outside the farm, the costs of purchased fertilizer not exceeding \$3,500.

At present the fertilizers used on the farm are derived mainly from the recycling of manure, through the composting process. Mr. Fleurent believes that, if properly done, composting promotes rapid stabilization of his manure, a major reduction in the mass to be spread on the fields, and provides for spreading purposes organic matter which has not been subject to loss through leaching and volatilization. Of course, he believes that the composting practice must be extremely meticulous, and that care must be taken to reduce to the minimum all nutrient losses in the barn, in storage, or in the production of the compost. To this end, Mr. Fleurent has introduced several changes in his management and plans to make some more. In his view, the fertility of the farm depends on the effectiveness of the recycling of manure.

**Addition of rock phosphate to compost** During the winter period, crushed rock phosphate is brought daily to the barn, representing a total of roughly 3 tonnes annually. Mr. Fleurent believes that application of phosphate directly to the trough stimulates the microbial process, and helps reduce ammonia losses in the barn. It enriches the manure in phosphorus and calcium, in insoluble form, which, through the microbial process during composting, will be quietly transformed and made available to the living organisms in the soil, and to crops.

However, since the practice means adding more daily tasks to an already full agenda, Mr. Fleurent plans in future to add the crushed phosphate to the compost when it is being stacked or turned.

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<sup>a</sup> They could also be described as "catch crops" (see appendix D)

**Use of the compost** The types of compost and the quantities brought to the fields are generally based on the needs of the crop in place or to be planted, and edaphic factors such as soil type, natural fertility, structural stability, etc.

In general, the mixed-grain crop will receive a supply of approximately 15 tonnes of compost per hectare. It is applied during turning of the meadow, in the fall preceding the cereal crop and is conserved and activated by the green manure crop. For this he uses a compost that could be described as fairly young, i.e. roughly 3 to 4 months in maturity.

The meadows, for their part, will normally receive in the seeding year a mature compost, aged 6 months or more, and may receive a second dose in the third crop year. The quantities supplied are in the region of 5 tonnes per hectare.

In the case of very specific sections of the land, i.e. sandy hillsides, very mature compost is used, to increase the fertility of these soils in the medium term.

**Soil analyses, pH and lime** Soil analyses are carried out regularly, not with the aim of determining annual nutrient requirements, but rather to help monitor over several years the evolution of various soil parameters: pH, organic matter level, cation exchange capacity, total and dissolved nutrients, chromatographic characterization of humus.

Mr. Fleurent observed that although the pH of these soils is generally relatively high for a cultivated land profile, the first few inches of soil (top soil) are often particularly acidic (pH between 5.5 and 5.9), which does not necessarily provide ideal conditions for an optimal conversion of organic matter, a conversion which is so important to the production model which the Fleuralic farm is developing.

Little use has been made in the past of lime. However, Mr. Fleurent wants to change this practice, and once again innovate, with fractional supplies provided from the compost. This would add roughly 300 to 400 kg of lime per hectare each time the compost is spread. The reason for this change is to ensure the process of evolution of the organic matter in the soil and the presence of available calcium which will be capable of gradually establishing an effective and stable absorbing complex.

**Green manures to conserve nutrients** The growing of green manure was introduced on the farm in 1989, and is now systematically practised on the soils in preparation for the growing of mixed grains, on old meadows beginning to grow wild, and first-year cereal crops. The species of green manure used are chiefly from the cruciferous family, i.e. canola, white mustard and/or fodder radish. These species grow late into the fall, effectively recycling nutrients left dissolved in the soil at the end of the season. They also stimulate microbial life, which in turn stimulates the mineralization of the organic matter accumulated under four years of hayfield, in order to provide for the needs of subsequent grain crops.

On the old meadows beginning to grow wild, Mr. Fleurent turns the soil very early in the season, i.e. between 15 July and early August, as soon as the second hay harvest is completed. A summer fallow is performed, if needed, to reduce the populations of perennials, particularly couch grass, and as soon as possible, the fall green manure is seeded. An early seeding of green manure, before 15 August, results in an excellent coverage of the soil by the green manure crop (3 tonnes of dry matter or more), which also ensures effective decomposition of the hardpan previously ploughed under. This guarantees a good seedbed in the following spring, and facilitates the weeding operations that are necessary in the cereal crop. If possible, the compost is applied before the seeding of green manure. The green manure is normally turned just under the surface at the end of the season, around the end of October.

### Tillage Practices

Historically, Mr. Fleurent used the practice of tillage which is general in the region, i.e. a fall ploughing, followed in the spring by the disk harrow and the vibrator tiller to prepare the seedbed. Since 1988, Mr. Fleurent has tried several secondary tillage practices, although deep and frequently repeated ploughing was not necessarily common practice on the farm. The reasons for a new tillage approach were mainly:

- to minimize the dilution of the organic horizon and mineral horizon;
- to stop the unnecessary ploughing under of hay stubble and cereal crops, and of manure or compost;
- to help improve control over perennial species, mainly couch grass (*Agropyron repens*) by means of a surface fallow;
- to reduce the annual costs related to maintaining the plough. The maintenance costs for a plough are between \$4.50 and \$5.00 per acre. The costs of maintaining a chisel plough are roughly \$1.50 to \$2.00 per acre. Hence the direction chosen. Mr. Fleurent has assessed these figures with his economic consultant.

**On the hay stubble** At present, Mr. Fleurent is turning his meadows before the end of July, after the second hay cutting. To do this, he uses two chisel passages, the first a cross-passage, directly on the meadow. The first passage is 3-4 inches deep, the second 6-8 inches, in order to raise and break the stubble as much as possible. Afterwards, he uses a disk harrow to break up the soil. If considered necessary for weed control, he continues with a fallow using a vibrator tiller in dry periods to bring couch grass rhizomes to the surface.

Mr. Fleurent performed tests with an 8-foot wide rotary cultivator on hay stubble, as a finishing operation before the seeding of green manure. Although the tool in question is extremely effective for the task performed, today Louis considers the cost of using it and, more particularly, maintaining it, excessive, and has decided to forgo this practice.

Green manure is then seeded, to reduce the leaching of nutrients, activate microbial life, control the establishment of end-of-season weeds, and help improve the decomposition of hay stubble, which will facilitate the use of the cultivator, the following spring. In late October, a passage of the chisel or disk harrow will facilitate the shallow turning of the green manure.

In the spring, a single passage of the vibrator tiller provides an adequate seedbed for the cereal crop.

**On the Cereal Crop Stubble** As soon as the harvest is completed, around mid-August, a chisel passage at a depth of roughly 6 inches facilitates the shallow turning of the cereal crop stubble. If necessary, a short fallow may be effected, using a vibrator tiller. Green manure is then seeded, before the end of August, and as in the previous case is turned just under the surface at the end of the season, with a passage of the disk harrow.

In the spring, a passage of the vibrator tiller provides a quite acceptable seedbed for the seeding of cereal crops.

If a meadow must be seeded in the fall, a rapid pre-seeding tillage is possible (the land should certainly be free of couch grass if the fallows of the preceding years have been effective), to allow for the earliest possible seeding.

### Weed Control

Herbicides have never been used on a large scale on the Fleuralic farm, although between 1982 and 1987, Louis introduced their use in a much more systematic way, chiefly for hay crop, and to eliminate couch grass. These included Round-up and broadleaf herbicides. The main weeds encountered are pigweed (*Amaranthus retroflexus*) and couch grass (*Agropyron repens*), and in

some specific locations, wild mustard (*Sinapsis arvensis*). Much less numerous are common ragweed (*Ambrosia artemisiifolia*), the dandelion (*Taraxacum officinale*) and the Canada thistle (*Cirsium arvense*), with the latter two found chiefly in the rough pastures.

**Partial summer fallow** Since 1988, herbicides have not been used on the farm. By way of compensation, a partial summer fallow has been introduced to control couch grass. Mr. Fleurent believes that this practice is very effective if it can be started early enough in late July, when the climatic conditions are most favorable. It is followed by seeding of a brassica.<sup>a</sup>

Thus in the rotation, a fallow is done at least once every six years, when the meadow is turned. If necessary, a second fallow may be done in the first cereal crop year after the harvest (around mid-August), before the seeding of green manure.

**Shorter hay rotations, more complex mixtures** By reducing the number of years the hay is kept in place, Mr. Fleurent expects that the species in place, principally alfalfa, will remain much more competitive with couch grass, and will effectively reduce the risk of major infestations, except when winter frosts damage the alfalfa.

Until 1988, the hay mixtures were simple: alfalfa-timothy, with a high percentage of alfalfa (more than 60%). In the past three years, the tendency has been to vary the mixtures much more. Added were a few species of grasses, such as orchard grass and brome, along with other legumes, particularly Alsike clover. The hay seedings are done primarily with a Brillion seeder. In general, the legumes tend to persist relatively well in the mixture, and better than average for the region.

**Use of a finger weeder** In the spring of 1989, Mr. Fleurent introduced on his farm the practice of mechanical weeding for the cereal crop. He purchased a Lely cultivator to help control the annual weeds, pigweed and mustard. (This "finger weeder" with numerous, fine individually sprung tines is popular amongst organic farmers). The \$3,500 investment proved to be an excellent decision, given the effectiveness of the weeding tool. The first two years of use allowed him to get acquainted with the machine, and the results were very good, particularly in this 1990 season.

The cultivator is used in the post-germination stage, prior to the emergence of the grain, i.e. approximately 6-7 days after seeding. At that time, several annual weed species have begun to sprout, although they are barely perceptible, and this first passage eliminates a majority of them while they are still at a very fragile stage. If necessary, a second passage is made at the 3-4 leaf stage, without damaging the cereal crop. On the contrary, Mr. Fleurent believes that this second passage would tend to stimulate the tillering of the cereal crop.

Since he began using the cultivator, Mr. Fleurent has tended to plant the cereal crops a little deeper than the current tendency, i.e. between 1 and 2 inches deep. This detail makes for a somewhat later emergence, and ensures a few more days for the sprouting of the weeds, and a more effective first passage.

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<sup>a</sup> Studies in Europe have shown this to be a very effective system (G.W. Cussans and P. Ayres. 1975. *The influence of chemical treatments and autumn cover crops of Brassicae, following spring barley, upon the growth of Agropyron repens*. Proceedings of the European Weed Research Society Symposium on Status and Control of Grassweeds in Europe, pp 314-321). New growth of couch rhizomes takes place in late summer and fall, and is stimulated by high levels of nitrogen. Cultivating in mid-summer reduces the rhizome initials, while the brassica crop consumes available nitrogen and competes with any growth of couch.

**Pasture management for improved weed control** Mr. Fleurent hopes in the next two years to make several changes to the system for using his pastures, in particular to introduce some type of rotational grazing. In his view, this should have a positive impact on weed control in the rough pastures, by reducing overgrazing of preferred species by the animals, and improving their aggressiveness against the less attractive species, principally thistle and plantain.

#### Pesticides other than herbicides

No pesticides are being used on the fields at the present time. Historically, Mr. Fleurent has used, among the conventional biocides used in agriculture, only herbicides (for five years). The crops show very little tendency to be affected by any particular disease. At one time the alfalfa was affected by what appeared to be a kind of wilt, but the problem was corrected by the use of a new resistant variety.

### III.3. Incentives, Limitations and Outlook

#### Economics

Since 1984, the Fleuralic farm has been a member of the Syndicat de Gestion Agricole de Nicolet (agricultural management pool). A MAPAQ program enables farmers to take advantage of a grant that pays up to 80% of the salary of their consultant. The Nicolet pool represents approximately 65 dairy farms, and works jointly with an agricultural economist, for the specific purpose of evaluating farm management. The thinking that led to this painstaking approach to farm economics enabled Louis Fleurent to question the economic effectiveness of some of his farming practices, including growing purchases of pesticides and chemical fertilizers.

The close economic monitoring which Louis Fleurent and Lorraine Lemire are performing on the farm they manage, enables them today to evaluate quite accurately the efficacy of the changes made on the farm in the past few years. Thus, all the innovations of the last few years have been analyzed within the overall management of the farm. Certain practices have required substantial investments, but in general the profitability of the farm today (Table III. 2) is, in economic terms, as healthy as it was before they began this transition to organic farming.

**Table III. 2. Revenues and expenses, Ferme Fleuralic**

<u>PRODUITS (revenues)</u>	\$
VENTES DE LAIT (milk sales)	80656
SUBSUDE (subsidy)	13642
VACHES DE REFORME (5 TETES) (cows sold, 5 head)	3147
VEAUX, 24 TETES (Calves, 24 head)	2543
ASSURANCE RECOLTE (insurance)	993
ASSURANCE STABILISATION (stabilization insur.)	1491
PAILLE (5 T.M.) (5 metric tonnes straw)	210
REMISE TAXES FONCIERES (tax rebate for farmers)	731
REMISE INTERETS (interest)	7328
RISTOURNE (payback)	320
TRAVAUX EXTERIEURS (off farm work)	1034
<b>TOTAL</b>	<b>112095</b>

**Table III. 2. Revenues and expenses, Ferme Fleuralic, concluded**

<u>CHARGES (expenses)</u>	\$
MISE EN MARCHÉ DU LAIT (marketing work for milk)	11790
MOULÉE VACHES (MOULANGE)(cow feed (concentrate))	8101
MOULÉE JEUNES, 240 KG (young cattle feed)	108
VÉTÉRINAIRE (MÉDECINE PREVENTIVE) (preventative medicines)	600
VÉTÉRINAIRE, AUTRES (other)	234
INSEMINATIONS (inseminations)	1509
APPROVISIENNEMENT DE LATIÈRE (milking device)	947
CONTRÔLE LATIER (Provincial milk control org.)	284
ENREGISTREMENT (registering fees)	277
TRANSPORT ANIMAUX (transporting animals)	43
ACHAT DE FOIN, 10 T.M. (hay, 10 tonnes)	500
SEMENCES (seeds)	
GRAINS MÉLANGES, (mixed grains) 1365 KG	675
FOURRAGE (forage)	1177
ASSURANCE STABILISATION (stabilization insur.)	421
ENTRETIEN MACHINERIES (maintainance of machinery)	3678
ENTRETIEN ÉQUIPEMENT FIXE STABLE (maintainance of barn)	1646
ENTRETIEN CAMION (truck maintainance)	1326
CARURANT CAMION (fuel for truck)	820
ENTRETIEN TRACTEUR (maintainance of tractor)	1148
CARBURANT TRACTEUR (2500 LITRES) (fuel for tractor)	587
LOCATION MACHINERIE (renting equipment)	390
CHISEL, 20 HA (Chisel plowing of 20 ha)	825
BATTAGE, 13 HA (harvest of 13 ha)	1400
ENTRETIEN TERRE ET BATIMENTS (Maintainance of fields and buildings)	1180
SALAIRES (salaries)	7648
INTERETS COURT TERME (short term interest)	2312
INTERETS MOYEN ET LONG TERME (mid to long term interest payments)	19394
ELECTRICITE	2228
TELEPHONE	612
TAXES FONCIERES (land taxes)	850
ASSURANCE FERME (farm insurance)	1300
ADMINISTRATION ET HONORAIRE (administration)	3169
<b>TOTAL</b>	<b>77764</b>
<b>MARGE (Profit)</b>	<b>34331</b>

**Table III.3. Machinery Inventory****INVENTAIRE MACHINERIES (machinery inventory)**

DESCRIPTION	MODELE	VALEUR
ANDAINEUSE (grain windrower)	M.F. 42 HP	1000
APPLICATEUR PRESERVATIF (preservative applicator for hay)	Fimco	271
CHARIOT A MOULEE (trailer for carrying feed to animals)	Mick	400
CHARRUE (moldboard plow)	Hydreen 4 raies	1000
HERSE A DISQUES (disc harrow)		75
HERSE A PACAGE (pasture renovator)	10 pieds	200
LAME (grator on tractor)	Lessard	700
MANGEOIRE (hay feeder)		400
MONTE-BAILLES (hay escalator)	28 pieds	250
PRESSE (hay bailor)	NH 278	3000
RATEAU (hay windrower)	12 pieds	150
REMORQUE (Trailer)		250
ROTOCULTEUR (rotovator)	Moletty 8 pieds	2500
SARCLEUR (finger weeder)	Lely 15 pieds	3000
SEMOIR A GRAINS (grain seeder)		100
TESTEUR HUMIDITE (humidity tester)	F4	150
VIBROCOLTEUR (vibrocultivator)	Georges White 11 p.	1000
WAGON (hay wagon)	Normand	1200
WAGON # 2	Dion	1700
CAMION (truck)	Ranger 84	3092
TRACTEURS (tractors)	John Deere model 3140, 85 hd	15000
	JD 2120, 60 hp	5500
BALANCE A LAIT (milk balance)		253
COMPRESSEUR (milking compressor)	Surge 1400	1266
COMPRESSEUR LACTODUC (coolong)	De Laval 78	128
CONDITIONNEUR A FOIN (water conditioner)		1876
CONVOYEUR A FOIN (conveyer)	Ideal	1360
EPANDEUR (spreader)	John Deere 450 HP	5265
HACHE-PAILLE (straw chopper)	Rovibec 7 HP	500
LACTODUC	De Laval	4078

**Information on Low Input/Organic Farming**

Interested in pursuing this line of thinking further, Mr. Fleurent set about in a more serious way finding information on the fundamentals of organic farming, and the application of its practices to dairy farms. His participation in a number of technical training sessions on the subject, more than 200 hours of courses in the past three years, accompanied by several conferences and a number of tours of farms using alternative practices, enabled Louis Fleurent and Lorraine Lemire to begin the transition to organic farming practices on their own farm.

Since 1988, Mr. Fleurent has worked with CDAQ (Centre de Developpement d'Agrobiologie du Quebec, located at Ste. Elisabeth de Warwick.) as an active member and participated in various



research projects they conducted the farm. In this way the Fleuralic farm has been able to develop a dynamic exchange of technical information related to organic farming practices with competent resource persons.

In the past two years the Fleuralic farm, in conjunction with several other dairy farms in the region, have developed, through a MAPAQ program, a technical extension service. This program enables a small group of participating farmers to hire a technical consultant, whose salary is paid on the basis of 80% by the program and 20% by the group as a whole, a program similar to the one which enabled them, a few years earlier, to hire an economic consultant.

Naturally, so many changes in growing practices and the way they look at agriculture demanded enormous energy, thinking, and time devoted to the search for information. In the past three years, Mr. Fleurent has devoted great effort to make the transition to all of these new practices, while continuing to perform the routine work which already occupies the bulk of his time, since no full-time employees assist him on the farm.

#### Limitations

For Mr. Fleurent, conditions have not always been so supportive of his efforts to develop more sustainable agricultural practices. A very short time ago the regional agronomic community still had serious doubts about the new practices he was introducing on his farm. Though today MAPAQ consultants are increasingly encouraging practices such as the cultivation of fall green manure, mechanical weed control, crop rotation, and even the composting of farm manure, Mr. Fleurent points out this has only come about after certain farmers, at their own expense, demonstrated the efficacy of these new practices, with very little support from those same consultants, who were until then very skeptical, and often even closed-minded regarding such innovations.

The policies of the two levels of government, in the view of Mr. Fleurent, are very poorly adapted to the reality of organic farming. For some senior government officials, whose long-term vision for agricultural development is, for all practical purposes, non-existent, the current development of organic farming represents just another "fad".

Thus, farmers embarking on this course are still denied government support, and have little alternative but to adapt current programs to their needs, which makes the process all the more arduous. It is also necessary that the bureaucrat to whom you are submitting a request for assistance already looks favorably on organic farming.

While for Mr. Fleurent it remains important not to conceal the fact of the origin of the current farm ecology movement, which was born in the agricultural community, today he considers it a priority to focus energy on developing a constructive relationship with the agronomic and scientific communities, because many challenges have still to be met.

#### Outlook: Mr. Fleurent

After this general description of Mr. Fleurent's farm, it is appropriate to give him the last word, in the form of his thoughts, the way he sees and, above all, is experiencing the transition that he began three years ago:

"The worst thing is that I do not see more long-term policies being formulated, despite the evidence, recognized today, of the catastrophic state of our soil and water resources, and its relationship to the absurd farming practices that are still encouraged.

"This long-term policy is still languishing in a multitude of compromises, while we continue, on the one hand, to subsidize to the tune of millions of dollars continuous cropping of corn (indirectly),

and strive, on the otherhand, to dress the wounds caused by soil depletion, also to the tune of millions of dollars.

"There is no overall policy, centered on soil health and conservation, which is in turn centered on the health (quality) of agricultural products, and finally, on the health of man and the environment.

"Up to now, only a few institutions have truly made a contribution to the practical implementation of organic farming on the region's farms. CDAQ is one of them. Through the work it performs in terms of circulating relevant information, its training sessions, its research work and technical developments, its technical assistance to farmers, and, finally, the political pressure it exerts, the Centre has had a major impact on the recent regional development of organic farming.

"The survival of the family farm in Quebec is problematic. Personally, I believe strongly in the family farm, for it enables, or should enable, a greater portion of the population to be more independent in terms of both its physical and spiritual needs. However, the reality of the current system, which is based on an economy which is no longer serving the community, greatly undermines the chances of the family farm surviving in any numbers.

"The only way I can see my family farm surviving is if I practise organic farming. It will provide me with a high-quality product for which it will always be possible to find a buyer, and it will enable me, through its low production costs, to own the bulk of the capital in my farm. So I would be on sounder footing to cope with unexpected economic, political and social events of any kind.

"With other farmers and professionals, perhaps we will succeed in restoring the fortunes of agriculture and give it back its true vocation: to feed the world without destroying it."

## **IV: A DIVERSIFIED MIXED FARM IN SOUTH WESTERN ONTARIO (Regional Researcher: Roger Samson)**

### **IV.I. Introduction**

Brian and Beverly Jeffray's farm on the Huron-Bruce Co. boundary in SW Ontario is 460 acres (186 ha) with approximately 310 acres workable acres. This is predominantly a mixed farming region with a heavy emphasis on beef production in Bruce Co. and on cash crops in Huron county. In the vicinity of the Jeffray farm, the land has a rolling topography with a considerable amount of land under pasture, hay and woodlot. Although many of the farmers in the area have supplemental income, off-farm employment opportunities are limited compared to other areas in the province.

The Jeffrays operate a diversified mixed livestock farm which they began to convert to a "certified organic" operation in late 1987. The main enterprise is a 40 cow milking herd. There are sheep, organic cereals and vegetables which are complementary to but subsidiary to, the dairy herd in the overall operation. They derive additional income from renting out maple tree taps and timber sales from their woodlots. The woodlots provide timber for their own farm buildings and wood heat for the house and hot water.

A wide variety of crops are grown including winter spelt, rye, oats, barley, open-pollinated corn, peas, barley, pasture, hay, and various vegetables (potatoes, carrots, turnips, parsnips, beets, onions, squash, and sweet corn). The farm's diversified production provides almost all the food consumed by the Jeffrays. Overall, the emphasis on the farm has been on developing a system that integrates soil, climatic and labour resources with the Jeffrays desire for a self sufficient farming lifestyle.

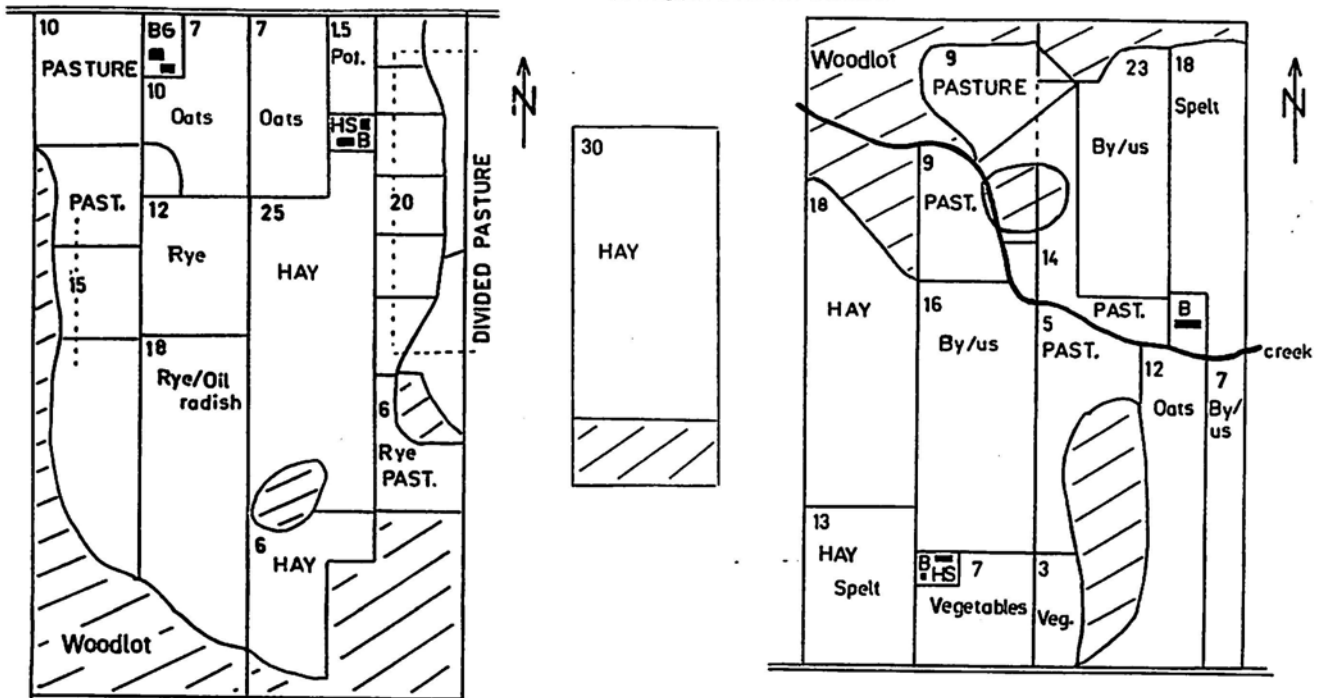
### **IV. 2 Farm Description**

#### Physical and Capital Resources

Sixty percent of the soils are Harriston Loam, ten percent Listowel Loam and the remainder Donnybrook gravel loam or muck. The soils are generally well drained naturally but there is some tile drainage. Soil tests of 20 fields in 1988 and 1989 indicated an average of 5.5% organic matter (higher than for most farms in this region), pH 7.4 and medium to high levels of Ca, Mg, K and P.

The Jeffray homestead is set on a knoll and includes a newly renovated stone farmhouse, a large garden area. The farm is well equipped with livestock facilities and feed storage. There is a double-three herringbone milking parlour and freestall barn for the dairy herd. Four barns are available for heifer-rearing and the sheep flock. Three steel grain bins are located on the farm which provide storage for 150 tons of grain. The livestock include: (LAU = large animal unit)

- Dairy cows, 46 (46 LAU)
- Dairy replacements, 20 (8 LAU)
- Ewes, 110 (14 LAU) (Suffolk & Suffolk x Dorset)
- Rams, 5 (1 LAU)
- Lambs, about 175 (8 LAU)
- Laying hens, 100 (1 LAU)
- Geese and Ducks, 30 (1 LAU)



**Fig. IV. 1** Map of Jeffray farm. Home farm on the left. Pot= potatoes, By/us = barley undersown with hay. HS = house, B = barn. Numbers are field areas in acres.

The farm has a complete line of tillage, planting and harvesting equipment. Custom work has been done in the past but is currently being phased out. The combine is too small to handle a heavy crop of rye so this job is hired out to a custom combiner with a larger machine. A Farmatic meter mill is used to process feed grains for the dairy ration. The current equipment inventory includes:

- 110 hp, 75 and 50 horsepower tractors
- 10 foot chisel plow
- 16 foot Western grain drill
- 4 furrow moldboard plow
- 20 foot pony trail harrow
- Disc mower and conditioner
- Forage harvester and two forage wagons
- Baler and 4 bale thrower wagons
- 300 bushel manure spreader
- 12' Combine
- 2-row rear mounted scuffler
- 2-row turnip planter
- 2-row potato planter
- 1-row potato digger

#### Labour. and sources of income

Approximately 73% of the gross farm income comes from the dairy, 7% from lambs, 6% from vegetable, 4% from cash crops, and 10% miscellaneous (woodlots, school board duties etc.). The farm is very much a family operation. Bev and Brian plan the farm operations together. Bev takes care of marketing of vegetables, lamb and eggs, does all of the book-keeping and as well as daily chores, some field work and taking care of four children (ages 2 and 7). The children are encouraged to participate as much as possible. They try to hire exchange students periodically to

help with farm labor, and outside labour is hired to help with household work in the summer. Brian's parents have helped considerably. The farm belonged to Brian's parents and his father still helps out. The farm was sold to them at a reasonable price and they obtained a low interest rate on the mortgage. Brian's father had a good rotation and kept a dairy herd which enabled Brian and Bev to take over a fertile farm rather than a worn out one; Brian says that they wouldn't have managed without them.

#### Livestock Management:dairy

The dairy herd, which processes most of the farm's field crop production, is the mainstay of the Jeffray's operation. High quality, legume based hay, silage and pasture are emphasized in the feeding of the dairy herd. The major change introduced in making the transition to organic livestock farming was that of reducing the importance of corn in the cows' ration. An increased amount of mixed alfalfa and grass silage was fed in place of corn silage, and corn grain was replaced by cereal grain. As a result of switching to the higher protein, mixed cereals and hay crop silage, soybean was also eliminated from the ration

Initially, the changes caused milk production to drop from approximately 50-55 lb (22-25 kg) per day to 45-50 lb (19-22 kg) per day per cow. In 1990 the production per cow again reached the 50-55 lbs per day which Jeffray attributes to several changes. He began feeding a limited amount of roasted soybean to high-producing cows which he felt weren't getting enough bypass protein when they were in peak lactation. As well, he began putting the cows in better body condition in late lactation. Other farmers in the EFAO (Ecological Farmers Association of Ontario) to which the Jeffrays belong found as they did, that when they changed over from the high energy, corn based ration, the cows needed to start off with a better body condition so that they could draw on body fat and tissue reserves during the period of peak energy requirements in the lactation. A longer term strategy that Jeffray is developing to improve herd performance is to switch away from narrow bodied "grain type" cows to full bodied "forage type" cows to better match his new feeding regime. Another major change, begun in, 1990 was to switch to natural breeding (the herd had been artificially bred for forty years). This change was made for several reasons: the high cost of A.I. service, reduced labour requirements to detect cows in heat, the belief that by using their own bulls they would be selecting in the long term for animals that were well adapted to their farm environment and finally to add to the self sufficiency of the farm. The major concern they had with the change was the danger of keeping a bull. As a result, they plan to use young bulls and retire them before they get too large.

The present feeding system was developed as part of the farm conversion plan worked out in consultation with their veterinarian and the EFAO (Ecological Farmers Association of Ontario). The forage consists of 2/3 haylage and 1/3rd dry hay with a top-dressing of kelp meal and a formulated mineral mix. The home-grown concentrate ration (13-14% protein) consists approximately of 33% winter rye, 30% oats, 25% barley, and 12% peas; it is supplemented with approximately 12 tons of roasted soybeans annually. Cows are fed the dairy ration and roasted soybeans according to production and body condition. A computerized feeding system is used which has individual necklaces for the cows. Two bins are in the computerized feeder, one for the grain ration and one for the roasted soybeans. The computerized feeding system enables accurate quantities of feed to be given to the cows up to six times daily. This system provides for more efficient use of feed while also reducing labour requirements. Currently, of the herd's feed, 5500 bales of dry hay, 175 tons haylage, and 85 tons of grain and peas are grown on the farm while 37 tons of grain, 12 tons of roasted beans and 9 tons of minerals are purchased.

Other dairy areas: In addition to changing the feeding regime, the Jeffrays changed the dairy herd health practices and dairy cleaning system. For the herd health program, they have maintained the regular use of the veterinarian but started using non-antibiotic treatments such as a colostrum based whey treatment for mastitis flare ups and for dry cows. Another major change has been their switch away from chlorinated alkaline soaps and phosphoric acid for cleaning milk house

equipment. They didn't like using disposable containers or the pollution that the cleaners caused. Their pipeline cleaning system has an aggressive flushing action and they started using hydrogen peroxide as a sanitizer. Since 1988, no other cleaners have been required which may in part be due to the farm having relatively soft water. Teat dipping with diluted hydrogen peroxide has also replaced the use of iodine based teat dips for the milking herd.

#### Livestock Management: Sheep.

The role of the sheep in the farm operation is that of a subsidiary enterprise to the dairy herd that makes better use of available resources. The Jeffrays state that the economic return from the Ontario Ministry of Agriculture and Food farm management return studies of sheep as a main enterprise is approximately 1 to 2%. They justify the sheep as a component of their operation by making use of resources that would otherwise be wasted.

The sheep play an important part in improving forage utilization and keeping pastures clean of weeds through tight grazing. The sheep are frequently folded onto cereal stubble if time does not permit seeding an oilseed radish catch crop. The sheep eat regrowth consisting of cereals and weeds such as quack grass (*Agropyron repens*). In the Jeffray's conversion plan, they have also slated some of the winter cereal stubble for seeding to fodder rape to increase fall pasture production. The sheep graze through to mid-December on the various fields generally preferring the early fall planted winter cereals and hay ground. The sheep are also fed or folded on crops that might otherwise be wasted, e.g. unmarketable vegetables. At the time of the regional researcher's visit to the farm in October 1990, the sheep were grazing a small field of open pollinated corn that had lodged. Overall the strategy has been to have a once a year lambing to minimize labour demands and to minimize use of grain. Production from the 110 ewe Suffolk based flock has averaged about 1.6 lambs per year.

In December of 1990, the sheep flock was sold. The main reason was that one 70 acre parcel of land that the Jeffrays had been farming was no longer available and a part of the enterprise had to be cut back. Other reasons were that the flock had an ongoing problem with foot-rot, wolves were beginning to be more of a problem, and it was felt the Suffolk and Suffolk x Dorset sheep were not the best sheep for a low input system. If the Jeffrays get back into sheep it will likely be with North-Country Cheviot. They believe that they are a more hardy, scavenging breed that would better meet the requirements of low labour and low grain requirements and good foraging ability.

#### Livestock management: Poultry

There are approximately 100 laying hens and 30 Muscovy ducks and geese. The laying hens are fed dairy ration and free choice roasted soybeans. The ducks and geese help to keep fly problems down around the barn area and clean up spilled grain. The Jeffrays feel that it is important that the farm is not too specialized. With the small scale poultry production there is room for children or elderly family members to play a role in the farm. They believe that intensive specialized farming leaves little place for family members that are not in the mainstream labour force.

#### Crop Rotation

Since beginning the change to organic management, the Jeffrays have relied on the EFAO for much of their information. Brian attended one of the EFAO two-day training sessions and then used their advisory service for making the major changes in the operation. Ted Zettel, a farmer advisor with a similar operation, visited the farm. As the Jeffray's operation was very similar to Zettel's, they implemented the rotation that Zettel uses on his own farm.

The major change that the Jeffrays made was to replace the corn acreage with winter cereals. Prior to 1987, approximately 1/4-1/3 of the farm was planted in corn. The switch to winter cereals from corn has obvious benefits in terms of reducing erosion. Much of the Jeffray farm is rolling and the use of perennial forages and relatively early planted winter cereals provides excellent winter cover.

The rotation is well planned and good records are necessary in order to receive "certified organic" status which requires a description of field history for the three years prior to the year of certification, and the intended management for the current and for the following years.

The rotation consists of:

- Year 1 Winter Spelt/ Oilseed radish
- Year 2 Oats and Peas/Winter Rye
- Year 3 Winter Rye/ Oilseed radish
- Year 4 Barley and Peas (undersown)
- Year 5 Alfalfa based hay mixture
- Year 6 Alfalfa based hay mixture
- Year 7 Alfalfa based hay mixture
- Year 8 Alfalfa based hay mixture/ Winter Spelt

In this system there is a growing crop, or a catch crop to provide cover in the fall in every year of the rotation. Compost is applied before planting oilseed radish in year 1, before seeding winter rye in year 2, and after 2nd cut hay in year 8 after which sod is plowed.

There are generally approximately 30 acres in each year of the rotation for a total of approximately 120 acres in grain and 120 acres in hay. Another 70 acres is pasture which is mostly rotated with field crops by replacing hay in the rotation. Occasionally seed crops of oilseed radish are also grown, most of which is sold off the farm. (The oilseed radish is commonly used by organic farmers as a catch crop sown after winter cereals and has been shown to reduce nitrate leaching.<sup>1</sup>) The winter spelt is a cash crop sold on the organic market.

### Vegetables

The Jeffrays began organic vegetable production on a relatively large scale for the first time in 1990. For advice, they relied on local organic farmers Jerome Schirter and Bernard Hack. The integration of vegetable production into the farm was thought to have many potential benefits including bringing high returns per acre and providing an opportunity to better use family and hired labour. It was believed that if vegetables were grown as part of a long term rotation, weed, pest disease and soil management problems that plague intensive vegetable growers would be largely absent. It was felt that vegetables could be planted in the various fields to match their fertility requirements, i.e. the heavy feeders could be planted in the most fertile areas, and light feeders in less fertile areas.

The entry into potato production began in July of 1989, when several sod fields were plowed up. The fields were cultivated at two week intervals and winter rye seeded in early September. The following spring the rye was plowed when it was about 8" height, and potatoes planted. Approximately twelve acres were planted in vegetables in 1990. The acreage consisted of:

#### Heavy feeders (planted after sod plowed in 1989)

Potatoes:	5 acres
Sweet corn:	2 acres
Squash:	1/8 acre

#### Light feeders (planted in fields in 2nd & 3rd years after sod)

Carrots:	2 acres
Onions:	1&1/4 acres
Turnips:	3/4 acre
Parsnips:	1/2 acre
Beets:	1/16 acre

In terms of producing a marketable product, good overall results were obtained from the potatoes, sweet corn, onions (grown from sets), parsnips, squash and beets. Compost was applied at a rate of 6 tons per acre prior to seeding of the high-feeding crops (sweet corn, potatoes and squash). On the crops which the Jeffrays categorize as low N feeders (carrots, onions, turnips and parsnips), no compost was applied. Varieties of potatoes grown were Yukon Gold, Atlantic Superior, Kennebec and Red Chieftan. Yukon Gold did best. There was very little pest damage.

The main problems experienced in the first year were marketing and weed control. Severe weed problems were experienced with the carrots and no carrots were marketed. The onions which were grown from seed were small in size as problems with weed competition and excessive seeding rate restricted bulb growth. The turnips were the only crop to suffer any significant pest attacks. Flea beetle was treated with ashes at an early stage in turnip development. Some loss of marketable turnips also occurred on the lower end of the turnip field where surface worm damage occurred, which was associated with too much fertility.

#### Weed Control

The key to weed control in the field crops is the development of a long, complex crop rotation. An alternation of spring and winter cereals followed by four years of forage results in a diversity of weeds, rather than in dominance by a few species. The main problem weeds on the farm in the past were quack grass (couch) and Canada thistle.

In addition to the rotation, use of competitive crop species, catch cropping and planting of mixtures of species helps to reduce the need for specific weed control measures. The principal weed control measures are:

- (i) **Blind Harrowing:** approximately 7 days after planting the springcereals (i.e. immediately prior to crop emergence), a diamond harrow is passed over the cereals to eliminate the first flush of weeds without disturbing the crop.
- (ii) **Stubble Cultivation:** after the oats and peas are harvested in year 2 of the rotation, the stubble is cultivated repeatedly (generally 3 times) at approximately 10 day intervals to deplete quack grass root reserves. In mid September, the field is seeded to winter rye which further helps to prevent the spread of quack grass because of its extensive root system.<sup>2</sup> They don't expect to have to do this in all fields, and hopefully less will be required as time passes.
- (iii) **Catch Cropping:** After winter cereal harvest, the stubble is cultivated and the land sown as quickly as possible to a rapidly growing cover crop of oilseed radish which suppresses weeds and acts as a soil conditioner.

In some fields of grain and in most of the pastures, Canada thistle is persistent which Brian thinks is related to compaction. However the subsequent four years of hay reduce the thistle population considerably.

Weed control requirements in the pastures are reduced by intensive pasturing. Clipping is also periodically performed to reduce thistle growth. Most of the pastures are part of the arable rotation where they replace hay in the rotation. This also helps to restrict perennial weed problems caused by long term selective grazing.

In the vegetable crops, weed control is simplified by planting all of the crops on 36" rows. Root crops are generally cultivated up to 4 times and hand-hoed 1-2 times. Both potatoes and sweet corn receive only blind harrowing and inter-row cultivation. The rye planted in early September on



the hay fields also helps to control perennial weeds. In the case of a small amount of tomatoes in 1990, the standing rye was cut in late May and tomatoes were transplanted directly into the rye mulch with no additional weeding performed.

#### Forage Management

A large proportion of the farm is planted in forage. The overall objective is to maximize as much as possible the use of high quality forages in feeding the dairy herd and the sheep flock. Brian found that barley is the best cereal to use as a nurse crop for seeding down hay fields. They use a two-row variety of barley, rather than a six row variety, as the grains are more plump and less grain is thrown over when combining. This reduces competition to the establishing forage stand from volunteer cereal growth after harvest of the cereal. Brian generally prefers to use complex mixtures for seeding down both pasture and hay fields:

##### Typical Hay Mixture

8 lb alfalfa  
 1 lb White Dutch clover  
 1 lb Birdsfoot trefoil  
 1 lb Timothy  
 1 lb Bromegrass  
 1/2 lb yellow blossom Sweet Clover  
 4 lb ryegrass

##### Typical Pasture Mixture

6 lb alfalfa  
 1 lb White Dutch Clover  
 1 lb Birdsfoot Trefoil  
 2 lb Orchardgrass  
 5 lb ryegrass

Brian believes that the complex mixtures reduce variability in production due to variable soil and climatic conditions and reduce weed pressure. Rotational grazing has been implemented on the farm for a number of years with different levels of intensity being tried. The current strategy is to set up ten 4 acre paddocks. The outside of the two main paddocks will be multiwire electric fence and the interior fences single strand electric wire that can be easily removed for field operations. Under this system of management, it is anticipated that some of the flush of spring growth will be taken as stored feed. In the past serious bloat problems have occurred from grazing the aftermath of hay fields; this risk will be avoided by keeping the cows off of fields seeded for hay.

#### Genetic Diversity. Adaptation

One of Jeffrays' concerns is disappearance of genetic diversity. They now save all of their own seed (spelt, barley, oats, peas, rye, oil radish, potatoes) and are beginning to select open pollinated corn and Holstein bulls that fit their particular farm environment.

#### Manure Management

All manure is handled as solid manure. Efforts are made to restrict liquid losses by using a large amount of bedding for the livestock: approximately 10 lbs of straw per day per cow (versus about 3 lbs in normal operations). The free stall area is scraped daily and piled on a cement slab. In the winter, after initial heating, the manure is stored on a cement slab in a pole barn. The manure is then hauled out to the edges of fields in May and windrowed. The manure is generally applied after harvest of cereals in August and September in year 1 or 2 of the rotation. The manure is incorporated and a crop of winter rye or a catch crop of oilseed radish is generally seeded to minimize losses of soluble or volatile nutrients. The oilseed radish has been used for approximately ten years by other ecological/organic farmers in Ontario as means to improve nutrient cycling and

to act as a soil conditioner. To clean out the yard before winter sets in, some manure is hauled out fresh in the late fall and put on hay fields that are in their 3rd or 4th year of production.

#### Marketing

Most of the crops grown on the farm are processed through the dairy and sheep herds. The vegetables and spelt are inspected by an agent of the Organic Crop Improvement Association (OCIA) of Ontario. The certified spelt is sold off the farm to ONTARBIO<sup>a</sup>, an organic marketing Co-op run by some of the ecological farmers in the area. Brian is the executive secretary of the Co-op and one of its 55 shareholders. Eighteen acres of spelt yielding 1.25 tons per acre were sold to the Co-op in 1990 for approximately \$300/ton. The Jeffrays buy back a quantity of corn or barley from the conventional grain market at approximately \$100/ton to meet livestock feed requirements on the farm. The milk and lamb go mainly through conventional marketing channels. A small quantity of eggs and approximately 25-30% of the lamb is sold from the farm.

Bev Jeffray looks after most of the eggs, lamb and vegetable marketing. In 1990, vegetables were sold from the farm by running newspaper ads. It was hoped that offering fresh local organic produce would stimulate a local market to develop. However, most of the produce ended up going to an organic wholesaler in Toronto where the organic premium brought a favorable price. In the end direct sales proved time-consuming and difficult to establish. Although they found some loyal customers, the Jeffrays believe that most people find it just too convenient to pick up vegetables at the supermarket. By selling the organic produce to a wholesaler in Toronto, they feel they can get a premium price with a lot less marketing headaches.

#### **IV. 3. Incentives, Limitations and Outlook**

There were two main reasons that the Jeffrays decided to adopt organic farming techniques. The first was that they didn't like handling pesticides, particularly those for corn. Brian says he was annoyed by the difficulty of getting rid of old pesticide containers. "If they are not safe to dispose of, why are we putting pesticide on the fields?" he asks. However, the most significant reason was that the Jeffrays were looking forward to the challenge of working towards a more self sufficient farm and lifestyle. They were influenced on this latter point by Tony McQuail, one of the founding members of the Ecological Farmers Association of Ontario, who was on the local school board with Brian. McQuail had been farming organically with horses since the mid 1970s and had set up his own electricity generating windmill. In the fall of 1987, McQuail suggested that the Jeffrays attend the annual Ecological Farmers Association of Ontario conference in Ethel, Ontario. Subsequently, the Jeffrays relied heavily on the organization's farmer to farmer training sessions and farm tours for information in making the conversion. Brian is now on the board of directors of the EFAO and has held a summer field day and organized a fall workshop for the group.

The Jeffrays also did a lot of reading to confirm ideas that they came across at EFAO events. For much of this information, they visited the Maitland Valley Conservation Authority where an extensive library on ecological farming was developed by Phil Beard. The Jeffrays think that it is important for farmers to have written information at hand to confirm the less formal ideas in more scientific terms.

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<sup>a</sup> The co-op was organized by some of the EFAO farmers in 1989. Local grain elevators were not equipped to handle organic grains so they purchased a mill. The co-op cleans, processes and markets organic grains. A lot of the produce is sold overseas, but an increasing proportion is sold in Canada and the U.S. The EFAO has promoted production of spelt for the speciality market. (It's a popular alternative to wheat). Spelt was a traditional, mixed farm crop. Today, the production in Ontario is entirely organic. The co-op currently handles about 1000 tonnes annually.

No major impediments were incurred in making the transition to organic farming which may be attributable to several factors: the relative ease of conversion of dairy systems, the skillful farm management abilities of the Jeffrays, and finally the guidance of EFAO farm advisor Ted Zettel who had previously gone through transition with a similar starting and ending point.

The economic benefits have been both in reducing input costs and in developing high value crops for off farm sale. In 1989, approximately \$20,000 was saved through reduced input costs (pesticides, fertilizers, feed concentrates). The difference between the sale of organic spelt and purchase of conventional grain is approximately \$200 ton which is a significant revenue advantage. The organic vegetables have also proven to be a worthwhile venture even though marketing and production problems were incurred in the first production year.

Probably the greatest interest has been shown in Jeffrays operation by the older farmers who are less skeptical than younger farmers. Many recall similar techniques that worked for them in the pre-chemical era. Very little interest has been shown in their farm by the local Ontario of Ministry and Agriculture and Food people.

The Jeffrays are critical of commodity subsidy programs and of the many grants that are building or machinery oriented where there is no assessment of environmental or social ramifications. The new federal GRIP program (Gross Revenue Insurance Plan) is the worst; it encourages production of corn and soybean in spite of low demand and at the expense of soil degradation. They would like to see subsidies that were oriented more towards improving the biological efficiency of the farm. They cite grants to improve manure management as an example of a "win-win" grant. It reduces farmers costs because it reduces fertilizer requirements and it also reduces a serious pollution problem.

The Jeffrays believe that a more self-sufficient approach to living is the one ray of hope for our society at the moment. They believe that the conventional system of agriculture has no future in the long term. In an ecological production system, the sun, rain, soil and people generate the production. With a conventional production system everything is running down: the soils won't last, fossil fuels won't last, the diverse landscape is disappearing, ground water is getting contaminated, the genetic pool is disappearing and more and more farmers are encouraging their children to leave the farm. The Jeffrays want farming to be an attractive option for their children.

#### IV. 4. Literature Cited

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## **V. RIDGE TILLAGE AND STRIP INTERCROPPING OF CASH CROPS (Regional Researcher: Roger Samson)**

### **V. 1. Introduction**

The home farm of Colleen and Doug Smith is located close to Thamesville, in Kent County, SW Ontario. The Smiths currently own 275 acres and rent and or do custom work on an additional 600 acres depending on commodity prices and land rental costs. Doug and his brother Jim, who is a salaried employee of the farm, perform all of the field work. Doug is an agriculture diploma graduate from nearby Ridgetown College of Agricultural Technology. Presently, the farm's cash cropping system consists of growing corn, soybeans and winter wheat. For the most part the crops are grown with reduced use of chemical inputs using a ridge-tillage system in which corn, soybeans and wheat are "strip-intercropped" in long, narrow (15 foot) strips. Each strip is routinely rotated into the next crop in the sequence corn-soybean-winter wheat.

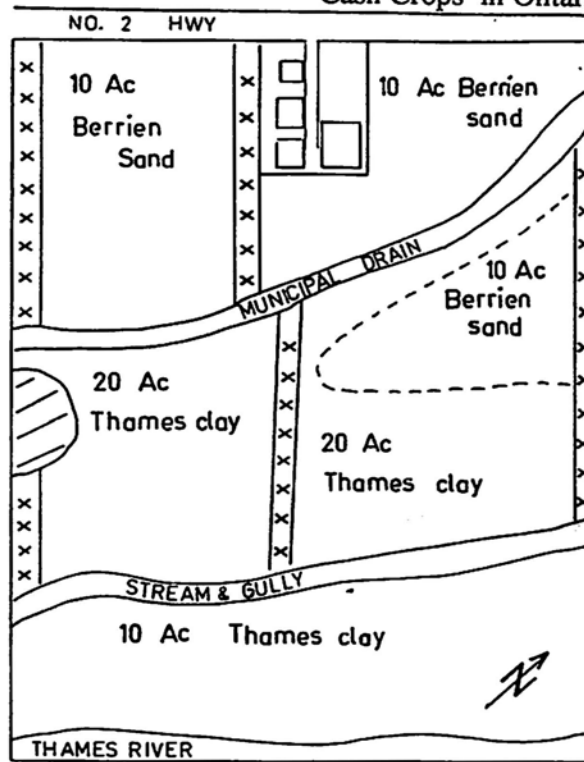
The predominant cropping system on the clay loam soil of Kent County is corn and soybean production with fall mouldboard plowing. Severe erosion problems can exist in the area through the winter and spring period with current land management practices. The fall mouldboard plowing provides minimal ground cover and windbreaks are generally lacking. The prosperity of the agricultural sector in the area decreased in the 1980's and the outlook for the area heading into the 1990's is dismal. The majority of farmers have sought off-farm income as their main means of support since the early 1980's and this trend appears to continue.

### **V. 2 Farm Description**

#### Physical and Capital Resources

Kent county soils consist predominantly of a Brookston Clay loam. Almost all of the farms with this soil type have now been tile drained, with some running of additional tiles between the original tiles. Approximately two-thirds of the acreage currently cash cropped by Doug Smith is Brookston Clay loam. This soil type has high cation exchange capacity and good moisture holding ability. Parts of the home farm and rented land, which are near the Thames river, are sandy loam. The soil type has little effect on the cropping strategy used on the farm except that the heaviest soil has been taken out of corn production. The topography of Kent county is predominantly flat.

The climate in Kent county is typical of south-western Ontario with warm, humid summers and cold cloudy winters. The proximity to the Great Lakes generally provides the area with adequate moisture in most years and a relatively low risk of late or early season frosts. Showers and thunderstorms account for most of the rainfall during the growing season. There is generally very little snow-cover. The Smith farm receives approximately 3250 Corn Heat Units. However, Doug believes his strip -intercropping system creates a warmer micro-climate that can support longer season varieties particularly for soybeans. Crop planting is generally performed early with the relatively warm climate. The ridges generally warm as fast as plowed ground in the area. In 1990 corn planting was completed by May 3. The ridge tillage system enables Doug to complete planting approximately one week earlier than neighboring farms. The main reason is that while other farmers' first spring operation is secondary tillage, Doug's is planting corn.



**Figure V.1. Diagrammatic map of the home-farm. XXXX = Tree windrows.**

Farm buildings are adequate to hold the equipment for the winter and for machinery maintenance. One large shed is used for machinery storage and a second shed is used for equipment repair and maintenance. There is a corn dryer and 5 grain storage bins. Most of the grain is sold or stored through a grain broker.

There are two 95 horsepower tractors 5 and 20 years old. Doug owns a 6-row ridge till planter, a 6-row cultivator with an anhydrous ammonia applicator, a rotary hoe, a deep banding fertilizer device, and a Case-IH combine equipped with a 15 foot header for wheat and a 6 row header for corn and soybeans. Some of the equipment he has access to is owned by the farmer for whom Doug does custom work. This equipment includes a new 15' John Deere no-till drill, a six row Hinniker ridge till cultivator, a field sprayer, a large gravity wagon and a 14' stalk chopper. The largest truck on the Smith farm is a small pickup. All grain is moved in rented trailers or grain trucks. The only other rented equipment is a boom spreader for applying nitrogen fertilizer on the winter wheat.

#### Farm Income

Like many farms in the area, much of the family income comes from off the farm. Colleen works part-time off the farm at the local Ontario Ministry of Agriculture and Food office and Doug obtains approximately half his income from custom work for other farmers. Sources of on-farm income by commodity group are roughly:

- Corn 40-45%
- Soybeans 40-45%
- Winter Wheat 10-15%

Custom work income comes from:

Combining 35%  
Planting and cultivating 35%  
Drying 30%

**Table V.1. Average Yields on Smith Farm (from farmer's records).**

Year	Corn		Soybeans		Winter Wheat		Kent County Averages <sup>a</sup>		
	bu/acre	t/ha	bu/acre	t/ha	bu/acre	t/ha	corn	soybean (bu/acre)	wheat
1988	110 <sup>b</sup>	7.0	40 <sup>b</sup>	2.7	-	-	92	36	62
1989	160	10.2	50	3.4	60 <sup>c</sup>	4.1	132	38	59
1990	175	11.1	45	3.1	80	5.4	123	42	74

<sup>a</sup> From Ontario Ministry of Agriculture and Food statistics.

<sup>b</sup> A record drought reduced yields in 1988

<sup>c</sup> Wheat yield was reduced by *Fusarium*

#### Crop Rotation

When Doug Smith took over the management of the farm in 1975, it for the most part consisted of monoculture corn with occasional crops of soybeans and winter wheat and a small acreage of cash crop hay. In 1984-85 he changed the cropping scheme over to a ridge-tilled, corn-soybean rotation. Winter wheat was introduced as a third crop in the rotation in 1988 on a limited acreage. In 1989, this acreage was increased to 200 of the 800 acres in crop production. However this was reduced significantly in 1990 due to wet fall planting conditions and low prices for wheat. Wheat is generally not grown in the area because of high land values and low crop returns, nor is it grown in ridge tillage systems in Canada.<sup>1</sup> Doug is trying to make the crop an economically viable option by including it in the strip-intercropping system and by either relay-cropping soybeans into winter wheat or by planting a nitrogen-fixing fall cover crop after wheat to reduce nitrogen requirements for the following corn crop. On a 50 acre section on the home farm with heavy clay soil (Fig. V.1), Doug is currently using a two year sequence of soybeans and winter wheat.

#### Tillage practices

Ridge tillage<sup>a</sup> is used for corn and soybean production and no tillage is used when winter wheat is seeded directly into undisturbed soybean ridges. The ridge-till planter sweeps the top of the ridge clean in the spring (sweeping

<sup>a</sup> Ridge tillage is a system in which soil is built into permanent ridges 3-6 inches high and (usually) spaced 30 inches apart. It requires a ridge cultivator to build the initial ridges and for cultivation and rebuilding of ridges, and a ridge planter. In the spring, the ridge planter removes residues and 1 to 2 inches off of tops of ridges to form a level 6 inch seedbed into which seeds are planted; soil and residues from top of the ridges are swept between the ridges. Ridges are built up again by cultivation between the ridges after the crop is established. It began in Nebraska in the 1950s, but because of equipment and management problems was not widely adopted. With trash between ridges) and plants the seed in the raised seedbed. Doug states that he has never had to replant a crop using the ridge planting technique. he cites several reasons: (i) the soil provides earlier soil warming in the spring and because greater surface area is provided by the corrugated

After planting, the row crops are cultivated twice. The first cultivation is primarily for weed control. The second cultivation is used for weed control and for rebuilding the ridge for next year's planting. Ridges are generally built to a height of 20 cm for corn and 15 cm in soybeans. Wheat is no-till drilled in the ridges following soybeans. On the fifty acres of heavy land, the two year sequence of soybeans and winter wheat are performed in a no-till system. Soybeans are direct drilled into a cover crop of winter rye that was planted after harvest of wheat in the previous August. The rye is killed using a contact herbicide. The rye mulch provides effective weed control by shading the soil and possibly also by immobilizing nitrogen which would restrict growth of weeds but has little or no effect on the nitrogen-fixing soybeans.

#### Weed Control Practices.

In the spring, a burn-back herbicide (Round-up at 1 liter/acre or 2,4-D and oil) is used on corn and soybean ground to kill winter-annual and perennial weeds. In corn and soybeans, a 25 cm band of herbicide is applied on ridges at planting and an 18 cm band at the first cultivation. If time permits the row crops are rotary hoed approximately 5-7 days after corn planting and 3-5 days after soybean planting (before emergence of the crops). The rotary hoe only removes weeds on top of the ridge. The first cultivation is performed at a speed of 10 km/hour using a six row Hiniker ridge till cultivator when the corn is 10-15 cm tall and the soybeans 8-12 cm tall. Rotary hoe wheels are used to protect the young plants from excessive coverage of soil and enable the use of high speed cultivation. The steel wheel shields break up clumps of dirt in the crop row and allow fine soil to smother in-row weeds. The spider wheels of the rotary hoe are run backwards to avoid residue build up. On the second cultivation the shields are swung out of position, the weeding discs are removed and wings are added to the sweeps to enhance the hilling effect provided by the cultivation. Doug has added 'Agri-Tech' hardened points to the ridging sweep blades to enable good penetration in firm soil conditions. This final sweeping operation buries any remaining in-row weeds.

In the row crops, problem weeds are mostly perennials. Wirestem Muhly, wild carrot, field bindweed and walnut, willow and Manitoba maple trees are the most significant weeds. Annual weeds are generally not a problem. Annual grass weeds have declined significantly since switching to a ridge till system and Doug anticipates that he will not have to use pre-emergent grass herbicides in the future.

If a good winter wheat stand is obtained, generally no herbicides are applied as the wheat is very competitive with weeds. If broadleaf weeds occur, 2,4-D may be utilized. Growing winter wheat provides a phase for spot spraying of problem weeds. After harvest of wheat, the wheat stubble is

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field effect; (ii) the crop is prevented from flooding because of the elevated ridges; and (iii) germination is ensured as the seed is placed into a moist seedbed (the top 2 cm of dry soil is swept off the top of the ridge at planting). Improvements in equipment and more practical experience gained by farmers, it became more popular in the U.S in the 1980s. It has not yet been very widely used in Canada. Many benefits are cited for the system: (i) soil does not need to be disked or plowed which retains plant residue on the soil surface thereby reducing runoff and evaporation and providing more protection, (ii) rows remain in the same place so traffic patterns are established and compaction is maintained between the rows; (iii) the seedbed is elevated and the top few inches with residue are removed just before planting; this results in good moisture, and in rapid warming which accelerates crop seed germination; (iv) weed seed on the soil surface are moved between rows during planting and weed germination between the rows is slowed by the cooler temperatures; (v) during wet weather the ridge dries more quickly than level ground, but as the season progresses and dries, the furrows retain moisture longer; (vi) fuel and labor costs for seedbed preparation and planting are reduced compared to flat seedbeds. (see Stone et al., 1990<sup>1</sup> and Wicks, 1986<sup>2</sup>).

mowed with a stalk chopper which helps to reduce weed pressure on the establishing cover crop. To date, vetch has been seeded by drill after the harvest of wheat, but it may be drilled in the spring in the future, or at either time. Reproduction of annual weeds after winter wheat harvest is not considered to be a problem as reduction in the seed bank of annual weeds is not part of the farmer's overall weed management strategy. Perennial weeds are seen by Doug to be the only weeds of concern on the farm with existing weed management practices.

#### Fertilization

Prior to planting corn, 150 lb/acre of 6-24-24 fertilizer is knifed into the ridge at approximately 20 cm depth. A liquid starter fertilizer (6-24-6) is applied at a rate of 3 gallons per acre with the seed at planting. In mid-June, 150 lb/acre of anhydrous ammonia nitrogen is knifed between the corn rows.

No fertilizer or inoculant is applied to the soybeans. New soybean ground is inoculated with a powdered peat inoculant containing *Rhizobium japonicum*. No fertilizer is applied to the winter wheat in the fall. In late March, the winter wheat is top dressed with 75 kg/ha (70 lbs/acre) of urea nitrogen.

Doug is cooperating in an on-farm research trial to test use of hairy vetch as a cover crop after winter wheat. Several studies have indicated that it can almost completely replace the use of purchased nitrogen fertilizer for corn the following year.<sup>3,4,5</sup>

#### Pest and Diseases

With the elimination of consecutive corn crops, the need for corn rootworm insecticide was also eliminated. Occasionally some lodging occurs from rootworm damage in the strip intercropping system. Yield losses are minimal however, as the corn header picks up almost all lodged corn. The only insecticide used routinely is D&L (Diazinon and Lindane) seed treatment for corn. Wireworms have proven to be a problem on sandy soils. Disease problems have been minimal in corn and soybeans. The winter wheat was infected by *Fusarium* in 1989. It was a problem throughout Southwestern Ontario and there is little opportunity to develop cultural strategies to reduce this disease problem which is mainly related to climatic conditions at heading.

#### Agronomic rationale and development of the strip-Intercropping system

Doug Smith has always been an innovator in his farming community. He was one of the first farmers to ridge-till and to apply herbicides in bands on rows (i.e. restricting herbicide application to the zones where weeds are most difficult to control).

Doug considers that the key to the success of his current system is the utilization of cropping innovations to take advantage of otherwise unused sunlight. These include (i) strip-intercropping of corn-soybeans-winter wheat; (ii) use of hairy vetch as a cover crop after wheat or relay-cropping soybeans into winter wheat; (iii) increased corn populations in outside rows (40,000 plants per acre versus 30,000 inside) and (iv) double-row (6" apart) seeding of soybeans on top of the ridges.

The permanent nature of the ridges greatly facilitates the development of the strip-intercropping strategy which makes the entire system possible. Strips are 15' wide and each strip is routinely rotated into the following crop in the corn-soybean-wheat rotation. Machinery has been selected to fit the system. A six row corn planter and six row head combine is used for corn and a 15' no-till grain drill and combine head is used for the winter wheat.

Strip-intercropping in the corn-soybean sequence boosted corn yields by approximately 20 bushel per acre with outside rows yielding approximately 60 bushels higher than inside rows (Table V.2).



**Table V.2. Average yields (bu/acre) for successive rows estimated from hand harvests. Data obtained by Adam Hayes, Ridgetown College of Agricultural Technology, Ridgetown, Ontario. Rows 1 and 6 are on the outside of each 15 foot strip. In the C-S-W sequence, R1 of soybeans is adjacent to corn and row 6, to winter wheat.**

CROP	R1	R2	R3	R4	R5	R6	Avg. Rows 1&6	Avg. Rows 2-5
1. Corn, 1988-90	243	177	191	187	193	248	207	187
2. Soybean in C-S, 1989	48	52	54	57	50	35	42	53
3. Soybean in C-S-W, 1989	50	62	64	63	63	74	63	63

However, soybean yields in outer rows suffered as a result of increased shading from the corn (#2, Table II). The idea of introducing winter wheat into the cropping strategy was conceived as a means to improve soybean yields. With the wheat harvested in mid July, the shading problem would be eliminated on one side of the soybean strip. Subsequent hand harvests illustrated that soybeans in the outside row grew out onto the wheat stubble and out-yielded interior rows (#3, Table II). The overall result was that soybean yields were no longer reduced in the strip-intercropping system compared to straight soybeans.

Wheat yields were not affected by the corn as the crop was well past the physiologically mature state when corn began to shade the wheat. The corn benefits the wheat by forming a windbreak for the wheat which reduces lodging. In the spring, the winter wheat also acts as a windbreak to reduce intensity of spring winds which stress young row crop seedlings. However, the wheat remains a marginally profitable crop in this high value land area. Doug is investigating ways to add profit to the wheat sequence by better utilization of sunlight in the 2-3 month growing season that remains after wheat harvest. One method being tested is to seed a hairy vetch cover crop after harvest of winter wheat. This reduces the nitrogen and phosphorus requirements for the following corn crop.<sup>5</sup> Another practice that Doug is currently field testing is to relay crop soybeans into winter wheat. Relay cropping consists of planting one crop into an existing unharvested crop. In this case soybeans are no-till drilled into standing winter wheat at the boot stage. Little damage occurs to the winter wheat during the no-till seeding of the soybeans. At the time of winter wheat harvest in mid-July, the combine cutter bar is raised to enable the wheat heads to be harvested without clipping the developing soybean canopy below.

### V. 3. Incentives, limitations and outlook

#### Summary of Development of Innovations

1983 Ridge tillage

1984 Herbicide banding & corn-soybean rotation

1986 Strip-intercropping corn and soybeans

1987 Higher outside corn row populations; established windbreaks

1988 Strip-intercropping Corn-Soybean-Winter Wheat in 15' strips

1989 Double row planting of soybeans on top of ridge

1990 Relay cropping and cover cropping in winter wheat

The development of ridge tillage was the cornerstone for the development of the entire system and it was due to field observations that Doug Smith developed the system. He began to experiment with conservation tillage in 1973 when he was one of the first farmers in the area to buy a chisel plow. On the chiselled ground he observed that weeds germinated at the top of the ridge earlier in

the spring than in the colder furrows. He decided that this would be the ideal place to plant corn. Upon further research he found out that some farmers in the U.S had been using a system of planting on ridges since the late 1950s. Doug then read the book "More Profit with Less Tillage" by American farmer Ernie Behn. He was ready to make the jump.

In 1983 he visited several farmers who had been given financial support from the Ontario Ministry of Agriculture and Food to begin ridge tillage and in that same year he bought a ridge-till cultivator. After the development of ridge tillage, many of the other changes were conceived as a result of his reading farm press articles from magazines and attending farm workshops. Doug found very little support from the government extension system and until 1990 had essentially relied on his own experimentation and reading to put the system together. In 1990 he began working with the University of Guelph and REAP-Canada (Resource Efficient Agricultural Production -Canada) to develop his cover cropping and relay cropping systems.

Doug now spends considerable time speaking at farmers' meetings through the winter, and telling other farmers about his system. Highlights of Smith's "extension year" in 1990 were speaking at the National Ridge Till Conference in Iowa and holding a Sustainable Farming Field Day on behalf of REAP-Canada. He enjoys seminars where farmers teach other farmers and he believes that this to be a very effective system of information transfer. Doug knows of at least three farmers in Ontario (Jim Scott, Bill Goddard, Jack MacGregor) that are now planting corn, soybeans and winter wheat on ridges in a strip intercropping system as a result of exposure to his system. One farmer in Quebec (Jean Asnong) who visited his farm is now strip-intercropping on ridges in a corn-soybean sequence.

**Table V. 3. Equipment and input costs for ridge tillage**

EQUIPMENT	
<u>Machinery Sold</u>	\$
225 hp 4WD tractor	35000
7-16" bottom plow	7500
35' Glencoe C-tine Cultivator	12000
21' BushHog disk	10000
6 row Kongskilde cultivator	2000
Total	66500
<u>Machinery Purchased</u>	\$
Planter Conversion	4000
6 row Hinniker Ridge Cultivator	9000
Rotary hoe	2500
50 HP tractor	10000
Total	25500

Table V.3, concluded

COSTS OF ANNUAL INPUTS	
Crop and Input	\$
<b>CORN</b>	
Seed (38,000 plants/acre)	37.45
Herbicide: spring burn back	
- 2,4-D 0.49 liters/acre	2.45
& corn oil, 0.5 l/acre	0.93
Dual (10" band at planting), 0.33 l/acre	6.27
Pardner (10" band) 0.19 l/acre	2.39
Fertilizer	
145 lb/acre 5-5-27-27	16.34
2.7 gallon/acre 6-24-6	7.47
177 lb/acre anhydrous ammonia (82%)	22.18
Machine costs	
Ridge till planting	15.00
Herbicide application	6.00
Ridge Cultivation (2)	12.00
Anhydrous application	8.00
Combine	<u>30.00</u>
TOTAL	166.48
<b>SOYBEAN</b>	
Seed 65 lb/acre Canada #1 Common	13.50
Herbicide	
Spring burn back, 2,4-D 0.49 l/acre	2.45
& corn oil 0.93	
Lexone (10" band at planting) 0.16 kg/acre	9.44
Pinnacle (10" band at cultivation)	
3.1 ml/acre	3.10
Machine costs	
Ridge -Till planting	15.00
Herbicide application (burn down)	6.00
Ridge cultivation (2)	12.00
Combine	<u>30.00</u>
TOTAL	92.42
<b>WINTER WHEAT</b>	
Seed 140 lb/acre	25.50
Fertilizer, 150 lb/acre 46-0-0	20.41
Machine costs	
Planting (no-till drill)	20.00
Combine	<u>30.00</u>
TOTAL	95.91

### Economic benefits

One of the major economic advantages that has arisen from making the changes is a lower machinery investment (Table V.3). At the time of the switch, Doug required a new planter and he estimates that it cost \$4000 more for a 6-row ridge till planter than for a conventional planter. In the case of the sale of the 225 HP tractor, no additional tractor was purchased as another 95 HP tractor was already on the farm and capable of doing the field work. Doug anticipates buying a 50 hp tractor to do light jobs on the farm such as rotary hoeing in the spring so this has been included. The rotary hoe was not present in his existing equipment line at the time although most conventional tilling farmers now own a rotary hoe to alleviate crusting problems. Overall the switch reduced his machinery investment by approximately \$40,000-\$50,000 and reduced his required machinery storage area by approximately 50%. Another benefit is reduced fuel costs which are estimated to be 60% lower with ridge tillage than conventional tillage.<sup>1</sup>

### Impediments

Overall, there have been few impediments. One of the first problems to overcome was keeping the planter on the ridge. This was achieved by putting the planter on a three point hitch instead of trailing it behind the tractor.

The other major constraint has been the economics of cash grain production. Doug Smith is concerned that essentially only two companies now control grain sales in Ontario, and that this is keeping crop prices lower than they would otherwise be.

A recent paper on ridge till systems<sup>1</sup> reviewed some of the problems with ridge till on the clay and clay loam soils in Doug Smith's area. The authors suggest that the major impediments to ridge tillage are a restriction of the system to only corn and soybean growing, the need for specialized equipment, and potential yield reductions. Corn yields were found to be slightly lower in ridge-till versus mouldboard plow systems and soybean yields were lower than with narrower row plantings. Doug has overcome all of these problems. He has found that wheat can be successfully no-tilled into existing ridges, corn yields can be increased by following soybeans or winter wheat and by planting the crop in strips. Significant financial savings can be made by reducing the equipment inventory. Switching to planting double row soybeans eliminates yield reductions as soybeans are at full canopy when flowering.

### Ongoing Research

In the past Doug Smith has cooperated with nearby Ridgetown College and the University of Guelph in research projects on the farm. Smith has found Ridgetown College valuable in collecting field data that verifies performance of the various rows in the strip intercropping system. The University of Guelph has been evaluating weed control systems in small plot studies in corn and cover crops following winter wheat. Much of the research work to date has been concerned with verifying the performance of Doug's existing methods. In 1990, he began working with REAP-Canada in field testing different cover crops using a side by side comparison technique with six replications. This on-farm research design is well suited to row crop production using field scale equipment. Doug plays an active role in the research by performing all the planting and harvesting operations and by being involved in planning and evaluation.

### Government Programs

Doug Smith has certain concerns over existing agricultural assistance programs. He carries no crop insurance and believes it only benefits poor producers. Crop insurance plans are averaged over long term yields including poor years where drought etc. bring down yields. As well it doesn't help farmers who have found ways to significantly improve yields as it takes ten years for old yields to stop influencing the average values. Doug says that crop insurance programs need more flexibility and that if a farmer wants to exclude insurance costs for replanting they should be able

to. He states he never replants because he plants on ridges and doesn't see why he should pay for coverage that he will never need.

Doug feels that programs that fund farmers for short term conservation such as in the land stewardship program in Ontario overall do little for long term sustainability. He doesn't like the word "conservation" because it doesn't deal with economics. Unless the economics are right, Doug says, farmers will quickly return to their former practices. He says that of the five original farmers that were helped to get into ridge tillage by government grants in the early 1980's, only two stayed with it. He had a vested interest in making the system work because it was of his own financial doing. Doug Smith believes that conservation compliance programs that require five year farm plans to be drawn up or that restrict plowing and high fall nitrate levels may be more effective.

#### V. 4. References

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## **VI. Grains and Hogs on the Prairies (Regional Researcher: Mark Gimby)**

### **VI. 1. Regional Background**

The Bauml farm is a four family unit consisting of 2080 acres located 13 miles northeast of Humboldt, Saskatchewan in the north central grain-producing area of the province. The average farm size for a single family unit in this municipality is approximately 1100 acres. The farm is situated in the black soil zone on level, gently undulating cropland. The soils are very productive Oxbow and Naicam loams with a capability classification of 2 (capability classification is based on a 7 point scale, numbers 1-4 denote arable land with 1 the most productive and 4 the least productive). The Baumls have also recently purchased 240 acres of bush land at the northern edge of the grain belt 30 miles north of Nipawin, Saskatchewan. Seventy acres of this very sandy land had been cleared for farming. The Baumls at present use this for hunting and recreation, and experimenting with organic techniques.

### **VI.2 Farm Description**

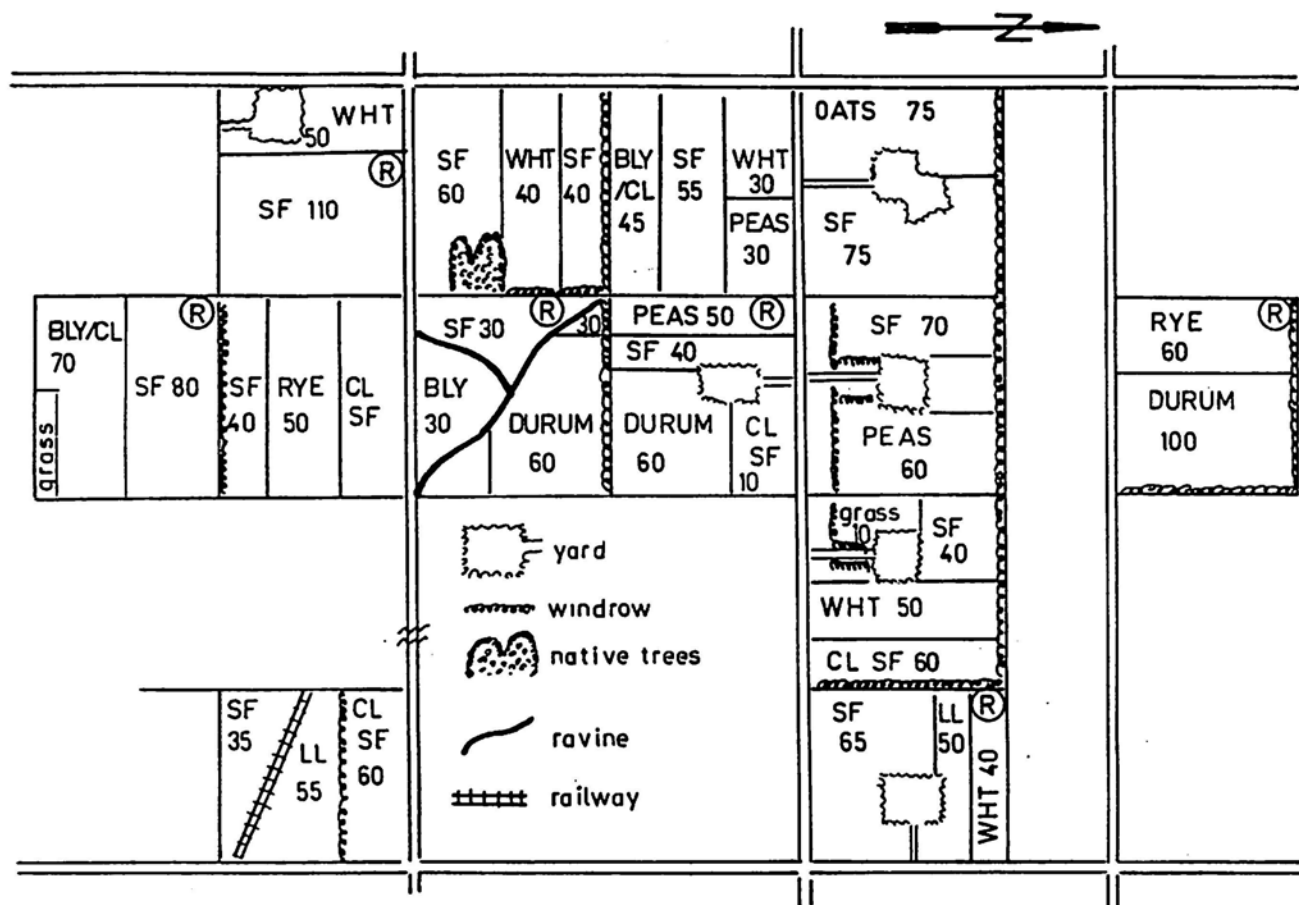
#### Income

The Bauml's on-farm income is derived from livestock and cash crops. In 1990 they sold 780 finished hogs and 20 sows and boars. They also sold two cows, although cattle are raised on the farm for on-farm use and are not normally viewed as a source of income. Wheat, barley and oats are the major cash crops. During 1990 the Baumls sold 9170 bushels of wheat, 4870 bushels of durum, 4835 bushels of barley and 5000 bushels of oats, as well as 3200 bushels of rye and 300 bushels of buckwheat. They also grow legume crops, with 1990 sales amounting to 4600 bushels of peas and 2980 bushels of lentils. 400 bushels of green peas and 1600 bushels of spring wheat were certified through the Organic Crop Improvement Association (OCIA) in 1990, but none had been sold as of January 15, 1991. As well, 1500 lbs of baled brome grass, were sold in 1990.

#### People, structures and equipment

Two generations of Baumls currently operate the farm - Ray, his brother Clarence and Clarence's sons Ron and Dave. The families occupy four farm houses. Farm structures include three machine sheds, three shops, a 50 sow hog barn and 43 grain bins, both steel and wooden, with 50,000 bushels of storage capacity.

The Baumls own three field tractors which range from 125 to 155 horsepower, and two smaller chore tractors. Their field equipment includes a 30 foot hoe drill, a 36 foot and a 39 foot field cultivator, a 36 foot rodweeder, 20 foot tandem disc, 68 foot harrow/sprayer, two pull type combines, three augers, one power take off feed mill, a bulldozer, a front end loader, one swather and one PTO swather, two grain trucks, seven half tons and four cars. They operate their own grain-cleaning plant. Annual fuel consumption on the farm is 20,182 liters of diesel, 33,087 litres of gasoline and 4465 liters of heating oil. All labour, including family labour, amounts to 1460 person days per year.



**Fig. VI. I. Diagrammatic map of Bauml farm. Numbers refer to areas of various crops (1990) in acres. BL = barley, BLY/CL = barley undersown with clover, CL = clover, SF = summer fallow, WHT = wheat.**

#### History of the farm

The farm was homesteaded by the Bauml's great grandfather in 1904. Their grandfather took over in 1917. Brothers Clarence and Ray started farming in 1952 with Clarence's sons Ron and Dave joining in 1978.

In 1952, when Clarence and Ray started farming the land, they had 3.5 quarters planted in wheat, oats and barley; the crop rotation consisted of one-third summerfallow to two-thirds crop. They started using chemical sprays including 2,4-D at that time. In 1952, the brothers cleared and broke 35 acres of bush. Phosphate fertilizer was used for the first time in the early 1960s. In the late '60s, they started growing canola. In the early '70s the brothers expanded their land base with the acquisition of an additional 3.5 quarters. They rented 6 quarters, making their total current total 13 quarters.

Over the past few years the Baumls have been slowly changing their management techniques, cutting chemical inputs and changing their management techniques, and changing their rotations to include 200 acres of clover plowdown per year which is used to combat weeds, build soil organic matter and function as a green manure. In 1990, one of the seven quarters they own was certified as organic by the Organic Crop Improvement Association. Within two years, one-half of their farm will be eligible for certification.

### Livestock

Current holdings of livestock include six cows, two of which were sold in 1990. Pork production occupies a much more important place on the farm. In 1990 the Baumls' 50 sows and three boars produced 80 piglets, 80 weanlings and 240 feeders. A total of 780 finished hogs, and 20 sows and boars were sold in 1990.

The cows are pastured for six months, from early April to late September. They are fed from 600 to 800 hay bales at 50 pounds each, 210 bushels of barley and 50 kg of a purchased mineral mix. They use 200 straw bales for bedding. All are from on-farm sources except for the mineral mix.

The hogs are fed 150 tonnes of purchased feeder feed. As well, the Baumls process 100 tonnes of farm produced sow feed, weanling feed and feeder feed, consisting of 60% barley, 20% wheat screenings, 10% pulse screenings, 5% purchased soy bean meal and from 2-3% purchased mineral supplements. In the future, they plan to process all of their feed using 100% on farm sources, with the exception of the soybean meal and mineral supplements. However, lack of time and the energy costs of grinding feed in -30°C weather are limiting factors.

Veterinary services totalled \$211 in 1990. (The Baumls have not actually needed a veterinarian on the farm in many years, so this might be called medical costs) Medications included antibiotics which came to \$150 and lindane at \$25, with other supplies making up the rest. They plan to try diatomaceous earth to replace the lindane.

Cattle manure is piled, composted and spread on the garden. The pig manure is collected in pits and applied to fields four times a year and worked into the soil.

### Field Crops

The Baumls have changed their crop rotation over the years, especially as they adapt to using fewer chemical inputs. On half of their fields, sweet clover is plowed down in a partial fallow or there is a straight summerfallow. Various strategies e.g., Indian Head lentil plowdown, are being implemented as a substitute for straight summerfallow. Half of the fields are seeded to crops including spring wheat, durum, peas, lentils, barley, buckwheat, oats, rye, and red clover. They are considering introduction of beans as part of their rotation. In 1990, 300 acres were seeded with grain legumes and 600-700 acres with cereal crops. They try to rotate a plowdown crop every five to six years. The only forage is 30 acres of native hay and five acres of seeded brome grass on which cows are grazed.

The major weeds on the farm are green foxtail, wild oats, stinkweed, wild mustard, buckwheat, sow thistle and Canada thistle. Tillage and crop rotations are used to minimize the effect of the weeds.

The Baumls observed that rye and oats have allelopathic-like effects on weeds. They observed that sweet clover is also harmful to weeds; on fields where sweet clover is grown they have fewer weeds than when they used chemicals.

The Baumls practice delayed seeding and post emergent harrowing to control weeds. Small amounts of chemical herbicides are still used. In the spring of 1990, they sprayed 200 acres with Treflan and 50 acres with Dival. They hope to eliminate herbicide use within two years.

They use a cultivator, hoe drill, rod weeder and harrow to till their land. They rod weed after seeding before the crop emerges and harrow after the crop is up to control weeds. A rotary hoe tested for post-emergent weed control on the farm in 1990 appeared to improve yields (Table VI.1). They plow down their clover with a tandem disc and cultivator and summerfallow four



times a year, three times with the cultivator, and once with the rodweeder, which saves as much trash as possible. Because they have flat land, water erosion is not a problem, but they still summerfallow carefully, and don't work the ground too much.

The Baumls recognize that the use of straight summerfallow results in soil degradation and is the weakest link in their farming operation. They plan to address this problem by expanding sweet clover ploughdown. Also annual legumes, i.e., Indian Head lentil, will be experimented with as a ploughdown in 1991. Other techniques being considered include the use of the wide blade cultivator to maximize trash cover and the use of livestock grazing of green manure planted on fallow fields to reduce tillage.

There are no pest or disease problems of great concern on the farm.

**Table VI.1. Yields of wheat as affected by post emergent weed control methods. Yields are for 14.5% moisture grain harvested from 4 one square meter quadrats in each treatment strip. Values are means and standard deviations.<sup>1</sup>**

Farm test location	Wheat Yield		
	Check	Harrow	Rotary Hoe
	(kg grain/ha)		
Glen Ewen	1970 ± 310	2040 ± 410	
Humboldt	3190 ± 150	3350 ± 310	3510 ± 320

#### Shelterbelts

The Baumls have 6-7 miles of shelterbelt which they plan to extend further. They began planting the shelterbelts in 1970, through the influence of two of their neighbours. They plant mostly poplar, but also have some green ash, chokecherries and willows. The poplars draw more moisture horizontally because of their fibrous roots than some other tree species recommended for field shelterbelts, but they are quick growing and tall, making up for any extra moisture loss. (The width effect of shelterbelts in the field is proportional to tree height, H; the effects are observable for 10-15 H of the trees).

#### Fertility management

No chemical fertilizers are used. Instead, they use green manure, plowing down their second-year clover in mid-June at the early bud stage. Comparisons of different treatments suggest that over the short term, use of clover increases the yield over planting on stubble but not as much as tillage fallow (Table VI.2). They also apply pig manure, which is spread four times a year and worked into the soil. They have experimented with soft rock phosphate and PB 50, a biological seed treatment for phosphorous enhancement (Table VI.3). PB 50 is a natural soil organism (*Penicillium bilaji*) which is reported to assist crops to make more efficient use of phosphorus fertilizer.<sup>2</sup> The product is sold through the Saskatchewan Wheat Pool. In this case, it had no evident effect on the crop, but it was not determined whether the crop would respond to a more soluble phosphate fertilizer.

**Table VI.2. Response of wheat yield in 1989 and 1990 to sweetclover hay harvest or plowdown in 1988. Comparison is made with wheat planted after wheat (stubble), or after a tilled summer fallow. Yields are for 14.5% moisture grain harvested from 4 one square meter quadrats in each treatment strip. Values are means and standard deviations.<sup>1</sup>**

Position	Spring Soil Test Values				Fertilizer Applied	Wheat Yield	
	N	P	K	S		bu/ac	kg/ha
1.1989							
Stubble	38	38	550	29	50 lbs N	20.2	1360
					100 lbs N	20.4	1370
Partial fallow							
(a) hayed	89	28	610	82	None	23.9	1610
(b) plowdown	102	28	630	75	None	32.4	2180
Tillage fallow							
	137	15	479	65	None	33.6	2260
					50 lbs N	37.3	2510
2. 1990							
Stubble							
(a) 0 N (89)	72	22	656	116	43 lbs N in	23.8	1600
(b) 50 N (89)	172	22	526	180	11-51-0	23.1	1560
(c) 100 N (89)	360	22	812	200	"	23.7	1590
Clover (88)							
(a) hayed	314	28	816	124	"	27.3	1840
(b) plowdown	192	26	610	132	"	28.3	1900

**Table VI.3. Yields of spring wheat at four sites in 1990 with or without rock phosphate and PB 50 seed treatment. Yields are for 14.5% moisture grain harvested from 4 one square meter quadrats in each treatment strip. Values are means and standard deviations.<sup>1</sup>**

Farm Test Location	Rate of Calphos (kg/ha)	Wheat Yield			
		Check	Calphos	PB50	Calphos/PB50
Pense	100	3350±370	3460±560	3030±320	3350±390
Glen Ewen	78	2520±520	2480±470	2360±500	2470±550
Humboldt	112	4030±320	4170±310	3620±420	3570±200
Leoville	112	1940±560	2410±410	1880±330	2550±140

### VI. 3 Incentives, limitations and outlook

The Baums practice many techniques that are innovative and contribute to long term sustainability. Legume ploughdowns, legume grain crops, post emergent tillage and fall seeded crops such as fall rye, and the planting of shelterbelts are all practices that are not common in their area.

These practices have been developed over a number of years. They began planting of shelterbelts in 1970, legume ploughdown in 1975, and use of legume grain crops, post emergent tillage and fall seeded crops in 1988. Environmental and economic concerns were the main motivation behind changing their techniques. Their innovative practices are intended to reduce input costs and to contribute towards the long term sustainability of their land. The Baumls question the effectiveness and long term viability of farm chemicals as well as the health risks these chemicals pose. Many farmers feel sick for the several weeks in spring and fall when spraying is done. Ray recalls that there used to be lots of Franklin Gulls feeding on earthworms in the soil; the gulls and the earthworms are pretty well gone now.

The main impediment facing the Baumls as they made their transition was a lack of information. They used farm publications, information gathered from the on-farm research projects carried out with Saskatchewan Research Council and Ray's memory of his father's pre-chemical farming techniques to help them make the transition. Extension services and farm product sales people were not of much help because they were geared to conventional farming.

The Baumls have noticed growing interest by neighboring farmers in their cropping techniques and in growing shelterbelts, and recently government agrologists have been expressing interest in the farm. More than 150 people showed up at a field day held on the farm in the summer of 1990. The Prairie Farm Rehabilitation Administration tree nursery at Indian Head, which gives farmers free trees and information to help them grow the trees is a government funded program that the Baumls consider to be conducive to SA practices.

However, as a whole, they feel the entire system is stacked against sustainability. Policies are designed to help big farmers. For example, acreage payments, the quota system and almost all research is still designed to help the larger, more intensive farms or encourages more capitalization rather than promoting low input practices, or smaller systems. It's difficult to get equipment for smaller systems, yet the big equipment is not economical.

The Saskatchewan Research Council (SRC) has been of assistance to the Baumls. The SRC does on-farm demonstrations for example, to illustrate the use of green manures. The Baumls cite also the 4H, production clubs and other rural organizations like AERO as being of some help in their search for information. (AERO stands for Alternative Energy Resources Organization, a non-profit, citizen organization dedicated to community-based development and the wise use of soil, water and other natural resources. Formed in 1974, it has more than 450 members and works through public education, technical assistance and leadership development. AERO is based in Helena, Montana). They also find that the Organic Crop Improvement Association and Canadian Organic Marketing Co-operative Limited, based in Girvin, Saskatchewan are becoming more helpful.

David Bauml is worried about changes in the environment such as the ozone destruction and climatic warming but he is optimistic about organic farming. As part of organic farming, we should leave some of the land in its natural state, he says, and consider the wildlife part of the rotation.

Ray Bauml says things will have to change to ensure the long term viability of the family farm. He remarks: "We have already lost, or almost lost, one generation of farmers. It does not look like this will turn around in the near future. The idea of growing grain for export, I think, has had its day. We will have to look at new crops and possibly new markets if we want the family farm to survive. We will probably have to go back to a more mixed kind of farming, with different kinds of livestock, possibly silviculture. We would be happy to just make a living farming. We don't need to get rich. The social aspect is great, the neighborliness has to be experienced to be believed. The challenge of farming without using hazardous chemicals and poisons is very exciting."

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## VII: AN INDUSTRY IN TRANSITION: TREE FRUIT FARMING IN BRITISH COLUMBIA

(Regional Researcher: L. Edwards)

### VII. 1. Introduction

#### Industry background

The tree fruit industry in British Columbia is in difficulty. While there are many schools of thought about how the current situation evolved, there is no disagreement that for approximately the past ten years, the majority of growers have not received prices in the market place equal to the cost of production of their fruit. Increasing world production and the advent of a global market, are certainly part of the problem. For example, over half the apples grown in B.C. are Red Delicious, a variety that has frequently given a negative return to the grower in the past few years. This is at least partly due to high production of this variety in the U.S. and elsewhere. Subsidies and off-farm incomes have been needed for many to continue farming.

There are approximately 20,000 to 30,000 acres (8100-12100 ha) of tree fruits in the B.C. Interior. The average size of an orchard in the 1986 census was 8.7 acres (3.5 ha). This is a decline from 10.4 acres (4.2 ha) in 1971.<sup>1</sup> There are approximately 2000 fruit growers. About 75 % are members of the B.C. Fruit Growers Association, a co-operative committed to one desk selling. Most of the large, independent growers market through an independent packing house. Other independents sell from their farm or to markets they have found.

The 40 to 50 persons growing organic fruit in the Okanagan Valley market their products outside of the B.C. Tree Fruits umbrella. The average organic farm is 6 acres (2.4 ha) and in the whole valley there are less than 150 acres (61 ha).

Cherries, peaches, apricots, prunes and plums are grown in the B.C. Interior but apples are the largest crop (75 % of production) and pears the second largest.

There are two events which have the potential to result in marked changes in the industry over the next few years: (1) a significant portion of the industry replanting new varieties, especially apples, at densities with the potential to greatly increase the volume of fruit produced, and (2) a non-chemical means of controlling codling moth, the major pest of pears and apples.

(1). In 1990, following a Commission of Inquiry conducted by the provincial government into the state of the tree fruit industry, a body - the Okanagan Valley Tree Fruit Authority - was established to oversee a ten year program to revitalize the industry. It is proposed<sup>2</sup> that this will be achieved by replanting with varieties that should command good prices in the world market and by producing high quality fruit on dwarfing rootstocks. While other subsidies are slated to be withdrawn, almost certainly making most of the standard plantings even more unprofitable than they already are, there will be financial assistance available to those who are willing to replant and who qualify. The latter is to be based on the growers ability to successfully plant and grow these trees. Exactly how that will be determined has not yet been established.

It is estimated that as much as 20,000 of the approximately 30,000 acres of tree fruits need to be replanted.<sup>2,3</sup> Most orchards are still comprised of standard sized trees - mostly Red Delicious, Spartans, Golden Delicious and MacIntosh - planted at densities of less than three hundred per acre. Growers are being encouraged to replace these plantings with high density plantings of up to 1000 trees per acre. Special dwarfing rootstocks are used - mainly M9's and M 26's. Trees come into production much earlier than with standard rootstocks and yields can be much higher. Because of the smaller size of the trees, labour costs associated with pruning, picking and spraying are greatly reduced. However, new skills are required to take care of these trees. These high

density plantings cost \$ 10,000 to \$ 15,000 per acre to plant, mainly because of the large number of trees required and the support systems necessary for them. Wires and posts replace the need to grow a strong trunk.

These methods have been used in Europe for many years. Holland in particular is held up as the model and many growers and extension people from the Okanagan have visited there. The Dutch undertook a similar renovation of their industry about 15 years ago. Although production has greatly improved and increased, there are still many climatic disadvantages such as lack of light which may always make profitable fruit growing very difficult. This renovation resulted in a downsizing of the industry by 2/3 of the land and 1/2 of the growers. While some growers are prospering, over-all the industry is still not a very profitable one (Mike Saunders, B.C. Ministry of Agriculture Apple Specialist, Ko Reinhoudt & H. Wiedenhoff - Dutch agricultural specialists visiting in the Okanagan this year)

(2). Pest control in tree fruit production is also in transition. The majority of the industry rely on a program of chemical sprays applied at times and rates laid out in the B.C. Tree Fruit Production Guide. This is a handbook revised yearly by local researchers and extension people. However, because of the arid climate and cold winters and the isolated nature of the area, local growers are able to use less chemicals on their tree fruits than anywhere else in the world. Pests like apple maggot, oriental fruit moth and plum curculio are not found here. For approximately 20 years, control of red and McDaniel mites has been almost totally by predator mites. The north end of the Okanagan is wetter and has to control scab on a regular basis but the pressure is still low compared with eastern Canada.

Development of resistance to chemicals by insects, mites and diseases in an increasing number of instances and a declining rate of chemical replacements, concern by consumers about what is or what is perceived to be toxins on produce ( Alar, the EDBCs) and pressures from urban people living in rural areas, has accelerated the need to reduce the use of chemicals even further.

Codling moth are a very serious pest of apples and pears. Conventionally they are controlled by organophosphates - usually azinphos-methyl. When these sprays are applied with the right timing - a relatively easy thing to do - excellent and economical control is achieved. There are no biological or cultural controls that are very effective and up to 100 % of the fruit can become infested if nothing is done. This has made them the chief limiting factor for production of organic pome fruit in most areas.

From 1976 to 1978, the Summerland Research Station carried out a pilot program of releasing sterile codling moth in the Cawston area. The result of this was excellent control of the pest.<sup>4</sup> The program was abandoned because the cost of continued releases was more than twice the cost of chemical control. However, even though the program was discontinued, many orchards did not require codling moth control for 4 to 6 years afterwards. There had been some organic tree fruit growing in the area previous to this. During the codling moth-free period, the organic tree fruit industry greatly expanded.

Reintroduction of codling moth into the area in about 1983 resulted in rapid build-up of the pest. Conventional growers returned to spraying, sometimes up to four times a year. Organic growers tried a wide number of techniques in what proved to be not very successful attempts to control this pest. One of the main techniques adopted was removal of infested fruit throughout the season. The costs of this increased each year until in 1989, most organic orchardists were spending prohibitive amounts.

Under the leadership of Wayne Still, they petitioned the federal and provincial government to revive the program. There was no debate about its effectiveness. However, the cost effectiveness

was a concern as was implementation of the clean-up program.<sup>5,6</sup> Release of irradiated males is effective only if wild populations have been reduced to a very low level; the goal is 0.05 %. To date, this has meant a very intensive program of chemical sprays and/or fruit and tree removal. Most commercial growers are controlling codlers below 1%. Organic orchards and backyard trees were of particular concern.

A third in a series of cost effectiveness studies was conducted in 1987.<sup>7</sup> It concluded that if the program was carried out for the whole Okanagan and Similkameen, that it would be cost effective. Since then, the industry has worked to gain grower support, involvement of the regional districts to administer the program and the money to implement it. Financing is still not in place although general agreement has been obtained to proceed with the program.

In the meantime, entomologists at Summerland Research Station had been doing some small scale experiments with codling moth mating disruption with pheromone. In 1990, a large scale experiment with this technique in the organic orchards in the Cawston area reduced codler damage from somewhere around at least 50 % (Hilary Sampson, B.C. M.A. district horticulturist) to less than 1 % (Gary Judd & Don Thompson Ag Can entomologists, personal counts at W. Still's farm). More experiments are planned for the coming year to see if this method can be successfully used in all types of terrains. One way or another, it is just a matter of time, until control of codling moth with a non-chemical solution is available for all growers. The immediate impact of this is that the organic growers' yields in 1990 have increased by at least 20 %, perhaps more and that their costs decreased.

The other consequence is that many conventional growers who were deterred from becoming organic growers because of codling moth are now planning to do so. Considerable acreage, far in excess of what already exists, is likely to become organic in the near future. Expansion of markets will be necessary to maintain the profitability of organic growing.

#### Cawston

Cawston is located in the Similkameen Valley - the southern interior of British Columbia, bordering on the U. S. It is an almost exclusively agricultural area with approximately 2000 acres planted to tree fruits. Apples are the main variety. However, most orchardists also grow apricots, peaches, pears and cherries.

There is less pressure in this area than in many others in the Interior from encroaching urban communities. Also replanting to the new varieties on the dwarfing rootstocks has occurred here at a more accelerated rate than elsewhere in the valley.

Cawston is also unique in that it has the largest number of acres in the Okanagan Similkameen under organic production. There are 41 organic orchards in the area; a total of 117 certified acres and 143 acres in transition. The Similkameen Okanagan Organic Producers Association, requires 5 years for organic certification. Reducing this to 3 years to harmonize with provincial and federal guidelines is currently being discussed by the association. The average size of the organic orchards is 6 acres. The largest is 12 acres. The majority of these became established during the codling moth free years.

The prices that the organic growers receive for their produce have been high - on average 4 to 5 times that received by conventional growers for fruit of the same type. However, since the resurgence of codling moth, volumes were reduced, costs greatly increased and overall profitability low. During this same period, conventional growers in the area had no significant changes in costs and volumes of marketable fruit have been high. However, those with the standard varieties have not done well because of the low prices. Those who have already replanted to new varieties such as Gala and Granny Smiths have received high prices - far above cost of production.

This year, because of the success with codling moth mating disruption, the organic growers now have lower costs, higher volumes and prices still well above the cost of production. Growers who were both organic and growing the new varieties did the best of all.

### Climate

The climate of the Similkameen valley is very arid. Summers are hot and dry and irrigation is required for agriculture. Growing degree-days average above 1390<sup>8</sup> and sometimes in excess of 2000. Winters are crisp, generally over-cast with little snow and with air temperatures below freezing for about 10 weeks. The region is in the rain shadow of the Coast Mountains. Occasionally arctic air masses bring brief cold periods when temperatures drop to -25. These can result in damage to the trees ranging from bud to tree kill.

### Soils

The Similkameen Valley is located in the extreme south central part of British Columbia. It is incised into the Interior Plateau and runs north-south for 30 km and is from 3 to 15 km wide. The level valley bottom elevation is in the 270 to 300 m range but side slopes rise out of the valley to over 1100 m above sea level.

Much of the soil is deposits of fluvial (alluvial) floodplains along the Similkameen River and fans from streams. The parent material of these Rego Brown soils consists of a gravel free, medium-textured fluvial veneer between 30 and 75 cm thick overlying coarse textured fluvial fan deposits. Surface and subsurface textures are either silt loam or loam while the subsoils are gravelly loam. The soils are well-drained with a high water storage capacity. Organic matter levels tend to be low. Soil pHs in the area are generally alkaline.<sup>9</sup>

### Water

The source of irrigation in the area is deep wells operated under the auspices of the Fairview Heights Irrigation district or privately owned. Water from these is alkaline. Sodium and calcium levels are high, particularly the latter.

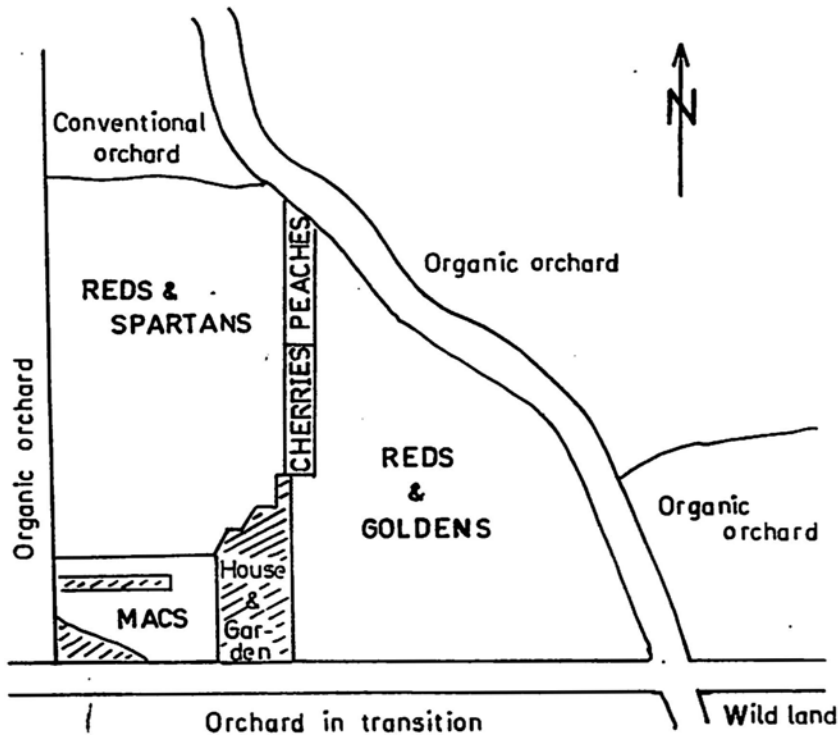
## **VII. 2 Vialo Orchard and Apiary: Farm Description**

Vialo Orchard & Apiary is a five acre certified organic orchard located in the Cawston area. It is owned and operated by Wayne Still. Except for buildings and a garden, most of the acreage - 4.5 acres (2 ha) - is in production. It is bordered by organic, conventional and transitional orchards. A hillside of native vegetation is to the immediate east of the orchard.

### Farm History

Red Delicious, Golden Delicious and Winesap apples were planted into virgin soil in 1952-53. The land had been a mixture of sage brush and native grasses. About 1960, MacIntosh apples were interplanted on the west side of the orchard. Only three Winesaps remain; most were removed or grafted over to Spartans in 1984. Most of the Golden and Red Delicious are still the original trees. Soft fruits - mainly peaches and cherries, were planted respectively, in 1980 and 1984.





**Fig. VII.1** Diagrammatic map of Vialo Orchard and Apiary. The total area is 4.5 acres.

Wayne Still took possession of this orchard in 1979. Until then it had been farmed conventionally. He used some chemical sprays and fertilizers in 1979 and 1980. However, from 1981 onward, the fruit has been grown with only organic methods and materials.

Wayne regards his orchard as an heritage orchard preserving for example, some of the old Red Delicious strains such as Starking and Harolds, the Winesaps and a tree of wood grafted from the first apple tree ever planted in the Okanagan Valley.

#### Crop Composition

The orchard has 440 apple trees and 62 soft fruits planted at an average density of 111 trees per acre (274/ha). There are 190 Red Delicious of various strains, 90 Golden Delicious, 80 Spartans, 60 MacIntosh mature trees. There are also twenty new trees - 20 summer apples (Solo and Sumac) and 2 Galas. They are all on semi-standard and standard rootstocks.

The Red Delicious are easy to grow and make up the bulk of the fruit produced. They are of excellent quality, grading at about 80% fancy or extra fancy. All varieties have good flavor and texture and store well, remaining firm and crisp in ordinary cold storage well into May and June.

The production of the MacIntosh has been consistently poor. They are also a poorly colored variety. Without chemical thinning - an option not available to organic growers - the Golden Delicious tend to overset one year and have little or no fruit the next. Pruning and blossom thinning have not been successful in breaking this cycle. They are also prone to mildew damage and fruit size has been poor.

The orchard also has 20 peach trees and 6 nectarines, 36 cherries, a pear tree and an almond tree. The cherries and pear are young trees not yet in production.

Other sources of farm income

For the first four years after beginning to farm, Wayne derived part of his income by working for other local orchardists. However, since 1982, his livelihood has been obtained entirely from his orchard and apiary.

Income from 60 hives for honey sales and rental for pollination have averaged 24.7 % of gross farming income over the past 11 years. The demand for honey is currently down but he has been able to sell all of his, mostly to local buyers. This season, he began using organic management methods with his bees. This has resulted in an outbreak of American Foul Brood which is being treated by burning the infected equipment. As a result, honey production is down. Wayne feels this is consistent with the experience of other farmers who make the transition from conventional to organic management methods. He is optimistic that in time, production will increase.

Wayne also investigated raising and selling free range chickens. There was a market for them - mostly specialty restaurants in Vancouver. However, testing showed that the chickens ( and presumably any raised in orchards) contained 2.7 ppm of DDT residues from use of this compound in the orchard some 20 years before. The maximum allowable is 1 ppm.

Vegetation management

In early spring, the smaller prunings are chopped up with a mower and left as mulch on the orchard floor. There is a diversified understory of indigenous grasses and broadleaf plants - 12 or more varieties - under the mature trees . Grass, plantain, mallow, lambsquarter, pigweed, alfalfa and clovers predominate. When Wayne began farming this land, the understory was mainly couch grass with a little alfalfa.

The orchard is mowed again when the alfalfa in the understory flowers mid-June. A strip of about 3 feet in every tree row is left as a habitat for beneficial insects. A third mowing, done in the opposite direction as the time before, is done at second flowering about mid-July. After that the plants are left to flower and seed and help with hardening off of the trees.

The ground is kept clean by hand weeding around the base of newly planted trees. Overwintered carrots are planted in sites throughout the orchard, providing large umbelliferous flowers for beneficial insects.

Fertilization:

The soil in the orchard is a typical alluvial fan with the coarsest deposits on the east side and a finer, less gravelly silt deposits on the west side. The organic matter levels are moderately high at 4.5 %. The pH is 7.6. All nutrients except boron are high.

The orchard is operated as a woodlot with trees of different ages and with a minimum of intervention. Mulching of the cover crop is integral to the soil management program. Plants with deep tap roots such as mallow and dandelions may be contributing to soil fertility by breaking up the hard pan, aerating the soil and bringing nutrients to the surface. Wayne feels that the large root surface of the mature trees enables them to extract sufficient nutrients from the soil. The natural composting action of fallen fruit, mulched prunings and mowings would contribute to this and compensate for loss due to fruit removal.

There is an abundant and inexpensive local supply of turkey manure mixed with sawdust. In 1979 and 1980, a layer of turkey manure was applied to the MacIntosh trees one inch thick to the drip line of the trees. In 1982, except in the MacIntosh area, a layer of the same material was applied with a manure spreader in strips between the rows . The following year, the Spartans had severe bitterpit. This may well have been the result of imbalances created by the fertilization.<sup>10, 11</sup> The whole orchard was treated again in the fall of 1986 and the Golden were lightly fertilized in the

fall of 1990. Newly planted and young trees are mulched with the turkey manure. They also receive ground and foliar fish fertilizer applications.

Soils in this area are usually deficient in boron and zinc. Because these micronutrients play an important role in bud development and fruit set, annual foliar application of both is standard procedure. Wayne stopped applying these foliar sprays to the mature trees 3 years ago. However, in view of the boron deficiency identified in the soil and a poor fruit set in the Golden's in particular, he may resume this.

Wayne maintains a flock of free ranging chickens. Their activities - scratching in the soil around the trees - may have some beneficial effects.

#### Irrigation

Watering is done by movable pipes. Wayne begins about the end of May and will water 6 to 8 times until the middle of August. A late fall irrigation is done to insulate the roots with water for winter.

#### Equipment

Wayne has a number of equipment sharing arrangements with his neighbors. He shares an air blast sprayer with two neighbors who are also organic growers, and a manure spreader and a 5 ton truck with one of these and two conventional growers. He has an arrangement with his closest neighbor to use a tractor in return for pollination services and honey. This neighbor also uses Wayne's mower. In addition to the mower, Wayne also owns fruit bins and picking equipment such as ladders and picking bags.

#### Pest Management

This year, Wayne's pest control program consisted of 2 dormant oil sprays for San Jose scale, sulphur at petal fall for mildew and putting out pheromone dispensers for codling moth mating disruption.

Checks of fruit in the bins in Vialo Orchard at harvest revealed that insect damage was on average 3.3 %. This is equivalent to the average for a conventionally sprayed orchard. The damage breakdown was 0.7 % codling moth, 2.5 % leafroller and/or budmoth and 0.1 % scale.

Since they first reappeared in the orchard in 1983 and until this year, codling moth have been the most serious pest and the limiting factor for the production of apples and pears. One of the techniques used in an attempt to control them was summer long inspection and removal of infested fruit from the tree. The majority of the infested fruit was in the top half of the tree. To make this operation easier to do, Wayne cut out the tops of the trees and lowered them so that only 6 foot ladders were necessary. However, this year (and presumably henceforth or until Sterile Insect Release is implemented), all that needed to be done was placement of the pheromone dispensers in the trees before mating began in the spring.

Budmoth, leafroller and fruitworm can be controlled fairly well by *Bacillus thuringiensis*. Fruitworm and spring leafroller damage is finished before thinning so Wayne stopped applying sprays for them two years ago. Fruit thinning is carried out every year. This is done to increase fruit size. Any damage done before this time can be selectively removed at that time.

Budmoth and second generation leafroller damage occurs after this time and consequently unless control measures are taken, is usually a source of insect damage to apples.

San Jose Scale can also be a problem in this area. Dormant oil sprays provide control. When this was not done for two years, this insect became a serious cause of fruit damage in Vialo Orchard in

1989. Application of two dormant oil sprays in the spring of 1990 reduced fruit damage to less than 1%.

Birds caused 1.5 % damage. However, 11.6 % russetting from powdery mildew was the main cause of down grading of the fruit in 1990. Application of sulphur sprays (an acceptable organic product) at times when the fruit is susceptible and removal of infested shoots at thinning can control it.

Wayne did not find it necessary to carry out a lot pest control in regard to his soft fruits. Cherry fruit fly can be a very serious problem on that crop. The damage destroys the fruit. Conventional growers use a systemic spray. Organic growers in the south usually grow early cherries and are able to harvest their cherries before this pest begins its cycle. The cherries in this orchard are young with little production yet so that the problem is still one for the future.

Pear slug, a member of the sawfly family which attacks both pears and cherries has become worse and is causing extensive leaf damage over the past 3 years. So far, no one is sure how to control this pest.

The black cherry aphid is a potential problem. Wayne has dealt with it by removing the infested growing shoots and an application of Safers insecticidal soap; he also puts a band of tanglefoot around the trunks to prevent ants from climbing up and tending flocks of aphids. Otherwise, cherries have few pest problems.

Peach twig borer and leafroller can be a problem in peaches. B.t. is generally used for their control. Aphids are an occasional pest. Peachtree borer infestations are very damaging.

Wood rots are common in most older orchards. Ten per cent of the trees have been removed for that reason.

Rodents are controlled by cats and a dog.

#### Comparison with conventional management

PEST MANAGEMENT: An average conventional apple grower in the same area would have carried out the following pest control program:

1. 1 to 2 oils for scale: the same as Wayne.
2. A pink and possibly a petalfall insecticide for fruitworm, leafroller and/or campyloma. These were probably organophosphates and would have been combined with fungicides ( sulphur or Benlate or Easout) for mildew. Wayne did not apply anything for insects after the oil spray. He did put on a sulphur petal fall spray for mildew and could have almost certainly reduced russetting damage (11.6 %) if he had also applied one at pink. There might be years when fruitworm in particular were high enough to make a B.t. spray worthwhile. Some local organic growers apply one or two of these during this period.
3. Three Guthion sprays. Financially equivalent to the cost of the pheromone dispensers. They only required one operation while the sprays were three.
4. Possibly an organophosphate for budmoth or second generation leafroller. However, the codling moth sprays usually take care of these pests. Wayne could have possibly reduced the damage done by these pests (3.3 %) with a well-timed B.t. spray during the summer.

5. One to three herbicide operations, mainly in the tree rows using compounds such as paraquat, glyphosate and simazine plus mowing between the rows. Wayne mowed only and many organic growers with mature trees do the same. However, many also use cultivation and hoeing which are much more labour intensive and expensive than herbicides. These methods are essential with young and dwarf rootstock trees. Conventional growers use cultivation, hoeing and mulches - often - plastic on their nursery and newly planted trees.
6. Rodent control is usually one or more applications of mouse baits in the fall. Wayne relies on predation.

**OTHER ORCHARD MANAGEMENT:** Most of the sprays applied by conventional growers which are not done by organic growers are in regard to other aspects of growing apples.

For example, the conventional growers would have put on two thinning sprays. These cost considerably less than hand thinning and prevent biennial bearing in trees prone to this. They also use growth regulators to avoid excessive fruit drop in the fall.

Many conventional growers also apply a number of nutrient sprays such as magnesium sulphate and calcium to prevent storage disorders. There may be some organic growers also using these.

Conventional growers in this area sometimes use manure. Many also use ammonium sulphate.

**EXPENSES:** Wayne does most of his own work - pruning, tree training, mowing. His main hired labour costs are for thinning early in the year to reduce the crop load and increase fruit size and for harvest. Between 1986 and this year, additional hand thinning throughout the season to remove codler infested fruit more than doubled his total bill for labour.

His expenses in regard to fertilizers and pesticides are much lower than those of a conventional grower.

Other expenses - for machinery, insurance, bee supplies etc. have been fairly consistent and similar to conventional growers.

Over-all expenses have ranged from 70 to 150 % of gross income. This is not dissimilar to the conventional growers with standard trees.

#### Marketing:

Fruit from Vialo Orchards was sold through the local co-op - part of the system handling and marketing 70 % of the tree fruits industry - from 1979 until 1984. Since 1985, he has marketed through Apple Whale, a locally based organic marketing organization. He sorts and packs his own fruit, adding \$ 2.00 to the value of each box.

Spartans return the best income. Vialo Orchards is in fact, a major producer of certified organic Spartans. They average 21.50 a box and are sold mostly on the Lower Mainland and Vancouver Island. Red Delicious are paying 18.50 per box and the other conventional varieties are somewhere in between.

Culls are sold for juice and average \$ 0.15 /pound - a price much higher than what conventional growers get for some of their fancy and extra-fancy standard varieties.

Prices have increased since Wayne started marketing his fruit as organic. This has been throughout the period when codling moth damage was increasing in all organic blocks.

**Production**

Production in this orchard has declined since 1982. From 1979 until 1982 the orchard produced an average of 155 bins. From 1983 until the present this has dropped to an average of 94 bins per year or by 40 %. There have been a number of reasons for this: reversion of the Golden Delicious to biennial bearing, age of the trees, tree removal - approximately 20

Winesaps in 1984, and the removal of bearing surface in renovating the trees to make it easier to remove codling moth infested fruit are some of them.

**Renovation Without Replant**

Much of the orchard is old and old orchards as a rule become increasingly less productive. The usual practice is to remove them and replant. Wayne decided instead to renovate. When he bought the orchard, the trees were very large with few branches on two sides due to wind patterns in the area. He pruned to correct this.

Because young wood bears superior fruit, he also began removing any branches over 4 or 5 years old. He also began tying and using wires to hold down branches to stimulate fruiting buds and by pruning to generate lots of young wood.

The renovation is now complete and the effect of these efforts should become apparent in the coming years.

Renovating older trees as described above is a unique innovation. Pruning heavily to stimulate new growth is common but tying down etc. is not. Standard practice is to remove old orchards especially if they are producing fruit with low market value. This has become much more feasible than in the past because of the dwarfing rootstocks. The dwarf plants are also very precocious and instead of having to wait for several years before cropping, can be producing sizable amounts of fruit the year after planting and in full production within 5 years instead of 10. It is unlikely Wayne's method will be widely adopted over the alternative method. As well, replanting on the new rootstocks also allows growers to quickly change varieties to take advantage of markets. This is not of as much concern to Wayne as it is to conventional growers.

The majority of trees in the Still orchard are Red Delicious, a variety which is generally considered to be non-viable in the conventional orchard community. An overproduction of this variety in Canada and the U.S. have resulted in little or no returns to the grower. Frequently, after costs are deducted, there is a negative return on this variety. In the south Okanagan, MacIntosh and Spartans often do not get the color demanded by the market and when this occurs, do not return cost of production. Golden Delicious have also been worth relatively little in the market place for some time.

This orchard would be non-viable as a conventional orchard and as such, replanting to new and more market acceptable varieties would be mandatory to make the land productive again. Other organic orchards in the area with standard varieties and trees are in the same position. As conventional orchards, they would have neither the volume or price per pound to remain in business. However, because the prices of standard organic fruits average 0.50 to 0.55 per pound, they can be viable. These types of trees average 20 to 30 bins per acre with a bin of apples weighing on average 825 pounds. Conventional fruit of the same varieties average between \$ 0.02 and \$0.18 per pound.

**VII. 3 LIMITATIONS AND INCENTIVES**

Wayne Still feels that more research is needed in regard to systems soil and pest management, for machinery suitable for in row vegetation control, for cover and/or nitrogen fixing crops and habitat enhancement to encourage beneficial insects. A reliable, non-chemical control of cherry fruit fly has replaced codling moth as a priority.

While individuals from the provincial Ministry of Agriculture and from Agriculture Canada have provided services and conducted research that has been very helpful, over-all policy and direction has not been supportive of organic growing. Very recently, the initiative to develop organic standards and projects such as the one currently being carried out by the Canada Science Council indicate some changes.

Wayne sees organic food production as part of a much larger environmental context, as part of a global clean-up and as the only viable alternative. He is optimistic that both organic growing and markets for this produce will expand together. He feels prices for the conventional varieties will continue to be high enough to make it worthwhile to keep growing them.

He is chairman of the South Okanagan Organic Producers Association established in 1986. This association has 52 members, 41 of whom have tree fruits. Many also grow ground crops. A few grow berries, hay, herbs, nuts and cattle. Both Wayne as an individual and as a member of SOOPA is very active in promoting and encouraging organic growing.

#### **VII. 4. Perspectives on the Future of Conventional and organic growing in B.C.** (L. Edwards)

Probably in order to be successful (financially sustainable), the conventional producers need to adopt one or more of the following strategies:

1. Be first: with a new variety that the market wants (or for which a market has been developed) - New Zealand's marketing of Granny Smiths, Galas and now Braeburns are examples of this - to get the initial high prices resulting from a limited supply and to already be switching to something else when the rest of the world is starting to plant the variety you introduced. B.C. has the breeding program to do this but not a selection and promotion arrangement. Generally, industry personnel and many growers have adopted the strategy of trying to be early adopters. There is a strong feeling that we are too small to be leaders or that there is less risk involved in copying what is hot elsewhere - regardless of whether or not it is adapted to our growing conditions and knowing less risk also means less profit.

2. Be cheapest: the U.S. has lower production costs than the B.C. fruit industry. So do a number of other fruit producing countries. These are related to factors such as the cost of labor and land prices. We cannot be cheapest without changing our whole way of life.

3. Be best: a consistent supply of high quality fruit is essential in a competitive market. Even today with an over-supply of Red Delicious, those who can meet that criterion will probably make some profit. Anyone who can produce high quality fruit of whatever variety is currently "hot" will do very well. Unfortunately, the desire to grow what is currently commanding a good price in the marketplace is resulting in growers planting varieties in areas where there is a great likelihood due to climatic restrictions, that only an inferior product can be produced. Too little attention is being paid to picking the variety best suited to the climate. There would also have to be changes at the packing houses and throughout the whole system in regard to quality control.

Consistent production of high quality fruit is the option most often extolled by industry leaders as the answer to the industry's problems.

4. Have a unique product. The B. C. fruit industry is not a large one. In fact, it produces less than one half of one percent of the world's total tree fruit production. Niche marketing might be at least a partial profitable alternative to the present marketing systems.

While there are some who feel niche and specialty marketing might be an avenue to explore, industry leaders to date and the majority of the growers have not shown much interest in niche marketing in general and organic or pesticide-free growing in particular.

Most feel that survival and success depends on trying to coattail on the success of others - in particular, New Zealand and Washington.

An example of successful niche marketing is the organic growers in the Cawston area. They have been able to command prices at least double and often many times more than those received by conventional growers by producing an uncommon product. For example, in 1989, Red Delicious averaged 2 cents a pound before subsidies for conventional growers while organic growers averaged 50 cents per pound, with no subsidies.

They market at fruit stands, directly or sell to one of the two organic wholesalers in the province - Apple Whale operating out of Cawston and Wild West Organic Harvest Co-op based in Richmond. The demand for their product has exceeded supply - a supply which for the past 5 to 6 years has been at least partly limited by codling moth.

The availability of not one but two non-chemical controls for codling moth has at least temporarily made apple and pear growing very economically viable again for Wayne Still and the other organic growers in the area.

However, it may have an effect far beyond this. A number of conventional growers in the area and elsewhere in the valley are planning to begin the transition to organic growing. There are a number who have been very sympathetic to this method of agriculture but were deterred by the devastating effect of codlers. There are also a number of growers who believe that the answer to economic survival might be growing a relatively unique product and niche marketing. The number of acres involved far exceed that currently certified.

Another interesting statistic is that there are currently 47 of the 117 certified acres that are apples. The rest are soft fruits. However, 117 acres of the 143 in transition are apples. Next year, 38 acres now in 5th year transition will be certified. This will almost double the volume of organic apples. Unless the market expands, the organic apple growers, especially those with the more traditional varieties may soon be facing some of the same price problems due to over supply as the conventional growers with conventional varieties currently are.

In Washington State last year, 60,000 boxes of organic apples - mostly Red Delicious - were produced by growers with one shipping organization. This year that increased to 120,000 boxes. This requires a movement of 6 truckloads (6000 boxes per week) to sell the fruit in the sales period. Demand is for only 400 to 600 boxes a week. The difference in price is \$ 2.00 per box. Cost are averaging \$ 3,000.00 per acre more than conventional apple costs. The high prices are mainly due to an average of 9 and as many as 20 sprays per year of ryania and *Bacillus thuringensis* for codling moth. (information courtesy of Tom Auvil, fieldman for the Trout Packinghouse)

Some local organic growers, like some conventional growers, have already started planting the new varieties at high density using dwarfing rootstocks. Prices for Jonagolds, Galas, Fuji and Granny Smiths average \$ 0.95 per pound. Yields range from 25 to 30 bins per acre (825 pounds/bin) and are expected to increase each year for a number of years. These apples bring 0.50 to 0.75 on the conventional market.

The organic growers in the Okanagan and Similkameen are practising environmental sustainability. Economic sustainability in the future will mean finding more markets and possibly being more market responsive in not only supplying organic apples but supplying organic apples of varieties of



high value in the market place at any given time. They may benefit from a melding of their growing methods with the new systems of planting and varieties.

And finally, because of the vastly improved control methods now available for what has been a major pest, both they and conventional growers joining their ranks should be able to produce high quality fruit at a relatively low cost.

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## A. THE REGIONAL RESEARCHERS

Linda Edwards has a B.A. degree in sociology from the University of Saskatchewan, and B.Sc. and M.Sc. degrees in agriculture dealing respectively with crop protection and entomology. She is President of Integrated Crop Management Inc., an agricultural research and consulting company located in Okanagan Centre, British Columbia. The company has contracts with orchards and berry growers to advise them on all aspects of producing food from an integrated crop management perspective, researches various aspects of integrated crop management and gives courses in integrated management, mainly for growers.

Mark Gimby is a Senior Research Technologist at SRC (Saskatchewan Research Council) in Saskatoon. He was raised on a mixed farm in the parkland area of western Saskatchewan and is a graduate of the School of Agriculture of the University of Saskatchewan. He has been working in the Biomass Resources Section of SRC for 13 years doing farm research projects aimed at reducing inputs of fuel, fertilizer and herbicides. He is currently Associate Manager of the Viability of Organic Agriculture Project which is examining the practices of 16 organic farmers in Saskatchewan. He also works as inspector for the Organic Crop Improvement Association.

Pierre Jobin has a BSc in agriculture from Macdonald College. He worked for 5 years at the Institut de Technologie Agricole de St. Hyacinthe for MAPAQ, (Quebec Ministry of Agriculture) mainly as an Instructor on horticultural crops. In 1988, he left the ministry to set up CDAQ (Centre de Developpement d' Agrobiologique du Quebec), a non-governmental organization with headquarters in Ste. Elizabeth de Warwick, in the dairy farming region on the south shore of the St. Lawrence. He is a Technical Consultant for a "Club d'Encadrement" organized by 12 dairy farmers. The farmers provide 20% of the funding, and 80% comes from a QDAFF (Quebec Dept. Agriculture Fisheries and Food) program which supports hiring of consultants by farmer groups. All of the farmers are in a process of transition to organic agriculture, some are already certified.

David Patriquin, also the coordinator of the Case Studies, is Professor of Biology at Dalhousie University in Halifax, Nova Scotia. He has MSc and PhD degrees in Marine Sciences from McGill University. He developed an interest in SA after spending a postdoctoral fellowship in a soil microbiology laboratory at Macdonald College and several visits to an agricultural research station in Brazil where he worked on nitrogen-fixing bacteria. Since 1977, he has conducted research on organic and conventional farms in eastern Canada with emphasis on nitrogen cycling at the whole farm level. He works with several farmer groups in eastern Canada, organized a Bioregional Farmer/Scientist Workshop on Organic Agriculture in 1988, and has served as a consultant on SA in several developing countries.

Roger Samson is President of REAP-Canada (Resource Efficient Agriculture Production) based at Macdonald College in Ste. Anne de Bellevue, Quebec. REAP-Canada is a non-profit organization formed in 1987 to promote SA through on-farm research, conferences, and publications. He is coordinator of their on-farm research program and editor of their quarterly magazine, Sustainable Farming. He is a graduate of the University of Guelph (BSc) and Macdonald College (MSc).

## **B. INFORMATION SOUGHT IN CASE STUDIES (GUIDELINES GIVEN TO REGIONAL RESEARCHERS)**

1. **REGIONAL BACKGROUND:** The landscape/climate/soil and its suitability for farming; its historical use; economic status of farms in the region.

### **2. FARM DATA:**

(i) A map of the farm, including information on areas and current use of fields; woodland, waterways; location of buildings; description of landscape, soil types.

(ii) Source of on-farm income, by commodities; indicate total sales in numbers, weights or volumes, or land area.

(iii) Farm structures; equipment and fuel consumption; labor (indicate person-days including family labor)

(iv) One generation history of the farm.

### **LIVESTOCK**

(v) Current holdings of livestock in different breed/age/sex categories and numbers bought/sold in the last year. Calculate livestock loading in terms of Large Animal Units per hectare of land.

(vi) Feed for livestock in the following categories:

- Number of days on pasture (give approximate dates);
  - Total weight of hay/silage (specify) fed;
  - Grain, specify;
  - Other feed, supplements;
  - Bedding (straw, other);
- For each indicate outside purchases versus on-farm source.

(vii) Total expenditures on medications, veterinary services for one year; specify principal needs.

(viii) Indicate means of collecting, processing and applying manure.

### **FIELD CROPS**

(ix) Rotation of crops; how consistently is the scheme followed? Calculate proportion of farm in soil-building, neutral and soil-degrading crops.

(x) Tillage practices, primary, secondary.

(xi) Use of fertilizers: amount, formulation; how are amounts decided; has the farmer experimented to find an optimum? Use of soil analyses.

(xii) Use of manure, compost, green manures. How are they managed, how much does the farmer allow for them in terms of fertilizer applications? Other fertilizing supplements used (e.g. fish emulsion).

(xiii) Weed control: what are the major weeds, weed problems, and means of dealing with those? Give amounts and types of herbicides. Researcher should list the major weeds noted in fields.

(xiv) Pests and diseases: what are the major problems; how is each dealt with? Give amounts and types of any pesticides used.

(xv) Composition of forage mixes; how often are forages seeded down; how? Comments on maintenance of feed quality, and persistence of legumes in long term forages.

(xvi) Pasture management: fencing; rotational grazing; overseeding; stocking rates etc. Researcher should examine pastures for legume cover (estimate percent).

#### INNOVATIVE PRACTICES

(xvii) Describe practices considered by farmer and/or researcher to be innovative for the region and contributing to long term sustainability.

(xviii) When were these innovations made (year)? What prompted them? Sources of information, assistance used.

(xix) Comment on the economic benefits or costs of the innovations.

#### LIMITATIONS, INCENTIVES

(xx) What impediments were encountered in making the innovations?

(xxi) What interest has been shown in them by (a) other farmers, (b) government personnel?

(xxii) What other innovations would the farmer like to make that would contribute to greater sustainability, and what are current impediments to making those (e.g information, time, finances)?

(xxiii) Comment on government policies or other activities that the farmer considers (a) conducive to sustainable agriculture practices; (b) encourage short term gain at the expense of long term sustainability.

(xxiv) What other institutions (universities, business, non-governmental organizations) have been of assistance. How?

(xxv) Comments of the farmer and family on their view of the long term viability of the family farm, e.g. on its financial security, the interest of offspring in taking it over etc. How do they view their activities, lifestyle in relation to society at large, how do they feel society at large views their activities?

(xxvi) Other comments by farmer and family related to the economic, social and ecological sustainability of farming.

(xxvii) Other information as available and appropriate, e.g. historical data on soil nutrients, yields, economic data; reports by other researchers.

(xxviii) Are there any major activities on the farm, major flows of materials into and out of the farm or within the farm, any chemicals used or any major expenditures in the farm that are not referred to above? Please elaborate.

### C. FACTORS FOR CONVERTING METRIC AND IMPERIAL UNITS

The metric system is standard in most areas of commerce and government in Canada, but a mixture of units is used in agriculture, officially and unofficially. The units given in the report are those cited by regional researchers and farmers, except that where a combination of metric and imperial units was reported (e.g. kg/acre), one system or the other was applied. "Ton" refers to the imperial measure (2000 pounds), and "tonne" to the metric measure (1000 kg). Some conversion factors for units used in this report are:

**Imperial to Metric:**

pounds to kilograms: multiply by 0.454  
tons to tonnes: multiply by 0.908  
inches to centimeters: multiply by 2.54  
acres to hectares: multiply by 0.405  
pounds/acre to kilograms/hectare: multiply by 1.12  
tons/acre to tonnes/hectare: multiply by 2.24

**Metric to Imperial:**

kilograms to pounds: multiply by 2.20  
tonnes to tons: multiply by 1.10  
centimeters to inches: multiply by 0.394  
hectares to acres: multiply by 2.47  
kilograms/hectare to pounds/acre: multiply by 0.892  
tonnes/hectare to tons/acre: multiply by 0.446.

#### D. USE OF THE TERMS "COVER CROP", "GREEN MANURE CROP" AND "CATCH CROP"

The terms "cover crop", "green manure crop" and "catch crop" are not consistently applied and are commonly used without being defined. Some ambiguity in their use is inevitable because they describe ecological functions or niches of the crops, and the crop may fulfil more than one of those at a time. Further, the possible functions of a species can vary according to the climatic regime in which it is used.

"Cover crop" generally refers to a crop whose primary function is to cover the land and protect it from erosion. A common example is winter rye planted in the fall, and worked into the soil in spring rather than being allowed to mature. "Cover cropping" refers to a system of cropping that maintains cover on the soil with different crops regardless of whether that is their main function. For example in the rotation below<sup>1</sup>, ryegrass is planted as a cover crop, wheat is planted for grain but also functions as a cover crop, and the oilseed radish is planted as a catch crop. The oilseed radish grows late into the fall but if not tilled before freezing weather, is "winter-killed", leaving a protective mulch on the surface of the soil. A crop used in this way is sometimes described as a "winter-killed cover crop".

<u>YEAR</u>	<u>CROP</u>	<u>WINTER COVER</u>
1	Corn grain	Ryegrass, established by interseeding in corn at last cultivation
2	Soybeans	Winter wheat, established by aerial seeding into soybean at leaf yellowing
3	Winter wheat	Oilseed radish, seeded after harvesting winter wheat, tilling soil and incorporating liquid manure

"Green manure" usually refers to a crop whose primary function is to increase the fertility of the soil for the next crop by adding readily decomposable organic matter to the soil, fixing atmospheric nitrogen (if it is a legume), and/or mobilizing soil nutrients. Such crops are worked into the soil when they are green and succulent (usually before or during early flowering) so that they decompose quickly, releasing nutrients and stimulating microbial growth.

Green manure crops do not generally contribute very much to the more stable fraction of soil organic matter, but they often improve soil structure. That is a result of microbial growth producing gums and hyphae which bind soil particles, giving the soil a good tilth. Also the green manure provides food for earthworms which in turn improve soil structure. Some workers use the term green manure only for legumes, in which case the addition of nitrogen to the soil is considered the critical function. Others use it for both legumes and non-legumes. Although the non-legume does not make a net addition of nitrogen to the soil, it may improve the nitrogen supply for the next crop by conserving nitrogen; because the green manure is turned in when the C:N ratio is low, this N is released quickly to the next crop. Some green manure crops are particularly efficient in taking up or mobilizing soil nutrients that are not readily available to other crops. These nutrients are made available to the next crop when the green manure decomposes. For example buckwheat can improve the phosphate supply in this way. Fertilizer or animal manure is sometimes added to the soil before green manures are planted to increase the organic matter production by the green manure, or because it is a convenient point to add nutrients.

An example of a green manure crop is vetch planted in late spring and turned under prior to planting a winter cereal. Green manure crops are often intersown in main crops. For example, red clover might be seeded with an early harvested summer cereal or intersown in a winter cereal in spring. After the cereal is harvested, the clover grows rapidly until mid-fall. It might be turned into the soil in mid-to late fall, or after further growth in the spring. The final hay crop in a field to be taken out of hay is often turned into the soil "as a green manure" or "clover plowdown". In the rotation cited above, the brassica crop might be considered a green manure if it was ploughed into the soil before freeze-up, but it probably wouldn't be if it were allowed to winter-kill and worked into the soil in spring (by then, the composition of the foliage would have changed substantially). A crop that is cut and used as a mulch is not usually considered to be a green manure.

**"Catch Crop"** In England, "catch crop" is used to describe "snatching of an extra crop between two of the main crops in a rotation", e.g. ryegrass and trefoil intersown in a summer cereal to provide some fall grazing after harvest of the cereal or to provide cover in winter; or mustard planted after a mid-summer fallow and plowed in as green manure before the next crop. Uses of such crops are cited as provision of stock feed at difficult times of year, replacement of main crops that have failed, conservation of nutrients (especially nitrates), checking of weeds, and additions of crop residues when plowed in.<sup>2</sup>

In Canada, the term "catch crop" is often used more restrictively to refer to a fast-growing crop that is planted after cultivation of soil to conserve the flush of nutrients produced on cultivation. Catch cropping of this nature is not common, but is increasing. Many organic farmers use brassicas as catch crops, seeding them in mid-summer to early fall after harvesting cereals (as in the rotation above) or after turning over hay sod. As noted above, such crops might be referred to as winter-killed cover crops if not cultivated until spring, or as green manures if cultivated before freeze-up. Some types of brassicas are sown in mid-to late summer to provide late season grazing. If the crop was grazed intensively and most of the vegetation removed, it is not a catch crop in the restricted sense of the term, nor would the terms green manure or cover crop apply.

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