State of Resources Report

based on farm practices surveys conducted on 1998 and 1999.

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Introduction

Resource Management is a Strategic Priority of the ministry. The objective is to support resource management and stewardship programs in order to maintain and protect land and water resources for agriculture and fisheries. The ministry is required to measure effectiveness in accomplishing this and other objectives. It is very costly to directly measure soil and water quality and to relate such measurements to specific agricultural activities. This type of data is also very difficult to interpret. Therefore, an alternate method for measuring program effectiveness is required. The alternate approach chosen for the State of Resources project was to conduct surveys of producers to collect data about practices used on their farms.

A survey of livestock producers was conducted by Statistics Canada in October/November of 1998 and collected baseline data on a range of farm activities, including:

- manure and fertilizer management
- soil management
- water conservation measures

A survey of crop producers was conducted by Statistics Canada in March/April of 1999 and collected data on:

- manure and fertilizer management
- water management
- irrigation
- soil management

This same survey will be repeated every 3 to 5 years. Over time trends will be determined for practices such as manure storage, ratios of land to animal numbers, irrigation scheduling, cropping practices, etc. Analysis of these trends will be used to evaluate effectiveness of ministry programs and to make modifications to programs.

In Context

Organization for Economic Co-operation and Development (OECD)

The OECD member countries, including Canada, are committed to developing ways of evaluating the impact of agriculture on the environment. In September 1998, the OECD held a workshop in York, England on 'Agri-Environmental Indicators'. At the workshop, David Baldock, Institute of European Environmental Policy, presented a paper titled "Developing and Using Agri-Environmental Indicators for Policy Purposes" and presented the following reasons for developing indicators:

- the need to monitor progress in meeting international commitments, such as the

Biodiversity Convention and Kyoto Protocol;
- the growth of legislation embodying specific environmental goals and targets;
- increased interest by many governments in evaluating the environmental impacts of policies;
- a trend towards legislation in which there is formal obligation on public authorities to evaluate the impact of their policies;
- a growing perception that such indicators are relevant to the international debate on agriculture policy, support levels, international trade and environmental quality, especially in the WTO.

Agriculture and Agri-Food Canada's (AAFC) AEI Project

Agriculture and Agri-Food Canada is leading a program to develop agri-environmental indicators for Canada. Since the 1989 Agrifood Policy Review there has been increased emphasis on the importance of resource and environmental sustainability and the need for indicators to track progress and target programming. In December 1993 an initial countrywide workshop was held in Aylmer, Quebec to discuss indicators and provide guidance to the AAFC indicators program. A subsequent 1995 workshop in Fredericton reviewed progress and provided guidance on future directions and activities. The project will be completed in 1999 with detailed reports on the following indicators:
- soil degradation risk;
- risk of water contamination;
- agro-ecosystem greenhouse gas balance;
- agro-ecosystem biodiversity change;
- land use efficiency;
- farm resource management.

Kyoto

Canada is a signatory to the Kyoto Protocol on Greenhouse Gases. To comply with the Protocol, Canada has established a greenhouse gas reduction target of 25% below the 'business as usual' situation by the 2008-2012 time period. The national implementation strategy is to be in place by 1999.

Carbon sinks, in particular the role of agricultural soils as carbon sinks, are being considered as a mechanism for helping to achieve emission reduction targets. Soils have a very large carbon pool and there are many ways for agriculture to increase the size of the soil pool. Current estimates are that 8 - 18% of Canada's commitment could be achieved through soil sequestration. Verification will be a key issue if soil carbon is to be included as a sink; this means a clear, valid method that is accepted internationally. There will have to be a good deal of rigour to the verification process before Canada will be allowed to include agricultural soils as a sink, and, in turn, each

province will have to meet certain verification standards. Indicators and data about these indicators will be essential to have certain farming systems accepted as contributing to carbon sinks (e.g. grain and oilseed production in the Peace and Interior range lands) and to evaluate other farming systems that have been identified as contributors to greenhouse gas emissions (e.g. livestock farms).

Indicators

It is apparent that at both national and international levels it will become increasingly important for the British Columbia agriculture industry to be able to measure and report on the impact of farming practices on the environment. However, in an era of scarce and diminishing resources, it is a challenge to identify indicators that are both valid and recognized and economically feasible to measure. The approach chosen is to measure the degree to which farmers are using 'environmentally friendly' management practices.

This approach is based on answering this question: "Are farmers using environmentally sound practices". Adoption of sound practices is a proxy for physical and chemical measurements of soil and water quality.

The rationale for this approach can be illustrated by using soil organic matter as an example. Soil organic matter, which can be estimated from soil carbon, is a key constituent of mineral soils. Without at least a minimal level of organic matter, soils have no value for agriculture. Therefore, trend lines that show decreasing levels of soil carbon over time would appear to indicate that the soil is being managed in an unsustainable manner. Stable or increasing trend lines would appear to indicate sustainable management. What, then is the problem with soil carbon as an indicator?

1. Time: Measurable, statistically valid changes in soil carbon occur over a very long time horizon. A decade or two is probably the shortest time over which useful data could reasonably be expected to be collected. Even with adequate base-line information and sufficient monitoring sites, useful information will only become available many years into the future.
2. Feasibility: Can it be done? Can we collect sufficient soil carbon data to make useful interpretations? How many sites need to be sampled, how often, using what methods, where in the province? It may not be even feasible to survey the province in sufficient detail to judge soil carbon trends.
3. Cost: Assuming it is feasible to do a soil carbon survey, what would be the cost? For this and other soil parameters that have been proposed as indicators, a massive new soil survey effort would be required to collect the data. It is simply not reasonable to expect governments to fund this type of effort.
4. Interpretation: How would one interpret soil carbon data? Less is bad, more is good? The best information on soil carbon in Canada is on the prairies. The small grain farming systems of the region have resulted in significant loss of the native

organic matter. This was seen as a potential disaster. However, it is now believed that a new stable organic matter plateau has been reached (especially where continuous cropping is practiced). The soils are capable of producing as much biomass as ever and the loss of native organic matter does not appear to have had any widespread negative impact. So how should one interpret data on soil carbon?

Many of the proposed indicators deal with the physical and chemical nature of soil and water. Trend data will indicate whether important quality parameters are moving in a negative or positive direction. However, these data are not linked to social and economic factors such as the stewardship ethic of the producers, commodity prices, etc. Some experts contend that physical and chemical data in isolation from its social and economic context is of limited utility.

In British Columbia efforts have been devoted towards identifying the key sustainability elements of a range of production systems. Measuring the degree of adoption of these elements by farmers will provide a good measure of the environmental sustainability of the industry. Two examples serve to further illustrate this approach: small grain production and dairy farming.

The key sustainability element of small grain production is soil cover. If the soil is adequately protected from wind and water erosion and organic residues are being returned to the soil, there is good evidence that the system is sustainable. The key question that needs to asked then is “Are farmers using systems that maintain adequate soil cover?”

For dairy farming, the key element is proper manure management. If farmers have sufficient land and storage to use manures in a safe manner as a fertilizer for crop production, the system is probably sustainable. The key question is “Do farmers have enough land and storage for their manure?”

Method

The State of Resources project was initiated in 1997. Mr. Jeff King prepared a report titled “Agriculture State of Resource Reporting Project”. His work was conducted under the direction of a ministry steering committee which included Ron Bertrand (Chair), Greg Tegart (Southern Interior Region), Dave Melnychuk (South Coastal Region) and Allan Blair (North Central Region). The King report was used as the basis for a more comprehensive project to design suitable questionnaires for farmers and ranchers

Initial versions of both questionnaires were developed using a focus group approach. Producers from around the province and from all commodity groups to be surveyed attended focus groups conducted by GroundWorks Strategic Marketing Solutions. The

focus groups determined the relevance of the questions, whether or not the questions could be easily answered and suggested changes to the questions and additional questions.

The questionnaires were finalized in consultation with Statistics Canada officials. Statistics Canada conducted the livestock farm survey during October and November of 1998 using a phone survey technique. The crop farm survey was conducted in March of 1999. Aspects of the survey included:

- farmers reporting gross returns of more than $25,000 in 1995;
- farms operated by the same operator as in 1995;
- dairy, hog and poultry farms in the Lower Fraser Valley;
- beef operations in the interior;
- cereal grains and oilseed farms in the Peace River Region;
- tree fruits and grape operations in the Okanagan and Kootenay areas;
- berry, vegetable, potato and nursery operations in the Lower Fraser Valley;
- the total usable sample size was 965 responses, distributed across the geographic and commodity strata described above.

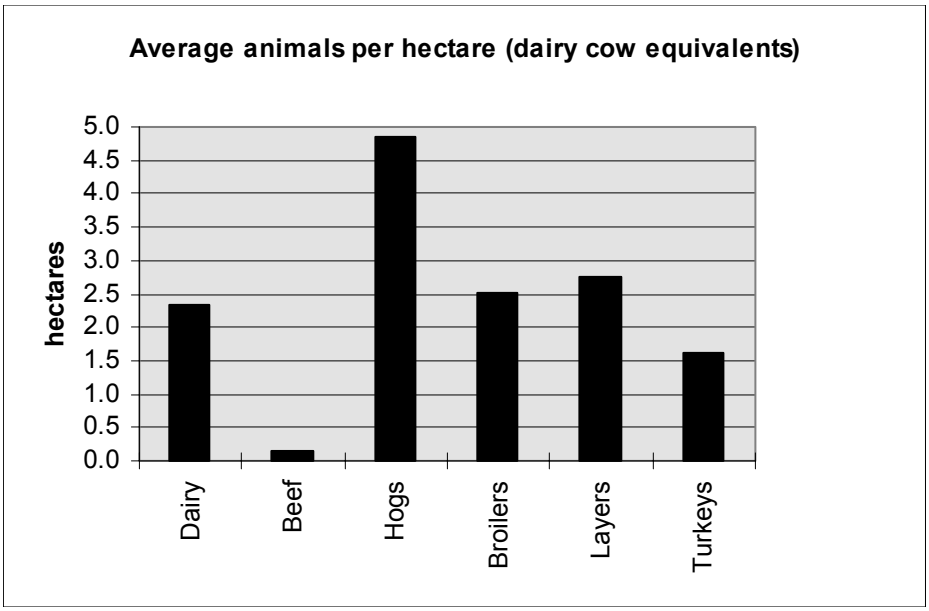
Findings from the Livestock Farm Survey

Manure Management

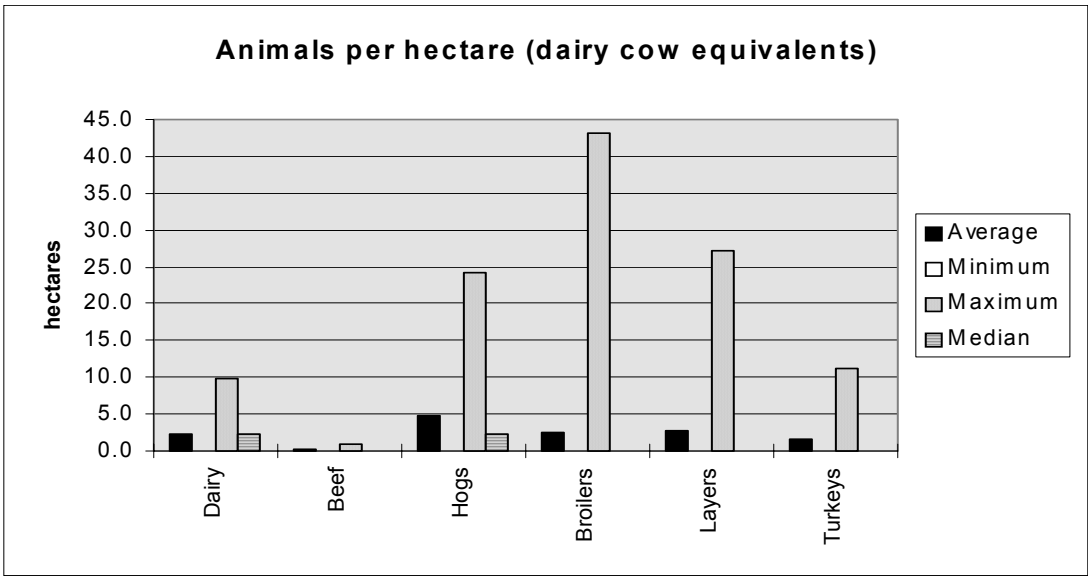
Manure management is the key to environmental sustainability on most livestock farms. The critical factors are animal density, manure storage capacity, and timing of applications.

Animal Density

Reporting densities as animal numbers per hectare makes it difficult to compare one type with another. Therefore, densities were converted to animal units based on nitrogen excretion. The conversions are: 1.0 for dairy cows, 0.33 for dairy young stock, 0.5 for beef, 0.17 for hogs, 0.0055 for broilers, 0.0073 for layers and 0.079 for turkeys. The following chart indicates animal units per hectare. Maximum animal densities in South Coastal B.C. should be between 2.0 and 2.5 dairy cow equivalents (based on manure nitrogen content and crop nitrogen demand). On average, dairy farms had access to sufficient land. Poultry densities were similar to dairy. However, where poultry manure is applied to low nitrogen use crops (e.g. raspberries) these densities are high. Hog farms, on average, had insufficient land.



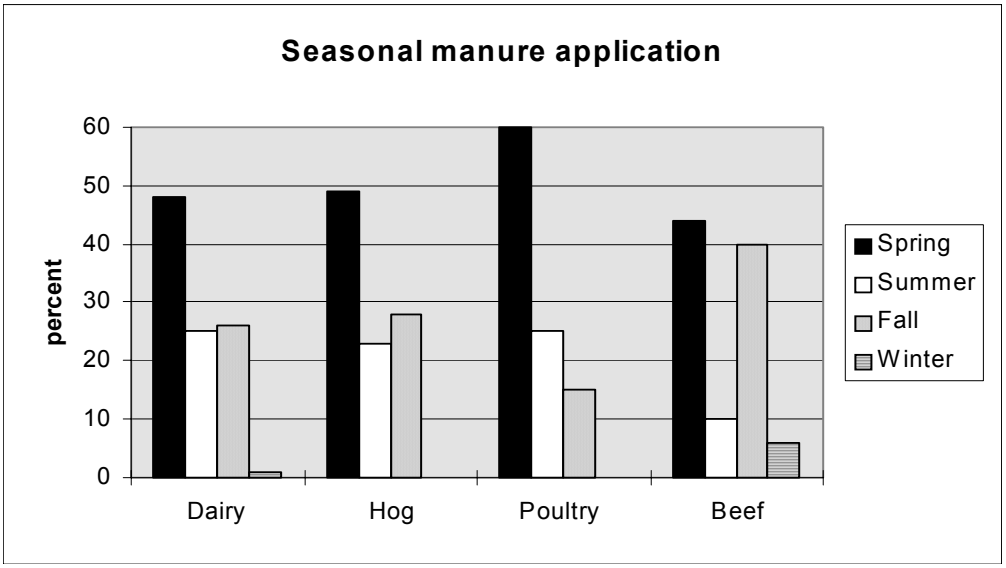
The next chart includes minimum, maximum and median animal densities. The minimum shows that, for all animal types, at least one farm shipped all manure off-site resulting in no manure being applied on those farms. Maximum densities indicate that



for dairy, hogs and poultry there were farms with extremely high ratios of animals to land.

The survey found that 4% of dairy, 14% of hog and 69% of poultry farms shipped all manure off the farm. When combined with farms that shipped some manure off farm, the survey found that in total 5% of dairy, 42% of hog and 85% of poultry manure was shipped off farm. For hog and poultry this means that many of the farms that applied manure to land had very high application rates.

Application during Seasons

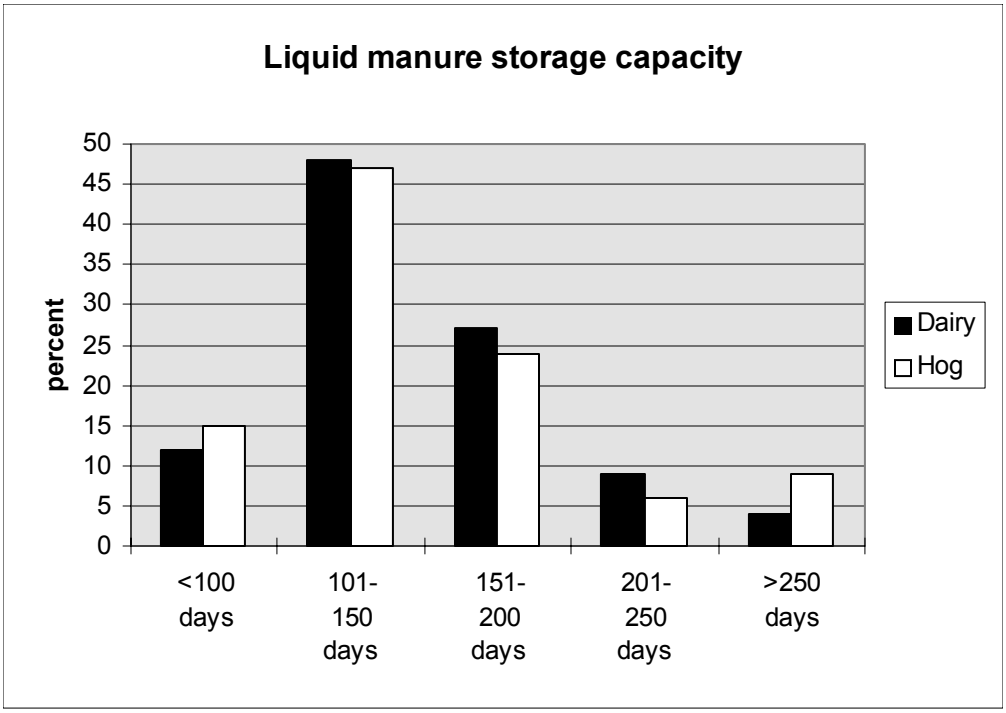


The seasonal distribution of manure application is presented on the previous page. More than 70% of the dairy, hog and poultry manure was applied during spring and summer when crops can make most effective use of nutrients. There were significant fall applications for all animal types. Depending on the timing of these applications and the presence of an actively growing crop, fall applications may or may not be of concern. Winter applications were low.

Storage Method

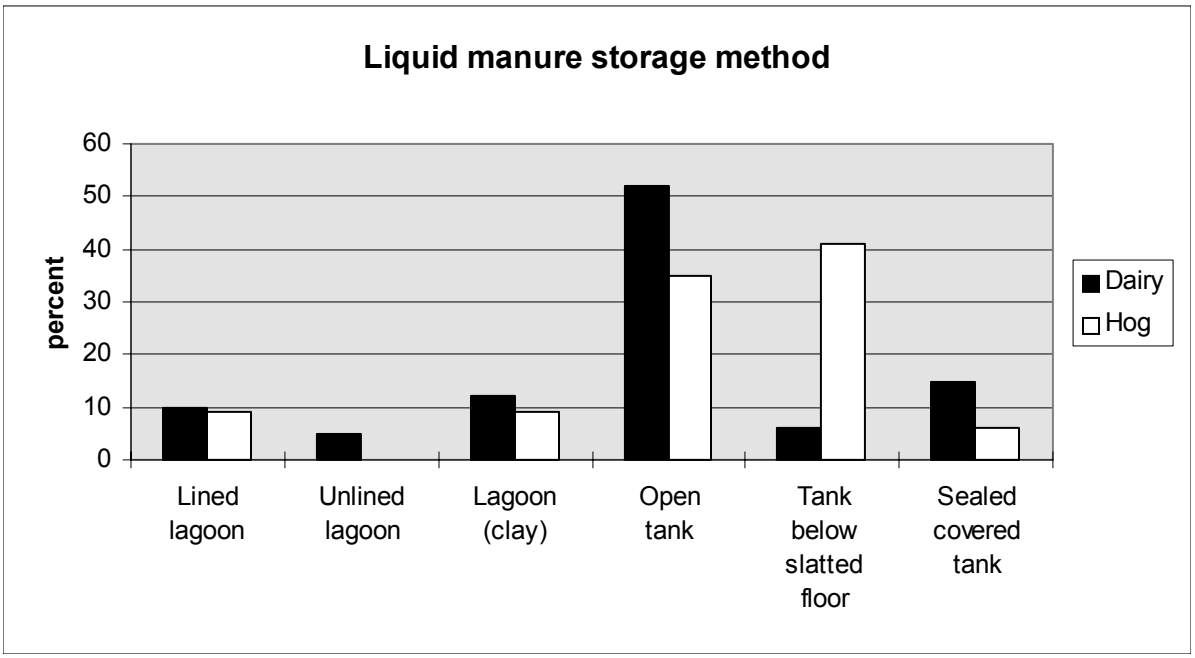
---Liquid Storage

Eighty-seven percent of dairy, 0.5% of beef, 92% of hog and 3% of poultry operations reported storing liquid manure in 1998. As shown below, more than 85% of the dairy and poultry farms in the Lower Fraser Valley have capacity to avoid the fall/winter 'no spread' period (November to January).



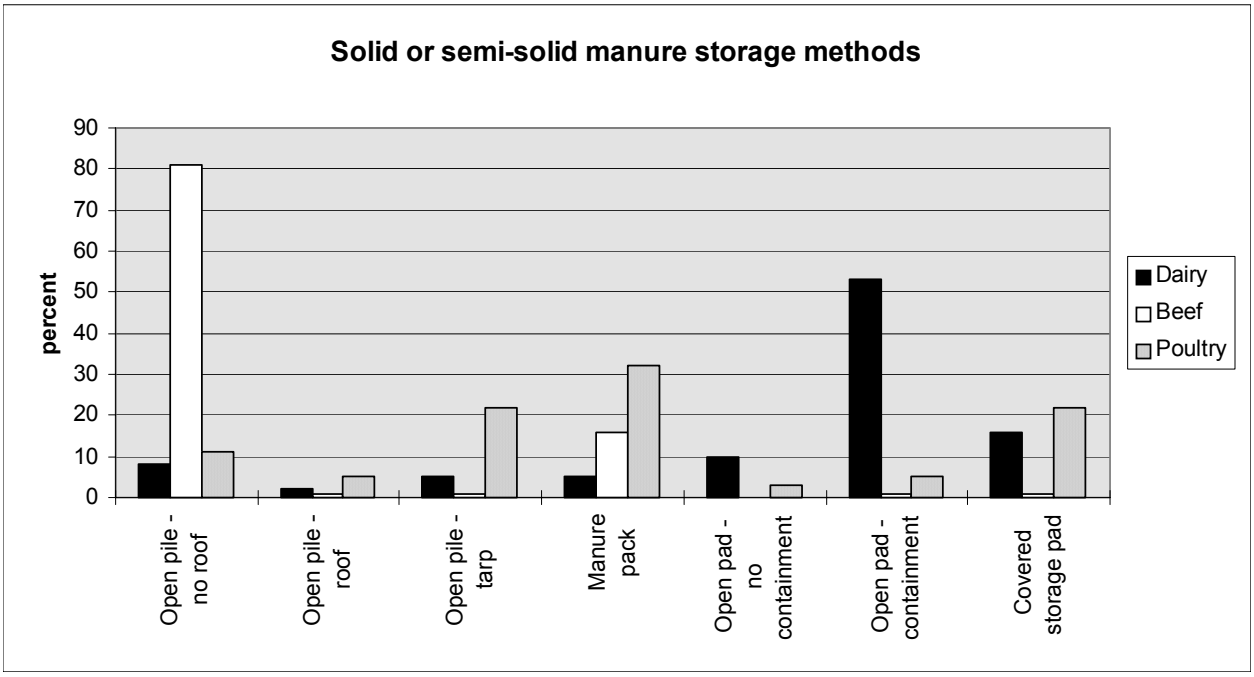
Liquid manure storage methods named in the survey were: lined lagoon, unlined lagoon, lagoon in impermeable soil (e.g. clay), open tank, tank below slatted floor and sealed covered tank. No hog manure and about 5% of dairy manure was stored in unlined lagoons. Therefore, over 95% of manure was stored in structures that prevent

leakage into the underlying soil. Over 50% of dairy manure was stored in open tanks. Of the farms with insufficient storage, over 60% of the manure was in open tanks.



---Solid and Semi-solid Storage

Fifty-nine percent of dairy, 70% of beef, 27% of hog and 25% of poultry operations reported storing solid or semi-solid manure. The survey categories for storage methods were: open pile on the ground without a roof, open pile on the ground with a roof over it, open pile on the ground with a tarp over it, manure pack in barns, pens or corrals, on an open pad without runoff containment, on an open pad with runoff containment and on a covered storage pad. Almost all beef manure was stored in either open piles or packs in pens without runoff containment. Although the beef operations surveyed are in low precipitation areas of the province, lack of containment raises some concerns with respect to potential impact on adjacent watercourses.



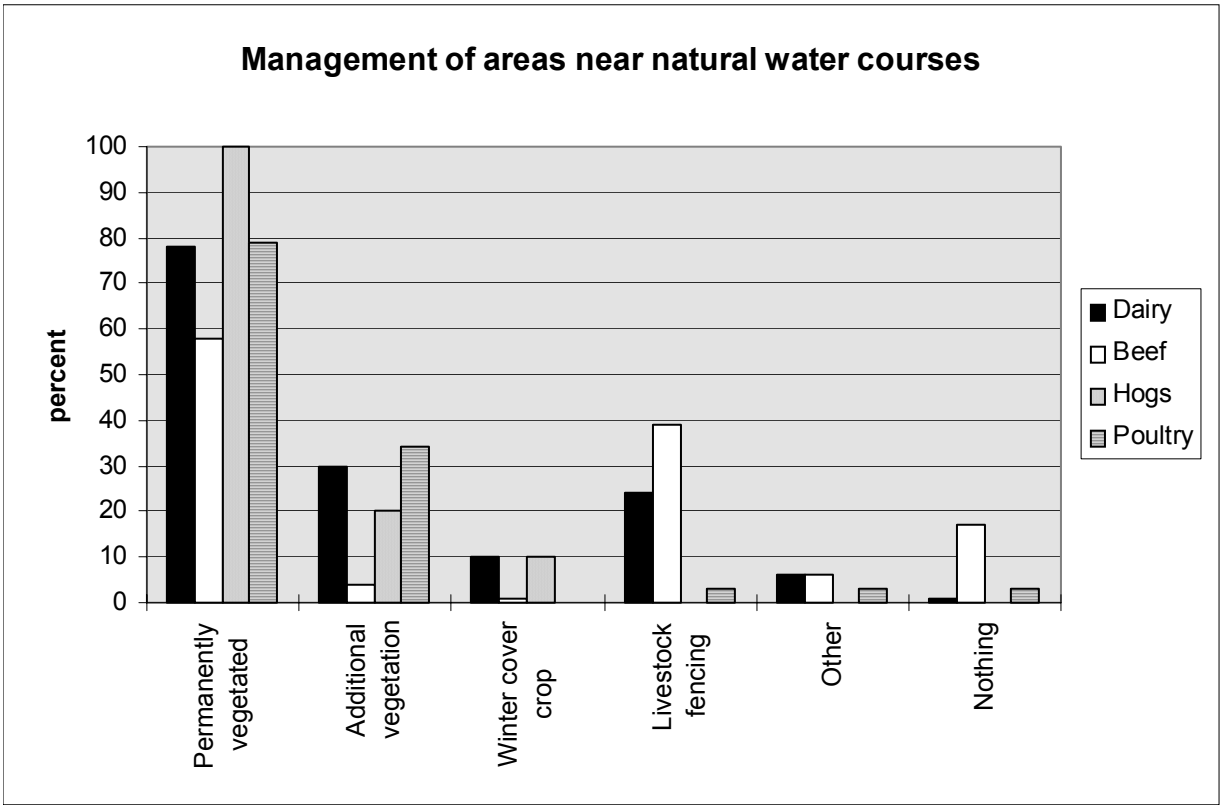
Water Management

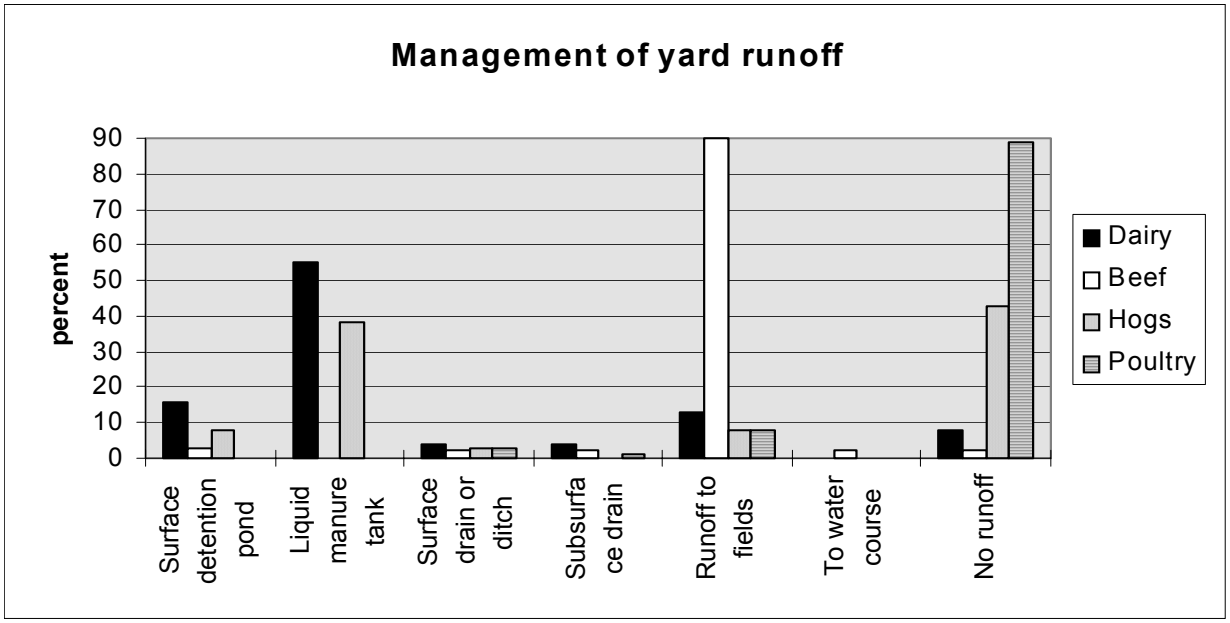
Management Adjacent to Natural Sources of Water

Survey respondents reported that 42% of dairy, 76% of beef, 27% of hog and 19% of poultry operations had natural sources of water on or adjacent to their farms. The chart on the next page shows the practices used within 3 metres of these water sources. By farm the most common practice was to leave the area permanently vegetated. A significant number of farms reported planting additional vegetation and, for dairy and beef, fencing livestock. Very few farms reported doing nothing different in these areas.

Runoff Control

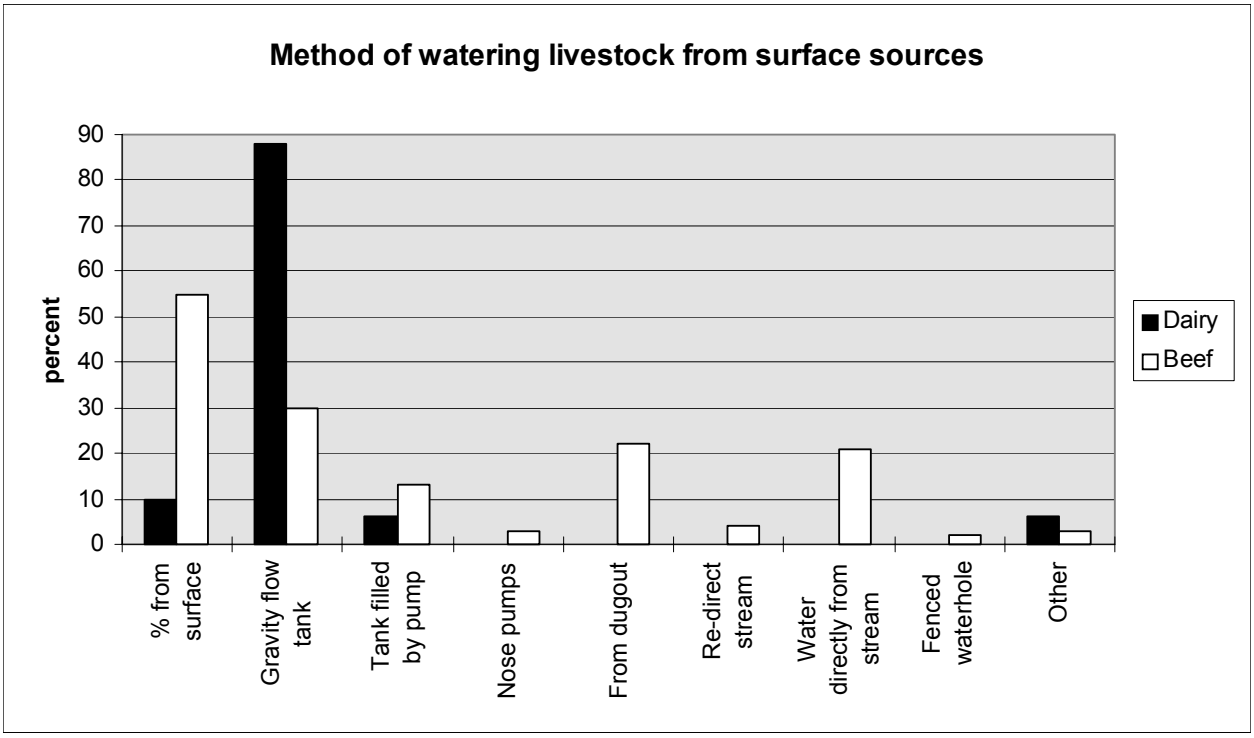
The survey asked the question: “Where does most of the yard runoff from livestock come to rest?”. The second chart on the next page shows that farmers provided excellent control of yard runoff with virtually no direct discharge to water.


Management of areas near natural water courses
percent
100
90
80
70
60
50
40
30
20
10
0
Permanently vegetated
Additional vegetation
Winter cover crop
Livestock fencing
Other
Nothing
Dairy
Beef
Hogs
Poultry


Management of yard runoff
percent
90
80
70
60
50
40
30
20
10
0
Surface detention pond
Liquid manure tank
Surface drain or ditch
Subsurface drain
Runoff to fields
To water course
No runoff
Dairy
Beef
Hogs
Poultry

Livestock Watering

Over 50% of beef operations and about 10% of dairy operations provided at least some water from surface sources. Of the beef operation using surface sources, approximately 20% watered cattle directly from these sources.



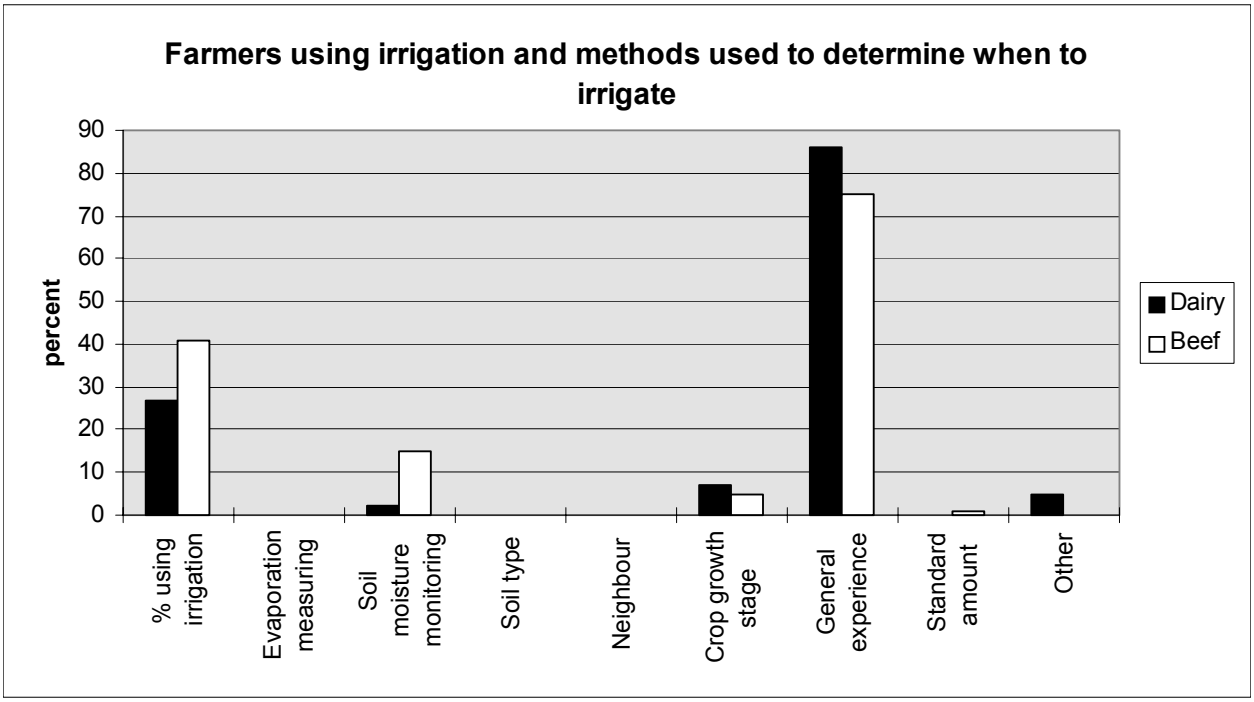
Irrigation

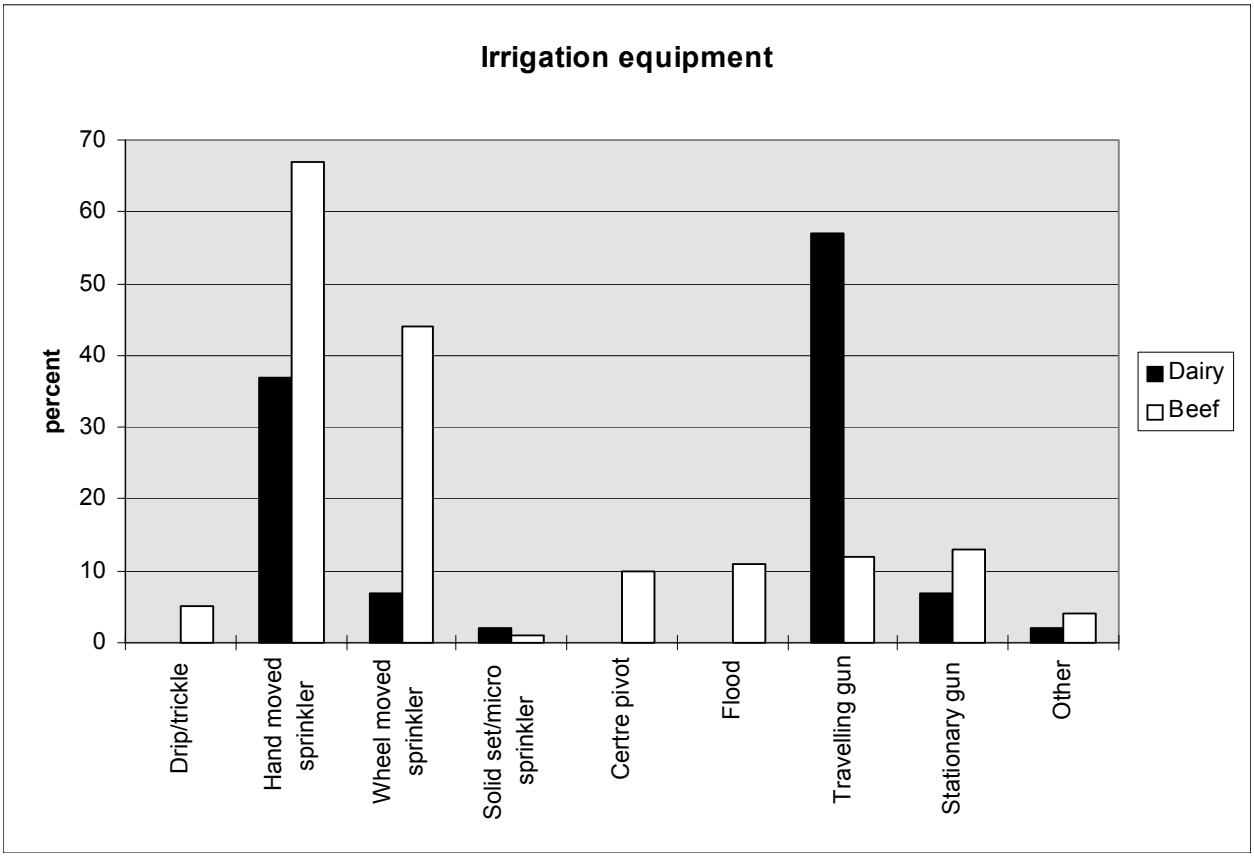
Scheduling Procedures

The survey found that 27% of dairy farms and 41% of beef operations used irrigation in 1998. Over 70% of respondents used 'general experience' to determine when to start and stop irrigating (next page).

Water Application Method

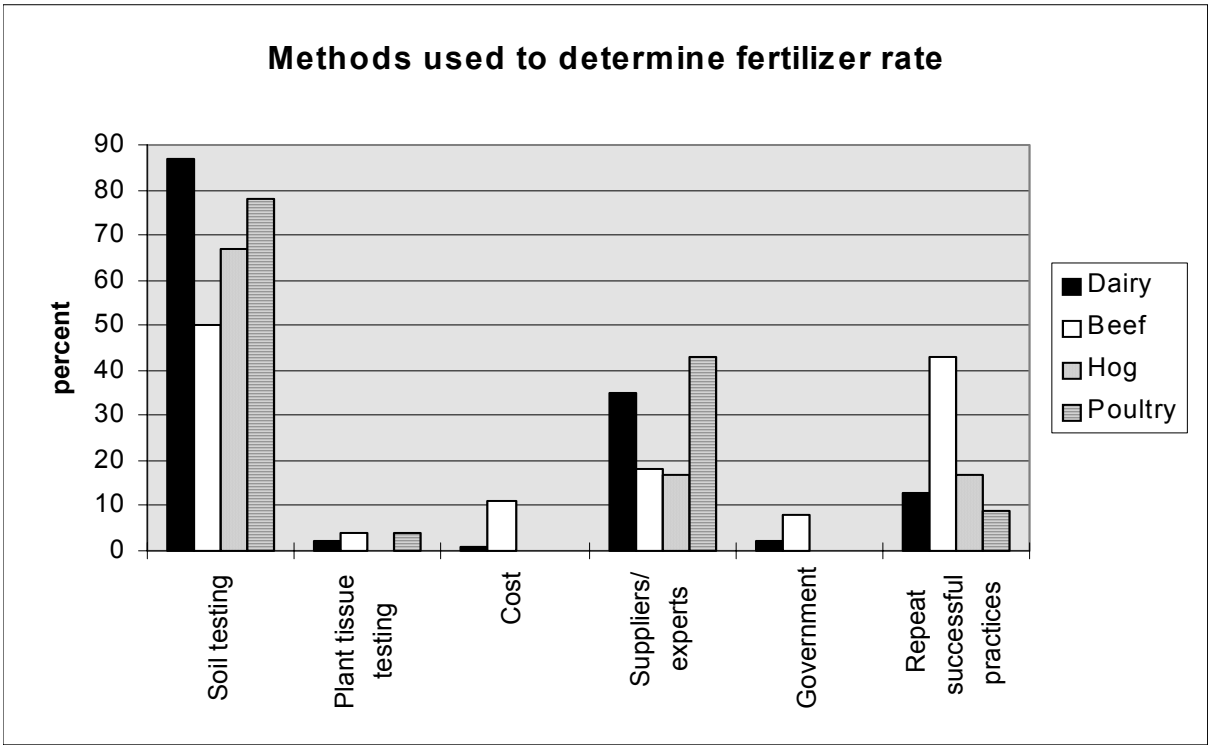
The chart on the next page indicates irrigation equipment used. Most dairy farmers used traveling guns and/or hand moved sprinklers and beef operators used hand moved and/or wheel moved sprinklers.


Farmers using irrigation and methods used to determine when to irrigate
percent
90
80
70
60
50
40
30
20
10
0
% using irrigation
Evaporation measuring
Soil moisture monitoring
Soil type
Neighbour
Crop growth stage
General experience
Standard amount
Other
Dairy
Beef


Irrigation equipment
percent
70
60
50
40
30
20
10
0
Drip/trickle
Hand moved sprinkler
Wheel moved sprinkler
Solid set/micro sprinkler
Certre pivot
Flood
Travelling gun
Stationary gun
Other
Dairy
Beef

Fertilization

Eighty-nine percent of dairy, 65% of beef, 16% of hog and 15% of poultry operations used commercial fertilizer in 1998. All farmers relied heavily on soil testing to decide the amount of fertilizer to apply. There was significant guidance from suppliers and other experts. It is significant to note that farmers reported very low reliance on government recommendations. However, the soil test interpretations used by soil labs, suppliers and other experts are based on historic government sponsored research.



Sixty-nine percent of dairy farmers and 33% of beef operators reduced the amount of fertilizer to offset the nutrient content of manure. It is important to note that 9% of dairy and 47% of beef operations did not apply fertilizer and manure on the same land.

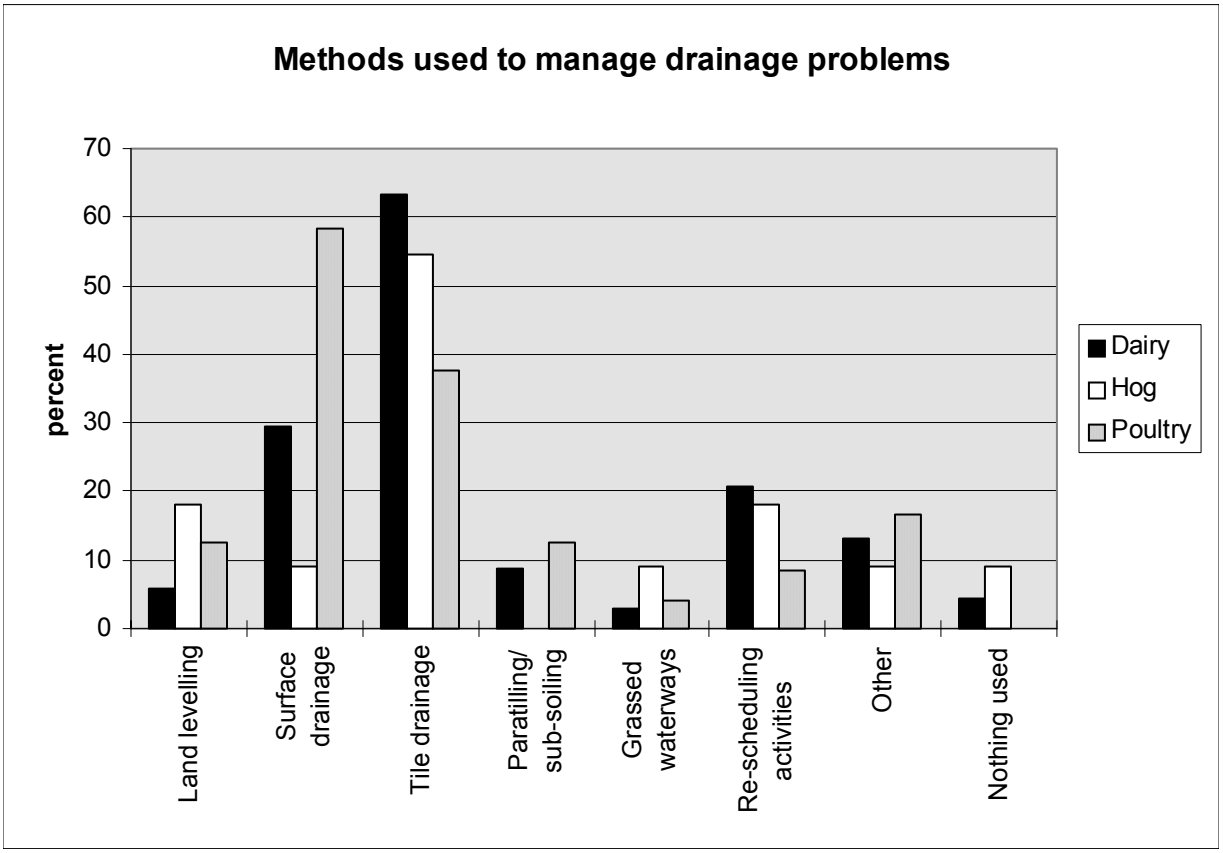
Soil Management

Erosion Control Practices

Livestock farmers did not report significant erosion problems (3% dairy, 8% beef and less than 1% hog and poultry). However, one of the issues mentioned for a number of beef operations was stream and river erosion.

Drainage Management

Excess water is an important issue in the Lower Fraser Valley. Forty-one percent of dairy, 30% of hog and 16% of poultry operations reported land prone to drainage problems. Of those reporting problems, the following chart illustrates the methods used to manage excess water. The most effective method is subsurface (tile) drainage, which was the one most often used. However, significant benefit in terms of crop yield, cropping options and soil compaction prevention could still be realized by installing more subsurface drainage systems.



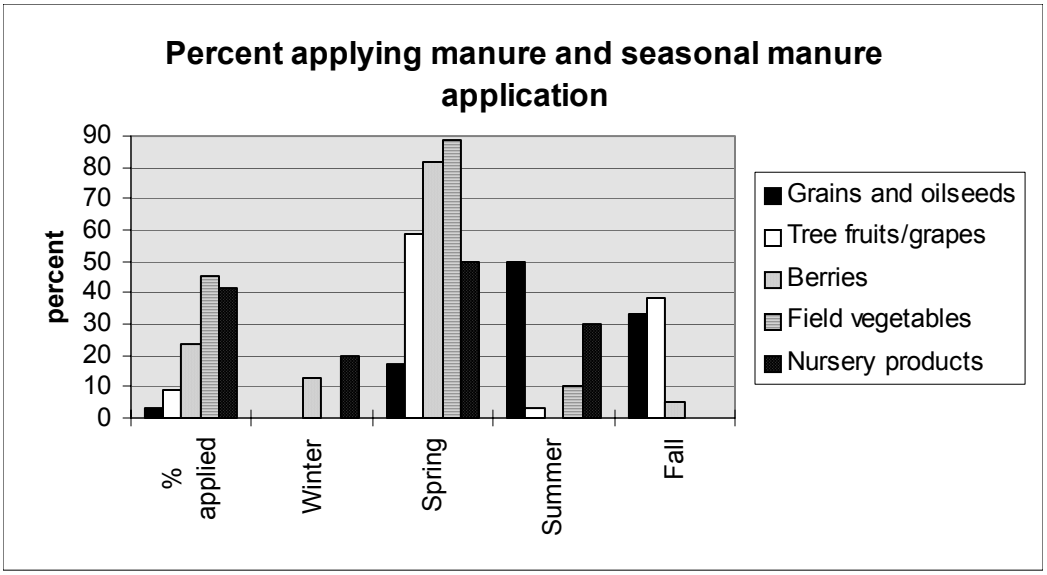
Findings from the Crop Farm Survey

Manure and Fertilizer Management

Nutrient management is an important factor to consider when measuring environmental sustainability.

Use of Manure and Application during Seasons

Manure use was limited in the grains and oilseeds and tree fruits/grapes sectors. Other sectors made significant use of manure with berries and vegetables accounting for most of the land receiving manure in the Lower Fraser Valley. Although over 80% of the manure was applied to berry and vegetable lands during spring and summer, a small



amount of berry land received manure in the fall and winter.

Solid and Semi-solid Manure Storage

Of the vegetable farms that used manure, 35% stored manure on their operations. The other sectors either used very limited amounts of manure or stored very little manure on their operations. Most of the manure stored on vegetable farms was in open piles on the ground without a roof. A lesser amount was stored in open piles on the ground with a tarp over it.

Type of Manure

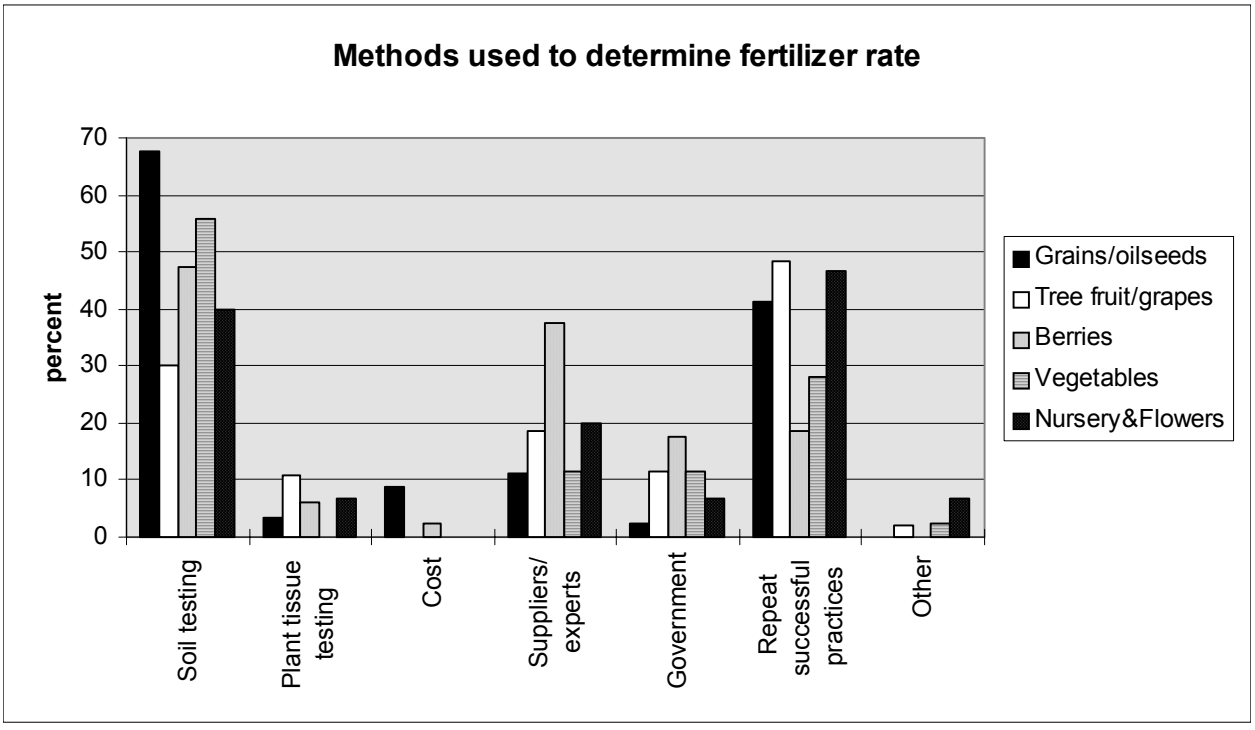
Of producers using manure, over 80% of berry and over 60% of vegetable producers reported using poultry manure. For farms outside of the Lower Fraser Valley, the main source was cattle manure. Very little hog manure was used on crop farms.

Fertilization

In 1998, fertilizer use was as follows:

Grains/oilseeds	Tree fruits/grapes	Berries	Vegetables	Nursery and flowers
99%	90%	89%	98%	88%

Farmers relied heavily on soil testing and past experience to decide the amount of fertilizer to apply. There was considerable guidance from suppliers and other experts. It is significant to note that farmers reported very low reliance on plant tissue testing and government recommendations. However, the soil test interpretations used by soil labs, suppliers and other experts are based on historic government sponsored research.



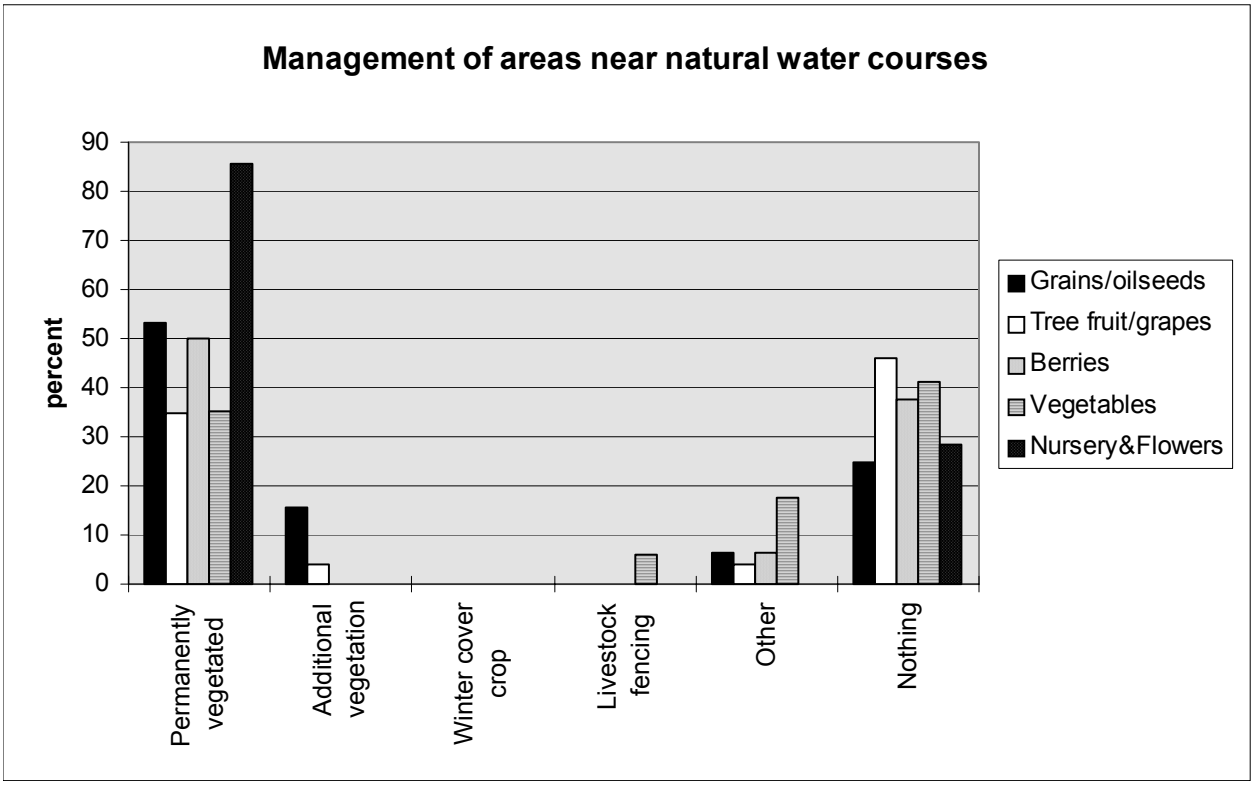
Water Management

Management Adjacent to Natural Sources of Water

Survey respondents reported having natural sources of water on or adjacent to their farms as follows:

Grains/oilseeds	Tree fruit/grapes	Berries	Vegetables	Nursery and Flowers
35%	15%	18%	39%	41%

The following chart shows the practices used within 3 metres of these water sources. By far the most common practice was to leave the area permanently vegetated. A significant number of farms reported doing nothing different in these areas.



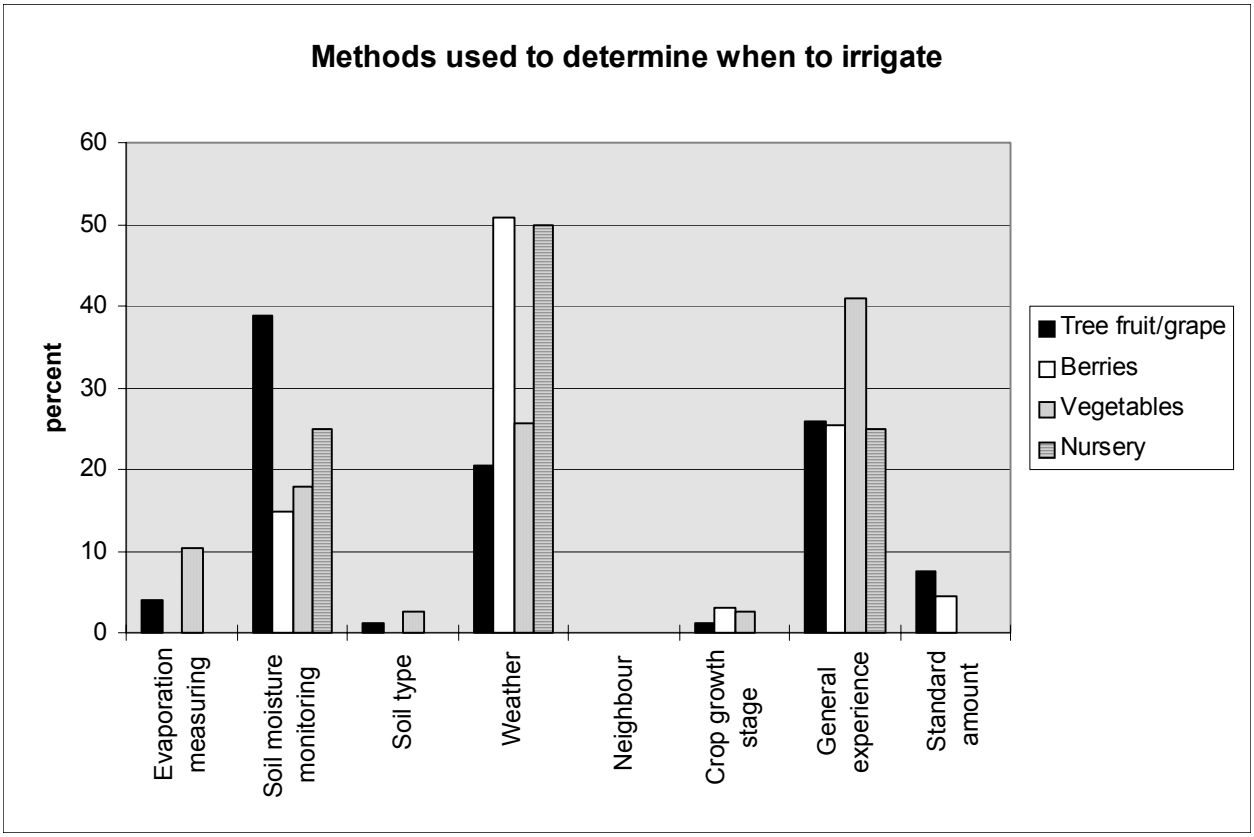
Irrigation

Scheduling Procedures

This table indicates the sectors using irrigation in 1998. Grains and oilseeds did not report any irrigation use.

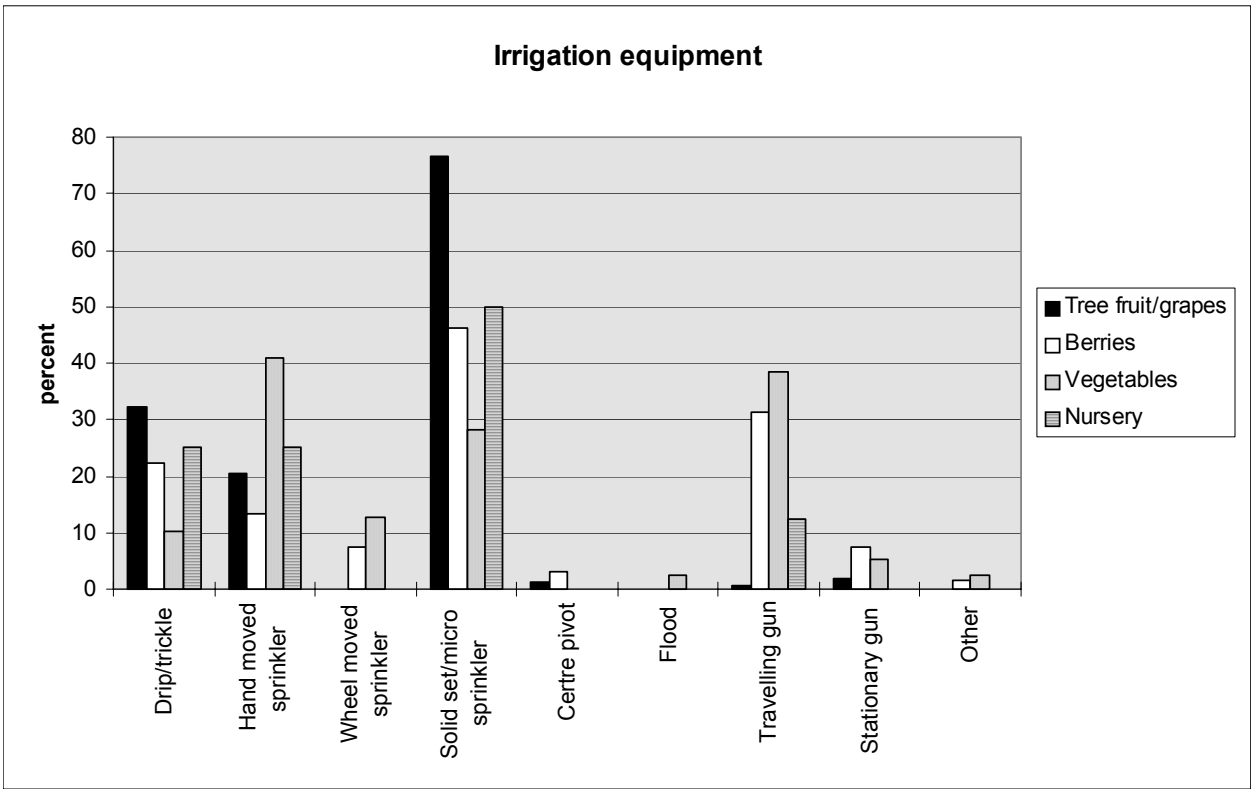
Tree fruit/grape	Berries	Vegetables	Nursery
98%	74%	89%	67%

This chart indicates methods used to determine when to irrigate. The most common methods were weather, general experience and soil moisture monitoring. Few farmers actually measured evaporation. However, almost no farmers applied a standard amount of water regardless of need.



Water Application Method

The chart following indicates irrigation equipment used.



Soil Management

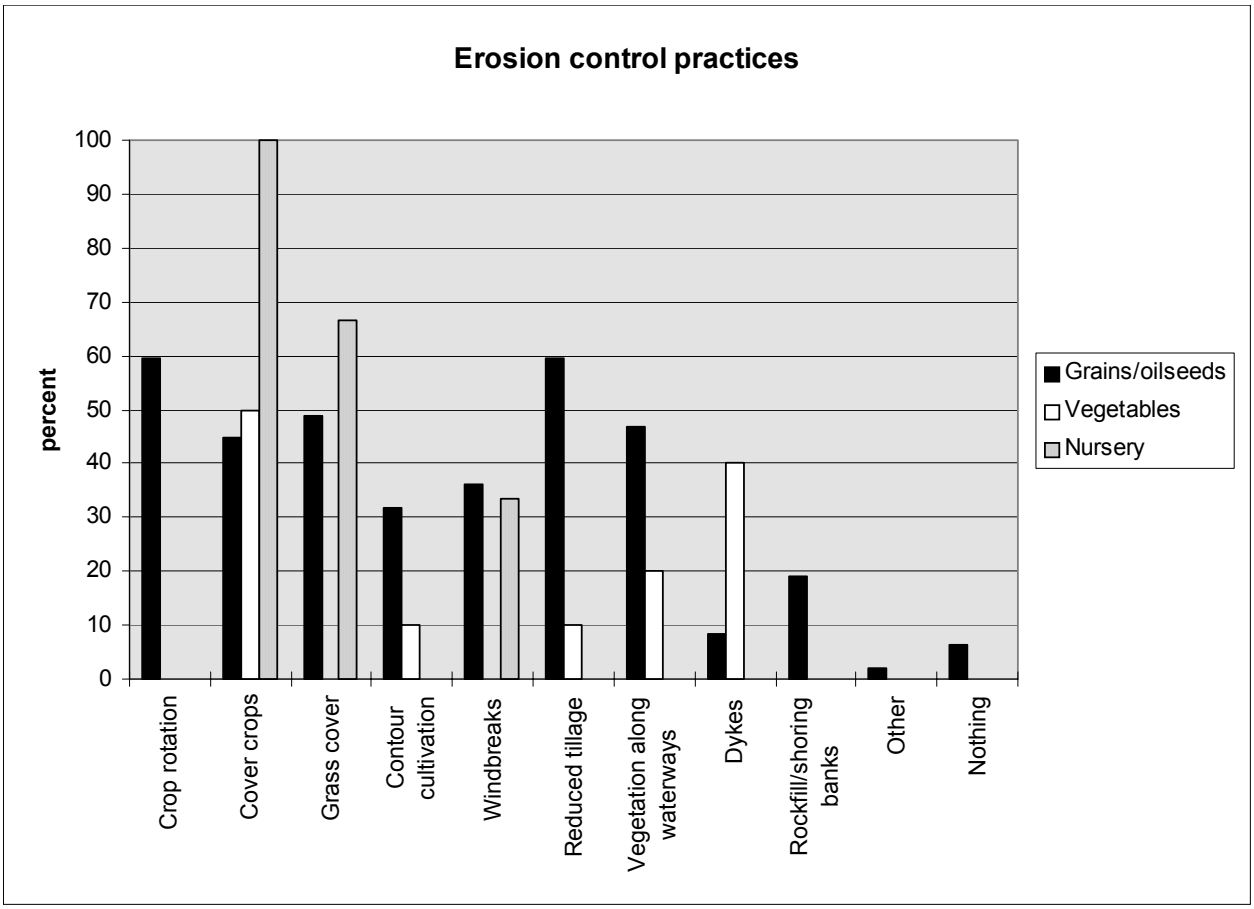
Erosion Control Practices

The survey asked if any of the farm area was affected by erosion. Farmers reported as follows:

Grains/oilseeds	Tree fruit/grapes	Berries	Vegetables	Nursery and Flowers
52%	6%	8%	23%	25%

The next chart indicates the practices used to control erosion on grain/oilseed, vegetable and nursery and flower operations. The other commodity groups are not included because of the low incidence of erosion. The grain/oilseeds sector reported a large range of control measures led by reduced tillage, crop rotation, grassed

waterways, permanent grass and cover crops. Cover crops were also widely used in the other sectors.



Farmers in the Peace River region were asked an additional question. What is the area of land seeded using:

- tillage that incorporates most of the crop residue into the soil?
- tillage prior to seeding that retains most of the crop residue on the surface?
- no-till seeding?

Tillage prior to seeding	All farms	Farms reporting erosion	All farms in 1996[1]
Incorporates most residue	39%	30%	59%
Retains most residue on surface	45%	53%	29%
No-till	16%	17%	12%

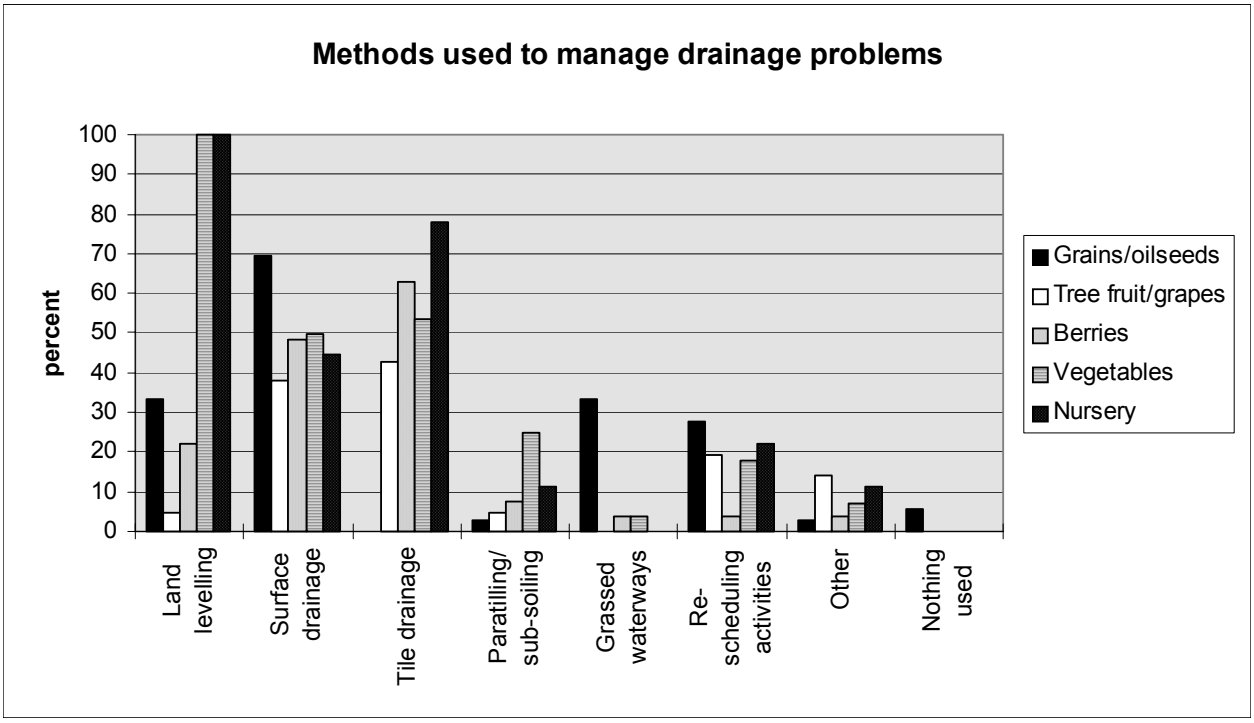
[1] from Agricultural Profile of British Columbia, Statistics Canada

Drainage Management

Farmers were asked if any land is prone to drainage problems. Following are the responses:

Grains/oilseeds	Tree fruit/grapes	Berries	Vegetables	Nursery and Flowers
40%	13%	30%	64%	75%

Excess water is an important issue in the Lower Fraser Valley and the Peace River region. Of those reporting problems, the following chart illustrates the methods used to manage excess water. Vegetable and nursery operations all reported using land leveling. A significant number of these also used subsurface and surface drainage, as did berry operations. Very few farmers reported using paratilling or subsoiling to aid in removing excess water. Grains and oilseeds producers, most located in the Peace River region, relied heavily on surface drainage.



Policy and Farm Management Considerations

Livestock Farm Survey

Manure Management

Animal Densities

With the exception of a few situations where animal densities are extreme, the animal numbers in the Lower Fraser Valley are in balance with the land used for manure application.

> 1992[2] / 1998 Comparison: Dairy animal densities were reported as 2.3 dairy cow equivalents per hectare in the two studies. Stennes found average hog densities of 12.8 dairy cow equivalents per hectare for farrow to finish operations and 6.9 for grower-finisher operations. These compare to an average of 4.9 in 1998. The data for poultry were not readily comparable because Stennes did not measure the amount of manure moved off farm.

On average, animal densities remain high, but, when compared to 1992, appear to be stable (for dairy) or declining (for hogs). However, from human population growth projections for the region it is reasonable to conclude that demand for food will increase and land available for spreading manure will decrease. Keeping animal numbers and land in balance over the coming decades will be a challenge. *A comprehensive nutrient management strategy for the region, developed in concert with industry, local governments and environmental agencies, should be considered.*

Manure Application

In the Lower Fraser Valley more than 70% of the manure was applied in spring and summer. Most of the remaining manure was fall applied with very little applied in the winter. These findings are very positive. In the Interior regions, almost half the beef manure is applied in the fall and winter months. Because of the arid climate in much of the Interior, there is limited potential for nutrients to contribute to environmental degradation and a high percentage of nutrients will be available for subsequent crops. *Never the less there is probably some potential to make more effective use of nutrients from beef manure by increasing use in spring and summer.*

[2] 1992 data is from a report entitled "Baseline Report on Awareness, Attitudes and Management Practices of Producers involved in Technology Transfer Sub-Program Canada British Columbia Soil Conservation Program" by Brad Stennes.

Liquid Storage Capacity

Approximately 60% of Lower Fraser Valley dairy and hog farms reported 150 days or less of liquid manure storage capacity. This means that in some years manure will have to be spread when soil, crop and/or weather conditions are not suitable. Farms with less than 100 days storage can not comply with the November to January 'no spread period' agreed to by the industry and Ministry of Environment, Lands and Parks.

> 1992 / 1998 Comparison: Stennes found that 30% of dairy farms had less than 2 months (60 days) storage capacity and a further 27% had between 2 months and 4 months (120 days) storage. This compares to 12% with less than 100 days storage in 1998.

Of the farms with insufficient storage, over 60% of the manure was stored in open tanks. *The majority of the capacity deficit could be overcome by preventing precipitation from entering uncovered structures.*

Solid and Semi-solid Storage

Less than 15% of poultry operations that store manure did so in open piles with no protection or containment.

> 1992 / 1998 Comparison: The number of poultry operations reporting on-farm storage of manure has decreased; 35% in 1992 to 25% in 1998. However in 1992, 65% of the broiler and roaster farms and 42% of layer farmers storing manure used uncovered piles on the ground. A further 20% of broiler and roaster and 25% of layer operations stored manure on concrete slabs with no containment. In 1998, these methods of storage decreased to less than 15%.

It is worth noting that the Sustainable Poultry Farming Group is the one livestock industry conservation group, originally formed under the National Soil Conservation Program in 1991, that remains active to this day. Awareness and education programs of the SPFG played a major role in the decrease in use of improper storage methods. *The success of this type of awareness and education programming emphasizes the need to provide organizational and fund support to producer-based stewardship groups.*

Fertilization

The majority of dairy and beef operations reported using fertilizer in 1998 and soil testing was the most common method used to determine fertilizer rates. This is both encouraging and troubling. The fact that farmers are relying on a proven system for guidance shows that they are attempting to optimize fertilizer use. However, a formalized system to develop and approve soil testing methods and interpretations no

longer exists in British Columbia. Following privatization of the provincial soil, feed and tissue testing laboratory there have been efforts on the part of provincial and federal government officials to establish a formal approval or certification program. Neither the private laboratories nor the fertilizer industry have seen the need to establish and administer such a program. *In the absence of such a program, farmers can not be assured of the quality of soil test recommendations.*

Considering the animal densities in the Lower Fraser Valley, 89% of dairy farmers using fertilizer seems high. Beef operators reported that only 33% of those applying fertilizer reduced the amount to offset the nutrient content of manure. *There are opportunities to reduce commercial fertilizer use further and, thereby, improve nutrient efficiency.*

Crop Farm Survey

Manure and Fertilizer Management

Manure Use, Application and Storage

Close to half of the vegetable farms and a quarter of the berry operations in the Lower Fraser Valley used manure. The vegetable data is particularly interesting since almost all of these farms do not have any animal production. Since many of the poultry farms in the region have surplus manure, it appears that efforts to encourage use of this manure on crop farms are having an impact. In addition, almost all of this manure is applied in the spring, which maximizes its fertilizer value and minimizes environmental risk.

A significant number of vegetable farms that use manure store it on their operations (35%) and most store manure in open piles in the ground without any protection from precipitation. This type of storage may not be in compliance with the Code of Agricultural Practice for Waste Management. *There is a need for improved manure storage practices on some vegetable farms.*

Fertilizer

Fertilizer is an input used by almost all crop farmers in B.C. As with livestock farms, there was considerable reliance on soil testing (see comments under livestock farm section). On the other hand, very few farmers (the highest use was on tree fruit and grape operations - 11%) used plant tissue testing. Especially for perennial crops, plant tissue testing is recognized as a valuable fertilizer management tool. *It is important to determine why plant tissue testing use was low and find ways of increasing use in the future.*

Water Management

A minority of farmers reported having natural sources of water on or adjacent to their farms (15% for tree fruit and grapes to 39% for vegetables and 41% for nursery and flowers). The most common management practice on the lands within 3 metres of the water source was to leave the area permanently vegetated. However, a substantial number did nothing different in the 3 metre area from the practices used in the remainder of the field. *There appears to be some potential to improve management practices adjacent to natural water sources*.

Irrigation

Efficient water use can best be achieved using irrigation scheduling techniques to determine when to irrigate and high efficiency application equipment. Scheduling is based on measuring evaporation and soil moisture. The survey found that very few farmers measured evaporation. Especially in the Southern Interior where water availability is a concern and the tree fruit and grape sectors are completely dependent on irrigation there needs to be a focus on water use efficiency. *There is considerable scope for greater use of irrigation scheduling techniques.*

Drip and trickle systems followed by solid set and micro sprinklers are the most efficient methods for delivering water to crops. These are the systems used by the tree fruit and grapes sector. However, with slightly more than 30% of farmers reporting use of drip and trickle systems, *there is considerable scope for improving the efficiency of irrigation systems.*

There was very little use of irrigation scheduling techniques on crop farms in the Lower Fraser Valley. There was considerable use of lower efficiency irrigation systems such as travelling guns. Although climatic moisture deficit and water needs are not as critical as in the Southern Interior, *some farmers could realize cost savings and improve crop performance by adopting improved irrigation practices*.

Soil Management

Erosion Control Practices

Grains and oilseed producers (mostly in the Peace River region) and vegetable producers in the Lower Fraser Valley reported significant areas affected by erosion; 52% and 23% respectively. A wide range of erosion control practices were used in the grains and oilseeds sector including crop rotation, cover crops, grass cover, contour cultivation, windbreaks, reduced tillage and vegetated waterways. Almost no farmers did nothing. In the Peace River region, 53% of farmers reporting an erosion problem used tillage systems prior to seeding that retained most of the crop residue on the

surface and 17% used no-till seeding.

In the vegetable sector the most commonly used practice was cover cropping. No farmers reported doing nothing.

These results confirm the value of producer-led conservation groups such as the Peace River Soil Conservation Association and the Abbotsford Soil Conservation Association. Awareness of soil erosion and use of erosion control practices has changed substantially since the formation of these groups in the early 90's.

Drainage Management

Water table control is the key to managing excess water on poorly drained lands. This control is most effectively achieved by installing subsurface drainage systems. Over 60% of berry and over 50% of vegetable producers reported using subsurface drainage. However, *significant benefits in terms of crop yield, cropping options and soil compaction prevention could still be realized by installing more subsurface drainage systems.*