Value-added growth opportunities for Alberta’s greenhouse vegetable industry

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January 2008
Table of contents

Executive summary .............................................................................................................. 3

Introduction to organic production, standards and the certification process
  Definition of organic production ............................................................................... 5
  Why organic? ........................................................................................................... 6
  Canadian standards for organic greenhouse production ........................................ 6
  Canadian organic greenhouse regulations ............................................................. 7
  New organic regulations for December, 2008 ........................................................ 9
  Getting started in organics and the certification process ....................................... 12

Conventional and organic greenhouse vegetable production in Canada and elsewhere
  Introduction .............................................................................................................. 14
  Greenhouse vegetable production in Canada ......................................................... 16
  Alberta’s place in the Canadian greenhouse industry ........................................... 17
  Greenhouse production in North America ............................................................. 18
  Tomatoes in North America .................................................................................... 19
  Organic greenhouse vegetable production in Canada ........................................... 21
  Estimating the volume of organic greenhouse vegetables in Canada ................... 25
  Estimating the farm-gate value of organic greenhouse vegetable production in
  Canada ...................................................................................................................... 26
  Estimating retail sales of organic greenhouse vegetables in Canada .................... 28
  What could the market be in five years? ................................................................. 31
  Organic greenhouse vegetable production in the USA ........................................... 32
  Organic greenhouse vegetable production in Europe ............................................ 33
  General trends in organic production in Canada and the world ......................... 33

General recommendations for the production of organic greenhouse vegetables
  Disclaimer ................................................................................................................. 34
  Introduction ............................................................................................................. 35
  Sources of information about conventional greenhouse production .................... 36
  Getting started in organic greenhouse production ................................................. 37
  Introduction to pest management and fertilization ............................................... 38
  The greenhouse structure and climate management ............................................. 39
An overview of pest management in an organic greenhouse ......................... 40
The basics of organic insect and mite management ........................................ 41
Using biologicals .............................................................................................. 42
Cultural control of insect and mite pests of greenhouse vegetables ................. 43
The basics of organic disease management .................................................... 51
Cultural and alternate control of diseases of greenhouse vegetables ............... 52
The basics of organic fertility management .................................................... 58
Soil or “soilless” production — a big question .............................................. 60
Soil culture ..................................................................................................... 61
Soilless culture and fertility ............................................................................. 64
The Quebec experience .................................................................................. 67
Suppliers of organic production materials and services ................................. 69
Could Alberta producers convert to organic? ................................................. 70
Pesticide-free production .............................................................................. 73

Opportunities for value-added production in Alberta’s greenhouse industry

Introduction ...................................................................................................... 76
General trends in vegetables consumption .................................................... 77
Organics: Trends and opportunities ............................................................... 82
Pesticide-free production: Trends and market opportunities ....................... 90
Local: Trends and market opportunities ....................................................... 91
Recommendations for discussion ................................................................ 94

Appendix .......................................................................................................... 97

Acronyms ....................................................................................................... 97
References ..................................................................................................... 98
Acknowledgements ....................................................................................... 103
Executive summary
The objective of this study was to investigate the potential for production and marketing of value-added greenhouse vegetables in Alberta. The primary greenhouse “product” considered in this study was organic greenhouse vegetables. However, information was gathered on the need and potential of promoting locally grown vegetables and promoting the freshness and nutritional value of Alberta-grown greenhouse vegetables.

Introduction to organic production, standards and the certification process
Existing greenhouse producers, or prospective greenhouse growers who are considering organic production, must study Canadian standards and become familiar with regulations governing the production of organic vegetables in greenhouses. They are encouraged to speak with at least two certifying bodies to understand the requirements for certification under that agency. Effective in December 2008, all certifying agencies in Canada must observe the same general standards; however some certifying agencies may impose more strict guidelines.

Conventional and organic greenhouse vegetable production in Canada and elsewhere
There were about 2,500 acres of greenhouse vegetables grown in Canada in 2007. There are an estimated 73 acres (+/- 20 acres) of organic greenhouse vegetables in Canada. Organic greenhouses represent about 3 percent of the total greenhouse vegetable area in Canada, but this may range from about 2 to 4 percent. Yields of organic greenhouse vegetables are deemed to be 20 to 50 percent lower than those from conventional production. Therefore, the actual volume of organic greenhouse vegetables might be between 1 to 3 percent of total greenhouse vegetable production. To add to the uncertainty, we don’t know what crops make up this estimated 73 acres (+/- 20 acres), although the vast majority is tomatoes. The farm-gate value of organic greenhouse vegetables is estimated to be between about $25 and $40 million annually. There is an estimated sales volume in the Prairie Provinces equivalent to about 2 to 4 acres of organic greenhouse tomatoes. However, this market opportunity is tempered because one large organic greenhouse operation in BC is currently well placed in the western Canadian marketplace.

General recommendations for the production of organic greenhouse vegetables
Organic tomato production offers the most chance for success because there is better technical information on organic greenhouse tomato production than for other vegetable crops. Tomatoes are less affected by pests than cucumbers, peppers and lettuce.

A producer considering organic vegetables should plan to ease into production to learn the nuances of organics. There are few, if any, “turnkey” production protocols for organic production. The consensus is that producers can expect yields from organic greenhouse vegetables to be somewhere between 50 percent and 80 percent of yields from conventional production. The yield reductions are directly attributable to inadequate, inexact or poorly timed nutrient supplies, and sustained levels of diseases which are marginally controlled by approved organic techniques.
Organic greenhouse vegetable production relies on modern greenhouse structures with good environmental control systems. Critical in organic greenhouses are: sanitation; understanding pests; crop and pest monitoring; environmental control; cultural control; use of resistant cultivars and biological control of insects.

Organic greenhouse crops are either grown in soil or in above-ground containers containing “biologically active” media amended with composts. Organic greenhouse crops are fed with composts or approved organic fertilizers. Precise control of nutrients is difficult and contributes to yield reductions. Although some commercial companies are selling organic media and fertilizers, there is little public information about media and nutrient feeding programs. Federal researchers are currently investigating media and feeding programs for tomatoes, cucumbers and peppers.

Alberta’s greenhouse producers could switch to pesticide-free production without excessively compromising yields and unduly increasing risks. However, switching to organic production is much more complex and hampered by uncertainties about media and nutrient management.

**Opportunities for value-added production in Alberta’s greenhouse industry**

Traditional greenhouse crops like tomatoes, cucumbers and peppers are undergoing change. New types of tomatoes, like tomatoes on the vine (TOVs), cocktail and grape tomatoes are seen on shelves. Mini cucumbers and many varieties of peppers are offered. These start out as niche products, but soon become mainstream products as supplies increase. There are opportunities to promote the health and nutritional benefits of greenhouse vegetables. New concepts in packaging, portion sizing and pre-cut offer new opportunities. There are opportunities for organic vegetables, but production and economics remain uncertain.

Research priorities are needed that consider cost-benefit ratios of research on organic production versus research on conventional and niche-market greenhouse crops.

Alberta Agriculture and Food (AAF) and Alberta’s greenhouse industry are advised to consider a detailed survey to evaluate consumer perceptions of, and demands for, vegetables that are: local, fresh, nutritious, organic, pesticide-free, in specialty packages or pre-cut.

Perhaps the most significant niche market to be promoted and exploited is **local**. Producers from outside can never supply **local**, and **local** produce will always be distinct from imported produce.

**Local** implies that vegetables are pure, fresh, and nutritious and require fewer “food miles.” AAF and Alberta’s greenhouse industry are advised to assess efforts at telling consumers they are indeed buying **local** when they buy Alberta greenhouse vegetables. The time is right to place an emphasis on promoting **local**.
Introduction to organic production, standards and the certification process

**Definition of organic production**
There are many definitions and descriptions of organic production. Here are two definitions.

The Canadian National Standards describes organic production as:

> Organic production is a holistic system designed to optimize the productivity and fitness of diverse communities within the agroecosystem, including soil organisms, plants, livestock and people. The principal goal of organic production is to develop enterprises that are sustainable and harmonious with the environment.

The Certified Organic Associations of British Columbia (COABC) define organic production on their website:
http://www.certifiedorganic.bc.ca/aboutorganic/organicwhat.htm

> Organic farming is an agricultural production system that promotes and enhances biological diversity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain, and enhance ecological harmony.

The Food and Agriculture Organization of the United Nations describes organic farming in World Markets for Organic Fruit and Vegetables:
http://www.fao.org/docrep/004/Y1669E/y1669e00.HTM

> Organic agriculture is best known as a farming method where no synthetic fertilizers and pesticides are used. However, this description does not mention the essence of this form of agriculture, which is the holistic management of the farming system. According to the definition of the Codex Alimentarius, "organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system."

Several national
governments and a multitude of private certification and farmer organizations have defined organic agriculture. In the past, differences in these definitions were significant, but the demand for consistency by the trade has led to greater uniformity.

An important concept about organic production
The FAO books, *World Markets for Organic Fruit and Vegetables*, states:

*Products labelled as “organic” are those certified as having been produced through clearly defined organic production methods. In other words, “organic” is a claim on the production process rather than a claim on the product itself.*

Why organic?

There are two general seasons why a producer would consider switching to organic production or starting an organic greenhouse operation. They are not exclusive of each other.

1) A producer might choose to grow organically as a way of life and believing that organic production in some way is an ecologically superior way of producing crops and that the products are healthier.

2) A producer might choose to switch to organic production to supply a specialty product to a niche market.

The reason for choosing to grow organically may affect which certifying agency the producer selects. It may also affect the type of production system the producer selects. A producer who grows organically as a “belief system” may want to grow only in soil. However, a producer who sees organics as a specialty product for a niche market may choose to grow in above ground systems (such as bags or containers) as is currently practiced by the majority of the existing greenhouse producers. (Soil versus soilless is discussed in more detail in the “organic production” section of this report.)

Canadian standards for organic greenhouse production

There are two general regulations governing organic production in Canada. They are issued by the Organic Agriculture group of the Canadian General Standards Board (CGSB). [http://tpsgc-pwgsc.gc.ca/cgsb/home/index-e.html](http://tpsgc-pwgsc.gc.ca/cgsb/home/index-e.html)

The CGSB is a federal government organization that offers client-centred, comprehensive standards development and conformity assessment services in support of the economic, regulatory, procurement, health, safety and environmental interests of our stakeholders — government, industry and consumers.
The Organic Agriculture group of the CGSB is described here:
http://tpsgc-pwgsc.gc.ca/cgsb/on_the_net/organic/members-e.html

The two governing regulations for organic agriculture are:

1) Organic Production Systems: General Principles and Management Standards

2) Organic Production Systems: Permitted Substances Lists

No interpretation of the Organic Production Systems: General Principles and Management Standards is offered in this report. A prospective organic greenhouse producer must seek the advice and interpretation by the agency selected for certification.

The Permitted Substances List is generic. A greenhouse operator seeking information on specific inputs must discuss the products with the certifying agency. All possible inputs that will be used throughout the course of the long greenhouse production cycle have to be prior approved by the agency.

**Canadian organic greenhouse regulations**

Following are the regulations regarding organic greenhouse production. They are printed as they appear in Organic Production Systems: General Principles and Management Standard, p. 24.

7.5 Greenhouse Crops Production

7.5.1 For greenhouse products to be sold, labelled or represented as organic, the operator shall manage soil and crop production units with an in-ground, permanent soil system or with a container system with soil free of prohibited substances. Construction materials shall not include biodegradable plastics or wood treated with prohibited substances. The growing medium shall be free of prohibited substances, and the soil shall be free of prohibited substances for at least three years before use.

7.5.2 The operator may use supplemental heat with proper exhaust of burnt gasses, and supplemental lighting. Supplemental nutrition may be used in accordance with CAN/CGSB-32.311. However, composted animal manure shall be the primary source of nutrients.

7.5.3 Plants and soil, including potting soil, shall not be in contact with prohibited substances, including wood used for greenhouse structures or frames of raised beds treated with such substances.

7.5.4 The operator shall
   a. use reusable and recyclable pots and flats whenever possible;
b. use growing media and wetting agents selected from substances listed in CAN/CGSB-32.311;
c. disinfect holding or storage facilities and equipment using only substances listed in CAN/CGSB-32.311.

7.5.5 Full-spectrum lighting is permitted.

7.5.6 The following procedures or processes are allowed to
a. enrich carbon dioxide levels:
   i. flame
   ii. fermentation
   iii. composting
   iv. compressed gas (CO2)
b. clean and disinfect plant containers, pots and flats:
   i. substances listed in CAN/CGSB-32.311
   ii. steam-heat sterilization
c. stimulate growth or development:
   i. plant-based growth regulators
   ii. animal-based growth regulators
   iii. control of daily temperature and light levels
d. prevent damping-off:
   i. low-temperature baking
   ii. hot-water treatment
   iii. steam treatment

7.5.7 For the prevention and control of disease, insects or other pests, the following procedures are allowed:
   a. methods and substances listed in CAN/CGSB-32.311
   b. pruning
   c. roguing
   d. vacuuming
e. air filters, screens or other physical devices to exclude pests from the greenhouse environment

7.5.8 Soil regeneration and recycling procedures shall be practiced. Alternatives to crop rotation may be permitted in greenhouse production, such as grafting of plants on disease-resistant rootstock, winter soil-freezing, soil regeneration by incorporating biodegradable plant mulch (e.g. straw or hay), and partial or complete replacement of greenhouse soil, provided it is re-used outside the greenhouse for another crop.

7.5.9 For operations where the plants are not growing in the ground, a biologically active growing-medium shall be evident at the end of each growth cycle.
New organic regulations for December, 2008

Those considering getting into organic production need to be aware that regulations in Canada are changing.

Agriculture and Agri-food Canada announced new regulations in July of 2007:

Essentially the new regulations will mean that any organic products offered for sale in Canada and displaying the “Canada organic” logo (show here) will have to meet Canadian standards for organic production. However, it is unclear if the logo will be mandatory on organic products sold within the province they are produced.

The Canada organic logo will be permitted for use only on those food products certified as meeting Canadian standards for organic production. Effective in December 2008, it will be mandatory that all organic products be certified for interprovincial and international trade.

New organic regulation Questions and Answers

In February of 2007, CFIA has published a Question and Answer page on Organic Products Regulations that will come into affect in December, 2008.

Following are a few excerpts from that page. Some minor changes to the original wording and format have been made. They are printed here as they offer some clarity about organic regulations, not obvious from many sources.

Q1 Why has the federal government introduced these regulations?
A1 The regulations are the Government of Canada’s response to requests by the organic stakeholder groups to develop a regulatory system for organic products to address consumer protection and domestic and international market access issues. The regulations will form the basis for oversight of the industry via the Canada Organic Regime (COR).

Q2 What will the Organic Products Regulations do?
A2 The regulations will require mandatory certification to the revised National Organic Standard (Canadian Organic Production Systems Standards: General Principles and Management Standards and the Permitted Substances Lists) for agricultural products represented as organic in import, export and inter-provincial trade, or that bear the federal organic agricultural product legend (or logo).
Q4 How will the Canada Organic Regime be structured?

A4 The Canada Organic Regime is based on a third-party service delivery model:

- The Canadian Food Inspection Agency will be established as the competent authority providing oversight to the system.
- Existing accreditation bodies will be authorized by the CFIA provided they meet criteria set out in the regulations and established by the Canada Organic Regime. Agreements will be formed with accreditation bodies following an evaluation and verification that they meet these criteria.
- Authorized accreditation bodies will, in turn, assess certification bodies to determine if they meet the established criteria prior to recommending that they be accredited by the CFIA.
- On-farm and facility organic production system verification will be conducted by third-party verification officers employed by accredited certification bodies.
- Compliance verification and enforcement activities will be carried out by the CFIA.

Q5 What is significant about the Canada Organic Logo?

A5 Use of the logo is voluntary. All products that bear the logo must comply with the federal regulations. Use of the logo will indicate to consumers that the product to which it is affixed has been certified as meeting the Canadian standard.

Q6 How will the regulations affect the organic industry?

A6 All persons whose products bearing organic claims for inter-provincial and international trade, or who wish use the federal logo will be required to comply with the regulations. Certification to the revised standard for organic agriculture will be mandatory for such products.

Q7 Is the federal organic regime different than systems in place in British Columbia and Quebec?

A7 The current provincial systems apply to trade within these provinces but they do not regulate movement of organic products between provinces, or into or out of the country. As trade in organic products moves from provincial markets to global markets, countries importing Canadian products are seeking assurance from the Government of Canada that organic agricultural products are labelled accurately and in accordance with national requirements. In addition it provides assurance to Canadian consumers that the products meet a national standard.

Q8 How will negotiations to promote acceptance of the Canadian provisions be handled under the regulated system?

A8 Negotiation of acceptance of the Canada Organic Regime with Canada’s trading partners is the responsibility of the Government of Canada and will be initiated on a priority basis with our key trading partners with the publication of the regulations. Documentation for the recognition of the
Canadian system has been prepared and submitted to the EU.

Q9 Will certification bodies be identified on product packaging?
A9 Certification bodies will be required to place their name on organic product packaging in accordance with the labelling provisions in the regulations.

Q10 Who will enforce the regulations?
A10 The CFIA will enforce the regulations.

Q11 Will there be fees for participants in the Canada Organic Regime?
A11 No fees relating to CFIA services or activities are anticipated for the participants in the Canada Organic Regime (COR) at this time. The cost of establishing the COR will be covered by existing government resources through March 2009. The establishment of any future cost-recovery scheme or fees for participants would first be subject to broad consultation with stakeholders.

Q12 Do many other countries have regulations for organic products?
A12 In 2005, there were 42 countries (25 in the EU alone) with fully implemented organic regulations. Thirteen countries including Canada are in the process of implementing regulations (5 in Europe and 5 in South America). Sixteen countries were in the process of drafting regulations (6 in Latin America).


A13 The regulations will come into effect two years following their date of registration with the exception of the provision relating to the use of the Canada Organic logo. Discussions will be held with stakeholders on the potential use of the Canada Organic logo during the transition period.

A word on emergency pest control
Greenhouses are expensive to build and operate. No producer can afford a major crop loss resulting from the outbreak of a pest that cannot be controlled with approved organic pesticides. There are regulations allowing for emergency use of a few restricted products (and prohibited, but registered, pest management products) which otherwise do not conform to organic regulations. The marketing of treated crops is affected depending on the status of the product used, be it restricted or prohibited.

A greenhouse producer must contact the certifying agency to discuss possible emergency needs. Clarifying these regulations is strongly advised before production so informed decision can be made if an emergency arises.
At this time, the *Canadian Organic Production Systems: General Principles and Management Standards* allow for emergency application of some restricted products, but the products allowed for restricted use for emergency purposes is very limited. Use of approved restricted pest control products will normally allow the treated crops to still be marketed as organic. Prohibited products (but otherwise registered pest control products) are not allowed at any time if organic status is to be maintained.

Regarding emergency use, the *Canadian Organic Production Systems: General Principles and Management Standards* (p. 27) state:

**EMERGENCY PEST OR DISEASE TREATMENT**

9.1 When a prohibited substance is applied on an establishment because of a federal or provincial emergency program for the treatment of pests and diseases and when the establishment otherwise meets the requirements of this standard, the organic status shall not be affected provided the operator complies with the following conditions:

a. Any treated harvested crop or plant part shall not be sold, labelled or represented as organically produced.

However, such an application could render the crops as unmarketable as organic product depending on the acceptance of the product used.

Following is an example of a restricted fungicide as listed in the *Organic Production Systems: Permitted Substances Lists*.

Lime sulphur is claimed to be effective for the control of powdery mildew. The *Organic Production Systems: Permitted Substances Lists* states that lime sulphur is permitted as follows:

*Foliar application as a fungicide is allowed on a restricted basis. May be used as an insecticide only if there are no feasible alternatives.*

If no other chemical alternatives were available, then lime sulphur would be permitted.

There is uncertainty about the emergency use of a prohibited product in one greenhouse structure. Using a prohibited product in one structure may or may not affect the certification status of crops grown in a completely separate greenhouse structure. Again, an organic greenhouse producer must seek clarification from the certify agency on this matter.

**Getting started in organics and the certification process**

A prospective organic producer must do a lot of homework because organic production involves a lot of regulatory and technical nuances.

A good place to start is the Alberta Agriculture and Food (AAF) website, *Organic Agriculture: Getting Started*

http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex10031
AFF (Alberta Agriculture and Food) provides a list of certifying bodies and it was updated on December 20, 2007:
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/bdv8046

(Internet links are constantly changing and AAF’s links are no different. The above link was updated on December 20, 2007 and was not working as of January 10, 2008.)

As already noted, it is imperative that a producer do much background homework before considering organic production in the greenhouse.

First, a producer must find a certifying body that he or she can work with and that will certify according to the specification required in the marketplace since certifying bodies use different certification standards. A prospective organic producer should first investigate some of the technical aspects of organic production and then contact two or three certifying agencies to see which agency is likely to best fit his/her needs. It is also imperative to meet with prospective buyers to determine if they require certification by a specific agency or according to a specific set of standards.

A producer must also become familiar with the markets, pricing and economics. There will be a period of learning and adjustments while techniques are learned and skills improve. At this time, there are virtually no turnkey production systems for organic greenhouse production.

In Alberta, there are no private consultants or companies who are experienced in organic greenhouse production that can offer knowledgeable or expert help. Other sections of this report are dedicated to the technical aspects of organic production.
Conventional and organic greenhouse vegetable production in Canada and elsewhere

Introduction

In this section, first some general statistics for greenhouse vegetable production in Canada are presented. This information is presented merely to describe the state of Canada’s and Alberta’s conventional greenhouse industry. These data are also used as a reference to help put the estimated size of Canada’s organic greenhouse industry in perspective.

Special emphasis is given to greenhouse tomatoes in this section because this is the one organic greenhouse crop for which we have the most data.

The descriptions for production of conventional greenhouse vegetables in Canada are followed by an attempt to estimate the size of Canada’s organic greenhouse vegetable industry.

Statistics Canada reports annually on the production and value of greenhouse crops in Canada based on surveys of producers. The data in Table 1 were gleaned from Greenhouse, Sod and Nursery Industries 2006, Statistics Canada catalogue 22-202-XIB. http://www.statcan.ca/english/freepub/22-202-XIB/22-202-XIB2006000.pdf

The following is excerpted from page 5 of that report:

Vegetables

Greenhouse vegetable growers indicated they sold a total of $826.9 million worth of product in 2006, the majority of which were sold to wholesalers. The vegetable that enjoyed the highest revenue was tomatoes followed by peppers and cucumbers. Tomatoes made up almost half of all vegetable revenue while peppers and cucumbers each had approximately one quarter of the total revenue. Tomatoes had the most area with 51.0 million square feet followed by cucumbers and peppers with 29.3 million square feet and 27.5 million square feet respectively.

There were between 2,300 and 2,400 acres of greenhouse tomatoes, cucumbers, peppers and lettuce in Canada in 2005 and 2006.

Statistics Canada has difficulties in reporting production data even though they conduct detailed surveys with known producers. They report numerous errors in data collection and that some data are not reported because they are unreliable or there are too few
producers to report. The reports do, however, show relative amounts of production and estimated values.

Statistics Canada claims about difficulties in reporting data for mainstream greenhouse crops like tomatoes, cucumbers and peppers emphasize the difficulties with reporting statistics on specific greenhouse sectors such as organic production. Simply, precise data do not exist for organic greenhouse vegetables.

All of the many government agencies involved in market studies and gathering of agricultural production statistics seem to have no concise data on organic production. At best, we have some estimates of organic production, but they are largely based on experienced comments and extrapolations. Other than our general knowledge of some pesticide-free production in Alberta, there are no statistics kept by authorities on this production and marketing process.

The request for proposals, included, “market fresh, locally produced, safe and nutritious greenhouse vegetables.” These are marketing constructs for which no statistics are available and therefore they are not reported in this section. They will be discussed later in this report under the Opportunities for value-added production in Alberta’s greenhouse industry section.
Greenhouse vegetable production in Canada
Statistics Canada data from Greenhouse, Sod and Nursery Industries 2006, are reported in Table 1.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Area, production and value of greenhouse vegetables in Canada, 2005 and 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomatoes</td>
<td>Acres (ha)</td>
</tr>
<tr>
<td>Quebec</td>
<td>103 (42)</td>
</tr>
<tr>
<td>Ontario</td>
<td>660 (267)</td>
</tr>
<tr>
<td>Alberta</td>
<td>29 (12)</td>
</tr>
<tr>
<td>BC</td>
<td>312 (126)</td>
</tr>
<tr>
<td>Canada</td>
<td>1,113 (451)</td>
</tr>
<tr>
<td>Cucumbers</td>
<td>Acres</td>
</tr>
<tr>
<td>Quebec</td>
<td>42 (17)</td>
</tr>
<tr>
<td>Ontario</td>
<td>420 (170)</td>
</tr>
<tr>
<td>Alberta</td>
<td>52 (21)</td>
</tr>
<tr>
<td>BC</td>
<td>91 (37)</td>
</tr>
<tr>
<td>Canada</td>
<td>620 (251)</td>
</tr>
<tr>
<td>Peppers</td>
<td>Acres</td>
</tr>
<tr>
<td>Quebec</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Ontario</td>
<td>344 (139)</td>
</tr>
<tr>
<td>Alberta</td>
<td>17 (7)</td>
</tr>
<tr>
<td>BC</td>
<td>216 (87)</td>
</tr>
<tr>
<td>Canada</td>
<td>574 (232)</td>
</tr>
<tr>
<td>Lettuce</td>
<td>Acres</td>
</tr>
<tr>
<td>Quebec</td>
<td>10 (4)*</td>
</tr>
<tr>
<td>Ontario</td>
<td>7 (3)</td>
</tr>
<tr>
<td>Alberta</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>BC</td>
<td>3 (1)</td>
</tr>
<tr>
<td>Canada</td>
<td>22 (9)</td>
</tr>
</tbody>
</table>

Source: Greenhouse, Sod and Nursery Industries 2006. Statistics Canada. 22-202-XIB. Data are for 2005, 2006 or an average of both. Statistics Canada was unable to report figures for some provinces when data are considered unreliable or there are too few producers reporting. They state that some data are “suppressed to meet the confidentiality requirements of the Statistics Act.” Data designated as E, signifies that the data are to be used with caution. Numbers here are rounded. Totals for Canada may not concur with sums for all provinces since some data are missing for some provinces.

* André Carrier reports there are 37 acres (15 ha) of greenhouse lettuce in Quebec in 2007.
Alberta’s place in the Canadian greenhouse industry

In 2005, AAF commissioned a study on Alberta’s vegetable industry. A full copy of the report, *Alberta Vegetable Industry: Profile and Analysis, 2005*, was obtained from Rob Spencer.

Figure 1 below, is used with permission. It compares several “benchmark” features between Alberta’s greenhouse industry and the Canadian greenhouse industry. The report is classed as confidential and is available on request. Details of the assorted footnotes have been excluded in the figure below and available upon request.

Figure 1

<table>
<thead>
<tr>
<th>BENCHMARK</th>
<th>ALBERTA</th>
<th>CANADA</th>
<th>ALBERTA SHARE IN CANADA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of vegetable greenhouse operations (annual operations)</td>
<td>57¹</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td>Size of the vegetable greenhouse sector (acres)</td>
<td>105¹</td>
<td>2043.1²</td>
<td>5.1%</td>
</tr>
<tr>
<td>Number of employees (F/T and FTE)</td>
<td>420³</td>
<td>18388²</td>
<td>2.3%</td>
</tr>
<tr>
<td>Annual (wholesale value) sales (millions of $)</td>
<td>40¹</td>
<td>694.88²</td>
<td>5.8%</td>
</tr>
<tr>
<td>Growth of the vegetable greenhouse sector 2003 - 2004 (%)</td>
<td>14²</td>
<td>12.3³</td>
<td>-</td>
</tr>
<tr>
<td>Total value of food and beverage shipments 2004 (billions of $)</td>
<td>9.5⁴</td>
<td>72.2⁴</td>
<td>13.2%</td>
</tr>
<tr>
<td>Value of greenhouse exports 2004 (millions of $)</td>
<td>1.1⁵</td>
<td>549.5⁶</td>
<td>0.2%</td>
</tr>
<tr>
<td>Value of greenhouse exports to U.S.A. (millions of $)</td>
<td>1.1⁵</td>
<td>547.1⁶</td>
<td>0.2%</td>
</tr>
<tr>
<td>Value of greenhouse imports (millions of $)</td>
<td>75.9⁵</td>
<td>573.0⁶</td>
<td>13.2%</td>
</tr>
<tr>
<td>Number of Alberta greenhouse operations exporting</td>
<td>1¹</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Investment in capital machinery and equipment (millions of $)</td>
<td>84⁶</td>
<td>1634.5⁷</td>
<td>5.1%</td>
</tr>
<tr>
<td>ACNielsen data, Alberta fresh vegetables (millions of $)</td>
<td>331.8⁷</td>
<td>2873.5⁷</td>
<td>11.5%</td>
</tr>
<tr>
<td>Consumption per person (kg/yr)</td>
<td>n/a</td>
<td>76.9⁹</td>
<td>-</td>
</tr>
<tr>
<td>Average economic unit for vegetable production (acres)</td>
<td>2</td>
<td>1634.5⁷</td>
<td>0.12%</td>
</tr>
<tr>
<td>Distribution of greenhouse vegetable by area (acres)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cucumber</td>
<td>65¹</td>
<td>511.6²</td>
<td>12.7%</td>
</tr>
<tr>
<td>Tomato</td>
<td>25¹</td>
<td>1097.8²</td>
<td>2.3%</td>
</tr>
<tr>
<td>Pepper</td>
<td>12¹</td>
<td>397.3²</td>
<td>3.0%</td>
</tr>
<tr>
<td>Lettuce</td>
<td>3¹</td>
<td>36.6²</td>
<td>8.2%</td>
</tr>
</tbody>
</table>

The data reported by Statistics Canada (Table 1 on the previous page) are reasonably consistent as those reported in AAF’s *Alberta Greenhouse Industry Profile 2007*: [http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/opp11211](http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/opp11211)

*There are 23 ha [57 acres] of greenhouse space devoted to the production of seedless cucumbers, 12.10 ha [30 acres] to tomatoes, 6.5 ha [16 acres] to peppers and 1.0 ha [2.5 acres] to lettuce.*

The areas reported by AAF for tomatoes, cucumbers and peppers are within 10 percent of the Statistics Canada figures. However, AAF reports more area dedicated to lettuce production than does Statistics Canada.
**Greenhouse production in North America**

Figure 2 below, shows greenhouse vegetable area (hectares) in North America in 2002. The table was captured from, *An Overview of the BC Greenhouse Vegetable Industry.* (BCMAFF, 2003) [http://www.agf.gov.bc.ca/ghvegetable/publications/documents/industry_profile.pdf]

<table>
<thead>
<tr>
<th>Crop</th>
<th>Production Area (ha)</th>
<th>Total North America</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Canada</td>
<td>US</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>482</td>
<td>350</td>
</tr>
<tr>
<td>Cucumbers</td>
<td>199</td>
<td>25</td>
</tr>
<tr>
<td>Bell Peppers</td>
<td>174</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>855</td>
<td>395</td>
</tr>
</tbody>
</table>

Source: BC Vegetable Marketing Commission.

The numbers for Canada are about 15 percent less than reported by Statistics Canada for 2006, which would be explained by industry growth and sampling errors as reported by Statistics Canada. They give a reasonable comparison for the three countries in North America. Greenhouse production in Mexico is a booming and a concern for the Canadian greenhouse industry.

In gathering information for this study, several greenhouse industry personnel were interviewed. Mexico was often mentioned because its greenhouse production has increased rapidly in the past few years.

Organic peppers were seen in a few retail stores in Alberta in November. The role of Mexico will be discussed later in this report as it is certain to influence organic markets in the future.


The vegetable greenhouse industry in Mexico is growing rapidly; from 50 hectares in 1991, to 350 in 1997, to 1000 in 2001. It is estimated that by the end of 2004 there will be close to 2700 hectares in operation. Rapid growth will continue as open field producers face new challenges and demand from North America for greenhouse grown produce increases... Dutch, Israeli, Spanish, French, Canadian, and Mexican suppliers are aggressively promoting the industry, and several State governments are now considering this mode of production as a key factor to induce agricultural change and technological innovation.
Tomatoes in North America

Tomatoes are of special interest in this study for two reasons. There is better information about existing production (and trends) than for the other main greenhouse products. But more importantly, tomatoes will probably be the main greenhouse organic crop in Alberta should growers choose to move into organics. The consensus from all involved is that they are the easiest crop (in relative terms) to be grown organically in greenhouses. This will be discussed later.

Tomatoes are a huge crop in North America and the production dynamic is changing rapidly. The following is taken from, North American Greenhouse Tomatoes Emerge as a Major Market Force. Although the article is nearly three years old it presents a “sense” of this dynamic commodity. Amber Waves, USDA online magazine. April 2005. [http://www.ers.usda.gov/AmberWaves/April05/pdf/april05_feature_greenhousetomatoes.pdf](http://www.ers.usda.gov/AmberWaves/April05/pdf/april05_feature_greenhousetomatoes.pdf)

Greenhouse tomatoes now represent an estimated 17 percent of U.S. fresh tomato supply … Around 37 percent of all fresh tomatoes sold in U.S. retail stores are now greenhouse, compared with negligible amounts in the early 1990s.

…

The United States, Canada, and Mexico have all developed major greenhouse industries. The United States is the largest North American market for greenhouse tomatoes, and U.S. imports from Canada and Mexico are larger than domestic production. In recent years, the growth in U.S. imports has exceeded the growth in U.S. production. In 2003, Canada accounted for an estimated 46 percent of U.S. imports of greenhouse tomatoes. Mexico’s share was 45 percent. As the greenhouse tomato industry has transitioned from niche to mainstream status, it has become part of a more integrated North American market, following the pattern established by the field tomato industry.

…

In 2003, total production of North American greenhouse tomatoes was estimated at 528,078 metric tons. Canada’s share of this total was 42 percent, followed by the United States with 30 percent, and Mexico with 28 percent. Though greenhouse tomato production soared in all three countries from the early 1990s, it has been stabilizing in the United States and Canada. In Mexico, the industry is still growing rapidly. Mexico’s growing area exceeds the combined total area of U.S. and Canadian greenhouses, but with many Mexican growers using extensive production methods with relatively simple low-yielding technology, output is lower than in the other two countries.

Canada was the first big greenhouse tomato producer in North America and still has the highest yields and total production. The Canadian industry is centered in southern British Columbia and Ontario. Long, relatively mild, summer days in these regions generate high yields. During the March to December period, Canadian production is a market force. U.S. and Mexican tomato producers, both field and greenhouse, have to compete with the high Canadian summer volume.
Naturally this enthusiasm of 2003 has been tempered by the relative strengths of the Canadian and US dollars. Mexican producers continue to build more greenhouses.

Table 2 was adapted from *North American Greenhouse Tomatoes Emerge as a Major Market Force*. The table was preceded with the caption, *Canada leads North American greenhouse tomato production in 2003*.

<table>
<thead>
<tr>
<th>Item</th>
<th>U.S.</th>
<th>Canada</th>
<th>Mexico</th>
<th>North America</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse tomato production (1,000 metric tons)</td>
<td>160</td>
<td>220</td>
<td>148</td>
<td>528</td>
</tr>
<tr>
<td>Greenhouse tomato area (hectares)</td>
<td>330</td>
<td>446</td>
<td>148</td>
<td>528</td>
</tr>
<tr>
<td>Average greenhouse tomato yield (metric tons/hectare)</td>
<td>484</td>
<td>494</td>
<td>156</td>
<td>378</td>
</tr>
<tr>
<td>Fresh field tomato production, excluding processing (1,000 metric tons)</td>
<td>1.594</td>
<td>27</td>
<td>1,804</td>
<td>3,425</td>
</tr>
<tr>
<td>Average fresh field tomato yield (metric tons/hectare)</td>
<td>32</td>
<td>15</td>
<td>28</td>
<td>25</td>
</tr>
<tr>
<td>Greenhouse share of total fresh production, by country (percent)</td>
<td>9</td>
<td>89</td>
<td>8</td>
<td>13</td>
</tr>
</tbody>
</table>

The table shows the importance of Canada’s greenhouse tomatoes in the North American tomato marketplace. It also shows the large volume of field tomatoes produced in the USA and Mexico, some of which conceivably can be replaced by high-quality and locally grown tomatoes as consumer trends shift toward *local* and TOVs— which cannot be grown in the field.
Organic greenhouse vegetable production in Canada

The request for proposal stated:

*Status of the certified organic, pesticide free, market fresh, locally produced, safe and nutritious greenhouse vegetables in the markets of Europe, Mexico, Ontario, Quebec, British Columbia and Alberta. It should include volumes, prices and trends.*

In trying to establish production figures for organic greenhouse vegetables contact was made with many people and agencies. No single person or agency has a package of information about the production or organic greenhouse vegetables in Canada. The following people provided assorted statistical production information and opinion.

<table>
<thead>
<tr>
<th>Horticulture Section</th>
<th>Anne Macey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture Division</td>
<td>On behalf of:</td>
</tr>
<tr>
<td>Statistics Canada</td>
<td>Canadian Organic Growers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mike Leclair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sectoral Industry Services Div</td>
</tr>
<tr>
<td>Agriculture &amp; Agri-Food Canada</td>
</tr>
<tr>
<td>Bev Appleby</td>
</tr>
<tr>
<td>Marketing Officer / Agente de Marketing</td>
</tr>
<tr>
<td>Canadian Produce Marketing Association</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mary-Margaret Gaye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Director</td>
</tr>
<tr>
<td>BC Greenhouse Growers' Association</td>
</tr>
<tr>
<td>Matthew Holmes</td>
</tr>
<tr>
<td>Managing Director, Canada</td>
</tr>
<tr>
<td>Organic Trade Association</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Margaret Savard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Agriculture Centre of Canada</td>
</tr>
<tr>
<td>Tom Demma, General Manager</td>
</tr>
<tr>
<td>BC Vegetable Marketing Commission</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rochelle Eisen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Extension Agent</td>
</tr>
<tr>
<td>COABC</td>
</tr>
<tr>
<td>Doug Peters</td>
</tr>
<tr>
<td>Market Development Advisor</td>
</tr>
<tr>
<td>Horticulture-Food Value Chain</td>
</tr>
<tr>
<td>Markets and Trade Branch</td>
</tr>
<tr>
<td>Agriculture and Agri-Food Canada</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>André Carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse Specialist</td>
</tr>
<tr>
<td>Quebec</td>
</tr>
<tr>
<td>Shalin Khosla</td>
</tr>
<tr>
<td>Greenhouse Specialist</td>
</tr>
<tr>
<td>Ontario</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Janice Elmhirst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent industry consultant, BC</td>
</tr>
</tbody>
</table>

Extensive online searches and discussions with many people revealed that there is virtually no information about these matters. As noted elsewhere, no agency keeps track of “… pesticide free, market fresh, locally produced, safe and nutritious greenhouse vegetables.” These are simply too vague to be tracked in the official statistics reporting system.
Specifically, regarding organic production, information such as “include volumes, prices and trends” do not exist. (If they do exist, they are a well-kept secret because officials in Statistics Canada and AAFC’s Market and Industry Services Branch do not know of their existence.)

Canada does track prices of some greenhouse vegetables, but these data are irrelevant without comparative prices for organic vegetables. Some casual observations were made in several retail stores in Alberta in an effort to compare retail prices of organic vegetables with conventionally produced vegetables. However, in late November and December there were few organic greenhouse vegetables on store shelves, so no objective comparisons could be made. Indeed, prices for the few organic tomatoes seen in grocery stores were considerably higher than those of conventional greenhouse tomatoes. Since the observations were limited it would be unwise to make statements about price ranges of organic produce because of the time or year and small samples. Produce managers for wholesale companies supplying mainstream retail grocery chains reported that retail prices were typically 30 or 40 percent higher than for conventional greenhouse tomatoes. (Price spreads are held down to promote sales and reduce waste of high-priced organic produce.)

Statistics Canada provided some reports for imported organic field tomatoes, but no reports were found specifically for organic greenhouse tomatoes.

Statistics Canada offers a fee-for-service database search here: 
http://www.statcan.ca/trade/scripts/trade_search.cgi

However, the database was unable to provide any statistics on organic greenhouse vegetable production.

Organic greenhouse vegetable production is not well documented in Canada and there are few accurate statistics recorded or published.


They reported the following organic greenhouse vegetable production.

<table>
<thead>
<tr>
<th>Table 3. Area of organic greenhouse production 2005 (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td>71*</td>
</tr>
</tbody>
</table>

* In dispute. See discussion below.
** None reported.
*** Not accurate. See discussion below.

These data show the difficulties with reporting organic production. The report states:

“Greenhouse” includes propagation greenhouses as well as greenhouse vegetables,
and both large scale producers and smaller operators who have a greenhouse as part of a mixed operation.

An attempt is made below to establish a range of probable organic greenhouse vegetable production in Canada. First, some comments about the numbers.

**Comments about organic greenhouse production in BC**

Regarding the organic greenhouse production in BC, the COG report lists 71 acres in BC in 2005. This was discussed with Rochelle Eisen, COABC’s Organic Extension Agent, and she felt the number might be too high as it did include area of greenhouse transplants.

One company (Origin) claims to produce 33 acres of organic greenhouse vegetables. Using COG’s number, that leaves another 38 acres in other organic greenhouses. Anne Macey (pers. comm.), who wrote the COG study, felt that the additional 38 acres was too high. However, she wrote:

... there were 5 acres reported on Vancouver Island ... by 17 farms. ... I know of 12 acres on 3 farms in the lower mainland which are not Origin.

Tom Demma (Manager, BC Vegetable Marketing Board) wrote that there is no more than one hectare of organic greenhouse vegetables in BC, not including Origin’s production. After questioning his figures and discrepancies two times, on January 3, he wrote, “A fairly large organic greenhouse ceased production late last year. This is why the 2008 figures I provided you do not jive with info you have from other sources.”

Susan Smith, BC’s greenhouse specialist reported there are 66 acres of organic greenhouses in 16 farms, including Origin’s 33 acres. Not including Origin, that’s an average of 2.2 acres on 15 other organic greenhouse farms. The best guess is that some of this is transplants and that the greenhouses are used for seasonal production. (For comparison, the average size of 29 organic greenhouses in Quebec is 0.36 acres, plus one large grower with 2 acres.)

With apologies to all who provided information about BC’s organic greenhouse production, there is reason to be sceptical about BC’s numbers. For purposes of this report, it is estimated to be 55 acres or about half way between 35 and 71 acres—about the high and low estimates. This may well be far too high and the calculations that follow are to be used with caution.

The conflicts with the BC production data exemplify the state of statistics for organic production in Canada. There are few hard numbers that can be confirmed—and many numbers are in dispute. Ironically, BC appears to be well organized “organically” with its marketing boards and the Certified Organic Associations of British Columbia (COABC).
Comments about organic greenhouse production in Alberta
The COG report shows no production in Alberta. AAF reported there were three organic producers in 2007. Two small producers, who had organic vegetables at one time, are currently not producing organic greenhouse vegetables. One operation near Calgary reports on the company’s website as having less than 0.5 acre of organic greenhouse. This company supplies at least two organic foods market stores in Calgary. Two or three contacts reported that there may be a small organic greenhouse producer near Edmonton. But none could confirm this nor offer contact details. If there are organic greenhouses in Alberta, in total, the production is relatively small.

Comments about organic greenhouse production in Ontario and other provinces
Shalin Khosla (pers. comm..) reported there are 3 acres of organic greenhouse vegetable production in Ontario in 2007 instead of the 4 acres reported here. Statistics for other provinces reported in the COG report cannot be confirmed, but assumed to be somewhat close. The COG report shows one acre reported for New Brunswick, but one large producer who was growing organic tomatoes in 2005 is no longer in production and they had one half of the one acre reported for 2005. No contrary figures for production in Nova Scotia were found. In any case, organic greenhouse vegetable production in provinces other than BC, Quebec and Ontario is uncertain, but undoubtedly small—a few acres at most.

Quebec comments
Regarding the organic greenhouse production in Quebec, André Carrier, provincial greenhouse specialist, reports (pers. comm.) that there are 12 acres of organic greenhouse vegetables in Quebec. These are primarily tomatoes.

“Guestimates” of organic greenhouse production in Canada
For this report the area of organic greenhouse vegetables production in BC will be accepted as about 55 acres, including the 33 acres from Origin. The Quebec area is about 12 acres and all other provinces will be assigned a total area of 6 acres, for a grand total of about 73 acres in 2007—plus or minus 20 acres.

In the past decade, production of organic food has increased in Canada, but that trend seemed to level off between 2004 and 2005. We do not have accurate data for organic greenhouse vegetable production so we can’t determine if there is an upward trend outside of BC. Certainly the Canadian area increased significantly as the one large company (Origin) in BC increased production to 33 acres in the past few years.

Based on Statistics Canada figures for 2005 and 2006, there were probably about 2,500 acres of greenhouse vegetables grown in Canada in 2007. The estimated 73 acres (±20 acres) of organic greenhouse vegetables in Canada, therefore, represents about 3 percent of the total greenhouse vegetable area in Canada, but this may range from about 2 to 4 percent.

Clearly, the production of one company (Origin) represents a large portion the total area of Canadian organic greenhouse production.
To add to the uncertainty, we don’t know what crops make up this estimated 73 acres, although the vast majority is tomatoes.

**Estimating the volume of organic greenhouse vegetables in Canada**

There are no formal production and marketing statistics for organic greenhouse vegetables in Canada so only estimates of production volumes can be made. Those familiar with the industry claim that organically grown vegetables yields are about 50 to 80 percent of yields from conventional greenhouses.

For our purposes, the area of organic greenhouse tomatoes is estimated at 80 percent of the total organic greenhouse vegetable production. This is about 60 acres which represents about 5 percent of Canada’s total greenhouse tomato area of about 1,200 acres.

An effort is made here to estimate the volumes of organic greenhouse vegetables produced in Canada in 2007. These will be based on the following assumptions:

- There are 73 acres of organic greenhouse vegetables in total, comprised of,
  - 60 acres of tomatoes
  - 6 acres of cucumbers
  - 7 acres of peppers

- Yields for tomatoes are estimated to be 70 percent of conventional production
- Yields for cucumbers are estimated to be 60 percent of conventional production
- Yields for peppers are estimated to be 60 percent of conventional production

There is no way to verify these yields. They are based on “best guesses,” and may be generous.

No estimate for lettuce is attempted. There are almost certainly small areas of organic lettuce production.
Table 4. Estimated production of organic greenhouse vegetables 2007

<table>
<thead>
<tr>
<th>Crop</th>
<th>Acres</th>
<th>Production X1,000</th>
<th>Approx yield/acre</th>
<th>Organic yield % of conventional</th>
<th>Estimated Yield</th>
<th>Estimated Acres</th>
<th>Estimated Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomatoes</td>
<td>1.113</td>
<td>466,000 pounds</td>
<td>420,000 lb/acre</td>
<td>70 %</td>
<td>294,000 lb/acre</td>
<td>60 acres</td>
<td>17,640,000 pounds</td>
</tr>
<tr>
<td>Cucumbers</td>
<td>620</td>
<td>27,000 dozen</td>
<td>43,000 doz/acre</td>
<td>60 %</td>
<td>26,000 doz/acre</td>
<td>6 acres</td>
<td>156,000 doz</td>
</tr>
<tr>
<td>Peppers</td>
<td>574</td>
<td>121,000 pounds</td>
<td>210,000 lb/acre</td>
<td>60 %</td>
<td>126,000 lb/acre</td>
<td>7 acres</td>
<td>882,000 pounds</td>
</tr>
</tbody>
</table>

Estimating the farm-gate value of organic greenhouse vegetable production in Canada

An estimate is made here of the farm-gate value of organic greenhouse vegetables. Prices for organic greenhouse vegetables are assumed to be 50 percent higher than grower prices for conventionally produce vegetables. Grower prices were obtained from John Judge, retired manager of Red Hat Coop. (Pers. comm.) These are gross prices and do not include deductions for packaging, shipping and coop fees. All producers incur these marketing fees whether done cooperatively or independently.

A 50 percent price premium was selected for tomatoes as it seems to be a reasonable mark-up over pricing of conventional greenhouse tomatoes in the wholesale-retail trade. There are fewer organic greenhouse cucumbers and peppers and for this estimate, it is assumed that the prices for these two vegetables are 75 percent higher.

Wholesalers said that they were paying a bonus for organics, but the premium could not be too high. As it is, wholesalers reported that the mark-ups on organic vegetables was less than for conventional in the retail stores in order to keep the price spread (between conventional and organic) at a minimum. They liked to see organic vegetables at between 30 and 40 percent over conventional vegetables.

Clearly, there is a huge range in prices received by organic producers depending on how and where the vegetables are sold. One major specialty chain (pers. comm.) reported selling cucumbers as high as $5 each. This is exceptional and this is also the retail price—the producer might have received and estimated 60 to 70 percent of the retail price.

Prices at farmers markets for organic vegetables are known to be higher. Prices growers receive when they deliver directly are also assumed to be higher. However, time and transportation costs of selling at farmers markets and direct store deliveries have to be taken into account and reduced from the gross price to calculate farm-gate price.
The prices reported in the following table below are also “average” and prices at the beginning and end of the year can be double these shown, although volumes are lower.

| Table 5. Estimated farm-gate price of conventional and organic greenhouse vegetables |
|-------------------------------|------------------|------------------|
|                               | Conventional     | Organic higher   |
|                               | (rounded)        | (rounded)        |
| TOVs                          | $1.00/lb         | $1.50/pound      |
| Beefsteak                     | 0.80 /lb         | $1.20            |
| Cucumbers                     | $9/doz ($0.75 each) | $15.75 ($1.30 each) |
| Peppers                       | $1.75/lb         | $3.00/lb         |

*Prices for organics are assumed to be 50 higher for organic tomatoes and 75 percent higher for organic cucumbers and peppers. Beefsteak production and prices is not considered in the table that follows.*

Using these estimated “average” prices for organic greenhouse vegetables, an attempt is made in the following table to estimate the farm-gate value of organic greenhouse vegetables in Canada.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
<td>Estimated Production</td>
<td>Estimated value</td>
</tr>
<tr>
<td></td>
<td>Gross value</td>
<td>Value $/ac ($/sq.ft.)</td>
</tr>
<tr>
<td>Tomatoes 60 acres 17,640,000 pounds</td>
<td>$1.50/lb</td>
<td>$441,000/ac $10.12/sq.ft.</td>
</tr>
<tr>
<td>Cucumbers 6 acres 156,000 doz</td>
<td>$15.75/doz</td>
<td>$409,500 $9.40/sq.ft.</td>
</tr>
<tr>
<td>Peppers 7 acres 882,000 pounds</td>
<td>$3.00/lb</td>
<td>$378,000 $8.70/sq.ft.</td>
</tr>
<tr>
<td>Total value of all three crops</td>
<td>$31,563,000</td>
<td></td>
</tr>
</tbody>
</table>

The estimation puts the farm-gate value of organic greenhouse vegetables at nearly $32,000,000 in 2007. Origin claims they sell $20,000,000 per year and their production of 33 acres represents about 45 percent of the estimated 73 acres of organic greenhouse vegetables in Canada. We can’t verify Origin’s claims, however, using the income from Origin, and extrapolating it to the entire 73 acres, results in a total Canadian organic greenhouse vegetable income of about $44,000,000.

Based on Statistics Canada’s figures for 2005 and 2006 there were about 2,500 acres of greenhouse vegetables produced in Canada in 2007 with a farm-gate value of about $850,000,000.
The estimated 73 acres of organic greenhouse vegetables represents about 3 percent of Canada’s total production. Three percent of $850,000,000 is about $25,000,000, but that would assume the same income per acre of production.

We might assume that the farm-gate value of organic greenhouse vegetables might be somewhere between about $25 and $40 million annually.

**Extreme caution must be used in considering these figures since they are estimates based on estimates and cannot be verified.**

Origin exports much of their production to the USA. Quebec and Ontario might export unknown quantities to the USA. (André Carrier reports that little of Quebec’s organic greenhouse crops are exported. Attempts to verify exports from Ontario to the USA were unsuccessful as of January 9, 2008.)

I am inclined to think the farm-gate value of organic greenhouse vegetable production is closer to $25,000,000 than $40,000,000—and may well be less than $25 million.

The discrepancies may be due to an overestimation of organic greenhouse area. The BC Vegetable Marketing Commission certainly disputes the area of organic greenhouses in BC as reported by the COG.

Estimates of actual acreage and estimated yields used in the calculations in Table 4 are probably too generous. Instead of being at 60 and 70 percent of conventional yields it is possible they are considerably lower—they may average less than 50 percent of conventional. (The data in Table 4 could be changed, but altering the figures would be just as artificial as those shown. Simply, we don’t know for sure.)

Below are estimates of organic greenhouse vegetable sales based on a study by the Organic Agriculture Centre of Canada. There are large discrepancies between the production estimates here and the estimates of retail sales of organic tomatoes.

If nothing else, the discrepancies merely indicate the lack of accurate statistics for organic production and sale—so the process is not entirely futile.

**Estimating retail sales of organic greenhouse vegetables in Canada**

An attempt is made here to compare the estimated production (above) and retail sales of organic vegetables in Canada.

**Organic tomato retail sales**

Estimates for organic tomato retail sales and organic lettuce sales are made here as these are the only major greenhouse crops for which reasonable estimate of organic sales are made. There are no references for retail sales of organic greenhouse cucumbers and peppers.
Much of this discussion is based on a study completed by the Organic Agriculture Centre of Canada, *Retail Sales of Certified Organic Food Products in Canada in 2006*: http://www.organicagcentre.ca/Docs/RetailSalesOrganic_Canada2006.pdf

Unfortunately, the retail sales study does not distinguish between greenhouse and field vegetables.

On page 4, the report states that fresh vegetables account for 25 percent of all organic food sales, or $102 million in mainstream supermarkets. Of that, tomatoes are 4.2 percent, or about $4.4 million. Therefore, sale of organic tomatoes represents about 1 percent of all organic sales in mainstream grocery stores that are estimated at $412 million. (This 1 percent figure is used to estimate sales in other outlets.)

The same report also estimates fresh produce sales through natural food stores. Organic tomatoes sales were estimated to be about $3.1 million.

The study also reports, a total of $175 million of organic sales through smaller grocery stores, mass merchandisers, warehouse clubs and speciality shops. Using the 1 percent estimate this would mean sales of organic tomatoes to be about $1.7 million.

The study estimates organic produce sales through buying clubs, box delivery and farmers market at about $70 million. There is no way to know how much of this is organic greenhouse tomatoes. Most probably sales are slightly higher and 2 percent of gross organic sales is used. Therefore there are an estimated $1.4 million in organic tomato sales through buying clubs, box delivery and farmers market. (That may be generous.)

Based on the *Retail Sales of Certified Organic Food Products in Canada in 2006*, the total retail value of organic tomatoes in Canada would have been about $11 million in 2006. There is no way to know how much of this is imported field grown organic tomatoes (probably very little) or imported organic greenhouse tomatoes. Based on casual surveys in Alberta grocery stores in November and December, it is safe to assume that the majority of these tomatoes are produced in greenhouses. (We know that all of the TOVs are greenhouse grown.) In December and January, some of the tomatoes would come from greenhouses in Mexico.

Considering that some organic tomatoes were imported, all that can be concluded based on the findings reported in the study, is that sales of Canadian organic greenhouse tomatoes in Canada was probably not more than $10 million in 2006. (Again, this estimate must be used with caution.)

The farm gate value of these sales would be considerably less, but perhaps between $6 and $8 million. (Wholesalers reported that their mark-ups are less for organic produce in order to keep the price spread between conventional an organic at a minimum.) Using an income estimate of $440,000 per acre (which might be generous), this translates to a
market in Canada of about 14 to 18 acres of organic greenhouse tomatoes for all of Canada, or about 2 to 3 acres for Alberta, Saskatchewan and Manitoba markets.

This estimate is tested against retail sales as reported by AAFC. They report on retail sales in, Retail Sales Data 2006: http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1193434690454&lang=e

Total retail sales of fresh tomatoes (field and greenhouse) were estimated at $443,633,364 in 2006.

In researching this report, several produce buyers for the main grocery store chains were interviewed. The organic greenhouse tomatoes, cucumbers and peppers sales were thought to be between 1 to 2 percent of all sales. If the retail price of organic tomatoes was 40 percent higher than other tomatoes, then the retail value of organic tomatoes would be between $6 and $12 million. These estimates fall around the estimate from the retail sales study of ~ $10 million.

The AAFC sales figures (combined with wholesaler estimates) and the retail study estimates are in close agreement.

In the previous section, farm gate value of $26 million was estimated for organic greenhouse tomatoes. A large portion of the organic greenhouse tomatoes produced in BC is known (or assumed) to be exported. If one half of the total estimated organic greenhouse tomato production was exported, that leaves about $13 million to be sold in Canada. However, that is farm gate value. At a mark up of 40 percent, this would translate to perhaps $18 million in retail value. So there are discrepancies.

Based on retail sales estimates there is a market of between 14 and 18 acres of organic greenhouse tomatoes in Canada. Based on production estimates from COG there could be as much as 30 acres of organic greenhouse tomatoes sold in Canadian markets.

**How many acres?**

For the Prairie Provinces, with 15 percent of Canada’s population, the market for organic greenhouse tomatoes is probably between 2 and about 4 acres. There is little production at this time in Alberta, Saskatchewan and Manitoba.

However, this seemingly optimistic market opportunity is tempered because one large organic greenhouse operation in BC (Origin) is currently well placed in the western Canadian marketplace. It is not known how much they are shipping into the Prairie Provinces. Wholesale produce managers say that for crops like peppers, they still can’t get enough.

**Organic lettuce retail sales**

The study, Retail Sales of Certified Organic Food Products in Canada in 2006, reports that organic lettuce sales, not including bagged salad lettuce, were 5.3 percent of the $102 million in 2006. We have no way to determine how much of that was grown in Canada,
but, again, casual observations indicate that most organic lettuce sold in mainstream grocery stores is imported. Most of the organic lettuce seen in stores is romaine lettuce. Probably a higher proportion of Canadian-grown organic lettuce is sold in natural food stores and at farmers markets. (Two greenhouse specialists in Canada report that organic and conventional greenhouse lettuce is not profitable.)

Lettuce sales in mainstream grocery stores are about 25 percent higher than for tomatoes. As with tomatoes, there is no distinction between field and greenhouse production. Based on the tomato sales estimates, there would have been about $14 million worth of organic lettuce sold in Canada in 2006.

To what extent current volumes of organic lettuce can be replaced with organic greenhouse lettuce produced in Alberta is not known. Clearly, there is a market should suitable methods to produce lettuce in greenhouses be established. To date lettuce conventional production has not made inroads because of production issues and economics. Anecdotal evidence indicates that greenhouse lettuce is a difficult drop with which to make money.

**Organic cucumbers and peppers retail sales**
The retail study did not report on cucumber and pepper sales and there are no statistics about organic production of these crops. Organic cucumbers and peppers are more difficult to grow in greenhouses than tomatoes.

**What could the market be in five years?**
The big question is: what share of the retail market in mainstream and specialty stores will organic tomatoes, cucumbers and peppers have in (say) 5 years? This question was posed to one produce manager for mainstream grocery chains. He estimated current sales at 2 percent of total sales for these vegetables. He did not foresee it going to 5 percent in the “near future.” Using an annual volume increase of 20 percent, sales would reach 5 percent by the end of 2012.

If tomatoes sales approached 5 percent of sales volumes, the Prairie market for tomatoes would be approximately 5 to 10 acres of tomatoes. Again, this is merely a “guestimate.”

Many factors will affect what actually happens. These include the general state of the economy in western Canada (in Alberta specifically) production economics, exchange rates, continued expansion in Mexico and production elsewhere in Canada of both organic and conventional tomatoes. The price spread between conventional tomatoes and organic tomatoes will play a role. A sluggish US economy and strong Canadian dollar could affect exports of conventional tomatoes from BC and Ontario. That could depress the price of conventional tomatoes and make organic production more attractive. Whereas the recent trend has been steady growth it is impossible to predicate the future.

No matter what external factors boost or depress the feasibility of the production of organic vegetable crops, organic greenhouse vegetable production has to be profitable.
No comments can be made about cucumbers and peppers because of the complete lack of existing production data.

Organic trends and barriers are discussed in the last section of this report.

**Organic greenhouse vegetable production in the USA**

Statistics for organic greenhouse vegetable production are as vague for the USA as for Canada. The difficulty in finding statistics in the USA is exemplified in this Mississippi State University message board discussion from April 2006.

http://www.msstate.edu/listarchives/greenhouse-tomatoes/200604/msg00016.html

In it Dr. Mary Peet (who has spoken at the Canadian Greenhouse conference on organic greenhouse vegetable production) wrote:

> I have given a number of talks on organic greenhouse vegetable production and have also looked unsuccessfully for statistics. There are a number of soil-based greenhouses in New England, which is probably the largest group, but I would estimate no more than 10 acres in total. There are also growers in Quebec who sell to the US market. In addition, there are about 10-15 Crop King greenhouses operating, but most of those are single houses, so not much more than an acre or so in total. Then there are a few operations in California, New Mexico, Wyoming, and now Arkansas, but none are large, to my knowledge. So I would estimate no more than 10 acres total in the US, but that is just a guess.

An overview of organic production in the USA is presented here:

http://www.ers.usda.gov/data/organic/

The USDA tracks organic production and produced a report, *Certified organic herbs, nursery and greenhouse, by State*:


Unfortunately, these reports do not separate greenhouse and nursery production. Reports for three years show total organic production of greenhouse and nursery crops in the USA to be: 3,331 acres in 2005; 563 acres in 2004; 232 acres in 2003 and 121 acres in 2002. Clearly there is a huge increase, but it is not known how the greenhouse and nursery crop areas are divided.

There appear to be no statistics kept on export of organic vegetables from the USA to Canada.

**Organic greenhouse vegetable production in Europe**

Finding up-to-date statistics on European organic production is difficult. Most references are at least 4 years old. Finding up-to-date information on organic greenhouse vegetable production is more difficult. No doubt some agency has such information but it is not apparent.


**Organic farming throughout the world**


Unfortunately the book was written in 2000.

**General trends in organic production in Canada and the world**


This is a general discussion of organics in the world and no greenhouse statistics or trends are presented.

Sale of organic goods is increasing annually in Canada. (Rates for various products vary widely.) However, there seems to be a trend in Canada for a levelling off of in the number of organic farms. As shown in, *Certified Organic Production in Canada 2005*. [http://www.cog.ca/documents/certifiedorganicproduction05E_000.pdf](http://www.cog.ca/documents/certifiedorganicproduction05E_000.pdf)

Unfortunately, statistics on organic greenhouse vegetable production are not well documented and establishing trends is not possible.

More current information from Europe and elsewhere about organic greenhouse production trends would be useful. Such trends might provide a key to what will happen in Canada in the future. With many trends, Europe tends to be ahead of Canada by a few years.
General recommendations for the production of organic greenhouse vegetables

Disclaimer

This report is for general information only and the onus for meeting all standards for organic certification remain with the end user or producer at all times. The organic greenhouse vegetable producer remains solely responsible for crop quality and yields. No liability for production of organic greenhouse vegetables is expressed or implied by the author of this report.

Canadian organic regulations are onerous, seemingly under constant review and open to interpretation. Different certifying bodies have different requirements or use different standards for certification depending on the agency’s accepted “organic philosophy” and accepted certification standards.

This production section was written with the best possible information at the time of writing and according to reasonable interpretation of regulations. Information presented here was gathered in a short time and, as such, the extent and veracity of all information was limited by the time constraint.

The Internet can be a good source of information. However, many organic reference pages on the Internet are out of date. Producers must be aware that some information they read may not be current. It also seems that acceptable materials and supplies are under constant review and subject to change.

During the course of researching this subject, contradictory and conflicting information and differing “organic philosophies” were presented. Many regulations are not clear to the novice reader, provinces have different views on organic greenhouse practices and regulations remain open to interpretation. Although many people were most helpful, many queries for clarification were often left unanswered by organic industry “experts.”

Producers considering organic production must confirm that all structures, all procedures used, all supplies used and all materials applied meet the requirements of the certifying body. The onus for meeting all aspects of organic production lies solely with the producer.

I accept no liability for any processes, practices or materials used, or not used, by a producer seeking organic certification. Nor do I accept liability for crop losses resulting from use of general recommendations or use of products mentioned in this report. I accept no liability for crop loss because a producer failed to use a product or products that may have been acceptable but not listed in this report.

Clive Schaupmeyer, P.Ag.
Coaldale, Alberta
January 2008
Introduction

This general organic greenhouse production section is written both for experienced producers and novice greenhouse producers considering organic greenhouse production.

The information here is more “conceptual” and lacks specific production facts. Developing turnkey recommendations for organic greenhouse vegetable production is not possible at this time (January 2008) because of lack of production experience and applied research. Precise recommendations, specifically for fertilization, of organic greenhouse vegetables are lacking. AAF will have to consider its future research plans if there is sufficient interest.

However, some general production considerations and techniques are presented here.

At this time, organic tomato production offers the most chance for success for two reasons.

• There is better technical information on organic greenhouse tomato production than for other vegetable crops.
• Tomatoes are less affected by pests than cucumbers, peppers and lettuce.

The novice organic producer will have to work closely with specialists and consultants to establish production techniques, especially fertilization that will work in a specific production system, i.e. the structure, environmental control and growing media and management skills. The experienced greenhouse producer will have to evaluate all aspects of the current production cycle and develop management alternatives that will be suitable for organic certification.

Clearly there are successful organic greenhouse vegetable operations in Canada. Therefore, one might ask: If there are existing growers, specialists and consultants who know how to produce organic vegetables in greenhouses, why can’t their knowledge be gathered and published here? Producers in other provinces have worked hard over many years to fine tune production techniques and they are reluctant to reveal hard-earned technical information to potential competitors.

Companies providing fertilizers will not make specific recommendations regarding feeding of their products and the content of commercial media are protected so this information is guarded. In gathering information for this report, it seemed that some organic fertilizer dealers were reluctant to offer specific recommendations because they either do not know what to recommend for greenhouse vegetable crops or were scared of being liable for recommendations that might prove to be inadequate for profitable yields.

Consultants with (what seem like) a wealth of successful experience make their living by selling their expertise and won’t divulge other than general information.

This section is intended as a general production guideline for the production of organic greenhouse vegetables. Experience greenhouse operators can skip much of the
preliminary information and move to *Getting started with organic greenhouse production*.

Details regarding pest management and fertility are not specific enough to allow a novice organic producer to grow a crop from start to finish without more research and testing.

**Sources of information about conventional greenhouse production**

Greenhouse design and many production practices are similar in conventional and organic greenhouse operations.

Conventional greenhouse production techniques are already well documented and do not need to be repeated here. Novice producers are advised to consult with AAF staff and read the following and associated links to become familiar with structures, production practices and pest management.

- Starting a Commercial Greenhouse Business in Alberta
  [http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp11207](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp11207)

- Commercial Greenhouse Vegetable Production
  [http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1443](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1443)

- Commercial Greenhouse Tomato Production: Introduction
  [http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7556](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7556)

- Commercial Greenhouse Tomato Production: Tomato Plant Propagation
  [http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7957](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7957)

- Commercial Greenhouse Tomato Production: Pest and Disease Management
  [http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7963](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7963)

- Guide to Commercial Greenhouse Sweet Bell Pepper Production in Alberta
  [http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp2873](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp2873)

- Pests of Greenhouse Sweet Peppers and their Biological Control
  [http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4527](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4527)

- Diseases of sweet peppers
  [http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4528](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4528)

- Links to many of AAF’s commercial greenhouse webpages are listed here:

There is no reason to copy large amounts of information from AAF’s webpages on greenhouse production. Established producers will be aware of the technical information in the above pages. Persons interested in organic greenhouse vegetable production are urged to read these pages for the vast amount of technical information they provide. The
websites describe structures, general practices, environmental and climate controls, integrated pest management and biological insect control—a key part in either pesticide-free production or in organic production.

**Getting started with organic greenhouse production**

As noted previously in this report, producers who are considering organic greenhouse production must spend a lot of time and effort sorting through the myriad of regulations and selecting a certification organization which will suit the needs of the proposed market. No attempt is made here to outline the processes as they are well outlined on many websites. AAF has many pages dedicated to organic production, but producers must be aware that some are not up-to-date.

Producers who decide to get into organic greenhouse vegetable production should consider the following:

- Ease into production over a period of time to learn the many nuances of organic production.
- There are few, if any, “turnkey” production protocols, unlike in conventional production where exact recommendations exist.
- Because of the variable nature of local manures and compostable plant materials, practices used in other regions and countries may not transfer directly to conditions in Alberta.

The process of producing organic vegetables in greenhouses is much more complex than with most field crops because of the warm environment and the (up to) 10-month production season. In the long season the crop is subject to attack by insects and diseases—which also like the favourable climate—and greenhouse crops have relatively high fertility demands when we consider they can yield (say) 50 kg per square meter—which is over 200 tons per acre. Such crops require adequate amounts of macro and micronutrients or yields will be considerably less.

The general consensus from a few people interviewed for this report is that producers can expect yields from organic greenhouse vegetables to be somewhere between 50 percent and 80 percent of yields from conventional production. The yield reductions are directly attributable to:

- Inadequate, inexact or poorly timed nutrient supplies, and
- Sustained levels of diseases which are marginally controlled by approved organic techniques.
Introduction to pest management and fertilization
Insects, mites and diseases like the warm and protected climate inside greenhouses.

The potential crop damage and loss from pests is aggravated since large-scale producers plan to have tomatoes (for example) in the greenhouse for up to eleven months or more. The goal of such long-term cropping emphasises the need to maintain optimal plant health through climate control, best cultural practices, pest management and adequate fertilization.

Producers will have to work through all aspects of pest management to foresee and assess potential pitfalls and develop plans to meet all production challenges. This process will require thorough research and advanced approval of anticipated pest management and fertility products.

Tomatoes, peppers, cucumbers and lettuce are attacked by numerous pests. Fortunately for the organic producer, insect pests can usually be managed at a level at which no economic loss will occur. The key to insect control is the use of “biologica ls,” i.e. other insects or organisms that attack the pest and keep it at levels which will not appreciably damage the crop.

However, diseases present another problem and can cause economic losses. One significant problem the organic greenhouse operator faces is being prepared to fight diseases with approved organic pesticides well in advance of their appearance. Any products approved by the certifying agency must be approved prior to application. So a producer must anticipate what organic pesticides will be allowed and be certain that a supply is readily available or on hand.

The importance of sanitation, cultural practices and environmental control in combating insects and pests cannot be overemphasized.

Fertilization presents a challenge because, as a general rule, nutrients in approved organic fertilizers are not readily available to crops. In conventional production, soluble fertilizers are usually in forms that are immediately available for uptake by crops. However, many approved organic fertilizers and media contain potential sources of nutrients that must first be converted to forms available to plants by biological activity in the media. Monitoring of the nutrient status of crops is imperative.
The greenhouse structure and climate management

One of the keys to pest management is proper climate control which promotes strong crop growth and may aid in limiting environmental factors which may favour pests.

There seems to be a sense that organic greenhouses are rudimentary “mom and pop” structures with limited climate systems. They may be low structures with poor ventilation and marginal heating systems only suited to the warmer seasons. Such greenhouses may have a role in smaller organic market gardens, where small quantities of greenhouse crops will supplement field production for farm gate and farmers market sales.

However, precise environmental control plays a key role in crop productivity, crop health and pest management.

Modern greenhouses offer precise computerized control of temperatures, air flows, carbon dioxide and other environmental factors. They are discussed in detail at AAF’s webpages, Components of the Greenhouse System for Environmental Control: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp2892

Copying AAF’s excellent information and recommendations would be pointless here. In addition, many books and workshops are available on greenhouse structures, control systems and climate management.

Organic production protocols for tomatoes are more established than for cucumbers, peppers and lettuce. Tomatoes are the crop of choice for gaining experience in organic greenhouse vegetable production. However, an organic greenhouse vegetable producer could conceivably produce a combination of organic tomatoes, cucumbers, peppers or lettuce. The different crops require different climates. These can be provided either by partitioning a large greenhouse with permanent or temporary walls or by building several smaller structures. Several individual structures cost more than one large structure, but allow crops to be grown in relative isolation. This separation allows for dedicated climate control and isolation of insects and disease.

A damaging outbreak of disease or insects can soon spread through and entire large greenhouse. However, when a major insect or disease outbreak occurs in one smaller structure, the producer could possibly rescue the severely damaged crop with pest control products that would not necessarily approved for organic certification. That is, the crop in a badly infested greenhouse could be saved by using non-organic products while crops in other structures would no be treated with these non-approved methods.

Unfortunately, the matter of using prohibited (non-organic) controls in one of several smaller greenhouse structures is not well defined by Canadian organic production standards. A prospective organic greenhouse producer must clarify what practices will be allowed by the certifying agency.
An overview of pest management in an organic greenhouse

Both insect and disease management are aided by several general management practices.

- Sanitation in between crops and during crop production
- Understand insect, mite and disease pests and their control
- Monitoring crops for diseases, insects and overall health
- Environmental control for optimal crop-production and minimal pest growth
- Use of carbon dioxide where appropriate to enhance plant health and growth
- Cultural control with proper watering and maintenance of adequate nutrition
- Use of resistant cultivars
- Use of grafted transplants may reduce root disease and prolong crop life
- Biological control
- Controlled movement of staff and equipment between greenhouses
- Use of lights for winter production will improve winter growth extend the marketing season
- Controlled access to greenhouses.

The importance of these general management practices is exemplified by André Carrier, greenhouse specialist for Quebec. In a personal communication he wrote that fertility practices have been the same for many years. He went on to say:

*What we improved a lot is climate control of the greenhouses, workers efficiency, biological control of insects. Grafting was a real improvement; we began this almost 15 years ago. Without grafting, I am sure that we cannot stay in production.*

His comments stress the need for a total management approach to organic greenhouse production. Whereas, there are specific control techniques for diseases and insect pests, these controls are pointless without proper cleaning and sanitation; without optimal climate control, watering and overall management techniques.

Summaries of major insect, mite and disease pests of greenhouse vegetables and other crops can be found at this AAFC site:

http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181157779290#P

The site is well worth exploring as it provides crop profiles that:

*… provide crop production and pest management information on a commodity basis. National in scope, they identify gaps in pest management and issues faced by growers.*

The profiles for greenhouse tomatoes, cucumbers, peppers and lettuce were prepared in 2006 and the information is reasonably up-to-date. Major parts of the reports cited below are copied (in sections that follow) to stress the importance of cultural management in controlling pests. Here are direct links to the four vegetables of concern in this report:
Tomatoes
*Crop Profile for Greenhouse Tomatoes in Canada.*
http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181758399927

Cucumbers
*Crop Profile for Greenhouse Cucumbers in Canada.*

Peppers
*Crop Profile for Greenhouse Pepper in Canada.*

Lettuce
*Crop Profile for Greenhouse Lettuce in Canada.*

These documents are important for conventional producers and those considering pesticide-free production or organic production because they summarize the major insects and diseases, their modes of damage and control practices.

Of particular interest in these documents is a detailed summary of all major insects, mites and diseases.

*The basics of organic insect and mite management*

There are many insect and mite pests of tomatoes, cucumbers, peppers and lettuce. The main ones are whitefly, spider mites, thrips and aphids. Greenhouse vegetables cannot be grown successfully without controlling one or more of these insect pests. Fortunately, insect control using approved organic methods is well documented and controls are effective.

AAF has many webpages dedicated to the production of organic greenhouse vegetables. These were all listed at the beginning of this section. Two pages dedicated to pest management in tomatoes and peppers are repeated here.

Commercial Greenhouse Tomato Production: Pest and Disease Management
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7963

Pests of Greenhouse Sweet Peppers and their Biological Control
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4527

“Biological” control is the main technique used by commercial greenhouse producers in Alberta and elsewhere for almost two decades.

Biological control (or biocontrol) is the use of organisms to control crop pests. Biocontrol insects include predatory and parasitic insects. Parasitic insects lay eggs inside the pest insect where the young develop on (or inside) the host pest and kill the pest as the young
feed and mature. The parasitic biocontrol insects emerge as adults and repeat the life cycle on other pest specimens. Predator biocontrol insects eat pest insects.

**Using biologicals**

Biologicals are purchased in small packages and placed in the greenhouse at recommended densities through the effected greenhouses.

When populations of either the biological insect or pest get out of balance, the biologicals must be replenished. The key to success of biological control is monitoring and replenishment of the biologicals as needed. Monitoring is done with yellow (or blue) sticky cards that trap insects or by visual inspections.

Several horticultural supply companies and biological companies supply packages or biologicals to greenhouse operators. They offer a wealth of information on their products, and can advise producers on the use of biologicals. Those interested should contact AAF’s greenhouse specialist for assistance in selecting biologicals.

Suppliers of biologicals include:

Koppert Biological Systems
http://www.koppertonline.ca/aboutus.asp

Grower Central/Westgro
http://www.growercentral.com/

Westgro Sales Inc. is an agent for Applied Bionomics which was established in BC over twenty years ago.

Applied Bionomics, Ltd. has an excellent series of downloadable factsheets for producers. They are listed here:

Included in the factsheet series are bulletins specific to the four major greenhouse vegetables. The Applied Bionomics factsheets for the crops are:

Tomatoes

Cucumbers

Peppers
**Cultural and alternate control of insect and mites pests of greenhouse vegetables**

As previously noted, summaries of the major insect, mite and disease pests of greenhouse vegetables and other crops can be found at this AAFC site: [http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181157779290#P](http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181157779290#P)

The following sections printed in blue are copied directly from crop profile reports prepared for AAFC. The introduction to the profiles states:

> Crop profiles are documents that provide crop production and pest management information on a commodity basis. National in scope, they identify gaps in pest management and issues faced by growers.

The profiles for greenhouse vegetables are particularly helpful for prospective producers considering organic production or pesticide-free production.

Only the cultural and alternative (where applicable) are shown here. Pest information, life cycles and chemical controls are not provided here. See original document for further details. Not all pests are included in the summaries below.

> Those familiar with greenhouse production will want to skip past this section, especially the parts printed in blue. Prospective producers will want to review this information which is presented here to stress the importance of cultural control for all pests. It is acknowledge that this information may be perceived as overkill, but the information is enlightening for prospective producers.
**Tomato Insects and Mites**

From: *Crop Profile for Greenhouse Tomatoes in Canada.*

Mites: Two-Spotted Spider Mite (*Tetranychus urticae*), Carmine Mite (*T. cinnabarius*) and Russet Mite

**Cultural Controls:** Proper humidity needs to be maintained in the greenhouse. Greenhouses need to be washed, cleaned and disinfected between crops. Circulation fans should be turned off in spider mite “hot spots” to prevent spread of pest. Plant heads should be misted mid-day, especially when humidity is low. The inside of the greenhouse should be kept free of weeds. Infested plants should be removed and properly disposed of.

**Alternative Controls:** Bush beans can be employed as a trap crop for monitoring. General thresholds can be applied to determine the type of treatment to be used (Presence/absence = biological control; moderate infestation level = chemical control). Biological methods of control are important for pest mites. Populations of *Amblyseius falilacis, A. californicus, Phytoseiulus persimilis*, (predatory mites) can help control mite populations. *Feltiella acarisuga*, a predatory midge can be introduced as a “hot-spot” treatment. The predator is released directly in the hot-spot.

Whiteflies: Greenhouse Whitefly (*Trialeurodes vaporariorum*), Sweet Potato Whitefly (*Bemesia tabaci*) and Banded wing Whitefly (*Trialeurodes abutilonea*)

**Cultural Controls:** Weeds should be removed in and around the greenhouse. The greenhouse should be washed, cleaned and disinfected between crops. Severely infested plants should be pruned to reduce populations. Enough lower leaflets should be allowed to grow to allow the development of beneficials, such as parasitic wasps. This is particularly important during the winter months when the wasps have a longer developmental time. Before de-leafing, ensure parasitic wasps have emerged from pupal cases.

**Alternative Controls:** Monitoring should be done weekly using yellow sticky traps and/or trap crops, as well as monitoring the tomato plants. As a general rule, the presence/absence of the pest requires biological control, while moderate infestation level require chemical control. Sticky boards and tapes can be used in ‘hot spots’ to trap and reduce populations. There are several biological controls available. *Dicyphus hesperus* is a predatory bug (Hemiptera) that is released weekly on mullein plants (*Verbascum theophrastica*) until a total of 1 per m² have been introduced. *Encarsia formosa* is a parasitic wasp and should be introduced before whiteflies are detected. The preventative rate is 1-1.5 wasps/m². Once whiteflies have been detected, the rate is increased to 3 to 6 wasps/m² depending on the level of infestation. Weekly introductions are continued until 80% parasitism is achieved. *Eretmocerus eremicus* is another parasitic wasp that is
released for “hot spot” treatments in winter and throughout the greenhouse in the spring and summer. *Eretmocerus* are more tolerant of pesticides than *Encarsia*. A combination product is available

**Cucumbers insects and mites**

From:  
*Crop Profile for Greenhouse Cucumbers in Canada.*  

Whiteflies: Greenhouse whitefly (*Trialeurodes vaporariorum*); silverleaf whitefly (*Bemisia argentifolii*) and sweet potato whitefly (*Bemisia tabaci*)

Cultural Controls: Screening vents and keeping doorways and other openings to the greenhouse closed will minimize entry by adult whiteflies. The crop can be monitored by the use of sticky traps and by plant inspection. Yellow sticky traps will reduce the adult population and should be used at a rate of 1-2 traps per 2-5 plants.

Alternative Controls: The parasitic wasps *Encarsia formosa* and *Eretmocerus eremicus* are commonly used to control whitefly larvae. The eggs of greenhouse whitefly are also preyed upon by a beetle, *Delphastus pusillus*. The predatory bug, *Dicyphus hesperus* is being developed as a biological control. Lacewing larvae and predatory bugs such as *Orius* spp. will also prey on whiteflies.

Western flower thrips (*Frankliniella occidentalis*), onion thrips (*Thrips tabaci*) and *Echinothrips americanus*

Cultural Controls: Monitoring and trapping of adult thrips is possible using commercially available blue or yellow sticky traps or ribbons. The screening of greenhouse vents and other entry points will help prevent thrips from entering the greenhouse. The elimination of weeds and ornamentals from around the perimeter of the greenhouse and avoiding moving non-crop material into the greenhouse, will eliminate sources of spread. The greenhouse should be cleaned and sanitized thoroughly between crops. If thrips become a problem at the end of the growing season, the infested crop should be fumigated and then removed and destroyed. Heating empty greenhouses to 35°C for five days or 40°C for 2-3 days to starve any emerging adults.

Alternative Controls: Several biological control agents are available including the predatory mites *Amblyseius cucumeris* and *Amblyseius barkeri* and the predatory bugs *Orius insidiosus* and *Orius tristicolor*. The predatory mite *Hypoaspis* also preys on propupae and pupae of western flower thrips and can reduce adult emergence by 40-60%.

Mites: Two-spotted spider mite (*Tetranychus urticae*) and carmine mite (*T. cinnabarinus*)

Cultural Controls: Routine monitoring for spider mite infestation should be conducted by examination of the lower surface of the leaves. Good sanitation, including the removal of weeds, especially chickweed, from around the perimeter of the greenhouse and the
maintenance of a 3-metre-wide weed free zone will help to minimize mite populations. Restricting the movement of people, equipment, and plants from infested to non-infested plant areas is also beneficial. Mite problems at the end of the growing season are controlled by fumigation followed by the removal and destruction of all plant material.

Alternative Controls: The predatory mite *Phytoseiulus persimilis* is widely used and is effective in controlling the two-spotted spider mite. To be successful, *P. persimilis* must be introduced when the mite population is low. *Amblyseius fallacis* and *Amblyseius californicus* predatory mites and the predatory midge, *Feltiella acarisuga*, are also used.

Lygus bugs: Tarnished plant bug (*Lygus lineolaris*) and other species

Cultural Controls: Greenhouse vents and other entry points into the greenhouse should be screened and a weed-free zone around the perimeter of the greenhouse, maintained.

Alternative Controls: None available.

**Pepper insects and mites**

From: *Crop Profile for Greenhouse Pepper in Canada.*

Aphids: Green Peach Aphid (*Myzus persicae*); Cotton/melon aphid (*Aphis gossypii*); Potato aphid (*Macrosiphum euphorbiae*) and Foxglove aphid (*Aulacorthum solani*).

Cultural Controls: Greenhouse vents must be screened and a weed-free zone maintained around the perimeter of the greenhouse. Other vegetable crops or ornamentals should not be grown in or around the greenhouse. Aphids should be monitored on a weekly basis and controls applied when aphids are detected. There is a very low action threshold for foxglove aphid (BC).

Alternative Controls: As a preventative treatment before aphids appear, pots containing banker plants (cereal grasses) can be placed in the greenhouse as soon as a new crop is planted. The banker plants serve as a reservoir for the parasitic wasps *Aphidius matricariae* and *A. colemani* (for green peach and melon aphid) and *Aphidius ervi* and *Aphelinus abdominalis* (for potato and foxglove aphid). The aphid and predator/parasitoid population is monitored carefully and additional wasp releases are made depending on the time of year or if an aphid outbreak occurs. The predatory midge fly, *Aphidoletes aphidimyza* and ladybeetles can also be released in the pepper crop; particularly if naturally-occurring hyperparasitoid wasps attack the predatory wasps, or as a curative treatment if an outbreak occurs in a “hot spot”. Naturally-occurring syrphid flies and lacewing larvae also attack aphids.
Fungus gnats (Sciaridae: *Bradysia* and *Corynoptera* spp.) and Shore flies (Ephydidae)

Cultural Controls: Screening off vents and keeping doorways and other openings to the greenhouse closed will minimize entry by adult gnats. Overwatering should be avoided and good sanitation practices such as the removal of waste plant material will help to minimize problems due to fungus gnats. Adult flies can be monitored through the use of yellow sticky traps.

Alternative Controls: The bacterial insecticide *Bacillus thuringiensis* var. *israelensis* can be applied as a soil drench for control of fungus gnat larvae. Commercially available biocontrol agents for larvae include a predatory nematode (*Steinernema feltiae*), the predatory mites *Hypoaspis miles* and *H. aculeifer*, and the predatory rove beetle, *Atheta coriaria*.

Cabbage Looper (*Trichoplusia ni*)

Cultural Controls: Vents are screened and doorways and other openings to the greenhouse are kept closed, especially at night, to minimize entry of adult moths.

Alternative Controls: Pheromone traps can be used to detect adult moths and plants are monitored for leaf feeding damage. The bacterial insecticide *Bacillus thuringiensis* var. *kurstaki* is registered for control of cabbage looper. Parasitic wasps such as *Trichogramma pretiosum* and *T. brassicae* which attack cabbage looper eggs are released when moths start flying. These can parasitize up to 50-80% of eggs but generally do not provide sufficient control alone. Additional control is obtained with release of the spined soldier bug or “Podi-bug” (*Podisus maculiventris*), which preys on all egg and larval stages. The egg-parasitic wasp, *Cotesia marginiventris*, has also shown promise in research trials but is not commercially available yet.

European corn borer (*Ostrinia nubilalis*)

Cultural Controls: Screening of vents, doorways and other entry points into the greenhouse helps prevent corn borer entry into the greenhouse. Eliminating overwintering sites such as corn and grassy areas in the vicinity of the greenhouse in the fall will eliminate a source of infestation.

Alternative Controls: ECB outdoors can be monitored using pheromone and/or black light (ultraviolet) traps in the spring. The pepper crop should be monitored at least weekly for eggs, larvae and early feeding damage during moth flight periods. The biological insecticide, *Bacillus thuringiensis* var. *kurstaki* is effective before the larvae bore into the fruit, but this product is not registered for this use. Releases of a parasitic wasp, *Trichogramma brassicae*, which attacks the egg stage of the European corn borer, have been shown to reduce corn borer damage in field corn trials, but have not been evaluated in greenhouse peppers.
Mites: Two-spotted spider mite (*Tetranychus urticae*) and carmine mite (*Tetranychus cinnabarinus*)

Cultural Controls: Spider mite infestations can be routinely monitored by the examination of the lower surface of the leaves. Good sanitation practices such as the removal of weeds, especially chickweed, from around the perimeter of the greenhouse and the maintenance of a 3-metre-wide weed free zone will help reduce spider mite infestations. The movement of people, equipment, and plants from infested to non-infested plant areas should be restricted. If the mite becomes a problem at the end of the growing season, the infested crop and greenhouse, can be fumigated followed by the removal and destruction of all plant material.

Alternative Controls: The predatory mite *Phytoseiulus persimilis* is widely used and is effective in controlling the two-spotted spider mite. To be successful, *P. persimilis* must be introduced when the mite population is low. *Amblyseius fallacis* and *Amblyseius californicus* predatory mites and the predatory midge, *Feltiella acarisuga*, are also used.

Thrips: Western flower thrips (*Frankliniella occidentalis*) and Onion thrips (*Thrips tabaci*)

Cultural Controls: Monitoring and trapping of adult thrips is done using commercially available blue sticky ribbons or yellow sticky traps that are used to monitor for other insects. Vents and other openings in the greenhouse are screened to prevent entry of adult thrips. Weeds and ornamental plants are removed from around the perimeter of the greenhouse. Infested crops are fumigated at the end of the growing cycle and removed and destroyed. The empty greenhouse may then be heated for 2-5 days to kill any remaining thrips and eggs.

Alternative Controls: Biological control agents are introduced before thrips build up in the greenhouse. These include the predatory mites *Amblyseius cucumeris*, *Amblyseius barkeri*, and *Hypoaspis miles*, which prey on propupae and pupae of western flower thrips and can reduce emergence of adults by up to 40-60%, if introduced before thrips become a problem. The predatory bug, *Orius insidiosus* can be released starting in mid-March and can reduce thrips populations after they appear.

Greenhouse Whitefly (*Trialeurodes vaporariorum*), Silverleaf whitefly (*Bemisia argentifolii*) and Sweet potato (silverwing) whitefly (*Bemisia tabaci*).

Cultural Controls: Screening off vents and keeping doorways and other openings to the greenhouse closed will minimize entry by adult whiteflies. Yellow sticky traps can be used to monitor for whiteflies and may also be used to reduce the adult population at a rate of 1-2 traps per 2-5 plants.

Alternative Controls: A parasitic wasp, *Encarsia formosa* is released when whiteflies are first seen in the crop. The parasitic wasp *Eretmocerus eremicus*, the minute pirate bug, *Orius* sp. and the predatory beetle, *Delphastus pusillus*, which preys on whitefly eggs,
can be released also. These will suppress the greenhouse and silverleaf whiteflies below
the damage threshold, but may be less effective on the sweet potato whitefly. Several
naturally-occurring predators such as lacewing larvae and predatory bugs also attack
whitefly larvae.

**Lettuce insects**

From: *Crop Profile for Greenhouse Lettuce in Canada.*

Aphids: Lettuce aphid (*Nasonovia ribisnigri*) and other species (Green peach aphid
(*Myzus persicae*) and melon aphid (*Aphis gossypii*)).

Cultural Controls: Screening of greenhouse vents and maintenance of a weed and garden-
free area around the greenhouse can help to control aphids. Close monitoring should be
conducted in the spring for the appearance of first aphids on the crop.

Alternative Controls: Several predatory mites (*Amblyseius* spp. and *Phytoseiulus* spp.)
and parasitic wasps, as well as ladybeetles, are available commercially for biological
control of aphids in greenhouse vegetable production. These provide suppression of the
aphid population, but do not provide a commercially acceptable level of control on
greenhouse lettuce.

Cabbage looper (*Trichopulsia ni*)

Cultural Controls: Vents are screened and doorways and other openings to the
greenhouse are kept closed, especially at night, to minimize entry of adult moths.

Alternative Controls: A nuclear polyhedrosis virus has been effective in controlling
cabbage looper larvae in research trials, but has not yet been developed as a commercial
insecticide. The bacterial insecticide Btk is registered for control of cabbage looper.
Fungus gnats (*Bradysia* spp. *Corynoptera* spp.)

Cultural Controls: Good sanitation, including the removal of waste material, is used to minimize fungus gnats. Vents are screened and doorways and other openings to the greenhouse are closed to minimize entry by adult gnats.

Alternative Controls: Only Vectobac (*Bacillus thuringiensis* var. *israelensis*) is specifically labelled for the control of fungus gnats in greenhouse vegetable crops. Fungus gnat larvae may be suppressed by predatory nematodes (*Heterorhabditis* spp., *Steinernema feltiae*) or a predatory mite (*Hypoaspis miles*), but predators alone do not provide commercially acceptable control in greenhouse lettuce.

Greenhouse Whitefly (*Trialeurodes vaporariorum*), Silverleaf whitefly (*Bemisia argentifolii*) and sweet potato whitefly (*Bemisia tabaci*).

Cultural Controls: The entry of adult whiteflies can be minimized by screening off vents and keeping doorways and other openings to the greenhouse closed. Yellow sticky traps, distributed at a rate of 1-2 traps per 2-5 plants, can be used to monitor for whiteflies and may also be used to reduce the adult population.

Alternative Controls: A parasitic wasp, *Encarsia formosa* is often released as a biocontrol agent. *Eretmocerus* spp. and the minute pirate bug, *Orius* sp., are also used. These will suppress the greenhouse whitefly but may be less effective on the sweet potato whitefly. The eggs of greenhouse whitefly are also preyed upon by a ladybeetle, *Delphastus pusillus*, and many general predators, such as lacewing.
The basics of organic disease management

Along with uncertainties about fertility, disease control in organic greenhouses remains a major concern for organic producers. Nutrient deficiencies can usually be overcome (even if too late) in an organic system, however several diseases pose serious threats to production than can result in significant crop losses.

As previously noted, the primary keys to disease management are:

- Sanitation
- Understanding the disease pests and their control
- Monitoring crops for overall health and signs of disease
- Environmental control
- Cultural control with proper watering and maintenance of adequate nutrition
- Use of resistant cultivars
- Use of grafted transplants
- Controlling movement of staff and equipment between greenhouses
- Controlling access to greenhouses.

Still, diseases will infect all greenhouse vegetable crops sooner or later.

The following two AAF sites present detailed information in major disease of tomatoes and peppers.

Commercial Greenhouse Tomato Production: Pest and Disease Management
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7963

Disease of sweet peppers
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4528
**Cultural and alternate control of diseases of greenhouse vegetables**

As previously noted, summaries of the major insect, mite and disease pests of greenhouse vegetables and other crops can be found at this AAFC site:  
http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181157779290#P

The primary purpose of copying the information here is to stress the importance of cultural control for all pests.

Only the cultural and alternative (where applicable) are shown here. Pest information, life cycles and chemical controls not provided here. See original document for further details.

Not all pests are included in the summaries below.

**Tomato diseases**

From:  
*Crop Profile for Greenhouse Tomatoes in Canada.*  
http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181758399927

Grey Mould, Canker and Ghost Spot (Botrytis cinerea)

**Cultural Control:** Cull piles should be kept far away from the greenhouse. All crop debris should be removed and buried. Dead and dying plants should be removed quickly to prevent the build-up of inoculum. Adequate ventilation and heat in the greenhouse must be ensured, especially at night. Relative humidity should be maintained below 80% as much as possible. Between crops, the greenhouse should be thoroughly cleaned and disinfected. Tearing during pruning should be avoided. Disinfecting knives periodically between cuts while pruning will limit the transmission of disease.

Alternative Controls: Weekly monitoring for lesions can help keep disease under control.

Pythium Root Rot (Pythium spp.)

**Cultural Controls:** Plant stress should be minimized by ensuring adequate drainage, ventilation and stable temperatures. Good water management strategies are required to ensure healthy, strong roots to minimize pythium infection. Appropriate measures should be taken to ensure good sanitation, including removal of infected plants, and re-circulated irrigation feed should be disinfected by pasteurization, UV, ozone, etc. to avoid spreading spores throughout the greenhouse. Fungus gnats and shore flies should be controlled to prevent the spread of spores. Regular monitoring for symptoms is important.
Alternative Controls: There are two biological control agents registered for use on greenhouse tomatoes. Trichoderma harzianum strain KRL-AG2 comes in the form of a wettable powder under the trade name Rootshield®. The product should be applied as a drench or granules should be incorporated into the seeding or transplanting medium. Streptomyces griseoviridis Strain K61, available under the trade name Mycostop® can be applied to seedlings in rockwool after emergence or immediately after transplanting.

**Powdery Mildew (Oidium neolycopersici)**

**Cultural Controls:** Humidity should be kept as constant as possible and good ventilation should be maintained. De-leafing can be done to improve air circulation and reduce humidity. Plants should be spaced adequately for adequate ventilation. Thorough cleaning, disinfecting and sanitizing should be done between crops.

Alternative Controls: Monitoring for early signs of disease is important, since the pathogen can increase rapidly under favourable conditions.

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**Cucumber diseases**

From:
*Crop Profile for Greenhouse Cucumbers in Canada.*

Pythium crown rot and root rot (Pythium aphanidermatum and other Pythium spp).

**Cultural Controls:** Irrigation troughs, tanks, and supply lines for water should be cleaned and disinfected thoroughly between crops. Reducing water and temperature stress on the plants and ensuring good aeration of recirculating water also helps to reduce disease.

Alternative Controls: Streptomyces griseoviridis and Trichoderma harzianum are microbiological fungicides that are registered only for preventative treatment of seedlings. They are not effective or registered on producing crops.

Fusarium root and stem rot (Fusarium oxysporum f. sp. radicis-cucumerinum)

**Pest Management**

**Chemical Controls:** None.

**Cultural Controls:** Good sanitation practices are important in minimizing the impact of this disease. Fungus gnats and shore flies should be controlled and greenhouse structures, reservoirs and irrigation lines cleaned and disinfected.
thoroughly between crops. The movement of workers from diseased to healthy crop areas should be restricted. Pruning shears and harvest knives should be disinfected frequently when working in infected areas and plant debris should be removed and destroyed promptly.
Alternative Controls: None available.

Powdery mildew (Erysiphe cichoracearum, Sphaerotheca fuliginea)

Pest Management

Cultural Controls: Sanitation practices such as the remove and destruction of infected leaves when the disease is first seen, good sanitation between crops and the prompt removal and destruction of cull piles and old crop debris will help to reduce sources of the disease. Maintaining a uniform, relative humidity of 70-80% will reduce disease development.

Alternative Controls: Spraying the plants every 2-3 days with water may reduce spore buildup, but may also predispose plants to other diseases, such as gummy stem blight and botrytis grey mould.

Botrytis grey mould (Botrytis cinerea = Sclerotinia fuckeliana)

Cultural Controls: As wounds provide an entry route for this disease, it is important to avoid wounding the plants. Good sanitation between crops and when handling the plants and using sharp, clean knives for harvesting fruit will reduce disease as will harvesting in the morning when fruit and foliage are dry. Crop residue should be removed promptly from the greenhouse. Preventing condensation on the leaves by controlling ventilation and raising temperatures gradually prior to sunrise and avoiding excessive nitrogen, will make conditions less hospitable for botrytis. Pruning should be done as needed to maintain a proper balance between foliage and fruit load, since lush growth is more susceptible to botrytis infection and a heavy canopy will slow drying of leaves.
Alternative Controls: None available.

Gummy stem blight (Didymella bryoniae, syn. Mycosphaerella melonis, syn. M. citrullina)

Cultural Controls: The removal of all crop debris from the greenhouse at the end of each crop cycle and the destruction of cull piles or the placement of cull piles away and downwind of the greenhouse, will help to reduce sources of infestation. The cleaning and disinfection of pruning shears and other tools and equipment in contact with cucumber plants will also help to minimize spread of the disease. Other practices which help to reduce disease development include; preventing condensation on the plants by providing good ventilation and raising temperatures gradually prior to sunrise; harvesting fruit in the morning when it is cool and dry and harvesting frequently to avoid over ripening of fruit.

Alternative Controls: None available.
Pepper diseases
From:
Crop Profile for Greenhouse Pepper in Canada.

Fusarium Stem and Fruit Rot (Fusarium solani = Nectria haematococca)

Cultural Controls: Cultural controls include avoiding wounding of plug seedlings during transplanting; strict greenhouse sanitation and crop hygiene; disinfecting pruning knives regularly; the use of disinfectant footbaths at entry-ways; sealing plastic around the edges of the greenhouse; the removal of cull piles, etc. Scraping away small stem lesions when first seen and applying a drying agent such as hydrated lime to the affected area will help eliminate an infection. Other management measures include keeping greenhouse temperatures less than 28oC and VPD>3; maintaining good air circulation in the canopy according to light conditions; and delaying irrigation until later in the day to avoid root pressure conditions. Avoiding the overuse of screens at the start of the crop and when outdoor night temperatures are >10oC, or using larger hole screens to improve ventilation will also minimize disease development. Rockwool blocks must not become too dry, as this will allow concentration of fertilizer salts which may in turn favor infection at the base of the plant stem.

Alternative Controls: Streptomyces griseoviridis, a mycological fungicide, can be drenched at the seedling stage to suppress infection.

Grey Mould (Botrytis cinerea)

Cultural Controls: Good sanitation practices and good plant hygiene including: the use footbaths at entryways, avoiding wounding of plants, disinfection of pruning knives regularly between cuts and the removal of crop debris and fallen fruit promptly from the greenhouse help to control gray mold. Good ventilation and air circulation in the crop canopy, ensuring roof sprinklers do not drip on plants and raising air temperatures slowly before sunrise to avoid condensation on plants will minimize foliar wetness, a necessity for disease development. Nutrient levels should be adjusted to avoid excessively lush vegetative growth and soft plants that are more susceptible to infection.

Alternative Controls: None available.

Powdery Mildew (Leveillula taurica)

Cultural Controls: Cultural controls for powdery mildew include maintaining a uniform relative humidity (70-80%), monitoring for disease symptoms and removing and destroying infected leaves. Practicing good sanitation and cleaning and disinfecting the house thoroughly between crops will help to minimize disease carry-over.
Alternative Controls: Spraying the plants every 2-3 days with water may reduce spore buildup, but may also predispose plants to grey mould and other diseases. Control weeds around the greenhouse.

**Lettuce diseases**

From: *Crop Profile for Greenhouse Lettuce in Canada.*

Pythium damping off and root rot (*Pythium aphanidermatum*; *Pythium* spp.)

Cultural Controls: Seeds should be sown in sterile propagation media and care should be taken to minimize overcrowding and overwatering seedlings. The maintenance of good aeration of the re-circulating solution helps to minimize pythium pressure.

Alternative Controls: None available.

Downy mildew (*Bremia lactucae*)

Cultural Controls: The prevention of dew formation on the leaves by controlling the night temperature and ensuring adequate ventilation, will reduce the occurrence of this disease as will maintaining reduced humidity. New crops should not be planted near older ones and old crop debris should be removed from the greenhouse.

Alternative Controls: None available.

Botrytis Grey mould (*Botrytis cinerea*)

Cultural Controls: Avoiding injury of plants will reduce infections, as wounds provide an entry route for this disease. Sources for disease spread can be reduced by good sanitation practices when handling plants and the frequent removal of crop residue from the greenhouse. Controlling ventilation and night temperatures to prevent condensation on the leaves will reduce disease development. Nitrogen levels should be monitored to prevent lush growth, that is more susceptible to the disease.

Alternative Controls: None available.

Powdery mildew (*Erysiphe cichoracearum*)

Cultural Controls: Maintaining a low, uniform relative humidity (70-80%), and prompt removal of infected leaves can help to prevent infection. Disinfection of the greenhouse between crops is also helpful in reducing the incidence of powdery mildew.
Alternative Controls: Spraying the plants every 2-3 days with water may reduce spore buildup, but may also predispose plants to Botrytis grey mould, downy mildew and other diseases.

A note about pesticide-free production

Up to this point, the practices described would generally be acceptable for those considering of production in their greenhouses.

By definition elsewhere, producers who choose to grow greenhouse vegetables without pesticides are permitted (there are no hard and fast rules here) to use disinfectants between crops that would not be allowed in an organic operation.

The section that follows on organic fertility management would not apply to pesticide-free production.
The basics of organic fertility management

Introduction
Lack of specific organic soil management and organic fertility management information is the biggest weakness in organic greenhouse vegetable production. Different techniques, fertilizers and soilless mixes will have to be evaluated in research studies or on-farm trials and/or developed here in Alberta.

Existing producers who have been growing organic greenhouse vegetables are reluctant to reveal their soil and fertility practices for fear of helping potential competitors. In the course of conducting this study, contact was made with specialists in Quebec and Ontario. Both specialists said that experienced organic producers would not meet with me as they were scared of competition in a fragile marketplace.

There is enough information from preliminary research and from suppliers of organic fertilizers to get a new organic producer started—at least started with trials. Existing or new greenhouse growers are advised to start slowly and build up knowledge about fertility management and develop an organic production system that works in their operation. Existing organic grower and researcher experience shows that yields tend to be lower in organic systems and the cost for fertilizers and growing media much higher, so clearly producers have to receive much higher prices for their vegetables in order to make a profit.

Producers considering getting into organic greenhouse vegetable production must conduct further research on establishing fertility programs that will work with the producer’s choice of either soil or soilless culture. Should a producer choose to grow in soil, the standard three-year transition period will be required before the crops can be certified. Producers who choose to grow outside of soil in bags or pots can start immediately provided all other organic criteria are met and approved by the certifying agency.

Greenhouse tomatoes are the best crop with which to start for two reasons. Fertility studies conducted by AAFC show that reasonable yields of organic greenhouse tomatoes can be produced. Tomatoes are more hardy and organic pest management less of a concern than with the other major greenhouse vegetables. At this time there is a general lack of (public) knowledge about production of organic cucumbers, peppers and lettuce in above ground containers and more work is required.


She said:

There are a number of obstacles to using organic substrates and fertilizers. An initial obstacle was locating suppliers. Some links to suppliers appear at the end.
of this document, but these lists are often out of date, or suppliers may only have a few specialized products. There’s no such thing as ‘one-stop shopping’ with organic greenhouse production … With many suppliers, it is even difficult to obtain straightforward information on NPK and micronutrient content, not to mention salts levels. In addition, there is a dearth of good, soluble, organic fertilizers, especially those that are locally available and affordable. Locally available compost can be used as a substrate component, but will vary in the rate of N mineralization (availability) both with time and between batches.

No one soluble organic fertilizer provides a balanced enough feed for the high demands of greenhouse tomatoes over a long growing season in soilless culture, although in our second experiment, we had fewer problems getting materials to go through the drip irrigation system. The only material that was consistently difficult was bloodmeal, as an N source, which required special extract techniques to get it into solution. The best approach seemed to be trying to select organic fertilizer and substrate combinations that provided roughly the same pH, NPK and micronutrient levels as conventional fertilizers. Higher salts levels may be unavoidable, but it may be useful to substitute ingredients that either lower, or at least do not raise, pH and salts. Unfortunately, it’s difficult to predict in advance how particular combinations will react, so experimentation has to proceed by trial & error. One bright spot is, there are now a number of organic-certified mixes available for transplant production, which appear to perform well.

There have been developments and improvements since Dr. Peet presented this paper five years ago. But many of her general comments about organic fertilizers and substrates still apply today. There are no well documented “turnkey” organic production systems as witnessed by the fact that AAFC is currently conducting studies on organic fertilizers and substrates.

**Preliminary fertility studies**

Studies are underway at three federal research stations to fill the fertility information void. One major 3-year study on fertilizers and growing media is underway at Harrow, Ontario and at Agassiz, BC. Most of this information will be made public on completion of the 3-year study at the end of 2008. The preliminary report (March 2007) provides some information which can be used as a basis for getting started in above-ground production. Concise recommendations can’t be made at this time from this study because the published results are only from one year and some details, like rates, are not reported in the preliminary study report.

In addition to the preliminary federal study information, commercial suppliers and consultants have been working with established organic producers and can offer advice on organic greenhouse management and products.
Soil or “soilless” production — a big question

Before discussing actual fertility, it is necessary to briefly review soil and soilless production.

Generally there are three general options for growing media:

1) Soil (in the ground) supplemented with applications of manure, approved organic fertilizers and composts.
2) An organic medium in an above-ground container, supplemented with approved organic fertilizers and/or composts. This would be considered a soilless medium.
3) Inorganic medium, such as rockwool or cocoa fibre, but their acceptance is uncertain. These would be considered soilless media.

No matter which growing medium a producer selects, it is imperative that the medium be approved prior to getting started. It is necessary for the beginning organic producer to discuss the plans with the certifying body to clarify the acceptance of all inputs before time and money are wasted on materials and facilities. Materials and supplies listed in the Canadian standards will have to be used.

The importance of getting prior approval is emphasized by the conflicts in regulations. The Canadian standards allow for above-ground production and state:

For operations where the plants are not growing in the ground, a biologically active growing-medium shall be evident at the end of each growth cycle.

Unfortunately there is debate over what constitutes, “a biologically active growing-medium” and interested producers must obtain a ruling on any above-ground medium unless it is already approved. (Commercial suppliers sell organic media that is already approved by various agencies, however because standards vary, prior approval must be obtained.)

The BC organic regulations state:

… certifiable greenhouse production must take place in soil, with the additional requirements that soil fertility is to be based primarily on composted animal manure.

Quebec apparently has similar regulations that allow production only in soil.

According to Quebec’s greenhouse specialist, André Carrier, to date all organic greenhouse production has been in soil and their traditional definition of organic production has only allowed for production in soil. Carrier also said he was aware of mounting pressure by existing conventional producers (or new investors) to invest organic greenhouse vegetable production that uses above-ground containers.
Rochelle Eisen, COABC’s Organic Extension Agent, does not agree with growing out of the soil, but is aware of the Canadian regulations and accepts that it is a choice for some producers. However, she feels strongly that a medium like cocoa fibre should not be allowed, even if top dressed with compost as it would not be considered to be “a biologically active growing-medium.” Others feel even an inert medium like rockwool might be considered biologically active after the cycle.

The onus remains with the new organic greenhouse producer to conform the needs of future organic markets, so different markets may require different standards.


**Soil culture**

Traditionally vegetables were produced in soil. In the transition to organic production, the first organic greenhouse producers chose to continue growing in soil. This is a matter of both personal philosophy and practicality as there are some advantages with organic soil production.

The main advantages of soil production are:

- Since the soil is the source of nutrients, well-establish techniques can be used for adding organic nutrients to the soil. These include addition of composted manures (and other composted plant matter) which might be available at low cost.

The main disadvantages of soil production are:

- Manures have to come from organic operations and supplies of allowable (i.e. organic) manures may be limited.
- Soils and composts vary from region to region and practices used in one region may not be transferable to other areas.
- Supplies of plant material for compost may be limited.
- The greenhouse soil would have to be out of conventional production (in which synthetic chemicals were used) for three years before produce could be certified.
- Unlike short-season field crops, greenhouse crops are grown for months on end and the crops have high nutrient needs to ensure profitable yields.
- Organic-source nutrients (manures, compost, liquid organic fertilizers) can run low and there is a lag time between application and uptake by plants when organic fertilizers are applied.
- Maintaining consistent supplies of nutrients over a long period can be difficult.
- Regulating exact ratios and supplies of nutrients is difficult and, whereas deficiencies can occur, excessive nitrogen levels can also occur resulting in excessive vegetative growth and reduced yields.
- Soil-borne disease organisms have to be controlled with steam pasteurization or other approved methods.
- Weeds have to be controlled.
- Tillage equipment for incorporating manures and composts is required.
Organic soil management in Québec

At the end of this section are some general comments about the Québec experiences with organic greenhouse vegetable production. Following are some comments specifically about soil and nutrient management.

- Soils need to be very “rich” with high cation exchange capacities (CEC)
- High organic matter soils with adequate nutrient capacity must be developed before the first crop is planted
- Soils are routinely amended with manures or compost
- Soil ECs should be taken every week during the production season using the 1:2 (soil:water) method
- EC should be between 0.5 and 3.5 during production
- When the soil is ready for the crop, and the crop planted, then compost becomes the main source of nutrients in a soil-based system
- Compost commonly used in Québec consists of:
  - Four parts cattle manure
  - One part straw
  - Assorted mineral amendments
- The compost is mixed two or three times before incorporation into the greenhouse soil.

Other amendments include:

- Dolomitic limestone at rates not specified
- Colloidal phosphate at rates not specified
- Sul-po-mag or K-Mag, naturally occurring minerals containing significant quantities of sulphur, potassium and magnesium
- Rock dusts
- Natural \( \text{K}_2\text{SO}_4 \)
- Gypsum (calcium sulfate — \( \text{CaSO}_4 \))

At the end of the composting period, the compost will be as follows:

- 30 percent dry matter
- 6-8 kg/tonne nitrogen. (0.6 to 0.8 percent) (10 to 25 percent available the first year.)
- 4.4. to 5.8 kg/tonne phosphorous (\( \text{P}_2\text{O}_5 \)). (60 percent available the first year.)
- 6.3 to 6.7 kg/tonne potassium (\( \text{K}_2\text{O} \)). (80 to 100 percent available the first year.)
- 1.5 to 1.8 kg/tonne Mg
- 4.1 to 8.4 kg/tonne Ca
- pH between 7.8 and 8.4
- The carbon:nitrogen ratio will range from 15 to 17:1.

Other organic fertilizers include:

- Meals made with animal products like bone, blood, hide, feathers and fish
- Meals from vegetable products like canola, flax, alfalfa and soybean
• Teas made from composts and manures
• Seaweed extracts
• Micronutrients
• Boron in the form of borax or solubor (in assorted trade names.)

The publication, *Organic Greenhouse Vegetable Production*, reports:

*In Quebec, organic farmers raising greenhouse tomatoes by the ground culture method use two rows per bed raised about one foot high. Compost is applied at a rate of 1.2 to 2.4 cubic yards per 1000 sq. feet. The first year it is applied 5–6 times per growing season at 5–6 week intervals. In years two through four the compost is applied at a lower rate. Following compost application, the beds are covered with straw mulch. Soil organic matter in these greenhouses ranges from 10–12% up to 25–30%.*


When the greenhouse crop is growing, composts are applied throughout the growing season as noted above. Quebec’s greenhouse specialist, André Carrier, offers some general recommendations about fertilization with composts:

• Understand the high nutrient demand periods of the crop
• Avoid over and under fertilization
• Anticipate future needs because organic fertilizers are slow to release nutrients
• Based on “normal” soil fertility, compost is applied one month after planting at a rate of 250 kg/100 m²
• Then it is added once every 3 to 4 weeks at a rate of 125 to 150 kg/100 m²
• Compost feeding is ended about 6 to 8 weeks before the scheduled crop finish
• The compost may not supply the full nutrients needs of the crop and other organic fertilizers are applied as required depending on crop needs based on soil and tissue tests
• Some minerals are supplied in the irrigation system.

**More about composts as organic nutrient sources**

An extensive list of composting references is in this Farm-Scale Composting Resource List: [http://attra.ncat.org/attra-pub/farmcompost.html](http://attra.ncat.org/attra-pub/farmcompost.html)

Alternate soil amendments are discussed here: [http://attra.org/attra-pub/PDF/altsoil.pdf](http://attra.org/attra-pub/PDF/altsoil.pdf)
Other composting resources are:
*BC Agricultural Composting Handbook*
http://www.agf.gov.bc.ca/resmgmt/publist/300series/382500-0.pdf

*Characteristics of on-farm composting materials*

**Soilless culture and fertility**

The main advantages of soilless production are:
- The three-year transition period is not required as the medium used is not soil based and considered new. (This would have to be verified with the certification agency as some restrictions may apply depending on the contact containers may have with the soil below.)
- Existing above-ground production systems can be used.
- There is no need for sterilization of the medium to control pests if it has been properly composted or purchased as a pasteurized media.

The main disadvantages of soilless production are:
- Timely feeding can be a concern as nutrients are still organic and not readily available as with soluble fertilizer production.
- Organic nutrients and media are expensive. (Researchers in Ontario estimate that costs for containerized media and organic fertilizers is two to three times that of media and fertilizers for conventional production. This was confirmed by a commercial supplier of both conventional and organic media and fertilizers.)
- Unlike conventional above-ground systems (and depending on the type of medium being used) compost may still be required in addition to liquid feeds.
- Soilless systems, in which the plants are grown in containers such as pots or bags, require that some of the nutrient needs are supplied with irrigation water through drip systems. The most commonly cited problem with drip systems and organic fertilizers is that there is a tendency for the drip tubes to plug. By all reports there have been vast improvements in recent years, but it remains a concern. This matter is being studied by Dr. David Ehret, Research Scientist, Agriculture and Agri-Food Canada, Agassiz, BC. Results are preliminary and more studies are needed.

**The basics of organic soilless culture**

There are a few common features of organic soilless systems:
- Plants are grown in a variety of containers such as upright bags, horizontal bags and upright pots.
- Plants may be fed all of their nutrient needs with soluble organic.
- Plants in open containers, like pots (as shown on the next page) can be fed with occasional applications of compost and soluble organic fertilizers through the water system.
The Ontario trials
Studies are underway at AAFC research station at Harrow, Ontario. The studies are managed by Dr. Tom Papadopoulos. The study is called, Integrated systems for the production of organic greenhouse vegetables. Following are the project objectives

- To identify and evaluate organic media as substrates for the production of greenhouse vegetables and to develop appropriate nutrient feedings derived from organic substances.
- To develop complete (integrated) methods for the organic production of vegetables in greenhouses and to provide appropriate detailed recommendations to the greenhouse industry.
- To assess the commercial feasibility of organically grown greenhouse vegetables.

The accompanying picture shows containers used in a research project at Harrow, Ontario. (This was a late-season cucumber crop photographed in late November, 2007.)

The study started in 2006 and the second year was just completed in December, 2007. Details of the preliminary report cannot be published at this time as the study is underway and the first-year report is confidential. Dr. Papadopoulos gave permission to make general comments on the study.

Tomato trials
In spring 2007, a study was conducted on tomatoes. The study evaluated the following:

- Two types of commercially available liquid nutrient feeds.
- Four types of organic substrates
  - Three variations on a custom blend formulated by the research team
  - A commercial medium
- Two rates of a custom compost sidedressing.

The three organic mixes were composed of the base of:

- 0.66 m$^3$ of peat moss
- 0.33 m$^3$ of vermiculite
- 3 kg of pulverized calcitic limestone
- 3 kg of pulverized dolomitic limestone
- 600 g of potassium sulphate
Three custom mixes all contained the above ingredients with 10L, 20L or 50L of soymeal.

The two side dressings were similar to the main soilless media without the vermiculite and they contained two rates of soymeal, 50L and 100L.

The study revealed differences in the treatment combinations. One combination of treatments resulted in yields approaching those that the researchers were accustomed to seeing in conventional research studies. The organic medium with the highest rate (50L) of soymeal and one of the commercial feeds showed promise. The feed contained fish meal, composted sea bird guano, sea kelp, soybean protein extract, rock phosphate, potassium carbonate, magnesium carbonate, calcium carbonate and other constituents.

**Cucumber trials**
In the fall of 2006, the researchers studied the effects of assorted combinations of four liquid feeds, including a non organic feed; four media, including rockwool, coir (cocoa fibre) and two organic media somewhat similar to the above described in the tomato trial.

The two organic media produced higher yields than those from the rockwool and coir. (Presumably because of the inability of the latter two to hold nutrient reserves.) One of the organic liquid feeds produced higher yields than the other feeds. The yields on all plots in the latter part of the study were severely reduced because of a heavy infestation of powdery mildew. The authors wrote in the preliminary report:

> ... the results ... should be treated as inconclusive because of a heavy powdery mildew infestation of the crop, which resulted in greatly reduced fruit production across all treatments.

**Pepper trials**
Preliminary pepper trials were conducted in 2006, but no results released. Peppers are scheduled for a major study in 2008.

**Commercially available mixes**
One Ontario supplier, MGS Horticultural Inc., in Leamington, Ontario reports that they have a proprietary soilless mix that is being used successfully by commercial organic greenhouse vegetable growers. In addition to using the proprietary soilless mix, producers are feeding one or more specialty organic fertilizers from Gaia Green Products Limited.
The Quebec experience

This is a brief review of the overall Quebec experience with organic greenhouse vegetable production.

Producers in Quebec have been producing organic greenhouse vegetables for about twenty years. According to Quebec’s greenhouse specialist, André Carrier, most of the details of organic production have been worked out by trial and error over many years. There is some organic research currently underway at the University of Laval details of which were not available as of January 10, 2008). Carrier reports that little production research has been done in Quebec.

Following are a few key points about the Quebec experiences primarily with tomatoes. Many of these points have been noted elsewhere in this report, are well-known in the greenhouse industry and well documented on AAF’s webpages.

These observations and recommendations are listed here to reiterate key points about organic production from an area with experience in organic greenhouse vegetable production.

- Greenhouses need the best possible coverings that allow in the most light.
- A one percent reduction in light transmission through the covering will reduce yield by an equal amount.
- High-gutter greenhouses offer better climate control.
- Computerized climate control is a must to maintain accurate temperatures and airflow within the greenhouse.
- Plastic greenhouse coverings should be “anti-condensation” types to reduce dripping which will increase diseases.
- Soils must be sterilized to reduce soil diseases, weeds and insects. Soil is held at 60°C for 20 to 30 minutes to a depth of 12 to 18 inches.
- Drain-tile sterilization is common in Quebec.
- Biologicals used for insect pests and nematode reduction.
- More research is required on biological control of diseases and soil-borne pests, like pathogenic fungi and nematodes.
- Bees are required for pollination of tomatoes.
- Coverings must be “bee friendly.”
- Seedlings of the production cultivars must be grafted onto hardy rootstock to reduce the incidence of root diseases.
- Maintaining proper nitrogen balance can be difficult.
- An obvious lack of “vigour” may be caused by:
  - Improper day-night temperature differences
  - An excessive number of fruit per truss
  - Improper leaf pruning
  - Improper watering.
- The main problem experienced in Quebec with tomatoes grown in soil is that the composts applied to the soil do not provide all of the nutritional needs of...
tomatoes. Supplemental organic fertilizers have to be applied and timing of nutrient release is not always perfect.

- Water needs are directly related to sunlight which must be monitored.
  - A tomato plant will need about 3 litres on a sunny day, and
  - From none to 300 mL per plant on dull days
  - If more than 1 L of water is required, the application should be split.
- Watering should be done about two to three hours after sunrise or two to three hours before sunset.
- Artificial lighting is worthwhile for winter production of transplants—if not buying off-farm transplants.
- Cucumbers are difficult to produce organically.

Growers in Quebec use a crop prediction model, Tompousse, developed in France that enables them to estimate future supplies.

**The problems with organic cucumbers, peppers and lettuce**

Tomatoes make up 80 percent of the organic greenhouse production in Quebec. They are affected less by diseases and generally are stronger plants than cucumbers, peppers and lettuce.

One of the main problems with cucumbers is root diseases which start to be evident after 2 or 3 years in soil production. Grafting recommended varieties onto disease-resistant root stock has not help the problem in cucumbers.

Lettuce grows reasonably well, but simply is not profitable.
Suppliers of organic production materials and services

Following are companies who are currently supplying organic products to commercial growers.

The companies and products listed below are provided for convenience of readers only. This does not constitute an endorsement of the companies or products nor a suggestion that no other companies provide organic products, and further that other organic products are not available or effective.

Organic media suppliers and media

Westgro Horticultural Supplies
http://www.growercentral.com/about_evergro.cfm
Premier Pro Mix organic media
http://www.premierhort.com/eProMix/Gardening/Products/GrowingMediaTM/ProMixOrganic/ProMixUltimate.htm
MGS Horticultural Inc.
http://www.mgshort.com/

Organic fertilizer suppliers and fertilizers

Westgro Horticultural Supplies (Growercentral.com)
Gaia Green organic fertilizer blends
http://www.gaiagreen.com/products/
MGS Horticultural Inc.
http://www.mgshort.com/
Agrowchem Inc.

Organic consulting services

Specific fertility management assistance
Mr. Michael Dean
Gaia Green consulting and educational programs
http://www.gaiagreen.com/consulting.asp

General consulting services regarding “getting into” organics
Rochelle Eisen
Organic Extension Agent (COABC)
extension@certifiedorganic.bc.ca
250 547.6573 (h)
250.306.7980 (c)
Box 370 Lumby BC V0E 2G0
Could Alberta producers convert to organic?

One of the objectives of this report was to:

*Examine if the existing practices in Alberta vegetable greenhouses are close to certified organic practices. Identify which practices can meet certification requirements and which may not.*

There are several aspects to this question, including market potential, economics and production matters. The four main topics discussed in this section are:

- The greenhouse structure and climate management
- Organic insect and mite management
- Organic disease management
- Organic fertility management

Briefly, here is where Alberta’s greenhouse vegetable producers stand in each of these areas with regard to organic production.

The greenhouse structure and climate management
The majority of Alberta’s producers have world-class greenhouse structures and environmental control systems. As such, they are well suited to organic greenhouse production which requires good environmental controls to reduce risks from disease and pest infestations. Changes would have to be made to growing system structures. Conventional cocoa-fibre or sawdust bag system may have to be replaced with containers more suited to organic media.

Organic insect and mite management
The state of biological insect and mite control currently used in Alberta’s greenhouses would lend itself to an easy transfer to organic production standards.

The majority of Alberta’s greenhouse vegetable producers use no pesticides to control insects. Some producers used limited amounts of pesticides. There is enough experience with complete insecticide-free production that the transition for remaining producers would be relatively easy.

Organic disease management
Many diseases of vegetables in greenhouse can be adequately contained with cultural practices. Powdery mildew and other diseases can reduce yields enough to concern to producers. Outbreaks of diseases and limited approved organic control measures clearly heighten risks for producers.

Organic fertility management
At this time, fertility management is clearly the most difficult production matter for several reasons.

Regulations in Canada allow for production in soil or soilless media. In Quebec, most production is in the soil as it is considered to be the only way to produce organically. This
the philosophy adopted by Quebec’s organic producers when most started their organic greenhouses many years ago.

It is most probable that the majority of existing producers in Alberta will not be interested in switching to soil-based production. A significant limiting factor is the mandatory “three-year transition” period required in the Canadian standards, Organic Production Systems General Principles and Management Standards, which state:

**5.1 Land Requirements for Transition to Organic**

5.1.1 Products shall not be labelled or marketed as organic until this standard has been fully applied on a production unit for at least 24 months before sowing or in the case of perennial crops, at least three years before the first harvest of products. Prohibited substances shall not have been used for at least 36 months before the harvest of any crop.

The main limiting factor for existing producers is that they could not sell any produce at organic prices for three years in the transition to organic production and certification. In that period, their yields would almost certainly be lower, their costs higher costs and yet they would have to sell their greenhouse vegetables at conventional prices. The three-year transition period to organic greenhouse production in soil will hamper the ability of existing soilless producers to change.

Smaller producers (who sell on-farm or at farmers markets) can communicate their practices directly to consumers and may be able to sell at organic prices during the transition.

The only practical alternative for existing producers is to grow organic greenhouse vegetables in soilless systems since the three-year transition period would probably not apply. (Producers should seek an official opinion on this matter with a certifying body.)

Typically, the accepted media are mixes of amended peat moss and composted materials that release nutrients slowly. Experience elsewhere shows that ongoing additions of organic fertilizers are required to supplement the nutrients released from the organic growing media. The additional nutrients are applied as composts or approved organic ‘soluble” fertilizers and the nutrients in these are not as readily available as in conventional fertilizers. Soluble organic fertilizers are fed with drop systems also used for watering.

Producers using conventional production systems use relatively inert media like rockwool, sawdust and cocoa fibre. However, as already noted, these media do not hold sufficient amounts of organic fertilizers at any one time for them to sustain growth. Many organic fertilizers contain “latent” nutrients that must be released by biological activity in the media. The inert media lack this ability.

Switching to organic production for most of Alberta’s existing growers would require a significant change in production practices.
There also remains a significant lack of hard fertility research information on organic production. The current research in Ontario is good and will provide useful information when completed. However, these study results will not directly transferable since the main organic compost is based on soybean meal which is not available in Alberta.

As noted, commercial suppliers and one consultant (in Ontario and BC) claim to be able to provide the necessary materials and information to grow reasonably good yields of tomatoes. Their proprietary information is not available unless a producer purchases their products and programs and hires consulting services.

**Overall assessment of Alberta’s producers to move into organics**

Today, many producers use no insect or mite sprays and rely solely on biocontrols. Others produce greenhouse vegetables with minimal sprays to control minor outbreaks of insect pests.

Based on comments from growers and marketing coop staff, the majority of greenhouse vegetables in Alberta are grown without any insecticides. With more careful monitoring and judicious use of biologicals, complete biological control of insects and mites could be achieved in most greenhouses in most years. Fungicides are more widely used, but use is limited.

Disease, insect and mite management are close to meeting the standards for organic production. However, at this time, the main groups of greenhouse producers in Alberta are not well placed to convert to organic. Tomatoes are clearly the least difficult crop to produce organically because there are fewer disease stresses compared to cucumbers and peppers. And overall, tomatoes seem to be less affected by assorted stresses and survive (and produce) quite well in greenhouses for 10 or 11 months. Information about organic lettuce production is too limited to draw conclusions, and there are production and possibly food-safety issues with lettuce. (Yet, organic lettuce is a major organic vegetable sold in mainstream grocery stores.)

There remain uncertainties about the economics of organic production. Researchers in Ontario have determined that the cost for media and fertilizers are two to three times higher than for conventional media and fertilizers, while yields tend to be lower. One commercial supplier on Ontario also reported that the media and fertilizers they sell to organic producers cost at least three times similar conventional materials. It is clear that Alberta-based production economic figures (via research or demonstration) are required before producers can make informed choices.

The technical issues and economic uncertainties are also influenced by human psychology and general resistance to change. Generally growers are comfortable with the level of management skill required and most are economically comfortable. Simply, most existing producers are pleased with their economic status and there is no real pressure to make them want to change.
Changes in the marketplace in the future may alter their feelings. Some factors that may influence grower interest in organic greenhouse vegetable production include:

- Continued expansion of greenhouse vegetable production in Mexico that could affect future pricing of conventional greenhouse vegetables.
- The relative value of the Canadian dollar. Producers in Quebec and Ontario (and undoubtedly BC) claim that selling into the USA has become more difficult and that prices in the past year have dropped.
- André Carrier, in Quebec, reports that more conventional producers are eyeing organic production as a way to maintain cash flows and it is possible that Alberta’s producers will look to organics as one option.
- In reality, the market for organic produce is limited and it is possible that the needs could be satisfied easily. (What would one more 33-acre organic greenhouse do to supply and prices? Conversely, what would happen to prices of organic greenhouse vegetables if one 33-acre greenhouse stopped producing organic vegetables?)

Until there are changes in the economics of existing production there is little to entice existing producers into organic production.

Unless there is a major disruption in the economics of conventional greenhouse vegetable production, I am of the opinion that the main force to make experienced producers shift would be a change in their belief system.

**Pesticide-free production**

One of the requested objectives of this report was to explore status of pesticide-free production in Alberta. Because of the limited number of producers involved in this type of production it is not appropriate to discuss details of the current status. (Statistics Canada and AAF have guidelines for reporting of statistical information when only a few producers are involved. It is imperative to respect the confidentiality of those producers and their production figures.)

The few growers who have taken the initiative to explore this niche market are to be congratulated for their initiative and hard work.

For this report, it is sufficient to report that a few growers are producing greenhouse vegetables in a conventional manner except they have chosen to use no pesticides in their greenhouses and market as such. Some production is sold locally, however most of the pesticide-free production from these producers is marketed through one mainstream retail chain. The produce buyer for that chain is “thrilled” with the produce from pesticide-free production.

Like organic production, pesticide-free production relies on the use of cultural management, environmental controls, biologicals and approved organic sprays to control insects and disease. However, conventional fertilizers are permitted as are assorted disinfectants.
The pesticide free producers of Manitoba have developed a neat and tidy definition of pesticide free. It is published here: http://www.buyfp.com/

In part, their definition states:

\[
PFP \text{ crops are } ... \text{ crops, that have not been treated with pesticides from the time of crop emergence until the time of marketing.}\]

Their definition was designed for field production, however, the basic principle applies and is a useful guideline for pesticide-free producers and basically the one in practice in Alberta. In short, the greenhouse crop is not treated with any synthetic chemicals to manage diseases, insects and mites while the crop is growing in the greenhouse.

Pesticide-free producers embrace many of the cultural practices of organic producers to minimize pest infestation. These include:

- Sanitation in between crops and during crop production
- Understanding insect, mite and disease pests and their control
- Monitoring crops for diseases, insects and overall health
- Controlling the greenhouse environmental for optimal crop-production and minimal pest growth
- Injecting carbon dioxide where appropriate to enhance plant health and growth
- Practicing cultural control with proper watering and maintenance of adequate nutrition
- Using biological controls for insect and mite pests

When hampered by pests, producers practicing pesticide-free production would be free to use any pest management products available to organic producers—although these are very limited. However, technically (and this is acknowledged to be ‘picky’), even “approved” pesticides are indeed pesticides and registered as such. The way around that is to simply claim that crops are produced without synthetic pesticides.

There is evidence that the fertilizer potassium silicate protects cucumbers from powdery mildew. This chemical could not be used in an organic greenhouse, but as a fertilizer it would be permitted in a pesticide-free production greenhouse. That it helps to reduce powdery mildew would be a bonus—the grower is simply feeding the crop to make it more resistant to a disease.

A word of caution about the term “pesticide-free”
Those practicing pesticide-free production are encouraged to continue. However, they are advised to be careful about the use of the term “pesticide free.”

Growers practicing pesticide-free production can make statements such as:

- Tomatoes produced without pesticides
- Pesticide-free production
- Grown in a pesticide-free environment
- Grown without pesticides, or
• Produced without synthetic pesticides.

However, there remain uncertainties about terms like:
  • Pesticide-free tomatoes ... or cucumbers or peppers
  • Pesticide-free produce.

Even though producers may be testing for a wide range of common pesticides, it may never be possible to claim unequivocally a tomato is pesticide free.

There is a difference between not applying pesticides and pesticide free. Since, laboratory tests cannot be performed for all pesticides, claiming a crop is pesticide-free, might pose a risk. One alternative might be to follow the organics method of “certifying the process” versus making claims about the actual products.

As noted, those practicing pesticide-free production are encouraged to continue.
Opportunities for value-added production in Alberta’s greenhouse industry

Introduction
A major focus in this report has been on the production of organic greenhouse vegetables, as this was identified in the request for proposals (RFP).

In this section we will address the “barriers, constraints and solutions to develop a value added Alberta Greenhouse Vegetables industry.”

The RFP asked for comments and analysis of:

… certified organic, pesticide free, market fresh, locally produced, safe and nutritious greenhouse vegetables in the markets of Europe, Mexico, Ontario, Quebec, British Columbia and Alberta. It should include volumes, prices and trends.

As noted already, there is a dearth of supply-chain information regarding organic greenhouse vegetables. Although people and agencies have snippets of information, there is little “big picture” information about actual production and movement through the supply chain to consumers. The Organic Agriculture Centre of Canada and Canadian Organic Growers have published recent studies on organic production and retail sales. To date, Statistics Canada has not published information on organic greenhouse vegetable crops. (They are starting to gather production information on some organic crops.)

The reports on organic vegetables (and other crops) rely heavily on extrapolations and assumptions. Some of the statistics they report are known to be inaccurate.

Not only is basic production information missing, there are no formal records of prices and trends specifically for organic greenhouse vegetables.

There is a significant amount of pesticide-free production in Alberta which was reported on earlier in the report. Because of confidentiality “rules” it is not appropriate that details of pesticide-free production be published. It will be discussed briefly later in this section.

The RFP also mentioned, “market fresh, locally produced, safe and nutritious greenhouse vegetables.” Needless to say, no records are kept on these “types” of produce. However, there are numerous articles and studies that discuss trends and opportunities for these marketing “items.”
General trends in vegetable consumption

Volumes are written on trends in food consumption. Only a few highlights will be discussed here.

Product and packaging trends

AAF’s webpage, Consumer Trends for Fruit and Vegetable Products, discusses many recent trends that might guide future decision by Alberta’s greenhouse industry. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sis8439

Some key points in this article:

• In 2001, about one third of all food dollars spent in Alberta were in restaurants.
• Consumers in the Prairie Provinces spent less on vegetables than the Canadian average.
• Between 1999 and 2003 there was an annual increase in fresh fruit and vegetables of about 10 percent in Canada.
• In the USA in 2003, mainstream grocery stores and other retail outlets, like club stores (eg. Costco) accounted for 98 percent of all fresh produce sales.
• A USA “fresh trends” study in 2004, determined that:
  o American consumers were serving 12 percent more fresh vegetables with meals
  o Use of washed, cut and bagged produce had increased 27 percent.
  o Use of organic produce had increased 20 percent.
• A USDA study in 2003, showed that produce retailers claimed that 20 percent of their sales were in speciality items such as:
  o Pre-packaged salads (9 percent of produce sales)
  o Organics (2 percent of produce sales)
  o Fresh cut vegetables (5 percent of produce sales)
• Retail sales of organic produce continue to increase at about 15 percent annually.
• The AAF article also reports that consumers want smaller packages, like pre-packaged and washed items (such as bagged salads). The article reports, “Consumers want smaller sizes but they also do not want to do the work.”
• The article reported that new opportunities for fresh produce include:
  o exotic or ‘niche” produce
  o value-added vegetables, that might include washed, cut and pre-packaged product
  o consumers will pay for the perception of quality and freshness (as witnessed by the success of TOVs).

The studies cited in the above article are a few years old and it is not known how trends have changed since. (The sale of TOVs has taken off in the past five years and there are
new vegetables such as mini cucumbers that have a place in producers’ greenhouses. There is one important “special” trend that will be discussed later.)

The AAF article summarized a few key points which may or may not be of benefit to Alberta’s greenhouse industry—and certainly not real news:

- Consumption of fresh produce continues to increase
- More food dollars are spent on restaurant meals
- Sales of organics, pre-packed and pre-cut fresh vegetables continue to increase.

**Tomato trends**
Despite concerns about tomato supplies and market pressures, the growth of greenhouse-grown tomatoes on North America is nothing short of phenomenal.

The following two articles quoted, although from the USA, show the growth of greenhouse tomatoes and (despite the current recession in the USA) this is likely to continue.


Although the article is nearly three years old it presents a ‘sense” of this dynamic commodity.

> Greenhouse tomatoes now represent an estimated 17 percent of U.S. fresh tomato supply. Even though greenhouse tomatoes still constitute a minority share of the U.S. fresh tomato market, their influence is concentrated and growing in retail channels, which represent about half of U.S. tomato consumption. Around 37 percent of all fresh tomatoes sold in U.S. retail stores are now greenhouse, compared with negligible amounts in the early 1990s.


*Bold highlights added*

Annual per capita consumption of fresh tomatoes in the U.S. has increased from 12.3 pounds per person in 1981 to 19.3 pounds per person in 2003. An increase in the consumption of healthy foods and the popularity of a variety of salads, salad bars, and vegetable and salad stuffed sandwiches has contributed to this upward trend. Tomatoes have been promoted as sources of different vitamins and antioxidants in recent years.

… The **TOVs** have become the dominant greenhouse tomatoes in recent years. Growers are now offering different sizes and shapes of the TOVs including the
traditional TOVs, cherry TOVs, Campari tomatoes (a type of cocktail tomato, midway in size between a traditional TOV and cherry TOV), as well as roma and mini roma TOVs. Growers are aggressively pursing and experimenting with **specialty varieties and use different names** to increase sales of greenhouse tomatoes.

They are also experimenting with **heirloom tomatoes**. Despite these product differentiation endeavors, there are no well-developed greenhouse tomato brands on the market today. However, it appears that **greenhouse tomatoes are more brand-oriented than field tomatoes**. They are, at least, marked with the names of the suppliers on each package or tomato …

Page 4

Large greenhouse operations guarantee **year-round supply**, and offer other services to these markets including **promotional support, stable pricing through forward contract, and other marketing services**.

**Packaging** will also be one key area growers need to focus on to differentiate their products from other local and regional suppliers. **Fresh tomato packages could convey different messages about the product including convenience, servings, flavors, and other product attributes and qualities**. **Wellness** is the other market driver that can help greenhouse tomato producers increase their sales. For example, greenhouse tomato varieties that could **be produced with specific benefits** or those **without the use of chemicals or pesticides** can be appealing to **health-oriented consumers**.

In the long term, **brand building** that help promote a **unique image and character** will play a significant role in increasing sales of greenhouse and hydroponic tomatoes. Greenhouse tomato growers who can produce **unique and specialty niche tomato products** can sell their products at **higher prices** to consumers who want to pay premium prices for these products…

**Nutritional trends**

Last summer, Dr. Mirza wrote an article, How the Alberta greenhouse vegetable industry can benefit from healthy eating trends: [http://www1.agric.gov.ab.ca/$department/newslett.nsf/pdf/ghb11788/$file/greenhouse_business_may_june_07.pdf?OpenElement](http://www1.agric.gov.ab.ca/$department/newslett.nsf/pdf/ghb11788/$file/greenhouse_business_may_june_07.pdf?OpenElement)

He said:

> [The] bottom line is that healthy eating trend is not a fad and is going to stay.

Volumes are written on the subject of healthy eating and food nutrition. There is no intent here to reiterate what has already been said about eating trends and nutrition. A few concepts are worth exploring further.
5 to 10 a day
The Canadian Produce Marketing Association (CPMA) has a new campaign promoting the consumption of five to ten servings per day of fresh fruits and vegetables:
http://www.5to10aday.com/

There is clearly an opportunity for Alberta’s greenhouse industry to take advantage of this campaign if not already done so.

Nature’s vitamin pills?
There may be some opportunity for the greenhouse industry to promote sales when certain chemicals are present. The most prominent current example is that of lycopene:
http://www.lycopene.org/

… lycopene, a powerful antioxidant abundant in red tomatoes and processed tomato products, may help prevent prostate cancer and some other forms of cancer, heart disease, and other serious disease …

A word on lettuce and related specialty greens
Alberta produces little greenhouse lettuce and yet it is a huge commodity.

There are difficulties with lettuce as reported by AAF here:
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1443

The primary lettuce market in Alberta is for crisp lettuce. Unfortunately, production limitations have prevented Alberta greenhouse growers from being able to economically produce crops suitable for this market. Loose leaf lettuce, romaine and butterhead lettuce have fewer production constraints, but market prices are not always sufficient to cover the cost of production.

However, lettuce is mentioned here because it is such a huge commodity and there has been large growth in specialty lettuce products. One popular lettuce item in recent years has been mesclun. This is a salad of mixed, small-leaved salad leaves that may contain lettuce, spinach, mustard greens, endive, and other leaf vegetables.

No strategies are offered. It is another example of changing consumer trends and a possible niche product for producers. As noted, lettuce has assorted production and economic difficulties.
Niche markets
A lot is said about “niche” markets and rightfully so since they offer opportunities for increasing greenhouse income. But what are “niche markets”?

A Purdue (Indiana) University Extension service article discusses niche markets:
http://www.ces.purdue.edu/sa/famfarm/market.html

The article defines niche markets “an area of consumer need not being completely filled.” Once the market is filled then it is no longer a niche market. Niche markets are constantly changing as market demands change and producers fill these niche markets. Therefore, monitoring market needs is required to identify new niches.

The “products” identified in this current greenhouse study identified niche markets or niche market concepts, namely organic, pesticide free, fresh, locally produced, safe and nutritious greenhouse vegetables. Comments have already been made about nutritional trends. The other “commodities” will now be presented in detail.

In reality, the entire content of this report is about niche markets. What can Alberta’s greenhouse industry do differently to increase sales and profits?
Organics: Trends and opportunities

Why organic?
Before looking at trends, here are a few comments on why consumers chose organic products.

AAF maintains a website, Consumer Trends in Organic Food: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sis8434

The article reports on the reasons why consumers purchase organic products:
- 32% believe organic is healthier
- 18% think they contain no pesticides
- 11% cite better quality
- 3% consider no GMO as a benefit
- 3% to prevent allergic reactions.

Other studies have shown slightly different reasons.

A study by the Certified Organic Associations of British Columbia is reported here: http://www.certifiedorganic.bc.ca/aboutorganic/highlights.htm

That study reported:
- Why are people buying organic?
  - Organic food purchasers buy organic primarily for health and nutritional reasons (e.g. the absence of chemicals) and taste.
  - Taste is particularly relevant to those who buy organic meat, poultry, dairy or eggs. Light organic purchasers are motivated by taste more than medium to heavy purchasers.
  - 61% of both current and prospective organic food purchasers agree that organic food is much healthier. 51% expect it to taste better than non-organic food.
  - Current and prospective organic purchasers define “certified organic” as food that has been grown, raised or made without chemicals, pesticides, chemical fertilizers, preservatives or hormones. 1 in 5 believe “certified organic” means that the food has been inspected or guaranteed to be organic.
A study in the Netherlands is reported here:

It reported that consumers chose the following reasons for buying organic (percent of consumers selecting a reason):

- Environmental friendly 51%
- Health 49%
- Taste 41%
- No use of chemicals 28%
- Supporting organic agriculture 14%
- Quality 12%
- Animal welfare 10%

**Trends**

The previously cited AAF website, *Consumer Trends in Organic Food*, reported that organic sales continue to climb.

The Organic Agriculture Centre of Canada (OACC) commissioned the previously cited report, *Retail Sales of Certified Organic Food Products in Canada in 2006*:

According to that report:

> The average growth rate of the sales of all certified organic products in supermarkets from 2005 to 2006 was 28%. The strongest growth was seen in Alberta with an increase of 44%.

And …

> In the west, sales from organic distributors are higher to natural food stores than to mainstream supermarkets… Supermarkets in Alberta are showing the highest growth in sales from 2005 to 2006 (44%).

Trends in organic purchases in the USA are reported by the Perishables Group in a report, *Organic Opportunities in Conventional Retail Supermarkets*. A summary is here:
http://www.fpfc.org/June2007v2.pdf

In general, the study showed significant differences in consumer habits between “heavy organic users” and “soft” organic consumers. Of particular interest is that fresh produce (like organic greenhouse vegetables) are the predominant entry point for consumers who are beginning to seek out organic foods. I.e. consumers buy organic fresh produce before other organic products such as (say) breakfast cereals or meats. Produce quality is a critical purchase trigger. I.e. organic vegetables must appear fresh and have overall visual quality.
Opportunities
There is an opportunity for Alberta’s greenhouse industry to supply organic greenhouse vegetables into western Canadian markets outside of BC. Earlier in this report, the market in Alberta, Saskatchewan and Manitoba for organic greenhouse tomatoes was estimated to be between 2 and 4 acres of production. At this time this market is being supplied primarily by one organic greenhouse operation (Origin) in BC. (That this one large company exists, may be seen as an opportunity in itself.)

The COG retail study found that sales of organic lettuce were higher than those of tomatoes, so the market for organic lettuce is probably several acres. (There are production and economic uncertainties.)

Sales of organic peppers and cucumbers were not reported in the retail study cited above, so actual market volumes are unknown, but there is a demand. One major mainstream produce manager said he could never get all of the organic greenhouse peppers he wanted and was always “short shipped.”

The market of organic greenhouse vegetables is huge in the USA, and there is some market opportunity for Alberta-grown organic vegetables. However, the majority of organic vegetables currently used in the USA come from organic greenhouses in Mexico and whether or not Alberta producers can compete is unclear—it will probably be difficult.

Prices for conventionally grown greenhouse vegetables are under pressure as sales to the USA are affected by the strong Canadian dollar. Such pressure could be seen as an opportunity to get into the niche organic market. The market complexities are unclear.

The produce manager for one major chain of speciality organic retail stores wants more locally produced organic vegetables and would like to speak with anyone considering organic production and would be pleased to enter into contracts with organic greenhouse producers. Such contracts would take some uncertainty out of production and marketing.

What the markets will be in five years is anyone’s guess. As noted previously in this report, if retail sales of tomatoes increase at a rate of 20 percent per year, by 2012 there might be the equivalent of 5 to 10 acres of production consumed on the Prairies. How the Alberta industry responds is unknown.

The production of organic greenhouse vegetables has a role on smaller organic farms and vegetable operations. Small commercial fruit and vegetable producers who sell field-grown organic produce to retail stores and farmers markets might see an advantage of producing some greenhouse vegetables to extend the marketing season. Such an operation could produce warm-season vegetables that perhaps don’t do well in the field. A small organic greenhouse can also be used to produce transplants for field vegetable crops.
Barriers to organic production

There are many factors that restrain organic production and marketing. There are also some unknowns about organics, which therefore become barriers. They are briefly presented here in point form.

- The federal government seems to have many people working in the organics sector, however they are unable to provide information specific to organic greenhouse production. This is probably because the industry is (or was) growing rapidly and in a constant state of flux. Market information would assist Alberta’s greenhouse producers to make informed decisions about organic production. Production information supplied in this report is woefully lacking and based on “guessimates.”
- Growth of organic sales is large, but the market remains small and what the market will be in five years is unknown.
- The overall organic fresh produce market is still relatively small at between 1 and 3 percent of fresh vegetable sales.
- Growth of organic greenhouse vegetable production may be held back by other opportunities.
- Organics as a greenhouse “business” venture may not be as economically appealing as other niche markets that may be easier to enter at lower cost and with less risk.
- The largest single operation in North America produces 33 acres in Canada and another 8 acres in California. If they stopped producing, or if another similar operation started, this would have a huge affect on the ability of smaller producers to compete in the mainstream wholesale-retail system.
- Expanding organic greenhouse production in Mexico is a concern. The following comment was recorded on an Internet “message board” managed by Mississippi State University in April, 2006:

http://www.msstate.edu/listarchives/greenhouse-tomatoes/200604/msg00016.html

I have one organic tomato grower here in the Central Valley of California that is about 3 [organic] acres by himself. He is VERY discouraged with competition from Mexican growers (he says about 2,000 acres there) and with the low prices he is getting this year. And he is not very optimistic with Whole Foods or Walmarts - they all want ‘cheap’ product, organic, and picture-perfect.

- The organic market is volatile and future markets are hard to predict. Trends have been strong and consistent, but will change one day. This adds uncertainty to someone investing in an organic greenhouse and who is faced with lower yields and higher costs of organic production.
- Consumer trends in the next year or two will affect decisions to enter organic greenhouse production. It is not known if organic sales will level off.
- The presence of one large (seemingly) successful greenhouse operation in BC is necessarily a concern of any Alberta producer considering organic production. What if that company, with its (apparent) extensive financial backing and experience, expands production? The reality is that new producers may
experience a (say) two-year time lag while they learned by “trial and error” as
growers did in Quebec. (Certainly an Alberta producer will have the “local”
advantage over a producer from BC.)

- The price of organic products limits their market penetration. In addition,
  wholesale produce managers report that the retail price mark-up is less for
  organics than for conventionally produced vegetables. They will be reluctant to
  continue this practice as organic vegetables increase in market share.
- Related to the price spread is the relatively slow movement of organic vegetables
  that result in higher wastage. As one produce manager told me, “Sell it or smell
  it.”
- Produce managers at two large wholesale companies also reported another
downside to organic vegetables. Products like TOVs are sold in bulk and each
fruit cluster is marked with the produce code, 94664, versus the code, 4664, for
conventional TOVs. They estimate that up to 40 percent of organic TOVs are
coded in at the cash register as conventional 4664s.
- The price spread will continue to constrain consumption. One American study,
  Organic Opportunities in Conventional Retail Supermarkets
  http://www.fpfc.org/June2007v2.pdf) reports:
    o Most consumers will pay up to 20 percent more for organics
    o Heavy organic consumers will pay up to 50 percent more.
- The strong Canadian dollar is reportedly affecting sales of conventionally grown
  greenhouse vegetables. In Quebec, there is increasing interest by conventional
  producers to get into organic production. This is likely to put downward pressure
  on organic greenhouse vegetables and make profitability more uncertain.
- Wholesalers told me that given a preference, they would chose “local” over
  “organic.” This does not mean both can’t exist together in the marketplace, but a
  push to supply more local production could impede organic production as “local”
  might be a simpler way to expand production of greenhouse vegetables.
- There is a trend to increased organic sales, however there remains no scientific
  evidence (or weak or controversial evidence) that organic products are superior
  from a health, environmental or nutritional standpoint. Consumers apparently
  believe there are benefits from eating organic vegetables, but presumed benefits
  are not proven and this might constrain future consumption. (However, as
  witnessed by many things in our society, “real science” does not matter and often
  consensus and opinion influence trends and bandwagons.)
- Consumers are encouraged to consume fresh fruits and vegetables for many valid
  health and nutritional reasons. Could high production costs and high market
  pricing actually impede fresh vegetable consumption?
- One of the often-heard beliefs of organic production is that it is in some way an
  environmentally superior form of production, is eco-friendly and may result in a
  lower carbon footprint. However, yields in organic greenhouses are lower than
  those in conventional operations and this is unlikely to improve substantially.
  Even the most devoted and experienced experts and dealers in the organic
  industry say that organic yields are unlikely to ever be more than 80 percent of
  conventional production. From an environmental perspective, herein lies the rub.
  If organic crops are yielding 20 to 40 percent less they are using 20 to 40 percent
more energy per unit produced than crops grown conventionally. This can’t sit well with many consumers. Solar and wind energy may play a role in small greenhouses, but will limit length of the production season.

- From my perspective, there appears to be a lack of leadership by organic organizations, provincial and federal governments given that organic has received a lot of attention and government input in the past several years.
- Several personnel in the Canadian organic industry said the organic industry was rife with (and I quote), “infighting,” “power struggles,” and “turf wars.” This could be perceived as a “turn off” to prospective organic producers.
- The certification process and costs could be considered significant barriers to organic production.
- There remain many challenges in the production of organic greenhouse vegetables.
  - “Public domain” production protocols have yet to be worked out for most crops.
  - Successful practices used elsewhere in Canada are well guarded and not part of the public domain as witnessed by the need for research projects being conducted by AAFC in Harrow, Ontario and Agassiz, BC. (Only preliminary results have been released.)
  - The large greenhouse company in BC (Origin), reports that they spent over $5 million on researching and developing their proprietary organic system.
  - Quebec production is well established, but all current production is in soil and such production is unlikely to be of interest to existing producers in Alberta.
- As more organic production comes on stream, prices will tend to drop. This will affect the profitability if production costs remain high and yields remain lower than conventionally produced greenhouse vegetables.
- There have been occasional “food-safety” issues with some organic products.
- Studies into the “food safety” of organic greenhouse lettuce show conflicting results. However, there may be legitimate concerns about *E. coli* contamination on lettuce produced in heavily manured soils.
- The rules and regulations governing organic production seem to change and vary from agency to agency. The new Canadian standards that will come into effect in December 2008 should bring more uniformity to the standards.)
- There remain variations in what materials and supplies are approved in organic production systems. This adds confusion for prospective producers.
- Lack of cost of production studies will impede entry.
Overcoming barriers to organic production and marketing

The biggest issue in the production and marketing of organic greenhouse vegetables is, without question, the deficiencies in production protocols. General practices have been reported in an earlier section of this report.

General practices are known and commercial companies and consultants can help new organic producers get started. But at this time, in Alberta, we do not have solid “turnkey” production packages that a prospective organic producer could use. Results from current federal studies will be available within about two years. We have preliminary results, but they are not specific enough.

At this time, production protocols for greenhouse cucumbers, peppers and lettuce are even less certain.

Without further research and development programs, the economics also remain unclear. Those considering large-scale organic greenhouse production must assess the feasibility based on best-available production and economic information—and they are lacking.

Agreements or contracts with wholesalers and retail stores will aid new producers by possibly easing pricing uncertainty.

Strategies and recommendations

It would be premature to develop a major marketing strategy when we have essentially no production. This is aggravated because we also lack confidence in the potential for the success of profitable organic greenhouse production.

The lack of solid production recommendations does not preclude producers from conducting “organic” trials within their existing operations. On-farm trials would help producers learn about organic production, gain experience and might provide enough information on which decisions about the future might be made.

Individual producers or producer groups may wish to approach specialty organic retail stores or major wholesalers and discuss market opportunities and perhaps contracts.

One strategy that is pertinent to “organics” and the other “commodities” (discussed below), is that consumer-preference studies specific to Alberta might help guide the focus on organics and other products. Such a study might clarify market trends and opportunities. A study could identify the relative importance of growing and promoting organic vegetables versus the promotion of “local” or “fresh, safe and nutritious” vegetables.

In addition to giving guidance to producers, such a study might also give guidance to AAF so they could better assess research needs.
Other strategies to consider might include:

- Hiring someone like Rochelle Eisen, COABC’s Organic Extension Agent to present a workshop about organic production in general. Someone like Eisen could outline the steps and pitfalls involved. It is most probable that an experienced person will shorten the time needed to establish successful organic greenhouse operations.

- If new or existing producers are interested, an organic nutrient and fertility consultant might be hired to present information. Michael Dean, of Gaia Green, appears to be a “go to” consultant for established organic producers. [http://www.gaiagreen.com/consulting.asp](http://www.gaiagreen.com/consulting.asp)

- AAF needs to address its research priorities. There is a shortage of hard information on organic greenhouse production. Research findings elsewhere are not necessarily transferable. For example, the preliminary results of current research at Harrow are of little use in Alberta since their promising compost was based on soybean meal, which is not available in Alberta. (The overall study results are expected to offer good information on organic fertility.)

- AAF staff will have to address if current research (supporting a large existing greenhouse industry) is more important than possible research for an industry that does not even exist. (Market-trend and consumer-preferences analysis would indicate the potential for organic production in the foreseeable future and put the acceptance of organics in perspective.)


**Pesticide-free production: Trends and opportunities**

The RFP requested that detailed information be provided for pesticide-free production.

A few greenhouse producers in Alberta have developed production protocols for producing greenhouse crops without pesticides. They are to be congratulated for their foresight and efforts. As noted earlier in this report, accepted rules for reporting statistics prevent reporting when only a few producers are involved. It is also imperative that their market position be protected.

In preparing this report, two producers spent several hours with me and were completely open about their pesticide-free production techniques and about their markets. In respect of their efforts, no further information about pesticide-free production will be reported here.

There is no intent to criticise the success of those practicing pesticide-free production and marketing. However, one wholesale produce manager (when asked about interest in pesticide-free production) expressed one concern about pesticide-free production. He was of the opinion that offering customers organic, pesticide-free and conventional vegetables might simply confuse consumers. This produce manager was also the one who, given the choice between organic and local, would take good local produce over organic produce for reasons that will be discussed later in this section.

Again, it is important to stress that those already in the pesticide-free business continue with their efforts and they should be congratulated for their initiatives, seek new markets and continue their obviously successful promotions and marketing strategies.

As one produce buyer said, they are “thrilled” with the greenhouse vegetables they get from pesticide-free production.

The efforts and success of these growers have a clear message for producers considering organic production. These producers have shown that disease, insect and mite pests can be controlled without synthetic pest-control products. However, producers not using pesticides do use some products between crops (for general disinfestation and sanitation) that may not be accepted according to organic standards.
Local: Trends and market opportunities

Managers in mainstream retail stores and “natural food” store managers were interviewed, as were produce managers for mainstream wholesalers. However, a well-designed survey of these industry staff was not conducted. Therefore, comments that follow may or may not represent the opinions of the wholesale-retail grocery industry.

Local local local

There are obvious reasons why “local” is popular:

- Obviously, local is grown by Albertans and that may make some people feel good about supporting local business
- Local vegetables are considered to be fresher
- Local vegetables have lower “food miles” than produce from elsewhere.

The trend for consumers to be concerned about “food miles” may be overstated according to one produce manager for one mainstream retail chain. His response to a query about “food miles” basically was, “I don’t care about food miles and what it means. What we want are more local vegetables.” He is of the opinion that consumers believe:

- Local crops are not sprayed as much
- Local crops are fresher
- Greenhouse crops (in general) are not sprayed with big machines, and
- Generally, local greenhouse vegetables are more “pure” than crops from (say) the USA or Mexico.

There is no way to tell if his opinion represents consumer thinking. But given the choice of organic or local, this produce manager said that he would much prefer local.

The issue of “food miles” is on the minds of many for a variety of “food freshness” and “environmental” reasons. The reasons for wanting local presumably vary with individuals, but it seems that the concept of local covers the needs of a lot of customers. There is a current wave of interest in local and this is a boon to Alberta’s greenhouse industry.

In January, 2007 a new 23-acre greenhouse complex started shipping tomatoes in Madison, Maine in the USA. A spokesperson for the company said:
There’s year-round demand for anything that’s locally grown. Common sense tells you that if it’s picked today and in the store tomorrow, it’s going to be a fresher, juicier, better-tasting tomato.


(As a side note, this company has affected shipments from Quebec into the northeast USA.)

André Carrier has been cited several times in this report. He is Quebec’s greenhouse specialist and offered many insights about production of organic greenhouse vegetables. The above comment from Maine was sent to him and he wrote back:

You're right about local produce! We have to focus on that; the momentum is there!...and it [does not] have to be organic. It's the same story about [the] greenhouse vegetable industry in England. The last years were very bad for the growers but now, there is light at the end of the tunnel with this trend to local product. But this local product has to be fresh, tasting good and convenient …

The whole concept of local bears serious consideration. The most obvious market for Alberta greenhouse producers are the 3 million Albertans who live here.

So we are pointing to the obvious: Alberta's greenhouse producers already sell local.

The big question is, do consumers really know they are buying local?

Local is a niche product that no one else can sell
Niche products were discussed earlier in this section. But there is something unique about local vegetables. Producers everywhere can supply niche cocktail tomatoes, niche grape tomatoes, niche organics or niche mini cucumbers, but when niche products become readily available then they are no longer niche.

The one niche product no one can ever take away from Alberta’s producers is local produce. Producers from outside can never make that claim. And further, local produce will always be niche, that is, always distinct from imported produce—provided consumers know.

Producers from elsewhere can never compete with Alberta producers for the niche market that we call local.

Barriers to selling local
There are no real barriers to selling local, however some questions arise.

- Do consumers really know they are buying local Alberta greenhouse vegetables when they shop in mainstream stores?
- Do consumers who buy (for example) Pik-N-Pak cucumbers or Red Hat TOVs really know where they are grown?
Without asking consumers, we can’t answer these questions, but I am of the opinion that the majority of consumers don’t know when they are buying local greenhouse vegetables.

**Overcoming “local” barriers**
If Alberta’s greenhouse industry and AAF are truly keen on expanding volumes or value of greenhouse vegetables it might be worthwhile to conduct a consumer survey. There are many things that could be investigated in a consumer survey. See last section, *Recommendations*, for more details.

**“Local” strategies**
If *local* is perceived to be such a positive attribute, then the obvious plan should be to address all issues surrounding a marketing campaign to tell Alberta’s consumers about locally grown greenhouse vegetables.

- Conduct a survey of consumers to get feedback on many aspects of local greenhouse vegetables—and other niche products.
- Ask retail store produce managers and wholesale buyers what they think.
- If local is in fact a “big deal” then devise a campaign to tell consumers when they are buying local. (Naturally this can be linked to telling them about the nutritional advantages of fresh, locally grown greenhouse vegetables.)
- A local campaign must be well designed and in cooperation with wholesalers and retailers.
- A marketing specialist may be retained to work with the industry to devise promotional campaigns. However, one possible way to let Alberta consumers know they are buying local, Alberta grown, greenhouse vegetables is to include a small (say) half-page flier, flag or banner with each flat of TOVs, beefsteak or other greenhouse vegetables shipped within Alberta. I am of the opinion that something other than the miniscule sticky “4664” label is needed to tell consumers they are buying local.

A personal side note about marketing *local* and other trendy concepts.

*Last September, I was in a mainstream grocery store in a smaller centre. They had a 2-metre-wide banner proclaiming, “We are proud to buy local produce.” The banner was over the banana display. To me, such a message is “empty” marketing hype.*

*All major companies also want to be seen as being green and eco friendly, but they also need to be more “honest” in these matters. Maybe I am just a cynic, but I find the current trend in “being seen to be green” is largely shallow.*

*I totally support the concept and opportunities for *local*, but it needs to be done right. Sell *local* for legitimate reasons.*
Recommendations for discussion
These recommendations are general concepts that arise from this and other sections in the study.

Consumer survey
AAF and Alberta’s greenhouse industry should consider a consumer survey to evaluate consumer opinions about locally grown, fresh greenhouse vegetables. The survey could cover many areas. Such surveys can be expensive, but costs could possibly be shared with other producer groups in Alberta.

Topics covered might include:
• Consumer general perceptions about
  o Local
  o Freshness
  o Nutritional value
  o Food safety

• Why consumers buy local, or non local, produce

• Consumer perceptions and preferences about
  o Organics
  o Pesticide-free production

• Consumer “ratings” or “ranking” of the importance of
  o Organic
  o Local
  o Fresh
  o Flavour
  o Appearance
  o Nutrition
  o Packaging
  o Other

• Consumer perceptions and preferences about
  o Pricing, price differences and price tolerances between organic and conventional vegetables
  o Packaging and portion sizes
  o Need for pre-cut vegetables

This is merely a skeleton draft of what a survey might address. A committee of marketing and production experts, producers and survey specialists could design a suitable “survey device” that will provide meaningful information on which to base marketing strategies and research and development strategies.
A detailed survey should provide direction to AAF and Alberta’s greenhouse industry on where to spend R&D money and on how to direct marketing efforts.

Where does organics fit?

The lack of organic research information has been mentioned several times in this report. An assessment of the relative importance of the potential of organic greenhouse vegetable production versus other market opportunities is required. The question is:

Given a finite “R&D” budget, how could it be best spent for the benefit of greenhouse producers and to the satisfaction of consumers and taxpayers?

Before such a research priority assessment can be made, it is probably beneficial to gather more information in organic production first. An attempt was made in this report to describe the basics of organic production. However, it may be worthwhile to invite experiences producers, extension staff or organic consultants to tell producers about organic greenhouse production. (I am not sure how successful this might be.) As previously noted, someone like Rochelle Eisen, COABC’s organic extension agent, could present a workshop on getting into organic production from the ground up. Someone with her background can describe the process and pitfalls and answer questions about organics. There are probably other organic specialists who can provide the same service.

AAF’s organics business development specialist, Keri Sharpe, could also supply Alberta’s greenhouse industry with needed background information.

AAF needs to address its research priorities. Research findings elsewhere are not necessarily transferable. AAF staff and the greenhouse industry will have to decide if current research (supporting a large existing greenhouse industry) is more important than possible research for an industry that does not even exist. Market-trend and consumer-preferences analysis would indicate the potential for organic production in the foreseeable future, thus allowing research managers to prioritize organic research.
Promoting local

This report has stressed the importance of promoting local in the Alberta marketplace.

No criticism of existing promotional efforts is intended or implied, but experience dictates that point-of-purchase advertising of Alberta-grown greenhouse vegetables might be lacking. (For the record, I am the main grocery shopper in our household and I pay attention to the fruit and vegetables I buy.)

However, AAF and Alberta’s greenhouse industry is encouraged not to disregard this as being a “done deal” and assume “We are already doing local.” It is probable that Alberta’s greenhouse industry would benefit from increasing the promotion of the concept of local. Like André Carrier said, “The time is right.”

Alberta’s producers are already supplying high-quality products like TOVs, other specialty tomatoes, long English cucumbers and an assortment of peppers. New types of speciality tomatoes, heirloom or unusual varieties and mini cucumbers offer an expanded product line. Naturally, this push can be enhanced if it is done on conjunction with the concepts of freshness, health and nutrition. And finally, new concepts in packaging and portion sizing can help differentiate Alberta’s greenhouse vegetables.

All of the new “products” fit perfectly with growing and promoting local.

The mainstream wholesale-retail industry seems to be most interested in selling local to their customers. Exploring promotional opportunities with the wholesale-retail industry would be worthwhile. Some options might include:

- Consumer education
- POP promotions such as price signage
- A “local” counter displaying Alberta-grown TOVs, cucumbers and peppers for 8 months each year. If low-volume organic produce have dedicated counter space, it seems reasonable that high-volume local produce should be afforded the same or more space. Especially, if it can be established that local is a higher priority with the majority of consumers.

The time is right.
## Appendix

### List of acronyms used in this report

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Meaning and affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAF</td>
<td>Alberta Agriculture and Food (Alberta government department)</td>
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<tr>
<td>AAFC</td>
<td>Agriculture and Agri-Food Canada (federal government department)</td>
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<td>AOPA</td>
<td>Alberta Organic Producers Association</td>
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<td>BCMAFF</td>
<td>BC Ministry of Agriculture, Food and Fisheries</td>
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<td>CFIA</td>
<td>Canadian Food Inspection Agency (Canadian government agency)</td>
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<td>CGSB</td>
<td>Canadian General Standards Board, (Canadian government agency)</td>
</tr>
<tr>
<td>COABC</td>
<td>Certified Organic Associations of British Columbia</td>
</tr>
<tr>
<td>COG</td>
<td>Canadian Organic Growers</td>
</tr>
<tr>
<td>CPMA</td>
<td>Canadian Produce Marketing Association</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization, United nations</td>
</tr>
<tr>
<td>IPM</td>
<td>Integrated pest management</td>
</tr>
<tr>
<td>NOP</td>
<td>National Organic Program (United States organic agency)</td>
</tr>
<tr>
<td>OACC</td>
<td>Organic Agriculture Centre of Canada</td>
</tr>
<tr>
<td>OCIA</td>
<td>Organic Crop Improvement Association International, Inc.</td>
</tr>
<tr>
<td>OMAFRA</td>
<td>Ontario Ministry of Agriculture Food and Rural Affairs</td>
</tr>
<tr>
<td>OPAM</td>
<td>Organic Producers Association of Manitoba</td>
</tr>
<tr>
<td>OTA</td>
<td>Organic Trade Association</td>
</tr>
<tr>
<td>TOV or TOVs</td>
<td>Tomatoes on the vine.</td>
</tr>
<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
</tr>
</tbody>
</table>
References

The Internet is a valuable source of information on greenhouse production. Generally, information on the Internet is more up-to-date than printed materials from libraries and other sources of printed documents.

It is imperative that a prospective organic producer have access to a computer and the Internet either at home or local library.

Any of the links below that end in “pdf” are available as “free-standing” booklets and can be saved and printed.

Internet resources seem to be constantly changing. Links may become obsolete.

This is not a complete list. Other agencies, organizations and companies may be available as resources.

CANADIAN STANDARDS AND REGULATIONS

Organic Production Systems: General Principles and Management Standards

Organic Production Systems: Permitted Substances Lists

CERTIFYING BODIES

AAF general list
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/bdv8046

Alberta Organic Producers Association (AOPA)
http://www.albertaorganicproducers.org/

Organic Producers Association of Manitoba Co-operative Inc. (OPAM)
http://www.opam.mb.ca/

Organic Crop Improvement Association
http://www.ocia.org/

OCPP/Pro-Cert Canada Inc. (OC/PRO Canada)
http://www.ocpro.ca/
Value-added opportunities for greenhouse vegetables
EUROPEAN STANDARDS

Link to approximately sixty European organic standards
http://organicrules.org/completestandard.php

More kinks to international organic standards
http://www.ioia.net/standards.html

GENERAL ORGANIC RESOURCES
AAF Organic Agriculture: Getting Started
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex10031

Organic Agriculture Centre of Canada (OACC)
http://www.organicagcentre.ca/index_e.asp

Canadian Organic Growers Inc.
http://www.cog.ca/index.htm

OMAFRA introduction to organic farming
http://www.omafra.gov.on.ca/english/crops/facts/06-103.htm

ORGANIC GREENHOUSE PRODUCTION

Integrated pest management in greenhouses

Organic greenhouse vegetable production

Organic greenhouse tomato production

General organic vegetable production links
http://www.certifiedorganic.bc.ca/rcbtoa/training/vegetable.htm

Growing organic vegetables general links
http://www.certifiedorganic.bc.ca/rcbtoa/training/vegetable.htm

Crop Profile for Greenhouse Tomatoes in Canada (Cultural and alternative pest controls)
http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181758399927
Crop Profile for Greenhouse Cucumbers in Canada (Cultural and alternative pest controls)

Crop Profile for Greenhouse Pepper in Canada. (Cultural and alternative pest controls)

Crop Profile for Greenhouse Lettuce in Canada. (Cultural and alternative pest controls)

Alternate soil amendments
http://attra.org/attra-pub/PDF/altsoil.pdf

BC Agricultural Composting Handbook
http://www.agf.gov.bc.ca/resmgmt/publist/300series/382500-0.pdf

Characteristics of on-farm composting materials

CONVENTIONAL GREENHOUSE PRODUCTION

Starting a Commercial Greenhouse Business in Alberta
http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/opp11207

Commercial Greenhouse Vegetable Production
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1443

Commercial Greenhouse Tomato Production: Introduction
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7556

Commercial Greenhouse Tomato Production: Tomato Plant Propagation
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7957

Commercial Greenhouse Tomato Production: Pest and Disease Management
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7963

Guide to Commercial Greenhouse Sweet Bell Pepper Production in Alberta
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp2873

Pests of Greenhouse Sweet Peppers and their Biological Control
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4527

Diseases of sweet peppers
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4528
Links to many of AAF’s commercial greenhouse webpages are listed here: http://www.agric.gov.ab.ca/app21/infopage?cat1=Crops&cat2=Greenhouse

AAFC pest management crop profiles (general)
http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181157779290#P

Biological control in greenhouse tomatoes

Biological control in greenhouse cucumbers

Biological control in greenhouse peppers

Biological control in greenhouse lettuce
Acknowledgements

Many people were contacted and offered assistance in the preparation of this report.

Special thanks to:

Dr. Mohyuddin Mirza  John Judge  
Keri Sharpe  Dr. Tom Papadopoulos  
André Carrier  Rochelle Eisen  
Shalin Khosla  Ted Vantienhoven  
Kelly Devaere  Trevor Aleman  
Ron Prins  Jack Reams  

Thanks as well to many others who offered assistance, information and opinions.

Nabi Chaudhary  Lyle Aleman  Matt Reid  
Dr. Jim Calpas  Dick Bos  Joe Doef  
Mike Dolinski  Doug Peters  René Cardinal  
Danielel Brault  Bev Appleby  Anne Macey  
Margaret Savard  Hugh Martin  Victor Chrapko  
Tom Demma  Janet Liefso  Matthew Holmes  
Rosalie Cunningham  Rob Spencer  Dave Lepine  
Steve Diver  Tim Livingstone  Andrew Hammermeister  
Dr. Ted Short  Dr. Martine Dorais  Michael Dean  
Dr. Janice Elmhirst  Phil Dixon  

Many wholesale produce managers, “whole food” store owners and produce managers offered advice and opinions.

My apologies to anyone I missed.

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Oldman Communications, Ltd.  
Coaldale, Alberta  
January 2008