

FOOD, AGRICULTURAL & RESOURCE ECONOMICS

CANADIAN POLLINATION INITIATIVE

Beekeeping in Canada:

Honey and Pollination Outlook

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This report is intended to provide an overview of the Canadian beekeeping industry including the issues it will face in the future.

Beekeeping in Canada: Honey and Pollination Outlook

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Executive Summary

Canada is the world's twelfth-largest producer of honey with an estimated total production of approximately 34,000 tonnes per year. Average annual honey production has fluctuated around this quantity over the last four decades after a significant rise in production during the 1960s and 1970s. The Prairie Provinces produce, on average, about 80% of Canada's honey and contain about 70% of the total number of colonies. Honey prices reached an unprecedented level of around \$2.00 per pound in 2003 but have since dropped with prices oscillating around \$1.40.

Honey and beehive-related products account for less than 0.5% and 1 % of Canada's farm agricultural and livestock cash receipts, respectively, 0.12 % of consumer food expenditure, and 0.17 % of total agricultural export value. The other major product of beekeeping is pollination services and its estimated value of \$1.3 to \$1.7 billion is nearly 10 to 20 times that of honey.

Currently, there are about 7,000 beekeepers in Canada, with three quarters registered in the provinces of Ontario (31 %), British Columbia (26 %), and Saskatchewan (15 %). This current total represents less than half the number of beekeepers of 1980 and approximately 16% of the total number of beekeepers in 1945. Average honey production in Canada is about 60 kg per hive, which is more than twice the world average.

Of the farms that own honeybee colonies (honeybee farms), the largest 13% own 85% of all honeybee colonies, whereas amongst farms that own *non-Apis* bee colonies (*non-Apis* bee farms), 38% own 99% of *non-Apis* bee colonies. Half of honeybee farms are apiaries i.e., specialized for the most part in apicultural activities. In contrast, *non-Apis* farms that specialize in providing pollinations service account for about one quarter of *non-Apis* bee farms.

The average *Non-Apis* bee farms are bigger businesses, more capital-, labor- and land-intensive, more diversified, and are more likely to be involved as partnerships and corporations than the average honeybee farms. However, the larger commercial honeybee farms are usually bigger businesses than their *non-Apis* bee counterparts. Regionally, *non-Apis* bee farms tend to concentrate in the Prairies, whereas honeybee farms concentrate in Ontario and British

Columbia. *Non-Apis* bee farms are slightly more likely to be operated by multiple operators and younger male principal operators than honeybee farms.

Canada is a net exporter of honey and exports almost half of its honey production. In 2008, Canada exported \$70 million of honey with the USA and Germany being the primary export markets. Canada also imports \$15 million of honey, mostly from three major partners: Australia, the USA, and New Zealand.

Disease is a major issue facing the bee sector. In Canada, the normal long-term overwintering mortality rate is 15%; however, this rate has doubled in recent years. In the winter of 2008-2009, about 35% of Canada's pre-winter stocks were lost with Alberta being the hardest hit by overwintering deaths. While Colony Collapse Disorder (CCD) is reported to have caused a 40 % loss of colonies in the USA, it has not been diagnosed by professional apiarists in Canada.

The Latest Buzz about Colony Collapse Disorder:

Science, Feb 2008

What's Killing The Honeybees?

CBS Evening News, Mar 2008

Plan Bee: As Honeybees Die Out, Will Other Species Take Their Place?

Scientific American, March 2009

Nature's Pollinators: Colonies in Crises

The Ontarion, Oct 2009

Finally, a Suspect in Bee Decline

Toronto Star, Jan 2010

To Bee or Not to Bee

CBC Documentaries, Aug 2010

Buzz Kill

Canadian Business, Sep 2010

1. Introduction

The continuous loss of honeybee *Apis Mellifera* colonies in Canada has increasingly become a major issue in the eyes of the public. Academic papers, news columns, magazine articles, Cable TV programs, and even internet blogs that touched on this issue have considerably sprouted in the last couple of years. With creative and eye catching titles, most of these media outlets warned that the demise of the honeybees will have substantial ramifications on food security and human wellbeing. The stakes are high: one third of food resources and the reproduction of a wide array of wild plants all depends on honeybee pollination. The livelihood of many beekeepers, who make living from selling honey and other hive products and renting hives to pollinate a variety of crops, is in jeopardy if these losses continue.

The recent spate of media coverage of the honeybee has raised the public awareness of the importance of pollination by the honeybee and other pollinators, such as the bumblebee and the alfalfa leafcutter bee. It has also motivated a growing body of research, often interdisciplinary in nature, that studies bees and pollination. For example, there have been many studies of the underlying biology, and many theories put forward as to the causes of CCD, such as the unprecedented harsh winters in recent years, increased mite and pest infestation and the use of insecticides in agriculture.

However, in spite of this heightened public buzz about the honeybee's potential calamity and a growing shift towards non-*Apis* bees, farms that keep and manage these bees are rarely studied, and the economic value of their agricultural outputs is vaguely understood. For example, the Canadian beekeeping industry is still considered by many to be one of the few remaining bastions of the small, hobby farm and the home of a single managed bee specie- the honeybee. In fact, there is a non-trivial number of both large commercial honeybee farms and an abundance of non-*Apis* farms. Further, beekeeping has been usually considered to be an industry with little economic impact. Truth be told, honey and beehive-related products account for less than 0.5% and 1 % of Canada's farm agricultural and livestock cash receipts (CANSIM). While the economic value of honey and bee-hive related products is relatively small compared to the rest of the agricultural sector and the Canadian economy as a whole, the value of other services from beekeeping, such as pollination, is becoming better understood and appreciated.

With all the above in mind, the main purpose of this report is to provide an overview of the Canadian beekeeping industry, including the issues it is currently facing. Though much of the information in this report is pulled from existing provincial data sources that draw an overall picture of and trends in the Canadian beekeeping sector, it contributes the first farm-level

analysis of the entire population of farms that manage honey- and/or non-Apis bees in Canada. The importance of this analysis is that it provides researchers with a better understanding of the underpinning structure of the beekeeping industry by focusing on the farm rather than the province as a building block of the industry. This report also attempts to provide the context to facilitate future research in the field. In particular, it is hoped that this report will prove useful to those conducting economically focused research of the Canadian beekeeping industry. In addition to providing would-be researchers with the necessary background to start their research, including the technical aspects of honey and pollination, this report should point to areas where more detailed research may be needed.

The report begins with a description of the bee farms of Canada, providing a fresh look at their types and a closer examination of their most important features. Farms are defined and typified based on what bee species they manage, for what purpose, and at what size. The economic, demographic, and regional characteristics for each type are also reported and compared amongst farm types. This is followed by a section discussing the status quo, major trends, and relevant institutions of the Canadian honey sector. Most importantly, it depicts how honey supply and price, number of colonies and beekeepers, and trade have changed over the past years. Then, the report provides a general description of the role of pollination services provided by the honeybee and non-Apis in agriculture with a focus on the Canadian experience. Due to the lack of data on this subject, this section draws mostly on qualitative, conjectural, and anecdotal information. Finally, the report concludes by explaining the threats the Canadian beekeeping industry is currently facing, namely colony losses due to overwintering mortality or bee diseases.

2. Bee Farms and Beekeepers

Due to the growing role of pollination provided by *non-Apis* bee colonies in Canada, it is very important to study the farms that manage colonies to gain a better understanding of the structure of the Canadian beekeeping industry. The new concept of bee farm adopted in this report effectively encompasses all farms that manage either honeybee colonies, *non-Apis* bee colonies, or both.

To start, there is a description of the trends in the number and nature of beekeepers in Canada. In what follows, major types of the bee farm are defined, analyzed, and compared with each other on the basis of several economic, demographic, and regional characteristics:

2.1 Beekeeper Numbers and Trends

While honey production and colony inventories have been generally increasing, the number of beekeepers has declined substantially (see Figure 1). Almost half of the total number of beekeepers disappeared between 1993 and 2009. The number of beekeepers has fallen in all regions, but the relative number of exits was greatest in Quebec, the Maritime & PEI, Ontario and British Columbia. During the last 17 years, 72% of Quebec's, 63% of the Maritime's & PEI's, and half of Ontario's and BC's beekeepers exited the industry, representing almost 80% of the 6,421 beekeepers who left the industry during the period (see Table 1). Currently, there are about 6,700 beekeepers in Canada and approximately three-quarters of this total are registered in Ontario (32%), British Colombia (27%), and Saskatchewan (14%).

With only 16% as many beekeepers in 2009 as there were in 1945 and colony numbers approximately the same, the average size of the beekeeping operation has increased significantly. In the last 15 years, the number of colonies per beekeeper at the national level has more than

doubled from 38 colonies to 86. However, there are significant regional differences in average farm size. The average beekeeping operation is largest in Alberta with 384 colonies per beekeeper, followed by Manitoba and Quebec with 149 and 140 colonies per beekeeper, respectively (see Table 2). The rate of increase in farm size has been greatest for the Maritimes & PEI and Quebec where the number of colonies per beekeeper has almost quadrupled. The rate of increase was lowest in Manitoba at 41%.

Although the total number of beekeepers in Canada has declined over the years, the number of beekeepers who generate at least half of their operation's income from honey has increased. According to the 2001 and 2006 Census of Agriculture, the number of apicultural operators (commercial beekeepers) increased 34%, from 1,626 in 2001 to 2,170 in 2006. The share of apicultural operators in the total number of beekeepers has also increased from 18% to 28% in five years. Assuming that the recent structural shifts in the sector continued, the beekeeping industry will have completely shifted from being dominated by part-time, hobby operations to one in which the largest share of operators are full-time, commercial beekeepers in about 15 years (see Table 3).

2.2 Farm Types

Any farm that owns bee inventories i.e., honeybee and/or *non-Apis* bee colonies will be referred to as a “bee farm”. A bee farm is classified as a “honeybee farm” if it owns honeybee colonies or as a “*non-Apis* bee farm” if it owns *non-Apis* bee colonies such as alfalfa leafcutter, bumble, or blue orchard bees.¹ Further, a honeybee farm or a *non-Apis* bee farm that generates at least

¹ These two types of farms are not mutually exclusive as some farms may own both types of bee colonies. These farms, as will be explained later, account for very small shares of both farms and colonies. Thus, and to simplify the analysis, they will not be analyzed separately rather; they will be grouped with the honeybee and *non-Apis* bee farms when each type is analyzed.

50% of its gross sales from apiculture activities or rendering pollination service will be called either an “apiary” or a “pollination farm”, respectively.

In 2006, there were 3,797 bee farms, representing 1.6% of all farms in Canada (see Figure 2).

About 79% and 17% of these farms were honeybee farms and *non-Apis* bee farms, respectively.

The remaining 5% farms had colonies of both honeybees and *non-Apis* bees. Apiaries accounted for 47% of all honeybee farms whereas pollination farms accounted for only 23% of *non-Apis* bee farms. The remaining farms, as will be explained later, specialize in the production of other agricultural commodities, particularly those which depend on insect pollination for commercial yields. Examples of the latter case are canola, blueberry, apple, greenhouse tomato and other fruit and vegetable farms.

2.3 Farm Sizes

Bee farms are classified into four size categories based on colony inventories. Size categories for both honeybee farms are a) 1-24, b) 25-299, c) 300-999, and d) at least 1000 honeybee colonies. As for *non-Apis* bee farms, the size categories are a) 1-24, b) 25-99, c) 100-299, and d) at least 300 *non-Apis* colonies. The operators of the smallest bee farms are usually hobbyists who keep bee colonies mainly for leisure, production of domestic honey, and provision of unremunerated pollination to plants on the household’s farm and adjacent properties. However, some hobbyists may also be full-time farmers of other agricultural commodities. This is more so for the operators of *non-Apis* bee farms. The operators of the second smallest bee farms, commonly called sideliners or part-time beekeepers, manage either honeybee mostly for domestic and/or local honey production and possibly remunerated pollination or *non-Apis* bee colonies mainly to render pollination to their own crops or someone else’s in exchange for pollination fees. The largest bee farms are usually considered commercial operations, the

operators of which are full time, possibly migratory beekeepers who rely for their income on producing honey in commercial quantities, in the case of honeybee farms, and on rendering remunerated pollination service to both local and non-local farmers, in the case of both honeybee and *non-Apis* bee farms.

Most honeybee farms are small hobby or sideline farms, whereas the majority of honeybee colonies belong to large commercial farms (see Table 4). For example, the smallest 60% of honeybee farms own only about 2.3% of honeybee colonies, whereas the largest 13% of honey farms own around 83%. Specializing in apicultural activities causes the distribution of colonies to skew more towards larger farm sizes. The number of apiaries with 25-299 colonies is 50% higher than that of honeybee farms. Also, the share of commercial farms is twice as large.

The structure of the *non-Apis* bee farms is somewhat different from that of honeybee farms (see Table 4). Approximately half of *non-Apis* bee farms are commercial farms and own 98% of *non-Apis* bee colonies. Like apiaries, specialization also skews the distribution of *non-Apis* bee farms towards larger farms. Large commercial pollination apiaries account for nearly 57% and 99% of *non-Apis* bee farms and colonies, respectively. This pattern of farm and colony distribution is indicative of scale economies in the bee farm sector. These economies are comparatively higher for the *non-Apis* bee farm than for the honey farm.

The distribution by size of bee farms that own both honeybee and *non-Apis* bee colonies and of their respective bee colonies is listed in Table 5. The majority of this type of farm consists of small hobby farms. About 60% own simultaneously less than 25 honeybee and less than 25 *non-Apis* bee colonies. Additional 20% own less than 25 *non-Apis* bee colonies but between 25-299 honeybee colonies. Around 3% of farms are commercial honey farms with a small number of

non-Apis colonies. A similar percentage also represents commercial pollination farms with a small number of honeybee colonies.

2.4 Economic, Farm, and Operator Characteristics

2.4.1 Honey vs. *Non-Apis* Bee Farms

In general, honeybee farms are single-operator farms, sole proprietorships, small businesses with low to moderate capital investment and small acreage. They are not only specialized in apicultural activities but also in crop production. Regionally, they locate mostly in Ontario, British Columbia and Alberta. The principal operator is usually a full-time, male farmer close to retirement age.

Like their honeybee counterparts, *non-Apis* bee farms are usually small businesses operated by a full-time, middle-aged, male operator. However, they are more likely to be involved as partnerships or corporations with moderate to high capital investment and a larger land base. Furthermore, they are mostly specialized in grain, oilseed, fruit and vegetable production. At provincial level, they are found mainly in the Prairies.

Figures 3-9 illustrate the distribution of bee farm types by several economic, farm and operator characteristics. About 60% of honeybee farms are sole proprietorships operated by a single operator. Nearly 80% make \$50,000 or less in gross sales per annum, and about half invest \$200,000 or less in capital. As for farm acreage, about three quarters of honeybee farms have 50 or less acres, and 43 % actually have no land at all. Most likely, the latter farms are specialized in apicultural activities. Indeed, about 47% of honey farms are apiaries, whereas the remaining farms are mostly oilseed, grain, fruit and vegetable farms. About 31% of honey farms are in Ontario , and a similar percentage is found in both British Columbia and Alberta. Finally, the

vast majority of principal operators of honey farms are males, nearly three quarters of them are between 35-64 years of age, and a little more than half are full-time farmers.

As for *non-Apis* bee farms, almost half of them are partnerships, corporations, or other form of organization. Around 60% and 70% generate \$50,000 or less in annual gross sales of farm products and invest at least \$200,000 in capital, respectively. In contrast to honeybee farms, about 80% of *non-Apis* bee farms have at least 50 acres in land, almost half of which have more than 500 acres. The land-intensive nature of the *non-Apis* bee farm is indicative of the important role of bee colonies as an input for the production of other commodities on a large arable acreage. In fact, nearly 80% of *non-Apis* bee farms specialize in other commodities that depend on bee pollination for final product such as fruits and vegetables or intermediary products such as seeds or forage for livestock production (e.g. canola and alfalfa). Given this specialization pattern, it comes as no surprise that the majority of *non-Apis* bee farms are in the Prairies (56%), British Columbia (14%), and Quebec (12%) where the aforementioned crops are mainly produced.

Gross sales of both honey and pollination farms increase with farm size. The share of farms that make less than \$10,000 in farms gross sales is highest for small farms, accounting for about half of them. Furthermore, the share of farms that makes at least \$300,000 increases between the smallest and the largest farms from 8% to 58% and from 16% to 35% for honeybee and *non-Apis* bee farms, respectively (Figure 10).

Capital investment and labor requirement also increase with farm size in both farm types. Large commercial farms require considerably higher capital investment and more labor than smaller farms (Figures 11, 12, and 13). The shares of large commercial honey and pollination farms with at least \$500,000 in capital investment are nearly two and three times those of hobby

honeybee and *non-Apis* bee farms, respectively. Nearly 80% and 68% of large commercial honeybee and *non-Apis* bee farms' operators are full-time farmers compared to about 48% and 58% of honeybee and *non-Apis* bee hobbyists, respectively. Furthermore, the share of farms with multiple operators increases with farm size for both farm types.²

Degree of specialization in bee-related activities generally increases with farms size, but to a lesser degree for *non-Apis* bee farms than honeybee farms (Figure 14). The shares of apiaries and pollination farms are highest for the large commercial honeybee and *non-Apis* bee farms- 99% and 32%, respectively. Nonetheless, unlike large commercial honeybee farms, large commercial *non-Apis* bee farms remain highly diverse in terms of their primary commodity. In fact, the share of livestock farms is the highest among large commercial *non-Apis* bee farms and is around 30%.

Change in land base with farm size is different between honey and the *non-Apis* bee farms.

While farm acreage decreases for the former, it considerably increases for the latter (Figure 15). Hobby farms for both types, for instance, have similar land base decomposition with one third of them having zero acreage. However, as farm size increase, as measured by colony numbers, honeybee farms become less land-intensive while *non-Apis* bee farm become noticeably more land-intensive. In fact, almost 60% of large commercial honeybee farms have no land. In contrast, about three quarters of large commercial *non-Apis* bee farms have at least 500 acres of land.

Geographical distribution for both bee farm types also changes with size (Figure 16). Hobby honeybee farms are more likely to be located in Ontario (37%) and British Columbia (27%).

² An average apiary farm with 500 honeybee colonies requires 535 work days per year divided almost equally into three categories: (1) hive production, (2) hive management, and (3) administration and marketing (BC, 1999). The demand for labour generally peaks in late spring and late summer-early fall when honey and wax are extracted and farm gate selling takes place.

However, larger farms seem to be located in the Prairies. Manitoba alone has one quarter of the small commercial honey bees, whereas Alberta alone has nearly half of the largest commercial honey farms (Figure 15). On the other hand, hobby *non-Apis* bee farms are usually located in British Columbia (31%), Quebec (23%) and Ontario (18%). However, larger *non-Apis* bee farms belong almost entirely to the Prairies with Saskatchewan accounting for 54%, Manitoba for 26% and Alberta for 18% of the farms in this size category. Proximity to canola, clover, and alfalfa fields in the Prairies helps both bee farm types to benefit from existing scale economies and become larger.

Finally, the organization type and age of principal operator also change with farm size but in a similar fashion for both bee farm types. Sole proprietorship seems to lose ground to partnerships and corporations as farm size increases. Larger bee farms are more likely to be operated by younger principal operators than smaller farms.

2.4.2 Apiaries

Apiaries account for 47% of honeybee farms. Specializing in apicultural activities does not have a big impact on the overall structure of the honeybee farm. Except for land base, most of their economic, farm, and operator characteristics are similar or have minor differences to those of the honeybee farms. About 43% of honeybee farms have no acreage as opposed to 76% of apiaries. This indicates, as expected, that specializing in honey production requires little to no land.

Apiaries are slightly bigger businesses, less capital-intensive, and slightly less geographically concentrated than the honeybee farms (see Figures 3-7 and 9).

2.4.3 Pollination Farms

Pollination farms account for 23% of non-*Apis* farms. In general, they are slightly bigger businesses, less capital-and labor intensive, have less land tenure, and are more likely located in

Saskatchewan than the average *non-Apis* bee farm. Pollination farms seem to remain fairly diversified with rather large acreage that is most likely cultivated with pollination-dependent crops such as grains, oilseeds, and fruits. Nearly one quarter of pollination farms have at least 500 acres (see Figures 5-9 and 11).

3. Honey & Hive Products

3.1 Domestic Honey Supply

Once the fifth largest producer of honey, Canada is no longer in the top ten honey producers, producing annually about 34,000 tonnes of honey (FAOSTAT). Following a dramatic drop in production during the years after World War II, Canada's annual honey production has increased steadily, with the exception of declines in the early 1990s due to an infestation of *Varroa* mites (see Figure 1). Average annual honey production has fluctuated around an average of 34,000 tonnes in the last two decades, but there have been significant changes from year to year.

Canada's honey production dropped to 29,000 tonnes in both 2008 and 2009, which was its lowest level since 1996, and a 42% drop from the historic high production year in 2006. The marked volatility in annual production is due to factors such as weather, location, proximity to nectar resources, management, and the presence and severity of diseases and pests (mainly *Varroa* mites).

Until recently, the annual changes in honey production mirrored the changes in national colony inventories (see Figure 1). Colony inventories dropped noticeably after World War II as the demand for non sugar sweeteners declined following the end of sugar rationing and since bee wax for use in ammunition storage was no longer required. Inventories and production levels increased steadily from a low of around 310,000 colonies up to a peak of approximately 700,000

colonies in the mid 1980s. During the 1990s, inventories dropped to 500,000 colonies as a result of increased mortality rates associated with the spread of *Varroa* mites into Canada in 1989. In the last decade, colony inventory levels have been steadily increasing with the annual change in a given year depending on weather and bee conditions. The Prairie Provinces produce, on average, about 85% of Canada's honey and contain about 70% of the total number of colonies. Alberta, as the largest honey producing province, accounts for nearly 40% of total colony inventories and approximately one third of Canada's honey production. Alberta's share in total inventories has increased over the last 15 years while those of other major honey producing provinces have either remained constant or declined (see Table 6). The long and warm summer days that are characteristic of the Prairies provide favorable conditions for the management of honey bees. Furthermore, access to vast areas of clover and canola provides suitable foraging environments for bees and results in a mild white honey that is internationally renowned for its high quality (Alberta 2001).

Given that the steady increases in honey production have been greater than the average increases in the number of bee colonies, it follows that the average productivity per colony has improved over time. During the last four decades, the average yield per colony was 56 kg of honey per colony, which is approximately a 52% increase over the average yield prior to 1970. Honey yield per colony, however, fluctuates annually due to weather, disease and pests. For example, average yields reached a high of 77 kg per colony in 2006 but was at its lowest level in 25 years at 51 kg per colony in 2009. Saskatchewan has the highest yield per colony at 91 kg of honey per colony followed by Manitoba (79 kg per colony) and Alberta (49 kg per colony) (see Table 7).

3.2 Honey Prices

There are several traits that affect the price of honey. However, the grade, colour, floral source, and processing and packing attributes are most responsible for determining the premium price of honey (Hoff 1995). Higher premiums are usually paid for higher grade, lighter coloured, and specific varieties of honey such as berries, canola or sweet clover. Bulk honey sold to wholesale markets is sold at a lower price than retailed honey. Other secondary factors affecting the price of honey include the geographic location, season, and the destination of the honey (domestic vs. export).

The nominal price of honey, on average, remained around 20 cents per pound for much of the previous century, until the early 1970s when the price doubled. Since then, the average honey price has tracked sugar prices; except for a slight drop in the mid 1980s, it has continued to trend upward. While the average price for honey is now around \$1 per pound, there is a great deal of variability in it. For example, honey prices reached unprecedented levels of about \$2 per pound in 2003, but fell to around \$0.75 per pound two years later, possibly due to increased imports of cheaper honey from China (see Figure 17).

The upward trend in honey prices during the last three decades can be partially attributed to the development of several forms of retail markets. Honey producers developed their own brands and sold directly to consumers through road stands, farmer's markets, and local outlets.

Currently, honey producers are able to extract price premiums since consumers are more willing to pay for locally produced and specialty honeys, such as organic honey. The retail price of honey is approximately double the wholesale price (BC 2007).

3.3 Marketing Channels for Honey

The honey market is well developed in Canada, with product marketed through a number of domestic and international channels to be used in food, medicinal, therapeutic, and other industrial uses. In general, marketing channels for honey include retailers, honey co-operative marketing associations, packers and dealers, bottlers, food manufacturers, consumers or the export markets (Alberta 2001). Selling honey directly to consumers is a common practice among beekeepers, particularly the hobbyists and part timers. Beekeepers sell their honey at the honey house, road side stands, or at farmer's markets. Producers who sell to retailers package and handle the honey product as required by each retailer. To market honey through co-ops, producers usually have to be members and must be able to deliver a specified quantity of the product (quota). Production beyond quota levels can be sold to the co-op at a reduced price or to different buyers. Bulk honey is usually sold in barrels to packers who then package honey products using their own label. In some cases, however, producers opt to develop their own label and market their honey directly to retailers in competition with packers.

The major marketing players in Canada are co-ops and packers. To help members market their honey, co-ops offer several services such as marketing expertise, free containers, and protective measures against non payment for honey, loss, or damage. However, marketing through co-ops may leave members with no leverage in negotiating price and payment schedule. Packers, on the other hand, allow producers to negotiate payment terms and guarantee quick payments.

However, they charge producers with freight cost of returning honey containers (Alberta 2001). Bee Maid Honey is Canada's most prominent honey marketer (Honey Locator 2007). This multi-co-op association has been marketing the entire volume of the Honey co-ops of Western Canada for more than five decades. In addition to its main function as a honey packer, Bee Maid also

provides other products such as beeswax and candles. Honey is not only sold in liquid form, but also as creamed (or whipped) and blended honey. Bee Maid products are usually distinguished by several brand names such as Altasweet, Bee Kist, Clover Crest, Prairie Queen, and Bee Maid honey.³

In addition to co-ops and packers, there are a few honey producers in Canada who supply honey in bulk quantities to both domestic and international markets in order to serve different sectors. Examples of this are TPLR Honey Farms LTD and Wendell Honey. In addition to selling honey mainly in its liquid form, they also deliver other products and services such as beeswax, pollination, and beekeeping supplies.

3.4 Honey Regulations

The honey grading system is only used for honey that is prepared in registered establishments and meets color classification, grading, packaging and labeling requirements. A registered establishment can be a producer, a packer, a pasteurizing, or a producer-grader establishment. Once registered, the establishment adheres with the grading rules for handling its honey (Honey Regulations 2010).

There are three grades of honey, namely “Canada No.1”, “Canada No.2” and “Canada No.3”. Honey classified under each of these grades differs in three aspects- appearance, flavour, and composition. In particular, Canada No. 1 has clear, bright, and uniform colour and its flavour is consistent with the colour classification. It has the lowest level of moisture and water insoluble solids and is free from visible crystals. The other two grades are characterized by darker, cloudier, and uneven colour. The flavour is allowed to be slightly off, but should not be

³ There are also many other honey packers and marketers that operate in the Canadian honey market such as Billy Bee, Golden Acres, and Wolf Honey Company Inc. to mention a few.

substantially impaired. Moisture and water insoluble solids levels are usually higher, but they do not exceed the permissible levels.

In broad terms, bulk honey is packed in containers of a size that ranges from 7 kg to 30 kg, the size for prepackaged honey ranges from 150g to 5 kg. Novelty containers of non-standard sizes require ministerial permission. High safety, sanitary, and labeling standards are mandated for all packages types to ensure safe use of honey and the proper presentation of its origin, class, and grade.

The label on honey containers should include the following information: (1) the floral source of the honey such as canola honey, sweet clover honey, etc; (2) the colour classification such as white, golden, amber, or dark; (3) the net weight; (4) the form of honey such as liquid, creamed, pasteurized, or pressed; (5) the name and address of the packer; and (6) the country origin such as Canada, USA, or a blend of Canadian and US honey.

3.5 Trade in Honey

Canada is a net exporter of honey. In 2008, Canada exported \$71 million and imported \$15 million worth of honey (Trade Data Online). In the last decade, the average value of the trade in honey, including both imports and exports, has typically ranged between \$40 and \$80 million. In years where the world price of honey increased due to drops in honey supplies, the average trade value of honey also increased. For example, in 2002, the total value of the Canadian honey trade, including both imports and exports, reached a high of \$115 million. Reasons for this irregular year included droughts, concerns over the safety of Chinese honey due to antibiotic residues, and anti-dumping action taken against China and Argentina.

However, the importance of honey in Canada's international trade in agricultural production is relatively small. Honey accounted for roughly 0.10 to 0.17 % of Canada's agricultural exports over the last five years (Trade Data Online). The share of honey imports in Canada's agricultural imports in general is negligible (Trade Data Online).

3.5. A. Honey Exports

On average, Canada exports almost half of its honey production. Following a general upward trend, the Canadian exports of honey have increased by fifteen folds over the last five decades, reaching an unprecedented high of 23,000 tonnes in 2008 (CANSIM). Nevertheless, exports oscillate over time due to the inherent variability in honey production and the honey market. The dramatic increase in Canadian honey exports has made it an important player in the world's export market for honey. In 2007, Canada was the eighth largest honey exporter in the world, accounting for 4% of world's honey exports by value (UN Comtrade Database).

Canada's major export partners for honey are the USA and Germany, with the first accounting for about 80% of Canada's honey exports (UN Comtrade Database). In 2007 and 2008, however, Australia and Japan emerged as growing markets for Canadian honey, overtaking Germany (UN Comtrade Database). Whether this market diversification is a long run marketing strategy or just an anomaly driven by short run market forces remains to be seen.

3.5. B. Honey Imports

Canada's honey imports remained negligible until the early 1990s, when due to the drastic drop in domestic production; imports reached a record high, even briefly exceeding honey exports in terms of quantity. Imports peaked in 1996 at approximately 13,000 tonnes, which was above exports levels for that year (CANSIM). However, following this peak imports crashed, largely

because the import in honey was being driven by a single company in Ontario which went bankrupt (USDA Foreign Agricultural Service, 2000). In the last two decades, Canadian honey imports have remained at higher levels than those of previous decades but have not been high enough to make Canada a major player in world honey imports. Notably, Canada is not one of the top ten of honey importers by value in the world (UN Comtrade). Imports in 2008 were at 3640 tonnes (CANSIM).

Canada's honey import market is less concentrated than its export market and more dynamic. Three countries, China, Argentina, and Australia, accounted for 85% of Canada's honey imports in 2004 (UN Comtrade Database). Over the last five years, the import market has become less concentrated and the relative importance of import partners has changed. In 2008, the largest three partners accounted for a reduced 73% of honey imports (UN Comtrade Database). These partners were Australia, the USA, and New Zealand. The switch in markets is mainly due to restrictions on Chinese and Argentinean honey for reasons mentioned earlier, such as dumping, antibiotics, pests, and residues.

3.6 Other Bee-Hive Products

3.6. A Beeswax

Beeswax is a substance produced by the worker bees and recovered primarily from honey and cull combs. It is usually sold in the raw form to manufacturers who then refine it before it is distributed for pharmaceutical, cosmetic, and other industrial uses. Beeswax is an important hive product. Beeswax and honey are both produced with a fairly constant relationship between their production- typically there is a beeswax to honey ratio of 1 to 60 (Personal communication). Of the beeswax traded internationally, 40% is used in cosmetics, 30% in pharmaceuticals and 30%

in candle making. The world price for beeswax fluctuates between \$4-10 USD per kilo (Bradbear, 2009).

3.6. B Pollen, Royal Jelly, Propolis, and Bee Venom

Pollen is another hive product and it is gathered by worker bees from available floral resources and used as a source of protein. Beekeepers harvest pollen using traps with a special filtering mechanism. Pollen can be fed back to the hive during periods of natural pollen deficiency or sold for human consumption or industrial use. Royal jelly, propolis, and bee venom are also important hive products and have important industrial value. They are used mostly for pharmaceutical, therapeutic, and medical purposes. In general, they require considerable additional effort and specialized equipment, and beekeepers producing these materials must often specialize.

3.6. C Live Bees

Live bees include queen bees and sometimes entire colonies of bees i.e., packaged bees and nucs (small colonies created from larger ones). Live bee purchases are important for northern producers, such as Canada, as producers in southern climates, such as Hawaii and California, are able to start honey bee production earlier due to favourable climates. Prices for queen bees vary, but approximately \$20-\$30 per queen is a typical price (Personal Communication). However, this price can reach over \$100 per queen depending on the method of producing the queen, with artificially inseminated queens being more expensive than naturally bred ones (Personal Communication). Traditional sources of queen bees for Canada are Hawaii, New Zealand, and Australia. In 2004, Canada imported 111,442 queen bees, with 101,710 from the United States, 9,518 from Australia and 214 from New Zealand. The number of queens imported had increased

from approximately 106,000 queen bees in 2002. The value of all US queen bees imported into Canada in 2004 was \$1.3 million USD (USDA Foreign Agricultural Service, 2005).

Due to concerns over the spread of diseases, particularly diseases which are not already present or widespread in Canada, the import of foreign bees is highly regulated by the Canadian Food Inspection Agency (CFIA). Canada buys bees only from pest- or disease-free regions such as Australia. Generally, if a disease is discovered in a bee producing region, it can be revoked of its right to export bees to Canada. Of particular concern are the packaged bees, which are worker bees that are sold by the kilogram, as opposed to the solitary queen bee. This is because it is much harder to adequately monitor packaged bees, and it is possible for sellers to unknowingly ship an order of package bees that has become infected with a pest or disease of some kind (Strange *et. al.*, 2008).

3.7 Honey Business Cycle

The annual business cycle for honey enterprise usually begins in the spring when hives are removed from winter bee yards where they were overwintered. In early spring, the hives are set out to forage on early blossoming flowers or fed with pollen or substitute to encourage early brood production. Later, they will be moved into areas of high-yielding bee forage to increase numbers and strength. In the summer, beekeepers spend most of their work hours managing and maintaining the bee hives. During late summer and early fall, the major honey crop is harvested. Once harvesting is completed, the hives are prepared for winter. During winter, beekeepers continue repairing and building the hives and marketing honey.

4. Pollination

4.1 Overview of Pollination Services

The estimated value of pollination services attributed to honeybees is estimated at \$1.3-\$1.7 billion annually, nearly 20 times that of honey (Canadian Honey Council). This value reflects the dollar value contribution of honeybee pollination in total dollar value of Canadian pollination-dependent agricultural production.⁴ The contribution of pollination by honeybees to Canadian agriculture can also be appreciated by looking at the number of honeybee colonies that are devoted every year to pollinate Canadian agricultural products. Every year, 300,000 honeybee colonies, almost half of Canada's total stock, pollinate canola oilseed fields, contributing to an annual canola crop of 12.6 million tonnes and making Canada the world's largest producer. Also, 80,000, 35,000, and 15,000 colonies are used to pollinate highly specialized hybrid canola seeds, blueberries, and apples, respectively.

While managed honeybees remain the major provider of commercial pollination in Canada, managed *non-Apis* bees are becoming increasingly important in Canadian agriculture as well. Alfalfa leafcutter bees, bumble bees, and blue orchard bees were initially domesticated and managed by Canadian oilseed, grain, sweet clover, forage legume, greenhouse tomato, and orchard producers to provide pollination to their crops. However, there is a growing number of producers who manage non-Apis bee colonies for commercial pollination.⁵ Although there is still a little known about the economic value of pollination provided by *non-Apis* bees, there has been a growing evidence of their effectiveness and efficiency as pollinators. For some crops,

4 The estimate is the product of the annual value of pollinated crop, the dependency of the crop on insect pollinators and the proportion of "effective" insect pollinators of the crop that are honey bees. This accuracy of this measure is highly debated in academic literature and claimed to overestimate the value of honeybee pollination and underestimate the value of pollination from other bee species (see Gallai *et al.* 2009; Allsopp *et al.* 2008; and Losey and Vaughan 2006).

5 More details on this issue will be given later (See section 4.3)

such as alfalfa, sunflower, clover, and legumes, it has been shown that *non-Apis* bees are more effective and efficient than honeybees (Fraser *et al.* 2004; Richards 1995; Shipp *et al.* 1994; and Richards and Edwards 1998).

The increasing importance of commercial pollination can be gleaned from the growing demand for pollination due to the fast growth of pollination-dependent crops such as fruits, vegetables, and canola seed and the change in consumers' preferences in favour of these commodities (see Table 8).⁶ In the period between 1991 and 2006, the acreage devoted for pollination-dependent crops grew 10 times faster than the acreage for all crops combined. Canola's acreage was the fastest growing among those which depend on pollination, followed by nursery and nut crops, and fruits. Vegetables were the only pollination-dependent crop that had a growth rate for total acreage slower than the average for all crops (see Table 9).

4.1. A The Honeybee

Honeybees are still the most commonly managed pollinating species. They possess several behaviour-specific characteristics that make them economically viable for the purpose of pollinating agricultural crops (Dupree *et al.* 1995). First, honeybees produce honey as well as other by-products of a high economic value. Second, they are easy to manage, transport, and culture in large numbers so they can be readily available for pollination. This is especially important for crops with short blossoming periods and experienced beekeepers can manipulate the number of colonies moved to crops during their bloom. Third, the entire bee colony overwinters, unlike other species of bees where only the queen does. Fourth, honeybees are generalist foragers that visit a broad spectrum of crop species. In fact, honeybees forage for

⁶ The introduction of commercial pollination has significantly improved agricultural productivity, product quality, and food's nutritional value (e.g. Gallai *et al.* 2009; Allsopp, De Lange, and Veldtman 2008). Quantity and quality of a few increasingly important agricultural products, such as fruits, vegetables and nuts, has also impressively improved (e.g. Nicodemo *et al.* 2009; Oz *et al.* 2009; Nerson 2009).

nectar and pollen from many thousands of plant species including economically important crops. Fifth, honeybees tend to specialize on a single crop until the end of its blossoming period. This makes them very effective pollinators. When a forager bee begins collecting nectar or pollen from the flowers of one species of plant, it will continue to visit flowers of *only that species* for at least one foraging trip and more commonly for several days, or until the flowers are no longer producing nectar or pollen.

Honeybee foragers normally specialize in collecting nectar, pollen, or both. Nectar foragers normally make up about 60% of total forager numbers. The remaining 40% of foragers is split between pollen foragers (25%) and nectar-pollen foragers (15%) (Winston 1987). This ratio of nectar to pollen foragers is geared towards honey production since nectar foragers are less effective than pollen foragers at collecting pollen and have little value to pollinated crops and for seed set for seed producers. In order to obtain a beehive that is more conducive for providing pollination services, beekeepers usually manipulate the bee population to achieve large numbers of pollen foragers and/or higher pollen to nectar ratio of foragers. By increasing the number of brood frames, beekeepers can stimulate the growth of the pollen foragers' population. Also, by altering the colony food stores, beekeepers can increase the pollen to nectar foragers' ratio. Removing and trapping pollen are two common practices to stimulate more bees to forage for pollen. Finally, by manipulating the queen's pheromones, beekeepers can stimulate foraging in colonies. The Queen Mandibular Pheromone, known to increase the number of pollen foragers, is usually synthesized, mixed with water, and sprayed on crops preceding peak bloom (Dupree et al. 1995).

Managed honeybees provide both incidental and paid pollination services. In the former, beekeepers exchange pollination for the right to access foraging areas owned by the growers.

Beekeepers who provide these unremunerated pollination services are most likely beekeepers who specialize in honey production, and are generally non-migratory with the possibility of traveling only to locate near nectar-rich crops (e.g. canola, sweet clover, and sunflower). In the case of paid pollination services, beekeepers provide these services in exchange for a per hive rental fee paid by the grower. These beekeepers specialize in providing pollination services and usually contract with the growers of nectar-poor crops (for example: blueberry and apple production make us of about 50 thousand colonies). In the contract, the beekeeper and grower responsibilities are outlined. In general, the contract should specify (1) timing of colonies' delivery and removal; (2) the pollinated crop and its location; (3) number and strength of colonies; (4) pattern of colony placement; (5) rental fee and other payment specifics; (6) rules of pesticide use; and (7) compensation to both parties for any additional unspecified tasks, damages, and violations (Dupree et al. 1995).

Finally, pollination-oriented practices cash flows are concentrated over short periods of time, normally from late winter till mid-summer, depending on the crops being pollinated and the location (BC 1999). Expenses usually spike in the early spring, while most revenues from pollination services occur during late spring and early summer.

4.1. B. The Alfalfa Leafcutting bee

As its name indicates, this solitary bee prefers alfalfa over competing bloom from nearby crops and weeds and, unlike the honeybees, is undeterred by the tripping phenomenon found in alfalfa flowers (Rainville 1996).⁷ Other advantages such as readiness to emerge after incubation, efficiency of pollen collection during nesting, and a preference for proximate foraging and

⁷ The tripping phenomenon occurs when the alfalfa flower trips and strikes pollinating bees on the head, which helps transfer the [pollen](#) to the foraging [bee](#). Honeybees usually avoid being struck by the flower. Hence, it can collect nectar without carrying pollens, failing in pollinating subsequent flowers.

above-ground nesting have made this bee relatively easy to manage, requiring only a moderate investment of labor and capital. Furthermore, there is growing evidence on its pollination effectiveness for many crop species (Fraser *et al.* 2004; Richards 2003; Richards and Edwards 1998; Richards 1995; and Shipp *et al.* 1994).

Alfalfa leafcutter bee colonies were first managed and used for pollinating alfalfa fields in the early 1960s in Saskatchewan. Using this bee to pollinate crops for seed is now a common practice across large parts of BC, Alberta, Saskatchewan, and Manitoba. Saskatchewan's alfalfa seed producers, for example, used 2.5 billion leafcutters, valued at about \$12.5 million, to pollinate 50,000 ha of alfalfa fields. Besides alfalfa, the alfalfa leafcutter bee pollinates hybrid canola for seed production, blueberry and many other forage legume crops like sainfoin, birds foot trefoil, and clovers. Blueberry fruit set, for example, increases by 24-95% when leafcutter bees are used (Rainville 1996). For good pollination, the bees are stocked at rates of 20 to 40 thousand bees per acre. Bee producers provide the bees and the nesting material to the crop grower in exchange for a pre-specified share of the ultimate crop value (commonly 25 %). Nesting materials range from wooden boards with drilled holes for nests to polystyrene, paper, and wood-laminated nesting boards, the basis of the loose cell system which has become the trademark for Canadian sales of excess production of leafcutter bees.

Managing alfalfa leafcutter bees is relatively straightforward, progressing through the year in three distinct stages. In the spring, bees should be placed for incubation when crop's blossom is at about 20%. This period is usually what is required for the bees to emerge, given certain incubation parameters such as temperature and humidity. Weather conditions also play an important role in delaying the introduction of the bees into the field. Cold and windy weather usually postpones the introduction time as well as irrigation of fields and application of

pesticides as many pests frequently appear just prior to bloom or when producers start to look at fields.

In the summer, the bees are placed in the field. Once the bees are in the field, bee producers arrange shelters in specific patterns across fields to maximize the effectiveness of the bees for pollination as well as to minimize bee losses. Some of the issues that bee producers consider when stocking their bee shelters in the field include avoiding exposure of nesting material to direct sunlight, positioning shelters across fields to obtain as even a seed set and pollination as possible and maintaining a sufficient number of nest materials to accommodate nesting bees.

4.1. C. The Bumble Bee

Unlike the honeybee colony, the bumble bee colony is annual. In the fall, a bumblebee colony dies out and only the young, mated queens hibernate separately in the soil. Queens emerge in the spring and forage for nectar and pollen to rear workers. When a sufficient number of workers is produced (50-400 workers per colony), the queen switches to producing the brood (young queens and males). During this stage, bumble bee workers forage for nectar and pollen and maintain the brood (Pollination Canada 2008).

Bumble bees are excellent pollinators in a greenhouse environment and in the field of forage legume crops as they produce more seeds per pod and forage at a faster rate than honey bees. They are more effective and efficient than honeybees due to their tolerance to foraging at lower temperatures and in cloudy weather. Bumble bees also supersede manual pollination since they are easy to manage. Finally, they are preferred to the use of hormones for greenhouse vegetables

since their pollination significantly increases the number of seeds per fruit and its quality.⁸ In addition to greenhouse production, bumblebees can effectively pollinate other crops such as forage legume crops (cicer milk vetch, sainfoin, red and white clover, birds foot trefoil, apple, cherries, berries, and zucchini and melons). They can also be used to improve yields from alfalfa, red clover, and sunflowers.

In Canada, bumblebees were first commercially used as a tomato pollinator in 1990. An increasingly large amount of fresh tomato production is produced in greenhouses where the bumblebee is used for pollination (Pollination Canada 2008). One widely used technology in bumblebee pollination is the *Biobest* hive. The standard hive contains about 70 workers and is active for 6-8 weeks. The hive can differ according to size (number of workers), coverage (only for greenhouse pollination), and estimated lifespan.

5. Issues facing the Beekeeping Industry

With increasing awareness of pollination's benefits to society comes an increased private and public interest in the wellbeing of the bees. Concerns about several existing risks that are facing the beekeeping industry and wild pollinators in general have led researchers across Canada to work together with government agencies, NGO's and industry to identify and understand the sources of these risks, the potential associated damages, and the economic ramifications on the industry. Examples of existing risks include spread of pests and diseases, urban sprawl, negative externalities from agriculture, including use of pesticides, land clearing, and destruction of natural habitat containing nesting sites and food resources and associated biodiversity, climate

⁸ Hormones are usually used for the purpose of increasing the size of fruits, the edible parts of most of the greenhouse vegetables. Pollination, by increasing the number of seeds per fruit, effectively enhances natural hormones produced in these seeds and, hence, increases the size of fruits.

change, and aggressiveness due to cross-breeding with Africanized bees. These risks individually and/or combined have caused increased deaths of honeybees colonies and may have contributed to Colony Collapse Disorder (CCD), a new endemic disease in North America.

5.1 Overwintering Losses

Every year, the stocks of bee colonies experience “overwintering mortality”. In Canada, the normal long-term overwintering mortality rate is 15%. In recent years however, bee stocks suffered unprecedented losses with the number of deaths more than doubling. In the winter of 2008-2009, 213,000 colonies, about 35% of pre-winter stocks, were lost. Experts point to four major factors that lead to these substantial losses: (1) harsh and unusual weather condition such as long periods of cold fall and winter and a cool or wet spring, (2) failure in detecting, controlling, and managing the parasitic mites *Varroa destructor* and *Nosema apis*, causing bees to become more susceptible to viral infection, (3) starvation due to inadequate nectar flows and Fall feeding, and (4) failure of both domestic and imported queen stocks.

Alberta suffered the most from overwintering deaths. It has consistently had the highest number of dead colonies and the highest mortality rate. In the winters of 2007 and 2008, Alberta lost around 100,000 colonies, representing 44 % of its bee colonies, each winter. More detailed information about overwintering mortality by province is given in Table 10.

The increased mortality risk gave rise to the importance of indoor overwintering, a method that has been practiced for years. This method has gained some popularity in Northern Alberta, Northern BC, and Quebec. Across the Prairie Provinces, the rates of loss for indoor wintered colonies in 2008 appear to be lower than average at approximately 20 %. In Quebec, a high percentage of colonies was kept indoors during 2008 winter. This method succeeded in reducing

the number of dead colonies to almost one half of the previous year from 11,000 to about 5,500 (Quebec, Institute de la Statistique).

To make up winter losses, beekeepers usually “split up” their own hives to make new colonies (The Manitoba Beekeeper 2009). A 2009 survey of Manitoba beekeepers showed 66% of beekeepers used this method. Other methods used to compensate for winter losses were nucs (13%), packaged bees (10%), and new hives (7%).

5.2 Colony Collapse Disorder

First reported in the Eastern US in November 2006, this new disorder of honey bees has become the biggest threat to bee populations in North America and some regions of Europe. The symptoms of this disorder are characterized by the rapid loss of adult bees from hives, leaving behind the brood (larvae and pupae), a small number of young workers and the queen. The remaining workforce is insufficient to care for the brood, so the colony “collapses”. Usually, the dead bees are not found near their colonies. CCD can be the result of one or a combination of more than one factors such as unfavourable weather conditions, malnutrition, pests and viral infections, pesticide residues, deteriorating health and genetic diversity, and excessive pollination. While CCD is reported to have cost the US 40 % of its colonies, the disorder has not been diagnosed by professional apiarists in Canada (Guzman *et al.* 2009).

6. Summary

The Canadian beekeeping industry, like other agricultural industries, has been undergoing two profound structural changes. First, it is no longer dominated by hobbyists managing a few hives, but rather full-time commercial apiarists managing thousands of hives. About four-fifths of

Canada's bee colonies are currently managed by full-time beekeepers. Although this change may have been the result of economies of scale in honey production, the growing importance of pollination services for commercial apiaries may have also had a significant effect on farm size. Second, it has evolved and become a more complex industry in that there are multiple bee species which are managed on nearly one quarter of all bee farms in Canada. The growth in the cultivated area of pollination-dependent crops such as fruits, berries, and seeds may have increased the demand for bee colonies and fueled the growth of both apiaries and pollination farms. As the sector of pollination-dependent crops shows no sign of slowing down, the demand for pollination is expected to increase and the structural change in the beekeeping industry will likely continue, creating the opportunity for expanding use of *non-Apis* bees as primary pollinators of Canada's major crops.

Honeybee and *non-Apis* bee farms have different size distributions. While honeybee farms have a unimodal size distribution with large number of small farms and small number of large farms, *non-Apis* bee farms have bimodal size distribution with many small and large farms. The vast majority of *non-Apis* bee colonies are commercial compared to about 60% of honeybee colonies.

Overall, *non-Apis* bee farms are bigger businesses, more capital- and labor- and land-intensive, and more diversified than the honey farms. However, large commercial honeybee farms are usually bigger businesses than their non-Apis bee counterparts. Pollination farms are more likely involved as partnerships and corporations than sole proprietorships, the dominant form of farm organization for the honeybee farm. Regionally, they tend to concentrate in the Prairies, whereas honey farms tend to concentrate in Ontario and British Columbia. Finally, *non-Apis* bee farms are slightly more likely to be operated by multiple operators and younger male principal operators.

The success story of the honeybee sector has been tempered by disease issues. In each of the last three winters, around one-third of honeybee colonies in Canada were lost to harsh weather, increased mite and viral infestation, unbalanced diet, and increased exposure to chemicals and pesticides. More threatening is an unknown endemic coming from the USA that is raising concerns among Canadian beekeepers about the health and survival of their honeybees.

Although, scientists have yet not found a case of Colony Collapse Disorder (CCD) in Canada, they remain cautious about the possibility that this disorder may infect Canada's bees.

In a nutshell, the Canadian beekeeping industry is facing opportunities as well as threats. The reliance on the honeybee for providing pollination is becoming increasingly risky. Non-Apis bee species have become increasingly popular among beekeepers for the provision of commercial pollination. They are potentially more effective and efficient pollinators and less susceptible to mite and viral infection than the honeybee.

Taken as a whole, this all suggests that the industry is currently undergoing large shifts. In order to better understand these shifts, and their implications for trade, agriculture, and the environment, it will be important for further research, encompassing economics, biology and other fields, to take place to analyze different aspects of the industry in greater detail

References

- Alberta Ministry of Agriculture, Food and Rural Development. 2001. Commercial Honey Industry. *Ag-Ventures*. Agriculture Business Profiles. Agdex 616/830-1.
- Allsopp, M. H., W. J. de Lange, and R. Veldtman. 2008. Valuing Insect Pollination Services with Cost of Replacement. *PLoS One* 3: Article No.: e3128.
- Bradbear, N. 2009. Bees and their role in forest livelihoods: A guide to the services provided by bees and the sustainable harvesting, processing and marketing of their products. Food and Agriculture Organization of the United Nations
- British Columbia Ministry of Agriculture and Food. 1999. Planning for Profit. Agdex 616-810
- British Columbia Ministry of Agriculture and Lands. 2007. Beekeeping Production 2007. Apiculture.
<http://www.agf.gov.bc.ca/apiculture/statistics/indexstats.htm>
- Canadian Association of Professional Apiarists. Honeybee Losses in Canada. Various years.
<http://www.capabees.com/main/news.php>
- Canadian Honey Council. Beekeeping Industry.
<http://www.honeycouncil.ca/>
- CANSIM. <http://tdr.uoguelph.ca/cansim.htm>
- Currie, R. W., S. F. Pernal, and N. E. Guzman. 2010. Honeybee Colony Losses in Canada. *Journal of Apicultural Research* 49: 104-106.

Dupree S. C., M. Winston, G. Hergert, S.C Jay, D. Nelson, J. Gates, B. Termeer, and G. Otis.

1995. A Guide to Managing Bees for Crop Pollination. Canadian Association of Professional Apiculturists, British Columbia, Canada

FAOSTAT. Natural Honey Production.

<http://faostat.fao.org>

Fraser, J., D. McCatney, and H. Najda. 2004. Yield Potential and Forage Quality of Annual Forage Legumes in Southern Alberta and Northern Saskatchewan. *Canadian Journal of Plant Science* 84: 143-155.

Gallai, N., J. M. Salles, J. Settele, and B. E. Vaissiere. 2009. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics* 68:810-821.

Government of Saskatchewan, Agriculture- Beelines

<http://www.omafra.gov.on.ca/english/food/inspection/bees/apicultu.html>

Guzman, E. N., L. Eccles, Y. Calvete, J. McGowan, P. G. Kelly, and A. C. Benitez. 2009. Varroa Destructor is the Main Culprit for the Death and Reduced Populations of Overwintered Honeybee (*Apis Mellifer*) Colonies in Ontario, Canada. *Apidologie* 41: 443-450.

Hoff, F. L. 1995. Honey: Background for 1995 Farm Legislation. Economic Research Service, USDA. Agricultural Economic Report No. 708.

Honey Locator. 2007. National Honey Board.

http://www.honeylocator.com/location_results.asp?Location_ID=92

Honey Regulations. 2010. Department of Justice Canada.

<http://lois.justice.gc.ca/en/C-0.4/C.R.C.-c.287/index.html>

Losey, J. E. and M. Vaughan. 2006. The Economic Value of Ecological Services Provided by Insects. *BioScience* 56: 311-323.

- Nerson, H. 2009. Effects of pollen-load on fruit yield, seed production and germination in melons, cucumbers and squash. *Journal of Horticultural Science & Biotechnology* 84:560-566.
- Nicodemo, D., R. H. N. Couto, E. B. Malheiros, and D. De Jong. 2009. Honeybee as an Effective Pollinating Agent of Pumpkin. *Scientia Agricola* 66:476-480.
- Oz, M., A. Karasu, I. Cakmak, A. T. Goksoy, and Z. M. Turan. 2009. Effects of honeybee (*Apis mellifera*) pollination on seed set in hybrid sunflower (*Helianthus annuus* L.). *African Journal of Biotechnology* 8:1037-1043.
- PEI Agriculture and Forestry. 1999. Agricultural Business Profile on Beekeeping. Agdex 888/616.
- Pollination Canada. 2008.
<http://www.pollinationcanada.ca/>
- Quebec Institut de la Statistique
http://www.stat.gouv.qc.ca/donstat/econm_finnc/filr_bioal/elevage/miel/
- Rainville, C. 1996. Little Bees, Big Potential. Canadian Agriculture at a Glance. Statistics Canada. Catalogue No. 96-325-XPB.
- Richards, K. W. 1995. The Alfalfa Leafcutter Bee, *Megachile rotundata*: A Potential pollinator for Some Annual Forage Clovers. *Journal of Apicultural Research* 34: 115-121.
- Richards, K. W. 2003. Potential Use of the Alfalfa Bee *Megachile rotundata* to Pollinate Sweet Clover. *Journal of Apicultural Research* 42: 21-24
- Richards, K. W. and P. D. Edwards. 1988. Density, Diversity and Efficiency of Pollinators of Sainfoin. *Canadian Entomologist* 120: 1085-1100
- Saskatchewan Agriculture and Food. 2006. Beelines. Issue 113

Shipp, J. L., G. H. Whitfield, and A. P. Papadopoulos. 1994. Effectiveness of the Bumble Bee, *Bombus-impatiens* as a pollinator of Greenhouse Sweet Pepper. *Scientia Horticulturae* 57: 29-39.

Statistics Canada. Census of Agriculture. Various years

<http://www12.statcan.ca/census-recensement/index-eng.cfm>

Statistics Canada. Farms and Farm Operators.

<http://cansim2.statcan.gc.ca/cgi->

[win/cnsmcgi.pgm?Lang=E&SP_Action=Result&SP_ID=1637&SP_TYP=5&SP_Sort=1&SP_Portal=2](http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.pgm?Lang=E&SP_Action=Result&SP_ID=1637&SP_TYP=5&SP_Sort=1&SP_Portal=2)

Statistics Canada. 2001. Food Expenditure in Canada.

<http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=62-554-X&lang=eng>

Statistics Canada. Honey Production, Value and Colonies, various years

<http://www.statcan.gc.ca/cgi->

[bin/imdb/p2SV.pl?Function=getSurvey&SDDS=3419&lang=en&db=imdb&adm=8&dis=2](http://www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=3419&lang=en&db=imdb&adm=8&dis=2)

The Manitoba Beekeeper. 2009. Vol.3. Issue 3.

Trade Data Online. Industry Canada.

<http://www.ic.gc.ca/eic/site/tdo-dcd.nsf/eng/Home>

UN Comtrade Database. United Nations.

<http://comtrade.un.org/>

USDA Foreign Agricultural Service. 2005. Canada Honey Production and Trade Update 2005. GAIN Report Number: CA5083

USDA Foreign Agricultural Service. 2000. Honey Situation and Outlook in Selected Countries.

<http://www.fas.usda.gov/htp2/sugar/1998/98-11/honey.htm>

List of Tables

Table 1: Current and Exited Beekeepers

	1993		2009		Exits	
	Number	%	Number	%	Number	% Change
Canada	13149		6728		6421	49
British Columbia	3700	28	1850	27	1850	50
Alberta	761	6	625	9	136	18
Saskatchewan	1400	11	971	14	429	31
Manitoba	800	6	474	7	326	41
Ontario	4500	34	2150	32	2350	52
Quebec	893	7	250	4	643	72
Others	1095	8	408	6	687	63

Source: CANSIM

Table 2: Colonies per Beekeepers

	1993	2009	% Change
Canada	38	86	126
British Columbia	12	21	75
Alberta	194	384	98
Saskatchewan	61	88	44
Manitoba	106	149	41
Ontario	20	38	90
Quebec	35	140	300
Others	15	63	320

Source: Statistics Canada- CANSIM

Table 3: Commercial Beekeepers Current & Future

	2001	2006	2023
Beekeepers	9102	7695	≈5753
Commercial Beekeepers	1626	2170	≈5789
	%	18	28
			≈100

Source: CANSIM

Statistics Canada. Census of Agriculture

Table 4: Size Distribution of Bee Farms and Colonies (1000)*

Size	Honeybee Farms		Apiaries	
	Farms	Colonies	Farms	Colonies
1-24	1904 (60)	13 (2)	464 (31)	4 (1)
25-299	839 (27)	77 (14)	617 (41)	63 (12)
300-999	291 (9)	149 (27)	278 (19)	143 (28)
1000 +	133 (4)	314 (57)	130 (9)	304 (59)
Total	3167 (100)	554 (100)	1489 (100)	514 (100)
	Non-Apis Bee Farms		Pollination Farms	
	Farms	Colonies	Farms	Colonies
1-24	348 (43)	1 (<1)	65 (36)	<1 (<1)
25-99	56 (7)	3 (<1)	9 (5)	<1 (<1)
100-299	97(12)	16 (4)	10 (6)	2 (1)
300 +	303 (38)	380 (95)	94 (52)	173 (99)
Total	804 (100)	400 (100)	181 (100)	175 (100)

*The values in parentheses are percentages.

Table 5: Bee Farms with both Honeybee and Non-Apis Bee Colonies

	Honeybee Farm Size (no. colonies)				
	1-24	25-299	300-1,000	1000+	Total
	Farms (%)				
1-24	104 (60)	34 (20)	4 (2)		142 (82)
25-99	9 (5)	8 (5)	4 (2)	5 (3)	26 (15)
100-299					
300+		6 (3)			6 (3)
Total	113 (65)	48 (28)	8 (5)	5 (3)	174 (100)
	Honeybee Colonies (%)				
1-24	560 (3)	3338 (15)	2061 (10)		5959 (28)
25-99	101 (1)	447 (2)	2175 (10)	12500 (57)	15223 (70)
100-299					
300+		407 (2)			407 (2)
Total	661 (4)	4192 (19)	4236 (20)	12500 (57)	21589 (100)
	Non-Apis Bee Colonies (%)				
1-24	194 (1)	122 (1)	38 (0)		354 (2)
25-99	365 (2)	247 (1)	223 (1)		835 (5)
100-299					
300+		16506 (93)			16506 (93)
Total	559 (3)	16875 (95)	261 (2)		17695 (100)

Source: Statistics Canada- Census of Agriculture 2006

Table 6: Provincial Share of Canadian Honey Production and Bee Colony Inventory

	1993-1998	1999-2004	2005	2006	2007	2008	2009
% Production							
British Columbia	5	5	4	3	3	3	3
Alberta	36	35	40	44	42	40	40
Saskatchewan	22	26	23	23	24	25	26
Manitoba	19	19	16	18	18	18	19
Ontario	12	10	11	8	9	7	7
Quebec	5	4	5	3	3	5	3
Others	1	1	1	1	1	2	2
% Colonies							
British Columbia	9	8	7	8	8	6	7
Alberta	33	38	41	40	40	40	42
Saskatchewan	17	17	16	16	16	16	15
Manitoba	16	15	14	14	13	13	12
Ontario	16	13	12	12	13	14	14
Quebec	6	5	5	6	5	6	6
Others	3	4	5	4	5	5	4

Source: Statistics Canada. Honey Production, Value and Colonies

Table 7: Honey Yield (kg/colony)

	1924-1965	1966-2005	2006	2007	2008	2009
Canada	37	56	77	53	52	51
British Columbia	30	38	32	23	21	24
Alberta	53	62	83	55	52	49
Saskatchewan	47	77	113	79	84	91
Manitoba	52	73	100	73	73	79
Ontario	34	38	49	35	26	26
Quebec	25	40	44	32	40	27
Others	18	15	16	17	14	15

Source: CANSIM

Table 8: Expenditure on Pollinated-dependent Food

Food Item	1992	1996	2001	Change (1992-2001)
All meat	18.6	18	16.3	-2.3
Dairy Products and Eggs	11.3	11.4	10.2	-1.1
Fruits and Nuts	7.6	8.0	7.9	0.3
Vegetables	6.5	6.8	7.0	0.5
Others	29.9	27.1	26.0	-3.9

Source: Statistics Canada- Food Expenditure in Canada

Table 9: Acreage Growth of Pollination-dependent Crops

	1991	1996	2001	2006	% Change (1991-2006)
All Crops	83718	86464	91518	88621	5.9
Pollination-Dependent	8340	9340	9993	13074	56.8
Canola	7762	8726	9348	12424	60.1
Fruits	226	245	258	272	20.4
Vegetables	303	316	331	309	2.0
Nursery & Nuts	49	53	56	69	40.8

Source: Statistics Canada- Census of Agriculture

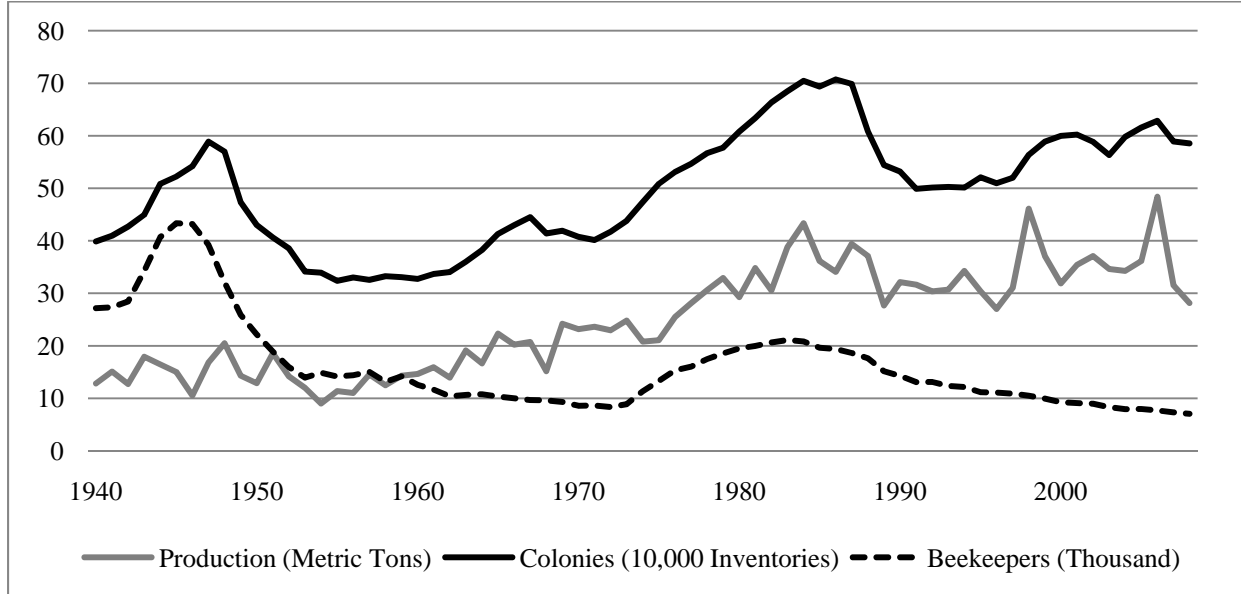
Table 10: Dead Colonies (thousand) and Mortality Rates

	2007		2008		2009	
	Colonies	%	Colonies	%e	Colonies	%
Canada	187	29	213	35	204	34
British Columbia	11	23	17	38	9	24
Alberta	78	31	110	44	99	44
Saskatchewan	24	24	25	26	24	25
Manitoba	23	27	23	28	25	32
Ontario	28	37	25	33	25	31
Quebec	12	30	6	19	11	29
Others	11	31	7	57	12	37

Source: Canadian Association of Professional Apiculturists

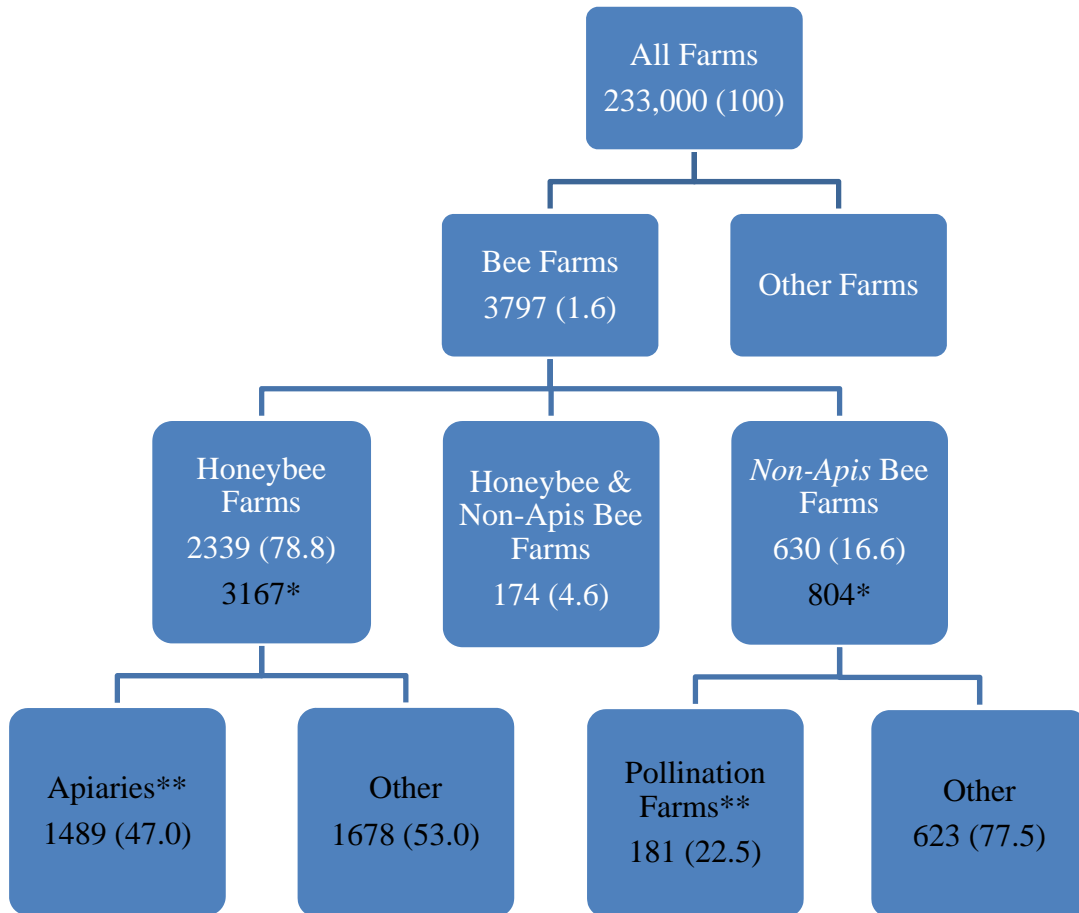
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Figure 1: Honey Production, Number of Colony & Number of Beekeepers in Canada, 1940-2009



Source: CANSIM

Figure 2: Canadian Beekeeping Industry by Farm Type- 2006

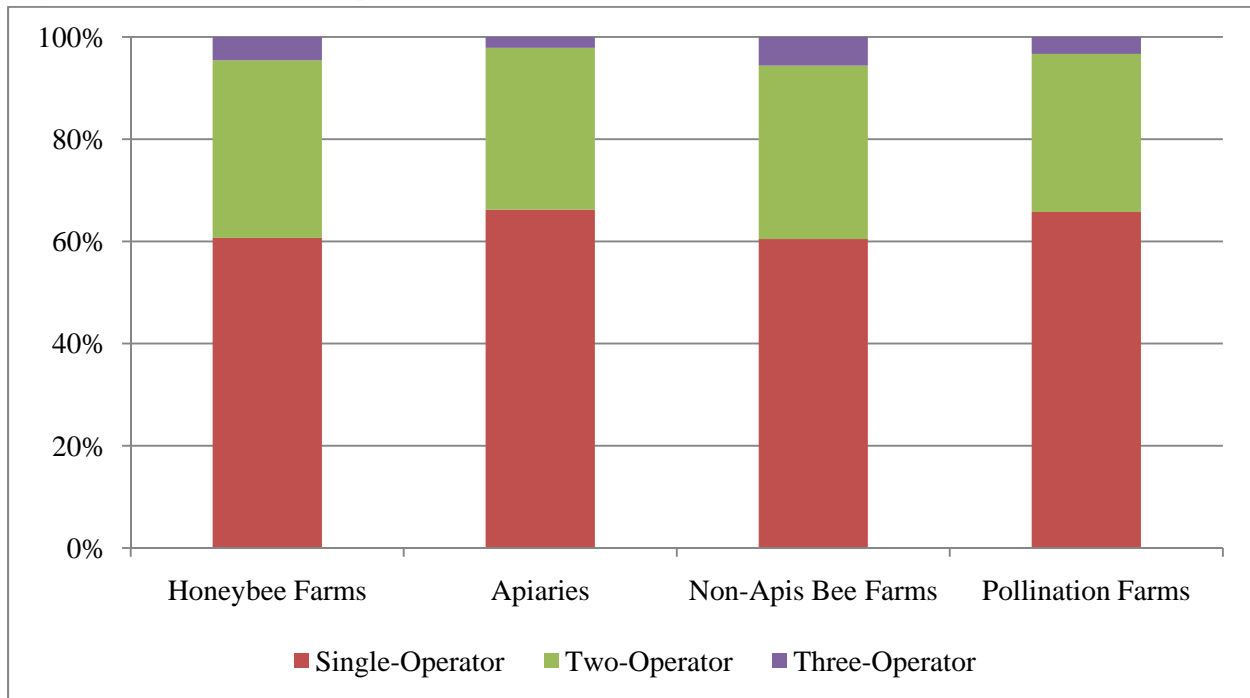


Source: Statistics Canada- Census of Agriculture

*These numbers include farms with honeybee & *non-Apis* bee colonies

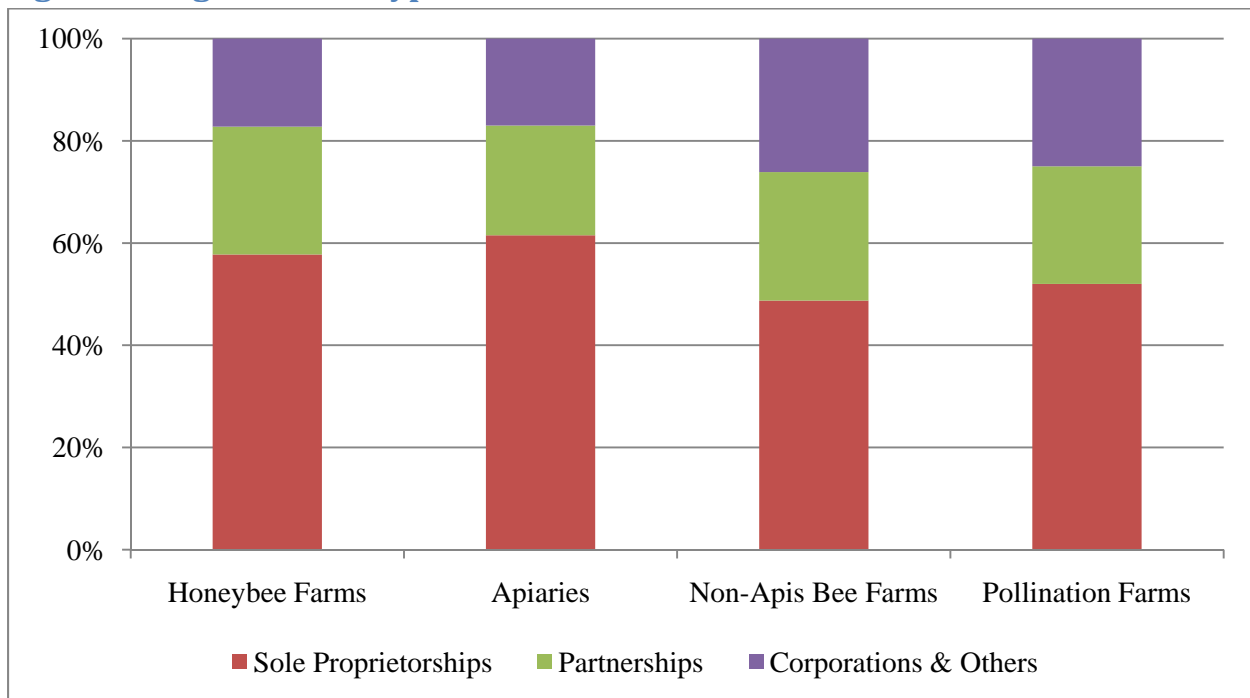
**An apiary or a pollination farm is a bee farm that generates at least half of its gross sales from apicultural activities or from rendering pollination service, respectively.

Figure 3: Number of Operators in Bee Farms



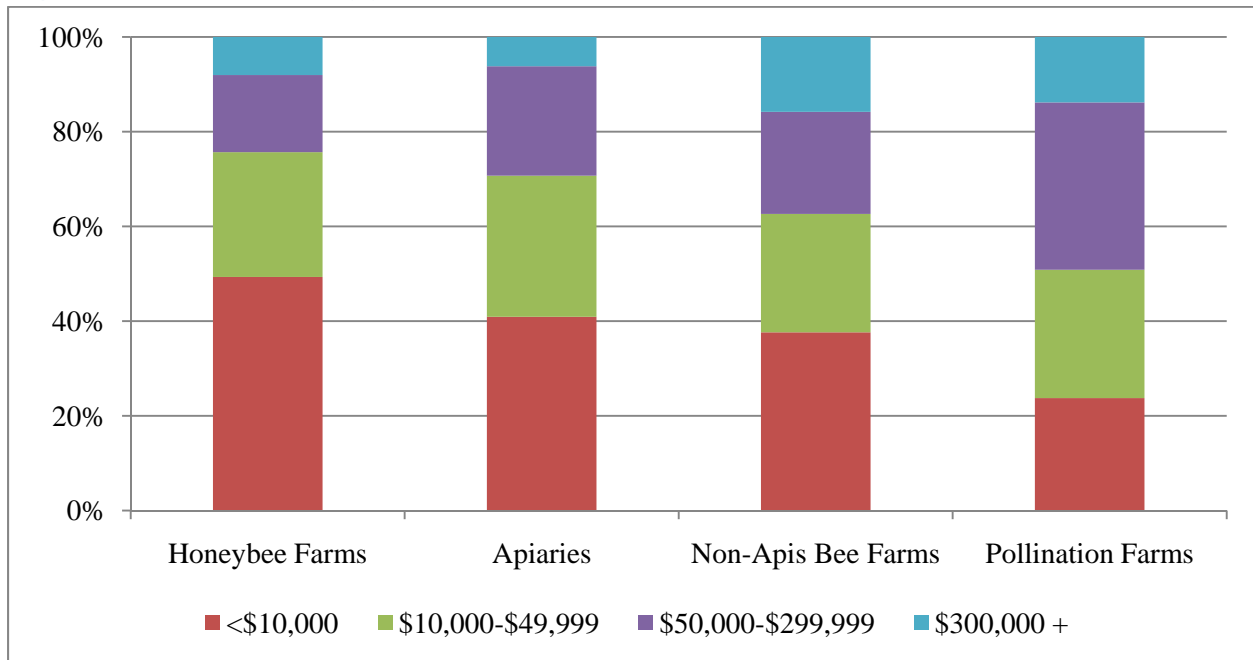
Source: Statistics Canada- Census of Agriculture

Figure 4: Organization Types of Bee Farms



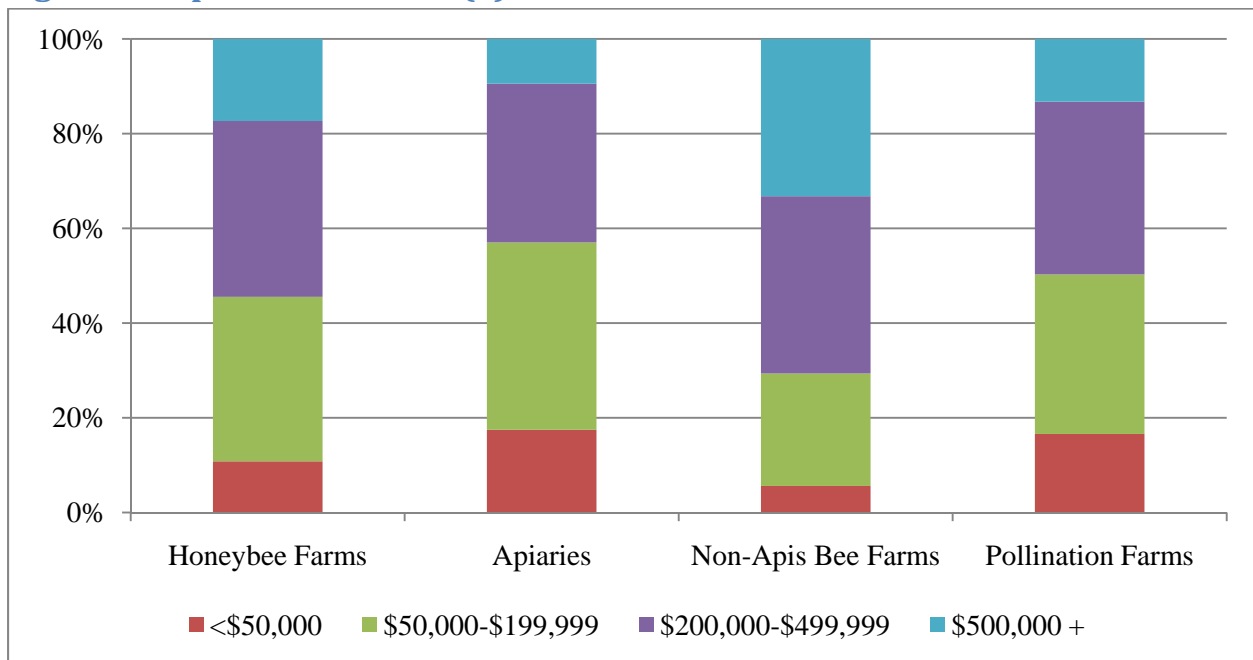
Source: Statistics Canada- Census of Agriculture

Figure 5: Gross Sales (\$) of Bee Farms



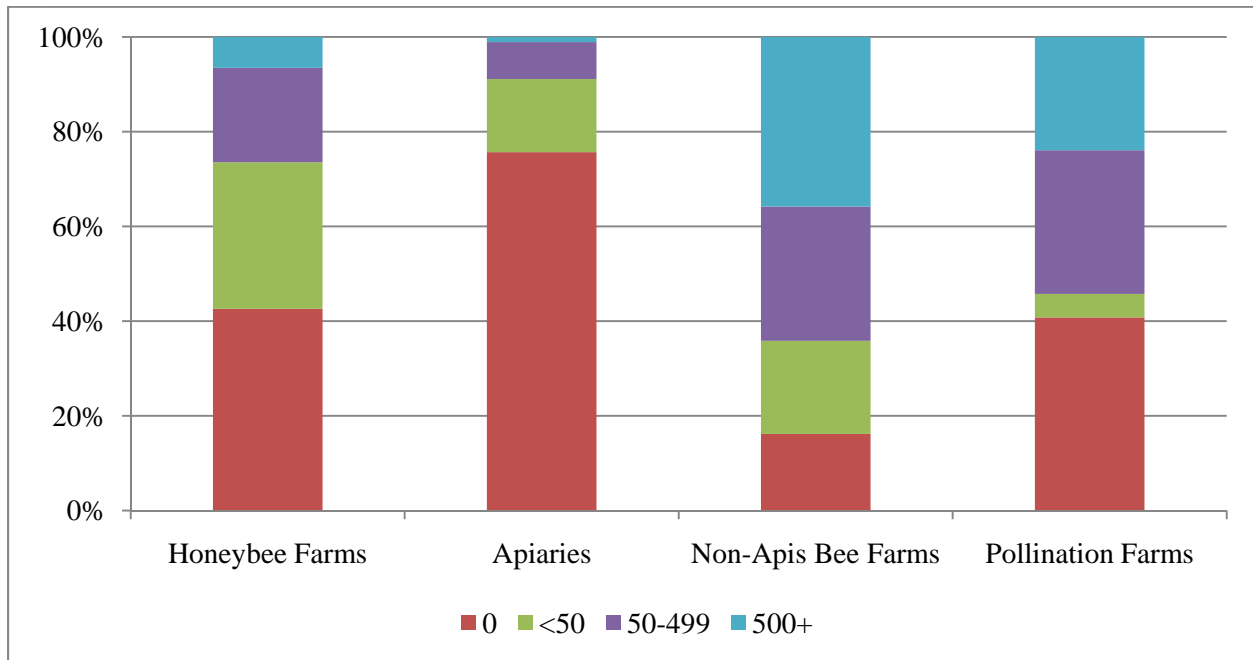
Source: Statistics Canada- Census of Agriculture

Figure 6: Capital Investment (\$) of Bee Farms



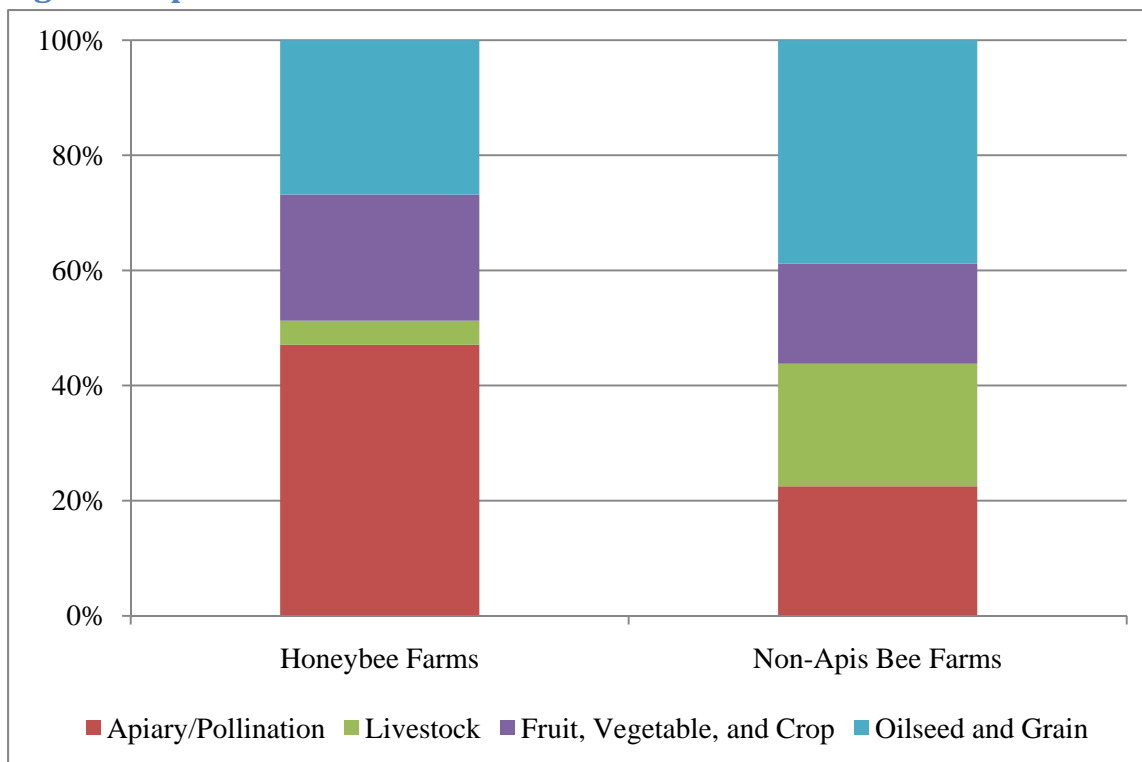
Source: Statistics Canada- Census of Agriculture

Figure 7: Land Base (Acres) for Bee Farms



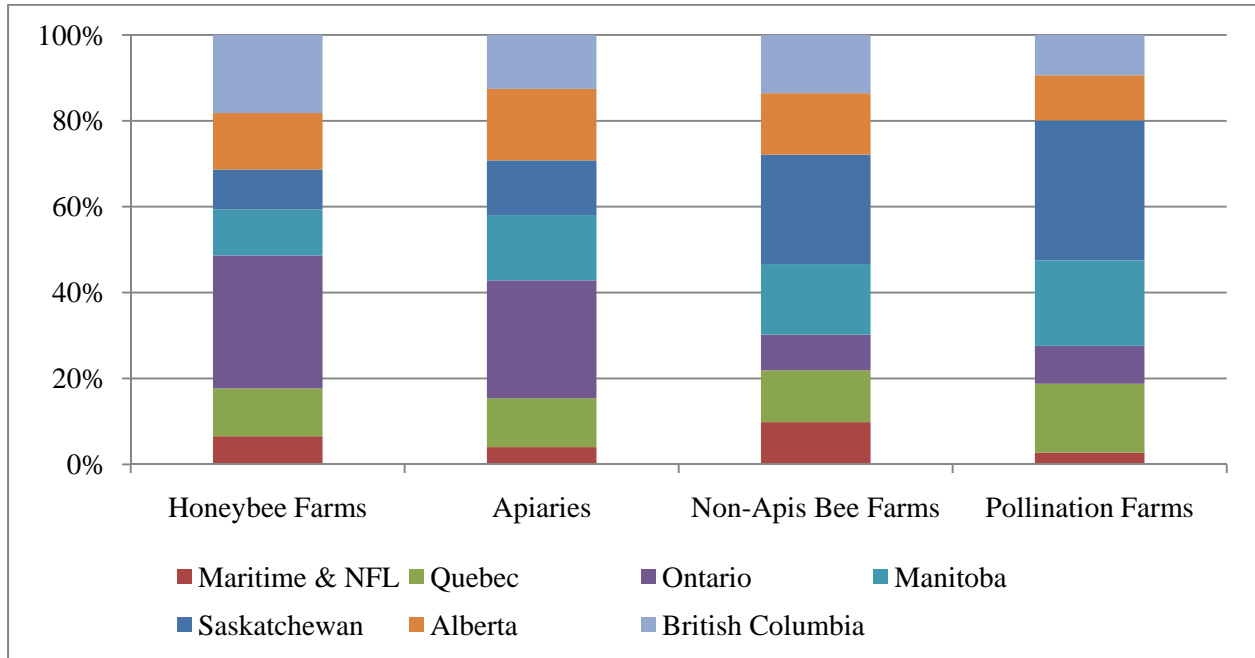
Source: Statistics Canada- Census of Agriculture

Figure 8: Specialization of Bee Farms



Source: Statistics Canada- Census of Agriculture

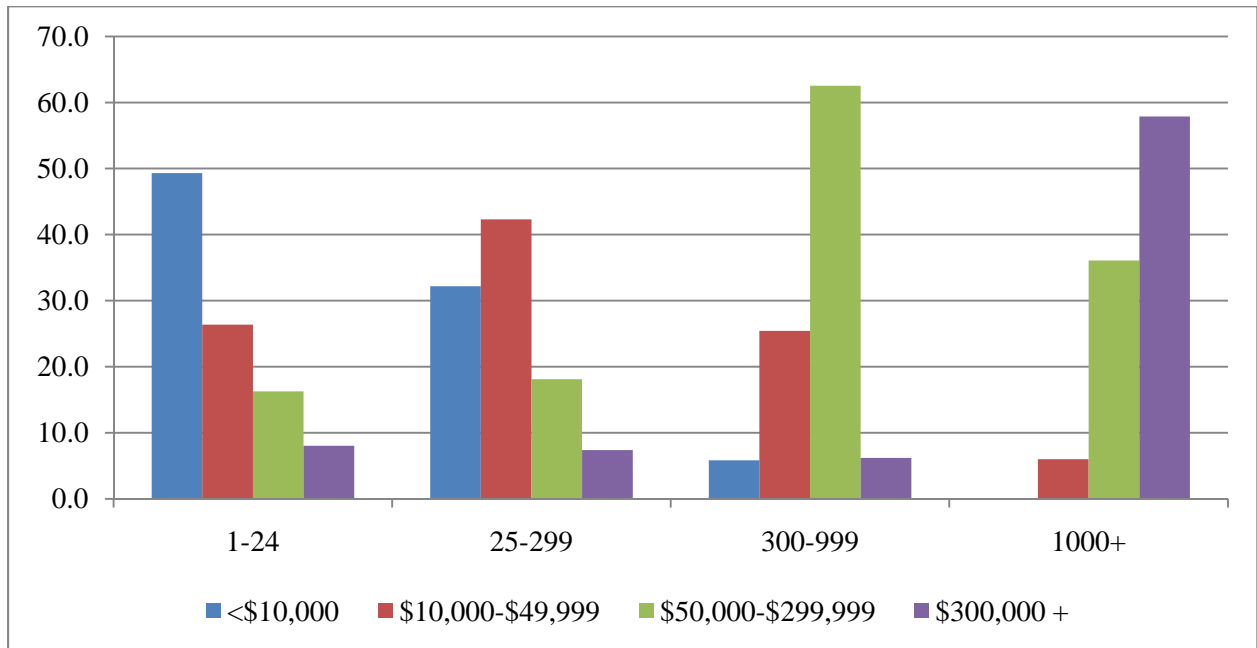
Figure 9: Provincial Distribution of Bee Farms



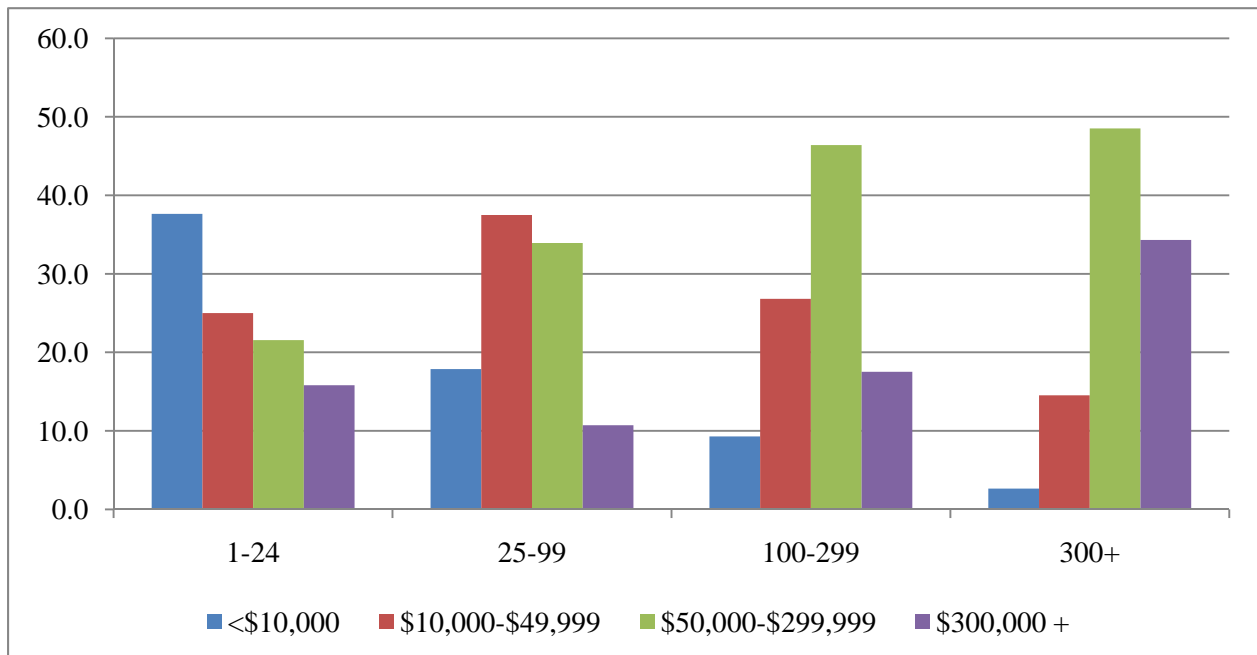
Source: Statistics Canada- Census of Agriculture

Figure 10: Gross Sales by Farm Size

a) Honeybee Farm



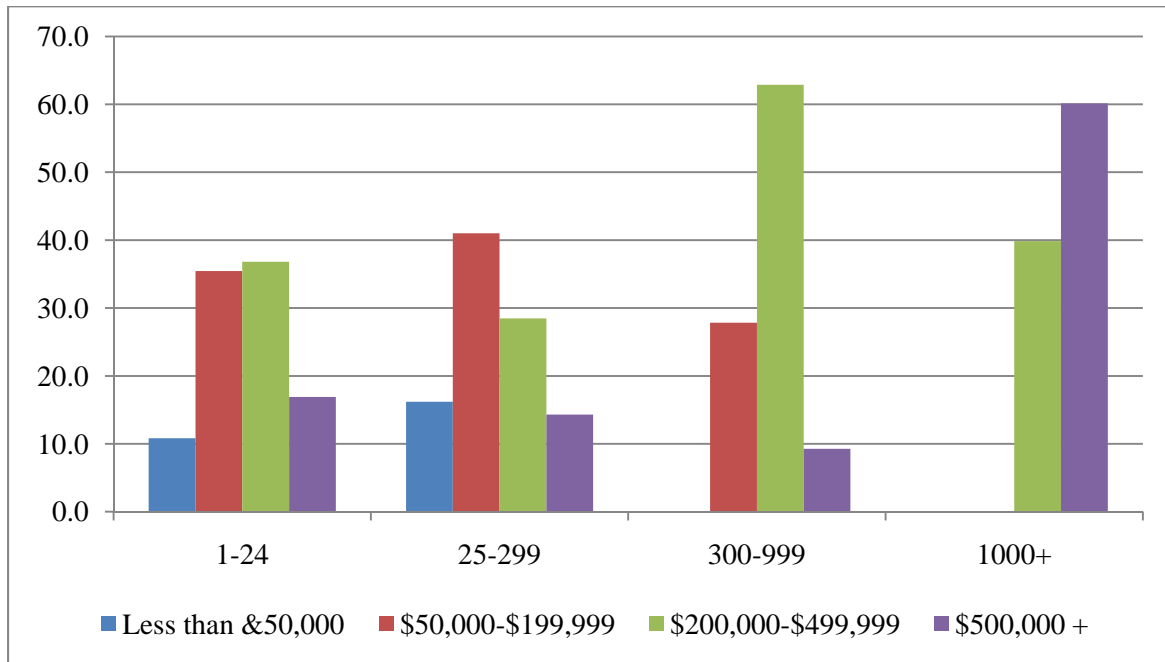
b) *Non-Apis* Bee Farm



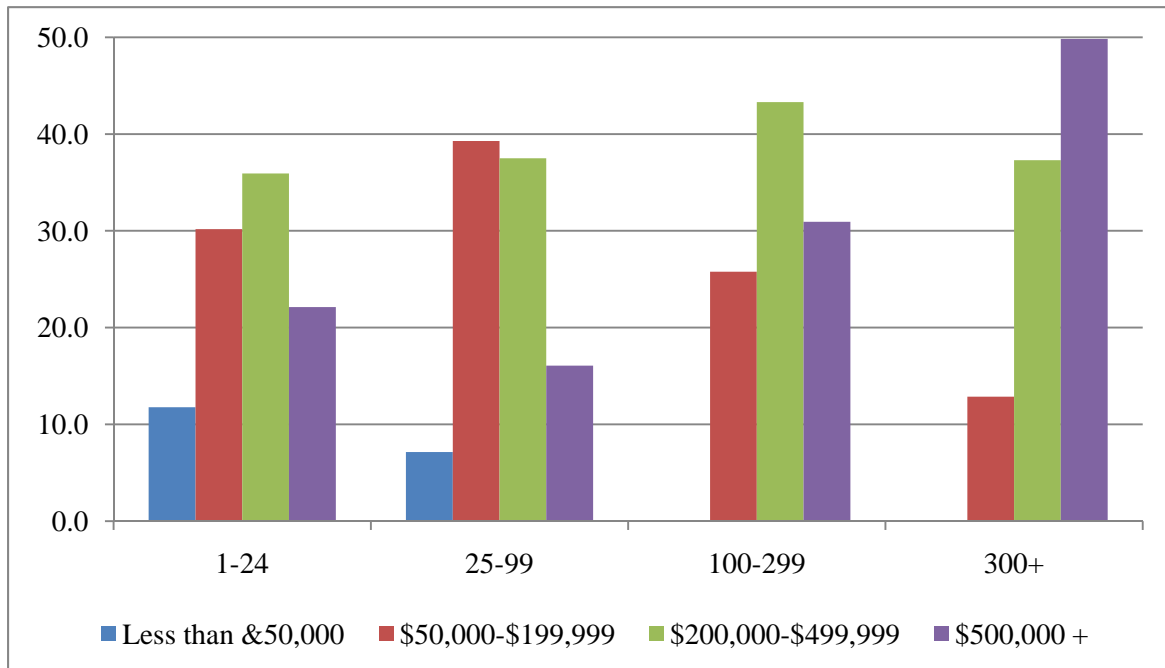
Source: Statistics Canada- Census of Agriculture

Figure 11: Capital Investment by Farm Size

a) Honeybee Farm



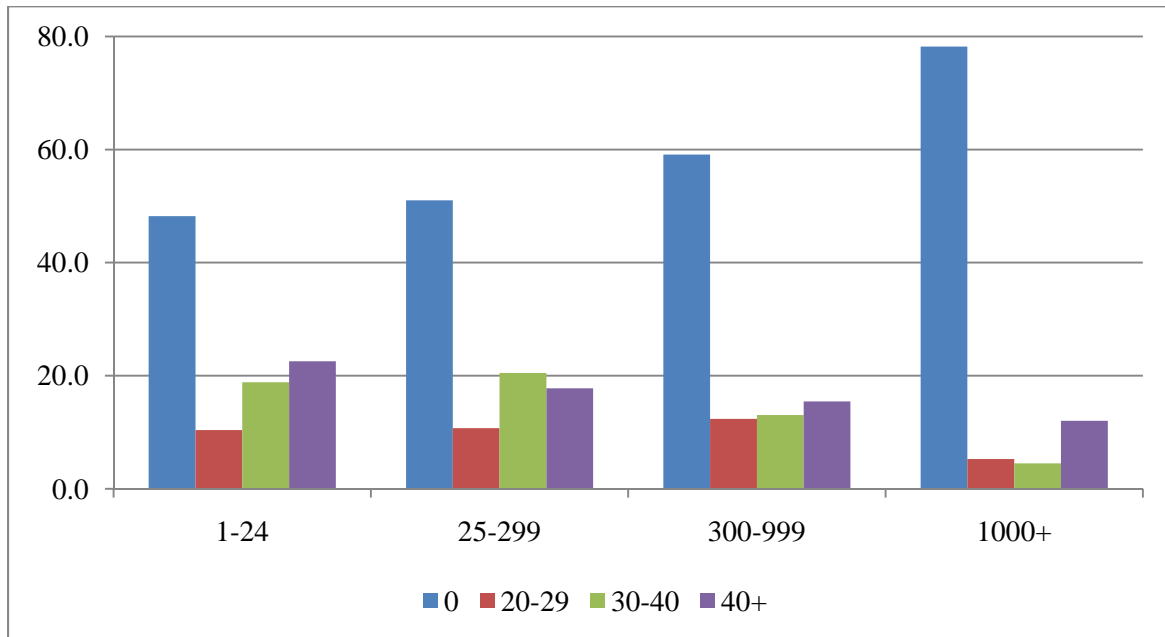
b) *Non-Apis* Bee Farm



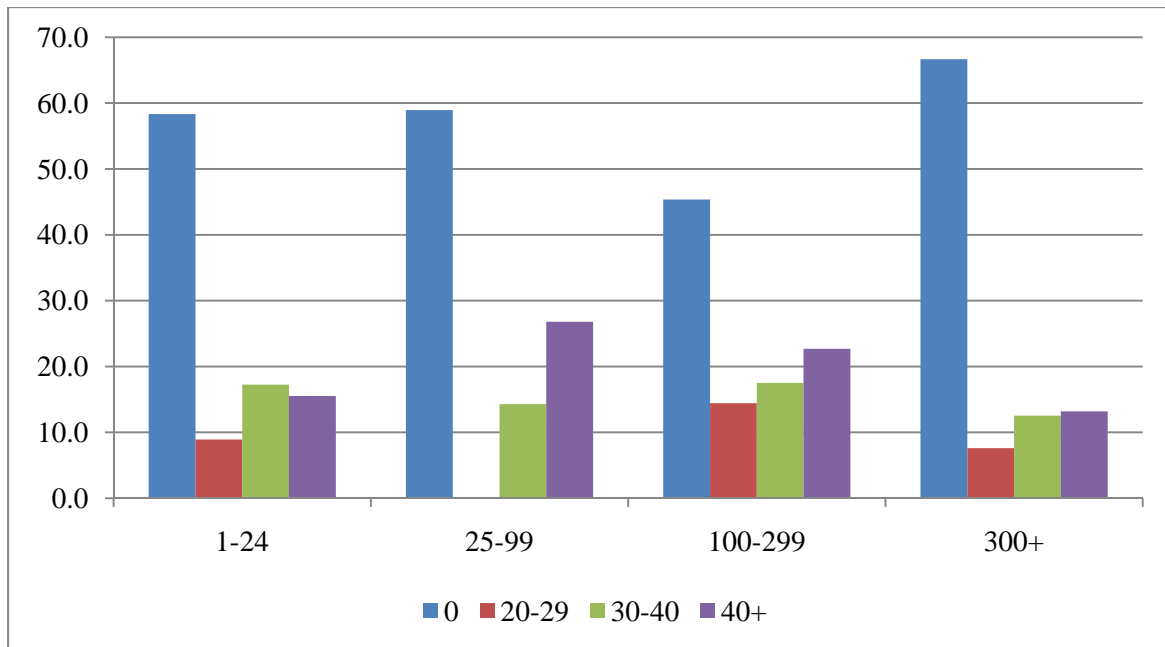
Source: Statistics Canada- Census of Agriculture

Figure 12: Principal Operator's Off-Farm Work (Hours/Week) by Farm Size

a) Honeybee Farm



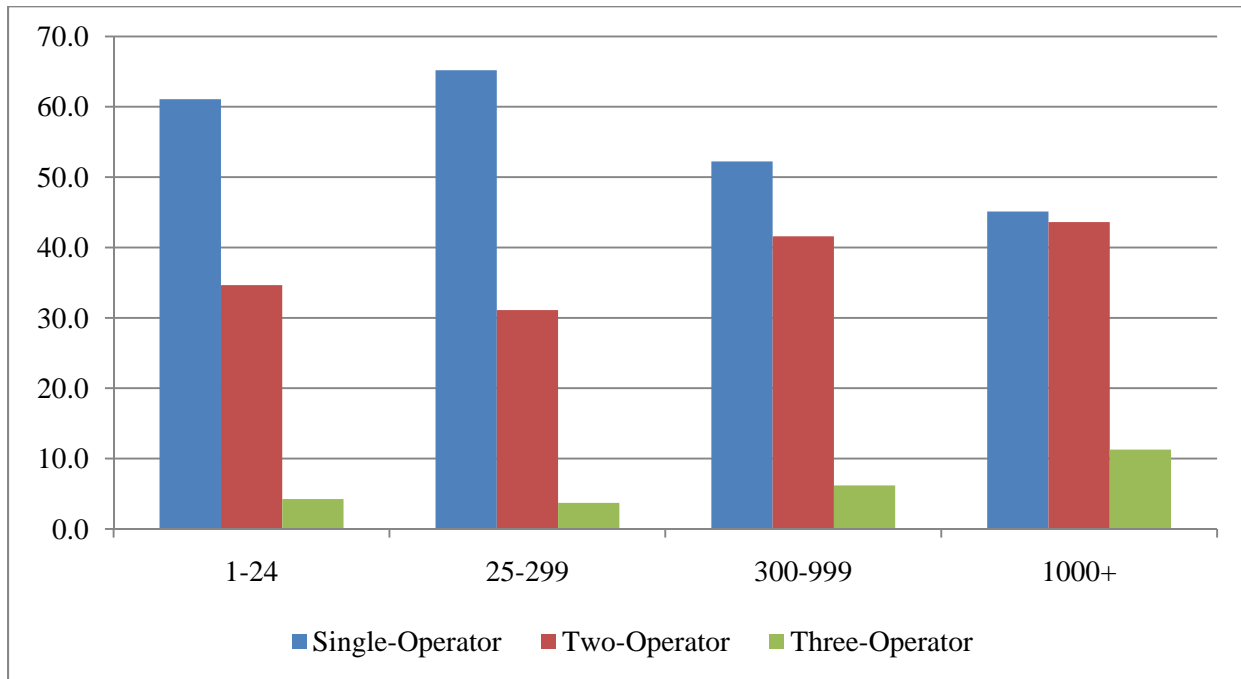
b) *Non-Apis* Bee Farm



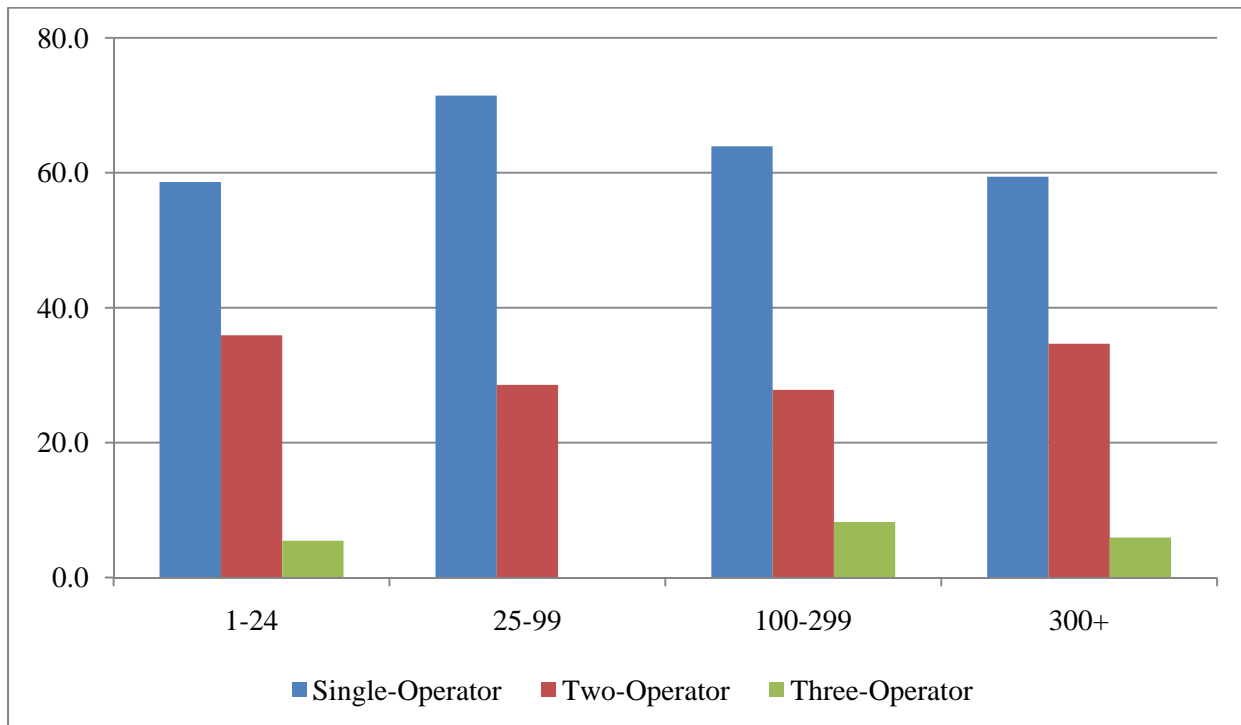
Source: Statistics Canada- Census of Agriculture

Figure 13: Number of Operators by Farm Size

a) Honeybee Farm



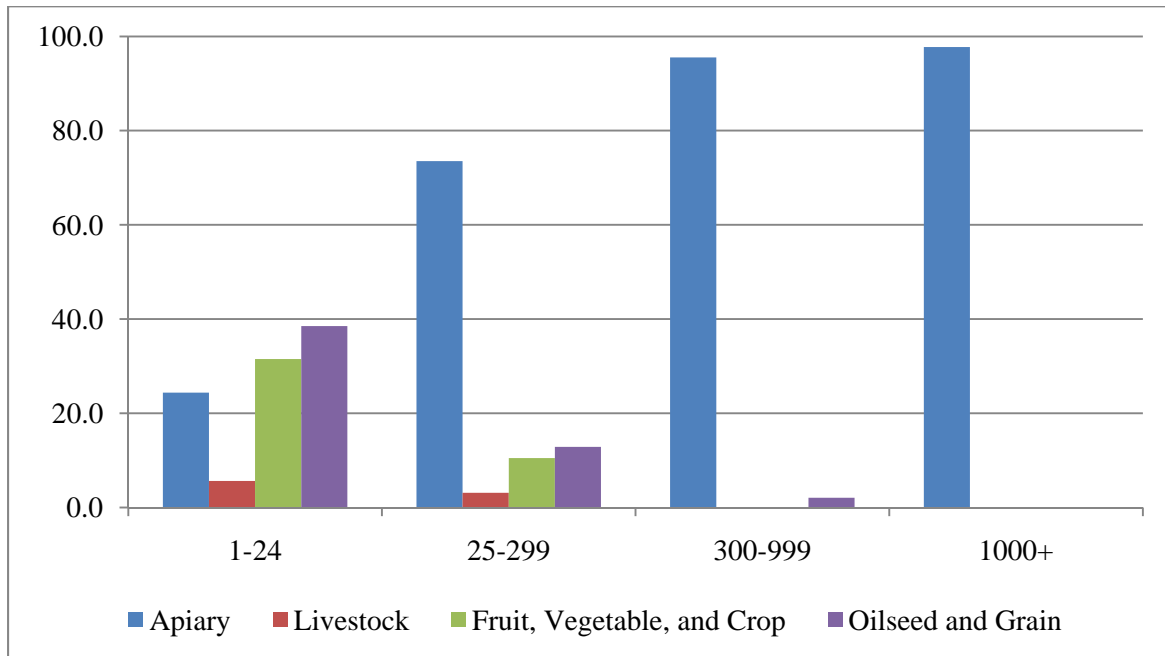
b) *Non-Apis* Bee Farm



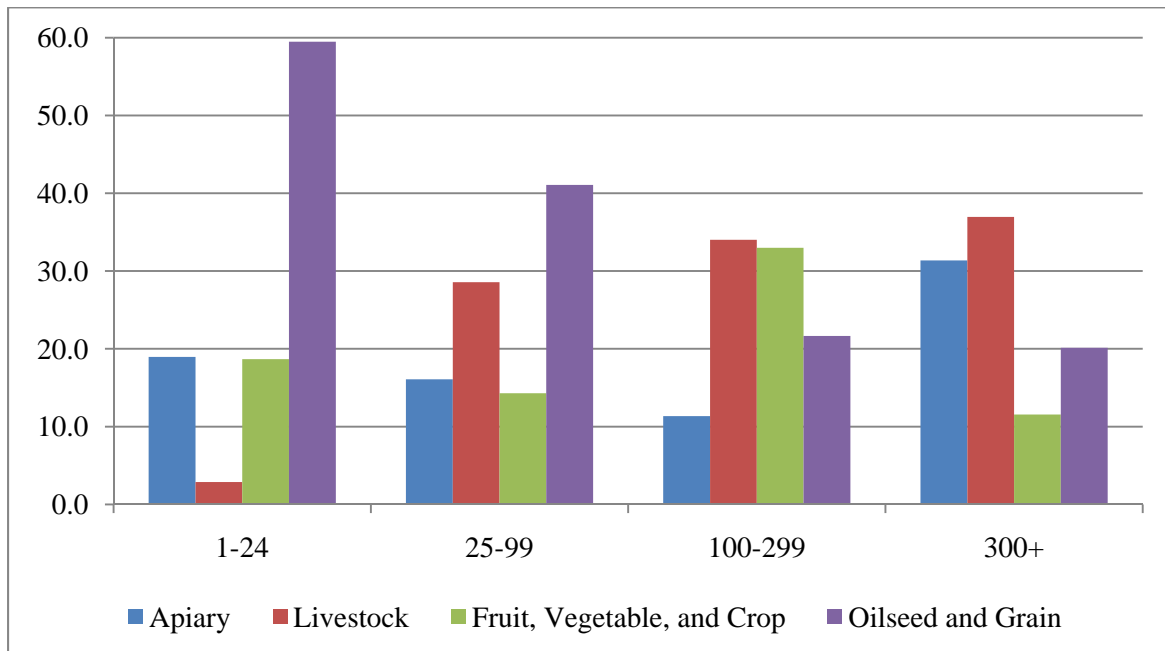
Source: Statistics Canada- Census of Agriculture

Figure 14: Specialization by Farm Size

a) Honeybee Farm



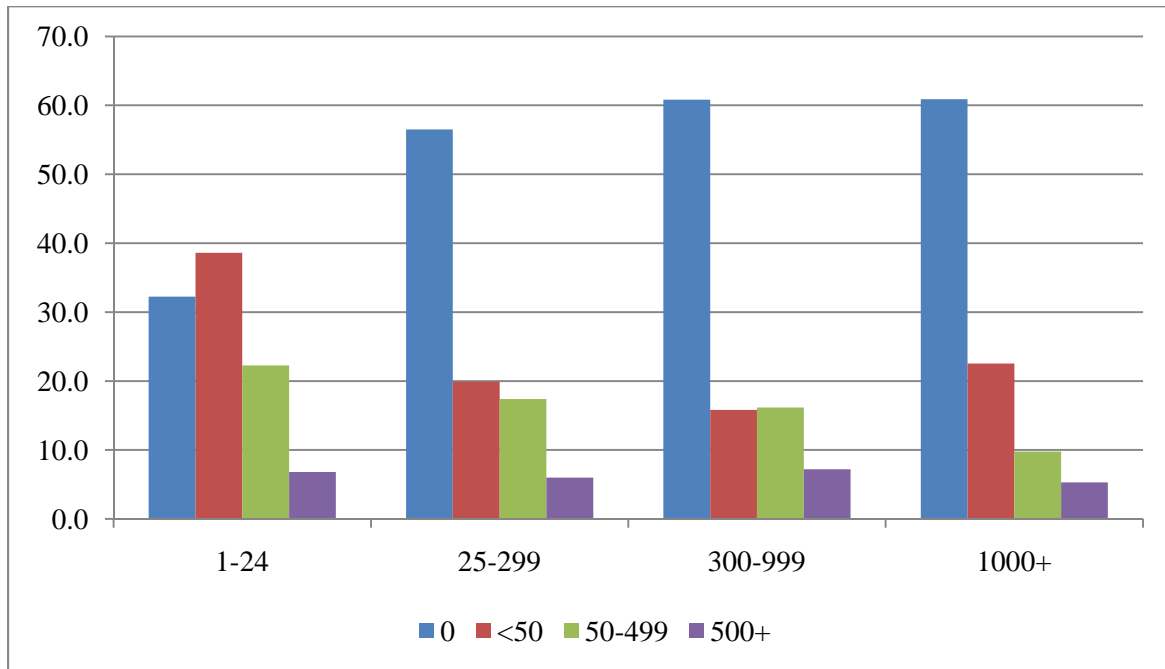
b) *Non-Apis* Bee Farm



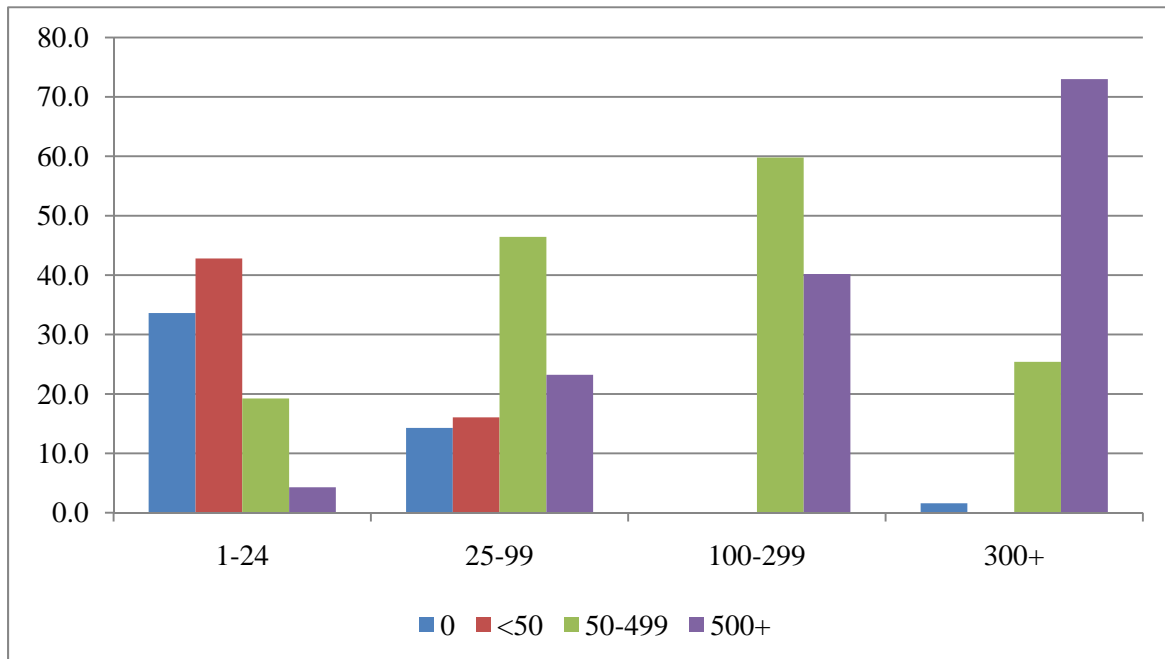
Source: Statistics Canada- Census of Agriculture

Figure 15: Land Base (Acres) by Farm Size

a) Honeybee Farm



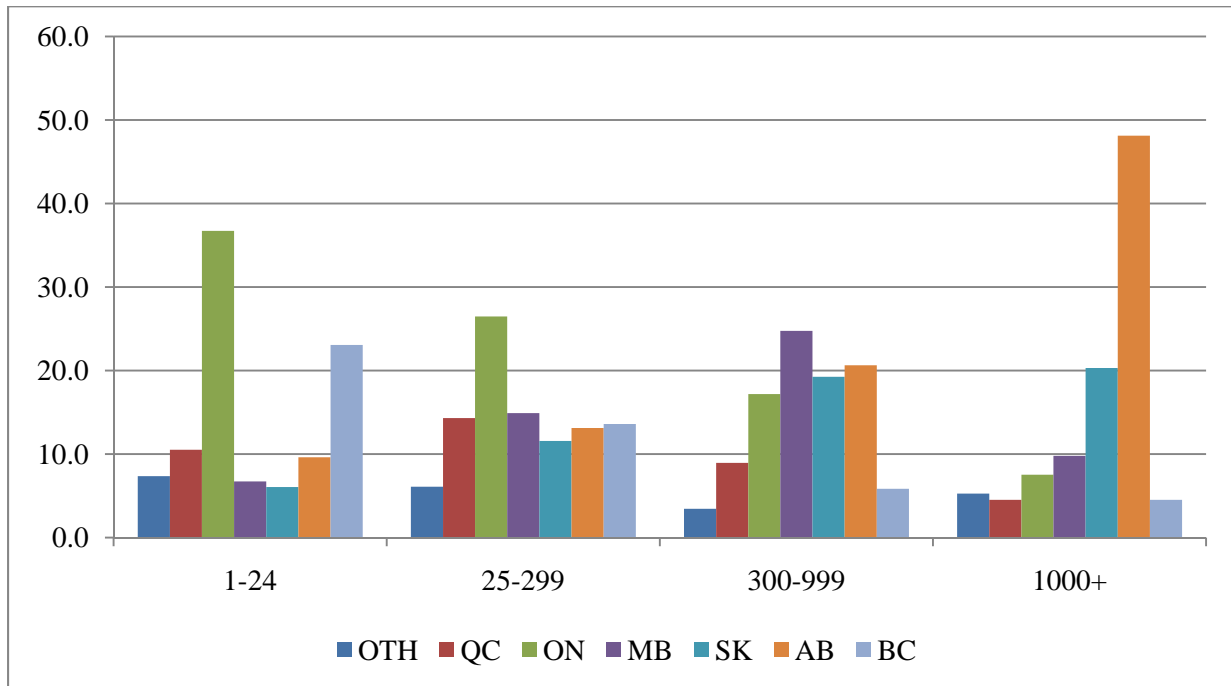
b) *Non-Apis* Bee Farm



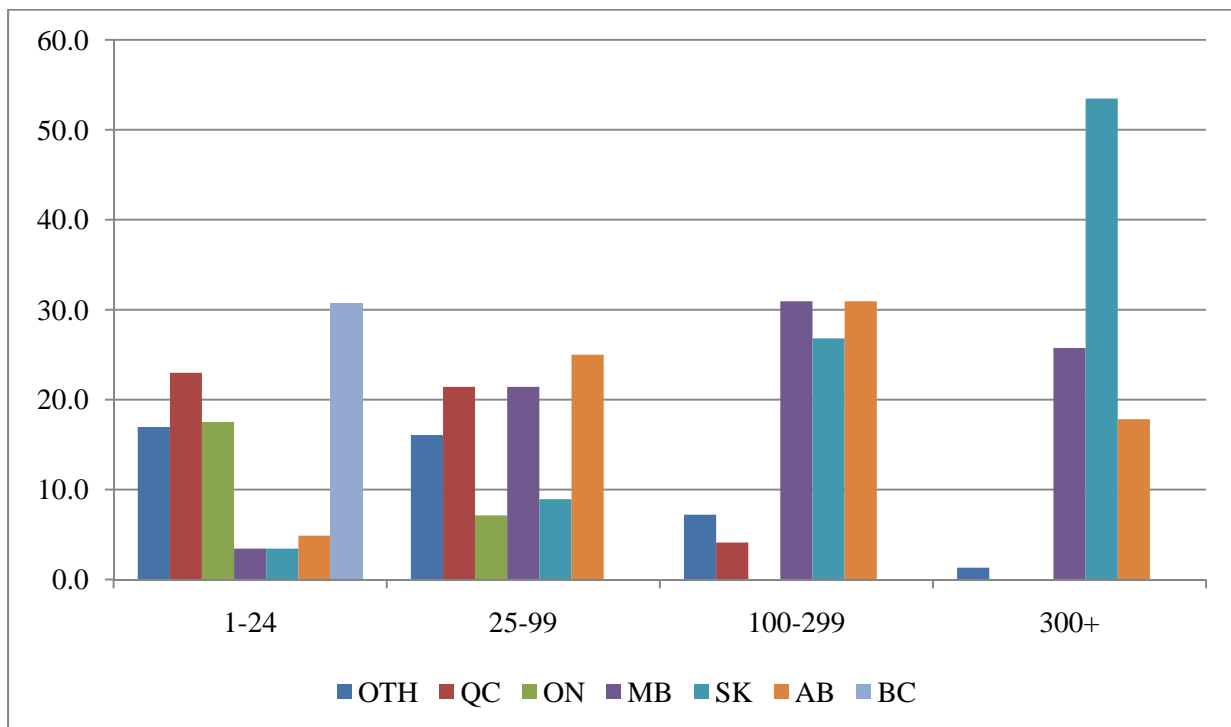
Source: Statistics Canada- Census of Agriculture

Figure 16: Provincial Distribution by Farm Size

a) Honeybee Farm

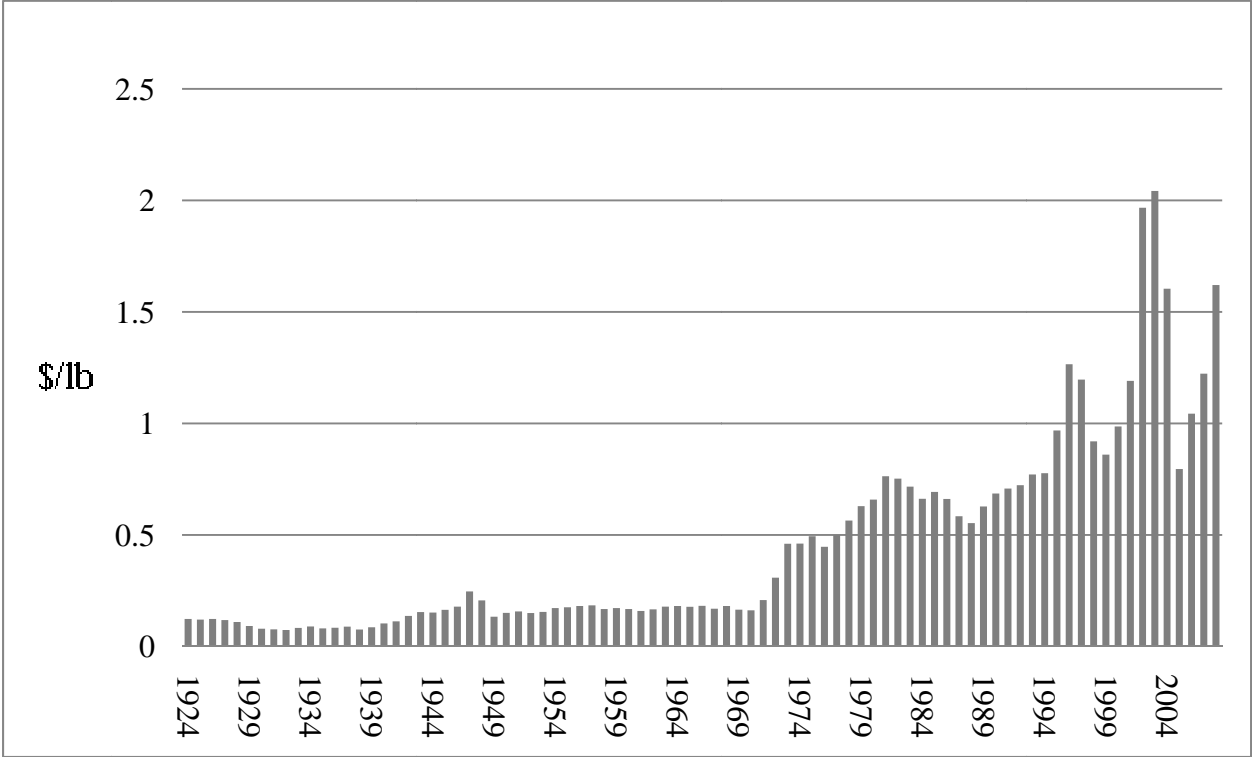


b) *Non-Apis* Bee Farm



Source: Statistics Canada- Census of Agriculture

Figure 17: Average Nominal Price of Honey, Canada 1924-2008 (\$/lb)



Source: CANSIM