

*Applied Mathematics 30*

**Student Project:  
Apiculture –  
The Beekeeping Industry**



**September 2007**

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# *Applied Mathematics 30*

## *Project: Apiculture – The Beekeeping Industry*

### *Introduction*

Most people in Canada associate beekeeping with honey production. However, in the United States and Mexico, honeybees are also used extensively for pollinating crops such as melons, almonds, plums, cherries, and cucumbers. In California alone, approximately 1.4 million beehives are rented out annually for this purpose.

The pollination industry in the southern United States and Mexico is being affected, however, by Africanized honeybees (sometimes referred to as “killer bees”). The colonization of Africanized honeybees affects the agriculture industry by influencing the domestic (European) honeybees that are used for pollination.

### *Part A*

Because honey production and crop pollination are important industries in states such as California, Arizona, and Texas, local officials have investigated what effect Africanized honeybees have had on domestic bees.

Research the problems that states like California, Arizona, and Texas, and countries like Mexico have had with Africanized honeybees, and what these states and countries have done to try to solve some of these problems. The following list of web sites may help in your research. You may also refer to encyclopedias or other reference material.

[www.bees.ucr.edu](http://www.bees.ucr.edu)

[www.ag.arizona.edu/pubs/insects/ahb/inflist.html](http://www.ag.arizona.edu/pubs/insects/ahb/inflist.html)

**Note:** Web addresses sometimes change. If the web sites listed above are not available, use a search engine and type in keywords such as *Africanized honeybees*.

Write a short (1 to 2 page) report on Africanized honeybees and their effect on agriculture in Mexico and the southern states. Include as much information as you feel is required, but make sure that you answer at least the following questions:

- How were Africanized honeybees introduced into the United States and Mexico?
- Compare the characteristics of Africanized honeybees with the characteristics of domestic honeybees. Why are Africanized honeybees more dangerous to humans and animals than are domestic honeybees?
- What part of the agriculture industry relies heavily on honeybees?
- What effects have the infiltration of Africanized honeybees had on the agriculture industry in states like California, Arizona, and Texas?
- What steps have some state governments in Mexico and the southern states implemented to help control the Africanized honeybees' population?

## ***Part B***

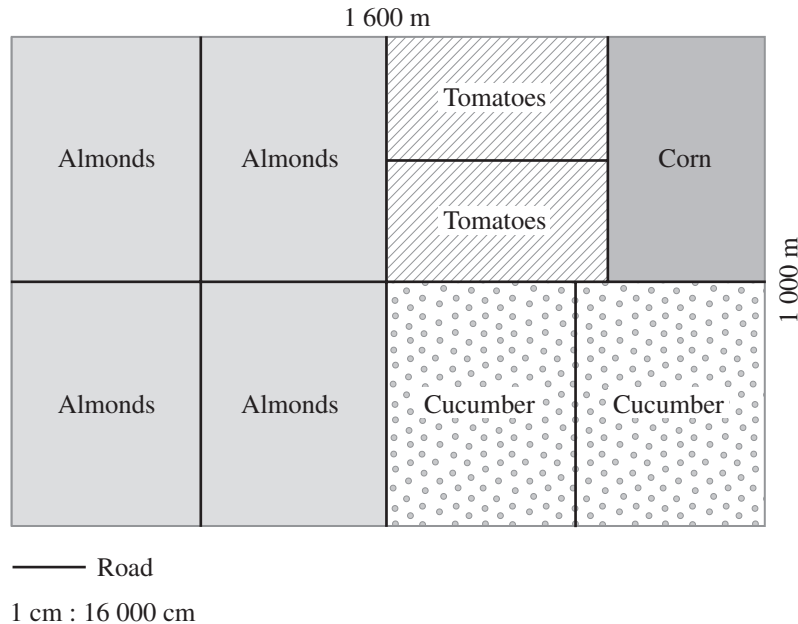
A California government agency monitors the number of swarms that contain Africanized honeybees in that state. The chart below shows the approximate number of swarms in California between 1994 and 1997.

<b>Date</b>	<b>Number of Swarms</b>
September 1994	1
December 1994	3
March 1995	5
June 1995	12
September 1995	15
December 1995	20
March 1996	23
June 1996	30
September 1996	35
December 1996	42
March 1997	58
June 1997	150

1. Create a regression equation to represent the trend in these data. Justify your choice of equation mathematically.
2.
  - Assuming that this trend continues, predict the number of swarms that California will have in June 2008. Support your answer.
  - According to the research that you did in part A, does this prediction seem reasonable? Explain why or why not.

### Part C

To produce fruit, crops such as almonds, apples, cucumbers, corn, and tomatoes require pollination. To aid the pollination process, many commercial produce farmers rent beehives and place them among the crops. Shown below is an example of a 160-hectare field that is part of a commercial farm in California. This field has 50% of its land designated for almonds, 15% for tomatoes, 25% for cucumbers, and 10% for corn.



1. How many hectares of each type of crop does this commercial farm have?
2. The optimal density for pollinating crops is 6 hives per hectare, and hives can be placed in groups of 10 to 20. The cost to rent one hive for one pollination period is \$36.40. Hives should not be placed within 50 m of a road or building.
  - How many beehives will the farmer need for optimal pollination of his crops?
  - What will it cost the farmer to rent sufficient hives for one pollination period?
  - Plan a layout for the location of the beehives in the farmer's field. Make a sketch of your layout, and briefly explain your plan.

## Part D

The Africanized honeybees have had a significant influence on the pollination industry. Each year, an annual report is produced that summarizes the data collected from commercial beekeepers in California. A dramatic increase in the average size of a commercial beekeeping operation has been noticed in the last few years. However, it should be noted that participation in the survey to collect data is voluntary.

A commercial beekeeper receives revenue from renting out his beehives to commercial produce farmers for pollination purposes and also from selling honey. Some of his production expenses include wages, costs to replace queen bees, and shipping costs. The chart below summarizes some of the changes to average revenue and average expenses that the commercial beekeeping industry has experienced since the infiltration of Africanized honeybees into California.

	1990	2000	2002
<b>Average number of hives</b>	765	2 055	4 255
<b>Average number of rentals</b>	2.58/a	2.36/a	1.75/a
<b>Average pollination rental price</b>	\$18.40/hive	\$32.85/hive	\$36.40/hive
<b>Average production expenses</b>	\$65 025/a	\$214 748/a	\$409 969/a
<b>Average wholesale price of honey</b>	\$0.55/lb	\$0.60/lb	\$1.25/lb

1.
  - Design a spreadsheet that can be used to compare the average net profit (or loss) per hive from hive rentals for 1990, 2000, and 2002.
  - Most commercial beekeepers also sell honey. Use your spreadsheet to determine the average number of pounds of honey per hive that must have been sold if the commercial beekeeper
    - broke even in each of 1990, 2000, and 2002
    - had a net profit of \$25 000 from hive rentals and honey sales in each of 1990, 2000, and 2002
  - Supply a printout of your spreadsheet showing these comparisons.

2. A particular commercial beekeeper in California, who rents hives out to commercial produce farmers, has noticed the following changes in his business:

- Because bee colonies that have been influenced by Africanized honeybees are more likely to abandon their hives, there has been a decrease in the number of hives that are available for rent. The hives that remain also produce less honey. As a result, the commercial beekeeper has increased his number of hives.
- Some expenses per hive have increased significantly. Workers demand higher wages because they now must wear heavy protective suits, and they need to work more during the night when the Africanized honeybees are not as aggressive. Purebred European honeybee queens must be purchased more frequently so that they mate with local drones and reduce the volume of Africanized honeybee blood in the hive.

The chart below summarizes some of the changes to revenue and expenses that this beekeeper experienced in 2000 and 2002.

	<b>2000</b>	<b>2002</b>
<b>Number of hives</b>	1 950	3 980
<b>Gross revenue from hive rentals and honey sales</b>	\$294 216.00	\$507 091.80
<b>Production expenses</b>	\$203 775.00	\$383 473.00

- Design a spreadsheet that can be used to determine the gross revenue per hive and the net profit per hive for this beekeeper in 2000 and 2002.
  - In 2000 and 2002, what percentage of revenue was profit?
  - What is the percentage increase or decrease in profit per hive from 2000 to 2002?
  - What does this indicate about the beekeeper’s operation?
3. • What percentage of the 2000 profit did the beekeeper make in 2002?
- From 2000 to 2002, the average annual inflation rate in California was 3.53%. If inflation is taken into consideration, how does the beekeeper’s net profit in 2002 compare with his net profit in 2000?
4. Based on your research from Part A, suggest some ways in which the beekeeper could increase his net profit per hive.

## ***Part E***

Between September 2006 and March 2007, 13 states reported that 26% of their beekeepers had lost half of their bee colonies to what some called “colony collapse disorder.” Research what may be causing this and what, if any, impact this may have on beekeepers’ colonies in Alberta.