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**EVALUATING  
HONEY BEE  
COLONIES  
FOR POLLINATION**

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**A GUIDE FOR  
GROWERS AND BEEKEEPERS**

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PNW 245 • Reprinted November 1993

**A Pacific Northwest Extension Publication  
Oregon • Idaho • Washington**



# Evaluating Honey Bee Colonies for Pollination

## A Guide for Growers and Beekeepers



**I**n the United States it is estimated that managed honey bee colonies are annually responsible for the pollination of agricultural crops valued between \$4 and \$8 billion. Honey bees are accurately described as indispensable pollinators.

The reasons for the success of honey bees as pollinators are seen in certain aspects of their biology. Honey bees forage for nectar and pollen from many thousands of plant species, so they efficiently pollinate a wide variety of crops we all consider important.

The second reason is that, while foragers from one hive may visit many species of plants in a given day, individual foragers display flower fidelity or constancy.

When a forager begins collecting nectar or pollen from the flowers of one species of plant, she will continue to visit flowers of *only that species* for at least one foraging trip and more often for several days, or until the resource is no longer producing nectar or pollen. This is obviously important to the plant she visits as it requires pollen from a flower of the same species for pollination.

The third reason honey bees are so successful in commercial agriculture is that colonies are mobile. Hives are easily moved to locations where native pollinators may not occur in sufficient numbers to adequately pollinate a specific crop.

Perhaps the most important question regarding pollination for the commercial grower is:

How many colonies are necessary to insure maximum pollination of a given crop?

This is a difficult question to answer because absolute pollination requirements are not established for most agriculturally important plant species.

Furthermore, bloom periods, bloom density, bloom attractiveness, blossom structure, competing bloom, and weather play major roles in determining how well honey bees will forage on and ultimately pollinate a given crop.

Finally, the quality of individual colonies needs consideration in determining how many to use. We designed this publication primarily to assist growers and beekeepers in evaluating the quality of colonies used in commercial pollination.

### What is a colony?

Honey bees are social insects. Look at a colony of honey bees as a family unit. A colony has a single queen, who is the sole female reproductive in the hive and is the mother of the sexually sterile female workers.

During periods of food abundance in the spring and summer, drones (male honey bees) will also be present in a healthy colony.

In addition to the adult bees, a healthy colony will also have *brood*, the collective term for eggs, larvae, and pupae (the immature stages in the life cycle of bees).

The population of a single colony of honey bees is not static. During the course of a normal year, a colony will have its lowest population of adult workers, approximately 10,000 to 15,000, in January and February. The colony will grow to a maximum of 50,000 to 60,000 workers by midsummer. The control and management of colony growth most frequently

depends upon the age and health of the queen and the skill of the beekeeper.

### Worker bees

These are short-lived. During the active foraging season (from March to October in the Pacific Northwest), a worker lives approximately 5 to 6 weeks. After an adult worker emerges from a pupal cell, her first 3 weeks are spent inside the colony serving as a “house” bee.

She goes through a series of tasks that includes cleaning comb, feeding larvae, secreting wax, building comb, accepting nectar loads from foragers, ripening nectar, ventilating the hive, and (for a short time) acting as a guard bee at the entrance of the colony.

When she is about 21 days old, she begins to take short orientation flights. This marks the beginning of her 2- to 3-week life as a forager bee, seeking nectar and pollen to bring back to the colony.

### Colony size and efficiency

You can probably appreciate that only the older worker bees in a colony serve as foragers. As a colony grows in worker population, the proportion of bees old enough for foraging increases.

As a general rule, smaller colonies send out a smaller percentage of bees as foragers. On the other hand, larger colonies send out not only more bees but also a higher proportion of the population as foragers.

The greater value of larger colonies for pollination can be illustrated by the amount of honey produced by colonies of different populations. The ability of a



colony to store surplus honey is a direct result of the number of bees foraging and the amount of forage available. It is the foragers that pollinate the flowers they visit.

Research has brought us these figures:

- One colony of 30,000 bees produces 1½ times as much honey as the sum of *two* colonies with 15,000 bees each.
- One colony of 45,000 bees produces 1½ times as much honey as *three* colonies with 15,000 bees each.
- One colony of 60,000 bees produces 1½ times as much honey as *four* colonies with 15,000 bees each.

The strength of the colonies a grower rents will be influenced by several factors:

*1. The time of year.*

The earlier a crop blooms in the season, the greater the likelihood that the colonies will not be as large as the same colonies

rented later in the season to pollinate another crop.

*2. Management of the colonies.*

Beekeepers can speed up or slow down the natural growth of their hives with a variety of techniques. Colonies provided with supplemental food such as sugar syrup and/or pollen supplement early in the season will be stimulated to grow more rapidly.

Colonies taken to California in December or January (primarily for almond pollination) will begin foraging earlier. Later on, they will be stronger than colonies left in the Pacific Northwest.

When the beekeeper brings such colonies back to our area, they will be in better

condition for early season pollination service. When beekeepers consider colonies overly strong early in the year, they often divide them or split them into several colonies, adding new queens to the new colonies. This is the method most beekeepers use to increase their colony numbers.

*3. Weight and size.* For commercial beekeepers—who often manage several thousand colonies—practical considerations (such as the number of hives they can haul on a given truck) are of prime importance.

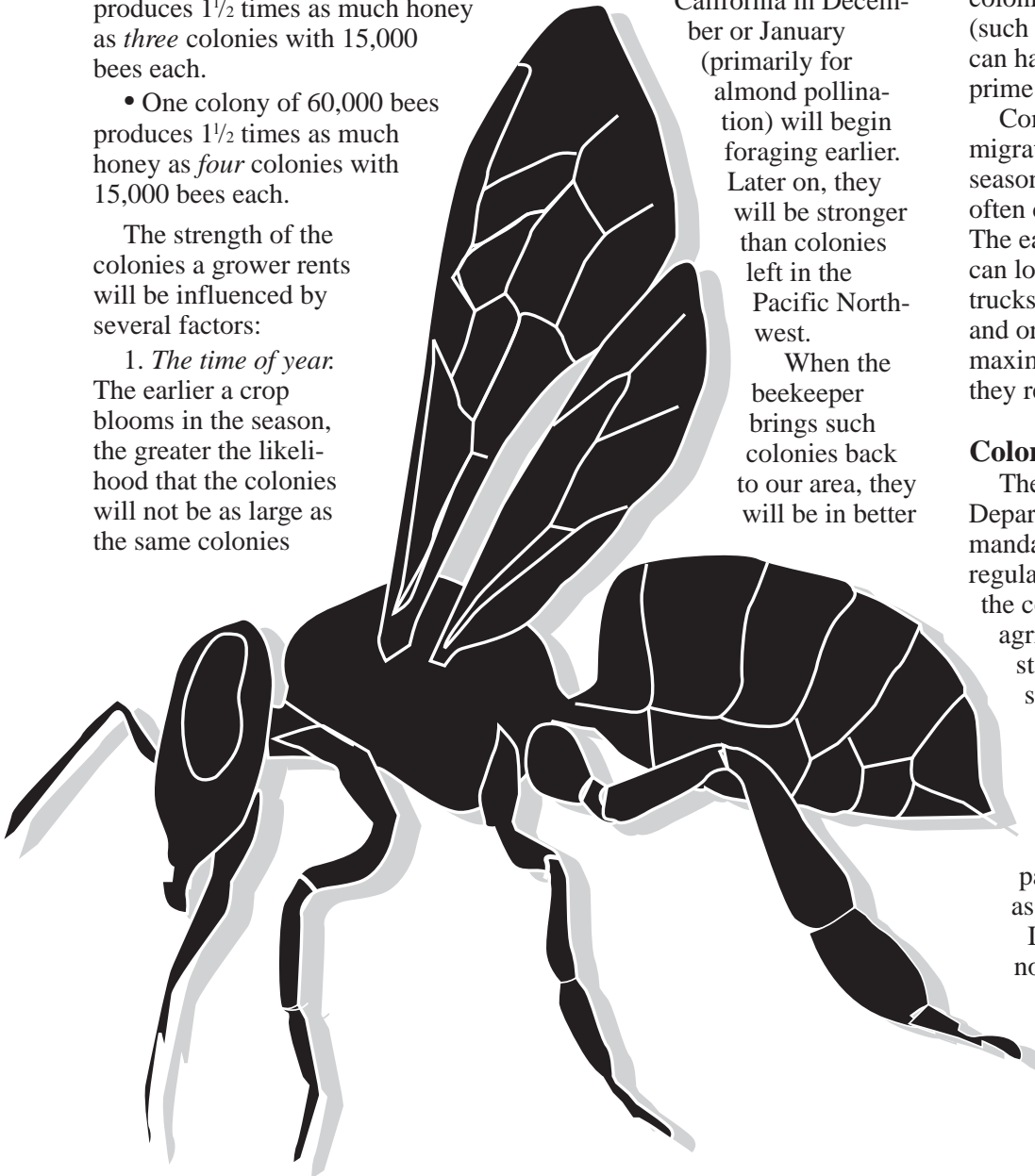
Commercial beekeeping is migratory in nature, and the seasonal movement of colonies often covers thousands of miles. The ease with which beekeepers can load colonies on and off their trucks and place them into fields and orchards often dictates the maximum size of the colonies they rent.

**Colony-strength regulations**

The Oregon and Washington Departments of Agriculture have mandatory colony-strength regulations for hives involved in the commercial pollination of agricultural crops within their states. Idaho does not have such regulations.

The regulations are designed to assure growers that colonies they rent will meet minimum biological standards. The box on page 7 outlines the standards as presently set forth.

In the Oregon regulations, note that while there are two grades (A and B), there are also two grade *types*, Field and Orchard. This recognizes the natural growth pattern of a honey bee colony. Colonies rented





for tree fruit pollination early in the season will not be as strong as the same colonies rented later

in the year for field or row crop pollination.

The colony grades, as defined by the regulations, can be more easily understood with a few explanations.

**Disease.** Two bacterial infections are significant for beekeepers, and it takes an experienced beekeeper to tell them apart. The difference between them, loosely, is that between cancer and a heavy cold.

American foulbrood is the most serious bee disease in North America. It simply means the death of the infected colony—it can't be tolerated at any time.

European foulbrood can be tolerated at low levels of infection, especially early in the season. It usually disappears in a month.

**Amount of comb.** Rather than mandate a specific type or physical size of a pollination unit, Oregon sets out the amount of comb required. This is preferable, as different sizes of hive bodies are regularly used.

A standard unit, used by most beekeepers, is the Langstroth deep-hive body (see figure 1). When used with 10 frames, it provides 2,700 square inches of comb. A common variation is eight frames deep, with 2,160 square inches of comb. Oregon requires 3,000 square inches of comb.

Therefore, a pollination colony requires more than one standard deep-hive body, or its equivalent. A commonly used unit is two standard deeps (see figure 2) or one deep (2,700 square inches) with an additional semideep-hive body (2,000 square inches).

**Amount of brood.** As we mentioned above, a healthy honey bee colony during the foraging season will possess



Figure 1.—A standard one-story colony consisting of one 10-frame-deep super. This unit would not meet the minimum requirements for amount of comb under the Oregon regulations, but it would meet Washington Department of Agriculture regulations.



Figure 2.—A standard two-story colony, consisting of two 10-frame-deep supers. This colony possesses 5,400 square inches of comb. Typical pollination colonies might substitute a semideep or western super in place of the second deep super. In either case, the unit would meet either Oregon or Washington Department of Agriculture regulations for amount of comb in a standard pollination unit.



eggs, larvae, and pupae. Brood indirectly influences the pollinating efficiency of a colony.

Larvae require food, especially pollen. Many studies have shown a direct correlation between the amount of brood in a colony and the amount of pollen returned to the hive by the foragers.

Grade A Orchard colonies are required to have 600 square inches of comb occupied by brood. Grade A Field colonies must have 1,000 square inches (one standard deep comb, if fully occupied, would have 270 square inches of brood).

Brood combs are rarely, if ever, completely filled by brood, but a good queen on a good comb will create a brood area that often occupies 90 to 95 percent of the comb space (see figure 3).

A Grade A Field colony should have six combs well filled with brood, and a Grade A Orchard should have four frames well filled.

**Number of bees.** Since the older bees in a colony do the pollination, the regulations take into account the relative number of bees a colony should have. Grade A Orchard colonies require six standard Hoffman combs to be well covered by adult bees; Grade A Field, ten standard Hoffman combs. (A Hoffman comb is a standard deep comb, 270 square inches.)

How many bees are on a well covered standard comb? Studies at Oregon State University have shown that one standard comb, when completely covered, accommodates about 2,400 adult bees (see figure 4).

Simple multiplication then shows that a Grade A Orchard colony must have 14,000 adult bees. The Grade A Field colony must have 24,000 adults.

Washington's standards are stated somewhat differently. The number of adult bees, "six frames,

two-thirds covered with bees at a temperature of 65°F," will not reflect all the bees in the colony, as

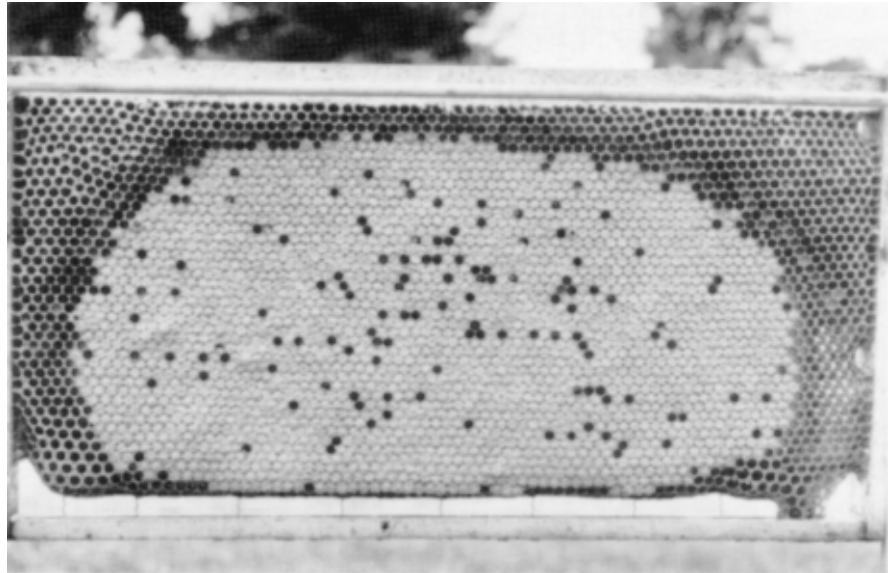


Figure 3.—A standard deep Hoffman comb with brood. For illustrative purposes, the worker bees have been removed. This comb is approximately 70 percent filled with capped brood (pupae). The picture is only one-half of the comb; for inspection purposes, both sides of the comb would need to be examined. This is a typical brood pattern for a young queen in good health. The top corners of the comb are filled with ripening nectar, and a narrow band of stored pollen is between the nectar and the brood.

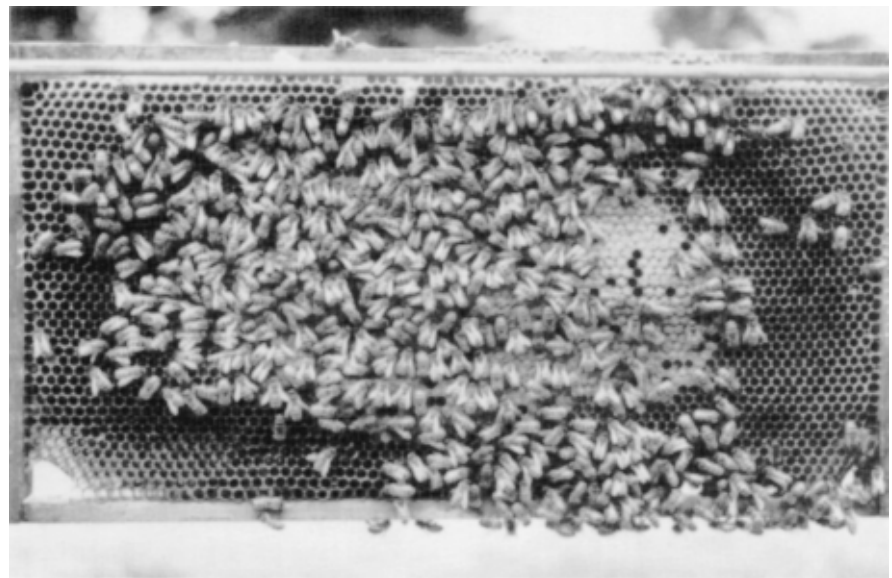


Figure 4.—A standard deep Hoffman comb with brood and adult bees. This comb side would be rated as 50 percent covered with adult bees. To estimate the amount of brood accurately, the bees would need to be shaken off the comb. There are approximately 600 worker bees in this photograph.



about one-third more adults than measured would be foraging. Therefore, the total number of adults in a minimum standard colony would be approximately six frames fully covered or 14,400.

**Food requirement.** A colony of honey bees requires nectar and pollen for normal growth. The food requirement of a hive is met in two ways, by the daily activities of foraging bees and from food stored in the combs.

An overwintered colony should never be allowed to have its stored food reserves drop below 10 pounds. Inclement weather is a frequent feature of early flowering crops such as tree fruit.

A colony unable to forage for even 2 or 3 days during poor weather can easily exhaust 10 pounds of honey in that short a time. Starvation could rapidly mean the death of that hive and the loss of its benefits for pollination.

**A normal queen.** The queen is the sole egg layer in a healthy colony and the heart of the hive. Without her, a colony will not increase in size because normal replacement bees will not be produced to compensate for the natural mortality of the older bees.

Eventually, a queenless colony will have no brood and, therefore, no stimulus for bees to collect pollen. As a general rule, production colonies should have queens less than 2 years old. The reason is that, as a queen ages, her ability to lay eggs decreases.

The egg-laying capacity of a queen 3 or more years old is usually not enough to maintain a colony at proper strength for pollination or honey production.

**Grade B colonies.** In the Oregon regulations, these are hives that fail to meet Grade A standards on the amount of bees and brood by not *more* than 25 percent—but do meet all other requirements of a Grade A colony.

These units for orchard pollination would have at least 450 square inches of brood, 4½ frames of bees, and approximately 10,800 adults. A colony of this size would be of minimum pollination value.

A Grade B Field crop unit would have a minimum of 750 square inches of brood and 7½ frames of bees, or approximately 18,000 adults.

Notice that a Grade B Field crop unit is stronger than a Grade A Orchard colony.

It is relatively simple to describe colony-strength standards for pollination. In the field, colony-strength inspections require opening the hives and removing combs to examine the biological activities within the colonies. This is a practice most non-beekeepers would rather avoid!

However, beekeepers who rent colonies for commercial pollination should be willing to open their hives and show the grower the quality of the units to be rented. Beekeepers will usually provide the grower with the necessary protective garments such as a veil and gloves.

We suggest that growers ask their beekeepers to randomly open portions of the hives, so that the growers can indeed see what they are paying for.

Ideally, colony inspections should take place in mild weather that allows for good bee flight. Growers should *not* attempt to

conduct in-hive inspections without the beekeeper's permission. Even gentle bees will offer a stiff defense if they're examined in cool, windy, or rainy weather—especially by an inexperienced person.

Colonies can also be examined with some degree of accuracy *without* opening them and inspecting combs. On a good foraging day, when the temperature is above 60°F (preferably above 65°F), a grower can observe the flight activity of the colonies. Good colonies will have relatively uniform flight from each hive.

Preliminary data from Washington State University indicate the colony is a good pollinating unit if there are more than 100 incoming bees per minute at 65°F and above, with winds less than 10 miles per hour.

By standing close to (but *not* in front of) the hive entrances, growers can examine incoming bees for the presence of pollen pellets attached to the pollen baskets of their hind legs.

On the average, one-fourth to one-third of the returning bees will be pollen foragers, as opposed to nectar collectors. However, this percentage will vary, depending upon the crop, the time of year, the time of day, and the amount of brood in a hive.

Rented colonies should be of uniform physical size, but remember that the quality of the colony *inside* the hive is not always related to the *outward* appearance of the hive bodies. A fresh coat of paint—or the lack of it—has no relationship to the number of bees in a hive!



## Oregon and Washington colony-strength regulations

### Oregon

*From Oregon administrative Rules, Chapter 603, Section 55-005, filed with the Secretary of State August 17, 1960, as Administrative Order AD 643.*

55-005 BEES. (1) As used in this section:

(a) European foulbrood shall be deemed serious if 20 or more larvae are found dead from this disease and more than 20% of the cells in the capped brood area are vacant.

(b) A queen shall be deemed a normal laying queen if her eggs that are in the worker cells are producing worker bees as indicated by the brood present.

(2) Oregon *Standard* (or Grade A) Field colony of bees for pollination shall be one that meets the following requirements:

(a) Free from American foulbrood and not seriously infected with European foulbrood or other bee disease.

(b) 3,000 square inches of comb, 1,000 square inches of which shall be occupied by live brood.

(c) Bees to cover well all brood. There shall be enough bees to cover well 10 standard Hoffman frames of comb or their equivalent.

(d) 10 pounds of honey or its equivalent of suitable bee food other than pollen or pollen substitute.

(e) A normal laying queen present.

(3) Oregon *B grade* Field colony of bees for field crop pollination shall be one that fails to meet the requirements of a standard field colony on amount of bees and brood by not over 25% but does meet all other requirements of a standard field colony.

(4) Oregon *Standard* (or Grade A) Orchard colony of bees for orchard pollination purposes shall be one that meets the following requirements:

(a) Free from American foulbrood and not seriously infected with European foulbrood or other bee disease.

(b) 3,000 square inches of comb space of which 600 square inches shall be occupied by live brood.

(c) Bees to cover well all brood. Bees to cover well at least 6 standard Hoffman frames of comb or their equivalent.

(d) 10 pounds of honey or its equivalent in suitable bee food other than pollen or pollen substitute.

(e) A normal laying queen present.

(5) Oregon *B grade* Orchard colony of bees for orchard pollination shall be one that fails to meet requirements for a standard orchard colony by not more than 25% on amount of bees and brood but does meet all other requirements of a standard orchard colony.

(6) To allow for variations incident to proper grading a tolerance of 10% shall be allowed on all defects other than diseases and queens.

### Washington

*From Washington Department of Agriculture Apiary Regulations, Chapter 15.60, Order No. 1582. Effective October 27, 1978.*

WAC 16-602-030 Colony Strength.

The official minimum standard required for colony strength certification in the State of Washington shall be six frames, two-thirds covered with bees at a temperature of 65°F.

**Colony flight.** Bees must have suitable light and temperature before they begin foraging. A general observation is that stronger, more populous hives will begin foraging at a lower temperature than weaker, smaller colonies. Even so, only rarely will honey bees fly at temperatures below 55°F.

As the outside temperature increases to about 70°F, the

number of bees foraging from a given colony increases. Here's a rule of thumb for relating *spring-time* temperatures to foraging:

- 55° to 60°F—some foraging
- 60° to 65°F—a moderate to fair amount of foraging
- 65° to 70°F and above—the maximum amount of foraging

During *midsummer*, the same colonies will often not start

foraging till the temperature reaches 70°F. The bees' "acceptable foraging temperature" apparently shifts with colony requirements and the season.

**Department of Agriculture colony inspections.** If you are concerned that a colony you have rented is not strong enough for the job, you can request an inspection of the hives, in Oregon and



Washington, by the apiary inspection service at your state department of agriculture. (The Idaho Department of Agriculture does not offer colony-strength inspections.)

A state bee inspector will then examine the hives for grade standards and will charge you for the service at an hourly rate.

In Oregon, phone the Commodity Inspection Division, Department of Agriculture, Salem (503-378-3774). In Washington, phone the chief apiary inspector, Department of Agriculture, Yakima (509-575-2756).

### **Recommendations for renting bees**

It is wise to contact your beekeeper long before the anticipated bloom period of your crop.

In order to schedule the movements of their hives, beekeepers need to know well in advance the time their colonies will be used.

**Use of a contract.** For many growers and beekeepers, the use of a written pollination contract has not been necessary. However, a written contract is often advisable for growers who use a new beekeeper, or for beekeepers who service a new grower.

Whatever the situation, both grower and beekeeper need to understand various aspects of the rental. These include—but are not limited to—the following points:

1. *Number of colonies* to be provided.
2. *Guaranteed colony strength.*
3. *Timing* of colony movement into and out of the crop.

4. *Placement* or distribution of the colonies within the crop.

5. *Colony rental fee* and *schedule of payment.*

6. *Right of entry* to the beekeeper, for colony maintenance.

7. *Advance notice* to the beekeeper if any pesticide that is toxic to bees will be applied while the colonies are in the crop.

Growers need to appreciate the value of a strong colony of honey bees in maximizing crop yields.

Consider the rental of honey bees *not* as a guarantee of crop success, but rather as a guarantee against crop failure.

A working partnership between a grower and a beekeeper best assures the maximum use of honey bees as pollinators.

**This publication** was prepared by D.M. Burgett, professor of entomology, Oregon State University; Glenn C. Fisher, Extension entomology specialist, Oregon State University; Daniel F. Mayer, Extension entomologist, Washington State University, Irrigated Agriculture Research and Extension Center, Prosser; and Carl A. Johansen, professor of entomology emeritus, Washington State University.

Published and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914, by the Oregon State University Extension Service, O.E. Smith, director; Washington State University Cooperative Extension, Harry B. Burcalow, interim director; the University of Idaho Cooperative Extension System, LeRoy D. Luft, director; and the U.S. Department of Agriculture cooperating.

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