

Great Lakes Fruit, Vegetable & Farm Market EXPO

December 4-6, 2007

DeVo Place Convention Center, Grand Rapids, MI



Pollination

Wednesday morning 9:00 am

Where: Grand Gallery (lower level) Room A-B

Recertification credits: 1 (1A,1B,1C, PRIV CORE)

CCA Credits: PM(2.0)

Moderator: David Epstein, Tree Fruit IPM Integrator, MSU

9:00 a.m. Honey Bee Colony Health and Agricultural Production

- Steve Sheppard, Entomology Dept., Washington State Univ.

9:30 a.m. Michigan's Honeybee Losses in 2007, and How Beekeepers Responded

- Michael Hansen, State Apiarist, Michigan Dept. of Agriculture

9:50 a.m. Working with Your Beekeeper for Optimal Pollination of Fruits and Vegetables

- Walter Pett, Entomology Dept., MSU
- Zachary Huang, Entomology Dept., MSU

10:10 a.m. What Growers Need to Know About Pesticide Safety Around Bees

- David Epstein, Tree Fruit IPM Integrator, MSU

10:30 a.m. Native Bee Biology and Bee Conservation Strategies for Michigan Farms

- Julianna Tuell, Entomology Dept., MSU
- Rufus Isaacs, Entomology Dept., MSU

10:50 a.m. Pollinator Protection Programs for Specialty Crop Growers - Making the Farm Bill Work for You

- Scott Hoffman-Black, The Xerces Society, Portland, OR

Michigan Honeybee Losses in 2007 How Beekeepers Responded

Michael G. Hansen, State Apiarist
Michigan Department of Agriculture

In State Bee Losses

- By beekeeper: 06/07 losses range from 7% - 100%,
- Most due to freezing and starvation compounded by brood diseases and parasitic mites.
- Most losses could be explained. CCD was not found in bees that overwintered in Michigan.
- Build up of in-state colonies relies on availability of replacement packages and queens. Beekeepers can increase or replace colonies by splitting remaining colonies if they are strong enough.
- Note that beekeepers in the UP had normal winter losses – freezing related to food resources, not just cold.

• Nutrition/Weather:

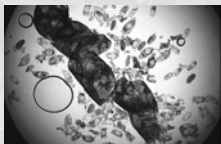
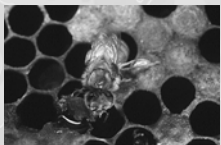
- Summer of 2006 – Dry and hot
- Fall of 2006 – Wet
 - Availability of Pollen Resources
 - Poor pollen production
 - Poor quality
 - Variety of Pollen
 - Honeybee diets require a broad range of pollens to ensure adequate nutrition. Not all pollens are equal in terms of vitamins or other measures of nutrition.
 - Inadequate brood development, young bees don't take over before older bees die.

Weather Change

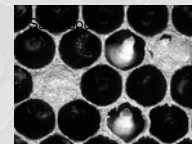
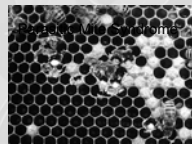
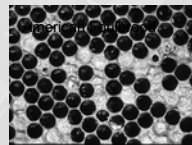
- December and January, Warm
 - Active bees use more honey.
- Deep freeze, late January, early February
 - Sudden change/bees cluster tightly.
 - Unable to locate food resources in the colony.
 - Location of food in a colony is critical.
- Result: bees die from starvation and freezing even with food resources in the colony.

Parasitic Mites

- Varroa Mite
 - External parasite
 - Reproduces in the cell
 - Deforms/Kills young bees as they develop
 - Moves from colony to colony on drifting bees
- Tracheal Mite
 - Internal parasite
 - Entire life cycle in trachea
 - Quests to locate juvenile bees
 - Damages young bees by sucking hemolymph, destroying the trachea.

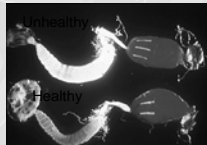
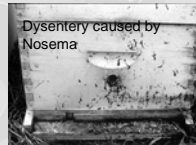


Brood Diseases



Brood Diseases

- Nosema disease: spore forming Protozoan
- *Nosema apis*
 - Easily controlled with preventive treatments.
- *Nosema ceranae*
 - Recently identified in US
 - Serious honeybee losses in EU.
 - Requires multiple treatments.
 - Affects adult bees.



Pesticides and Bees

- Beekeepers using several products to control mites. Mite resistance to labeled products is high.
- Field loss of bees when moved for pollination is estimated at 10% for each move.
- Interaction with pesticides compounds adult losses.
- Use of surfactants with fungicides?

Colony Collapse Disorder

Symptoms

- Sudden loss of adult bees, lack of dead bees in or in front of the colony.
- Honey and pollen stores usually present.
- Queen and a small number of survivor bees may be present in the brood nest.
- Presence of capped brood.
- Robbing delayed and slower than normal invasion by wax moth and small hive beetles.
- Insufficient work force.

Colony Collapse Disorder: CCD

- Nosema: Ruled out
- Mad Bee Disease (Gaucho): Ruled out
- Mite loads: Ruled out
- Migratory beekeepers: Some had high losses to CCD, others none – each situation different.
- IAPV: present, but not believed to be the cause.

Colony Collapse Disorder

- Response:
 - National attention: Media, Legislative, Research.
 - USDA, Penn State and others form CCD Workgroup.
 - Samples collected from both healthy and collapsing colonies
 - Few common denominators for colonies that were crashing, except for stress.
- Farm Bill Authorizes up to \$20 Million for research over 5 years.

Michigan CCD Losses?

- CCD was reported by Michigan beekeepers while their bees were in southern states. CCD was not observed in Michigan.
- In 2006/07, approximately 5000 Michigan colonies may have died from CCD. (Per comments from beekeepers)
- Most losses occurred early in the winter.
- Michigan beekeepers rebuilt prior to spring pollination in Michigan.
- Bees looking much better this fall.

US Queen and Packaged Bees

- 8 lines of bees being produced in the US
 - Concern about genetic diversity.
- Limited number of producers
- Hawaii now has Varroa Mite
- Queen/Package industry cannot quickly respond when severe colony loss occurs.
- Rush to market queens affects quality.

Michigan Bee Movement

- 1993, changes in Michigan Apiary Law
 - Beekeepers allowed to move freely into and out of the state.
 - Inspections done only to certify bees for movement.
 - There is no bee registration, data for honeybees is an estimate at best.
- Michigan has an estimated 100,000 colonies in the summer. (72,000 listed in Ag Statistics)
- More than ½ of the colonies move south in the winter. Many of those go to California for part of the winter.
- Beekeepers moving so they can treat colonies in warmer weather, prep for spring pollination.

Pollination

- California: Almonds lure 1.2-1.6 million colonies of honeybees for pollination.
\$120-\$160 per colony for pollination.
 - US population of honeybees: 2.5 Million colonies.
 - Could be 30,000 colonies from Michigan.
- Maine: Lowbush blueberry pollination, 60,000 colonies in 2 counties.
\$75-\$85 per colony.
- Michigan: Bees pollinate at least 60 crops.

Africanized Bees



Small Hive Beetle

- Beetle feeds on pollen and eggs
- Larvae leave a slimy trail, distasteful to bees.
- Larvae pupate in the ground.
- Prefers a hot climate.
- Pest of regulatory concern for some states.



Importing bees?

- Federal Bee Act
- Permits:
 - Australia, New Zealand: 2004
 - Aussie bees were used in Michigan in 2007.
 - Other requests: Argentina? Mexico?
- National Survey to determine baseline for North American honeybee pests and diseases.
- USDA Research looking to increase bee diversity through imports of semen.

Except where noted, photos were taken from the Mid Atlantic Apiculture Research and Extension Consortium webpage: <http://maarec.cas.psu.edu/index.html>

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Working with your beekeepers for optimal pollination for fruits and vegetables

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Importance of honey bees to Michigan agriculture

Due to their large numbers, easy transportation, and special adaptation for efficient foraging (e.g. dance language), honey bees (*Apis mellifera* L.) play a critical role in Michigan and US agriculture. The value of the primary fruit and vegetable crops in Michigan that depend on pollination was approximately \$422 million in 2005. Inadequate pollination of fruit and vegetables results in greatly diminished yields and reduced quality (McGregor, 1976). All important crops (such as apple, blueberry, cherry, and cucumber and pumpkins) in Michigan depend heavily on honey bees. Therefore without honey bees to supply pollination services, most fruit and vegetable producers would be forced out of business and Michigan's agricultural industry would be devastated. Nationally, the value of honey bees due to pollination is estimated to be around \$14.6 billion per year (Morse and Calderone, 2000).

The decline of honey bees, a national trend

Despite the importance of honey bees, the beekeeping industry has been in decline since two parasitic mites, varroa and tracheal mites, invaded US in the 1980s. Varroa mites (*Varroa destructor*) have nearly totally wiped out the feral (unmanaged) honey bee population in the US (Kraus and Page, 1995) and managed honey bee colonies have been declining mainly due to more complicated management because of the mites. For example, in Michigan alone, the total number of honey producing colonies has decreased from the 95,000 in 1988 to 65,000 in 2006. This is almost a 1/3 reduction of managed bee colonies during the last 16 years. About 30,000 of these colonies are "migratory", whereby beekeepers move their bees to southern states (e.g. FL, GA) to overwinter their colonies, and come back in April for fruit tree pollination.

Colony collapse disorder (CCD)

The most recent crisis in honey bee population is the so called CCD (colony collapse disorder), which has been literally the news of the nation during 2007. The disorder has the symptoms of bees "disappearing" and a colony seemingly healthy in September would have no bees left, or a handful of bees left with the queen, around October/November. This disorder was large in scale, it has been reported in 25 different states (CCD Working Group, 2007a). The disorder is also severe, with large beekeepers (5,000 to 9,000 colonies) losing up to 90% of their colonies (CCD Working Group, 2007b). Luckily, in Michigan only about 6,000 colonies (out of a total of 65,000 colonies) were reported to be affected in 2006. The cause of this disorder is still unknown and honey bee scientists all over the country are studying the problem. The earlier report that the Israeli Acute Paralysis Virus (IAPV) could be the cause of CCD is now in doubt as the virus is found in bee samples as early as 2002.

In light of these problems of honey bees, the growers are urged to work even more closely with beekeepers to ensure good pollination result. We feel that the following steps can help growers to optimize their fruit and vegetable pollination.

1. **Understand basic honey bee biology and behavior** Understanding some basic bee biology and beekeeping will facilitate your inspection of the hives, gauging of quality/strength of the hives, and help maximize the use of bees for your pollination.
 - a. **Social structure.** Honey bees are social insects and only the sterile female workers do all the in-hive work (cleaning, drying nectar into honey, feeding young) and outside work (foraging for water, pollen, nectar and propolis, and colony defense). The queen's only job is to lay about 2,000 eggs per day and releases queen mandibular pheromone to let the workers know that she is present and healthy. The males' (drones) only job is to mate with queens and are produced only during May to August. A typical colony of bees have about 30,000 workers, one queen and a few to hundreds of drones. About 1/3 of these workers are foragers. Foragers show flower constancy so that they tend to focus on flowers of a single species, resulting more efficient pollination.
 - b. **Internal factors affecting foraging behavior.** To provide adequate pollination, honey bee colonies must be of sufficient strength, free of diseases, having a laying queen, and with enough "brood" (immature stages which include eggs, larvae and pupae). A newly installed package bee colony, with 2 lbs of bees, would have about ~9,000-11,000 workers and is considered on the weaker side. Such a colony would concentrate heavily on brood rearing and only have about 1,000-2,000 foragers, only stronger colonies would send out about 30% of bees as foragers. A typical median strength overwintered colony would have about 30,000 workers and can send out 10,000 foragers. If you are comfortable checking bees, check for the presence of chalkbrood, American foulbrood and varroa mites. In general, 3-5 frames of solid brood suggest a fertile queen and a healthy colony.
 - c. **External factors affecting foraging behavior.** Environmental factors also affect honey bee foraging. Bees do not work in the rain and work less on cloudy days. Foraging activity is positively related to temperature, with a linear relationship from 60-90°F. Bees also slow down when it gets too hot (over 90°F). High winds (above 20 mph) will inhibit flying activity. Bees tend to fly lower, near the orchard floor when winds are high. Bumble bees can forage at lower temperature and lower light conditions.

Daytime sprinkling irrigation of vine crops will reduce yield by discouraging honey bee visits. Bees do not like to get wet while in flight, they also will avoid visiting flowers filled with water. In addition, too much water getting into the flowers will also disrupt pollen germination. For these reasons it is better to sprinkle the crops at night or early in the morning before honey bees are actively foraging, or use drip irrigation.

2. **Finding a beekeeper nearest to you.** Zachary Huang has established a database of beekeepers who are willing to provide pollination services, with over 420 beekeepers registered. The majority of them are from Michigan. Go to <http://cyberbee.net>, click beebase on the left, then click #2 "For beekeepers providing pollination services" and you have a choice to search beekeepers by area code, county, zip code, or a last name. Once you have a working relationship with a beekeeper, it is best to keep working with the same one year after year.

3. **Pest Management During Pollination.** Do not apply broad-spectrum insecticides when flowers are open. Bee hives should be removed immediately after pollination if post-bloom pesticide applications are planned. By monitoring for pest problems carefully during bloom, growers can help minimize the need for pest control. If an insecticide application is necessary during bloom, the compounds that are least toxic to bees should be used, with careful observation of the pollinator-restrictions on the label. In general dust form is more harmful to honey bees, and morning or day applications are not as safe for bees as evening applications. Inform the beekeeper before a spray so that colonies can be shut down for 1-2 days with

wetted burlap blocking entrances, if highly toxic insecticides have to be sprayed. This database lists the toxicity of various pesticides to honey bees: <http://apiculture.com/databases/pesticides.htm>.

4. Different strategies for different crops

Use the “early” strategy for tree fruits and vine crops. For tree fruit crops, it is advantageous to have bees working the flowers as soon as they open. This provides multiple benefits. It improves the odds that fertilization will occur before the ovules start to lose vigor (this can happen in only three days on some crops), flowers are more likely to receive the multiple visits needed to deposit enough pollen, and in many crops it is important to pollinate the first flowers (cherry) or “king blossoms” (apple) because they set the best fruits.

Cucurbit flowers (cucumber, squash, pumpkin, melons) are open for only one day, and unpollinated female flowers will abort and drop off if pollen is not received on that same day. For pickle cucumbers, honey bees are crucial because most varieties now are gynoecious (mostly female flowers, with another variety to provide pollen) and mechanical harvest requires quick fruitset and more even ripening. Honey bee colonies should be moved into the field or on its border 2-3 days before the first female flowers are to bloom.

Use the “late” strategy for small fruit crops

Generally, flowers of small fruit crops are less attractive to honeybees than other flowers due to flower shape and less nectar, so the opposite strategy is used. Let the crop starting to bloom before bringing bees in so that bees tend to forage more on your crop. If brought in too early, bees will learn to forage elsewhere and when crops bloom, they are not attractive enough to get the bees “back” to where you want them. Blueberry flowers have about 3 days to be pollinated after the flowers open, but you want the bees to stay in the field, so move bees into blueberry fields after 5% bloom but before 25% percent of full bloom. The “late” strategy is especially important for cranberries, which is not very attractive to bees. Luckily, cranberry flowers will stay open for a while if not pollinated, and the petals will turn to a rosy color if not pollinated in time. In cranberries, it is better to wait until 10% bloom in order to maximize the yield. If you see too many flowers turning rosy, this means you did not have enough pollinators, so make sure you increase the number of bee hives next year.

5. Hive density recommendations. Because Varroa mites had wiped most of our feral (unmanaged) honey bee populations, recommended rates for pollination prior to 1987 have to be increased to compensate the lack of “free” honey bees. The table below lists recommended rates for hive density. From an economic point of view, it is best to start with the highest hives you can afford, then cautiously reducing it next year and see if your yield is affected. An alternative method is to stock different densities and determine if yield is different later.

Table 1. Recommended density of honey bee colonies (per acre) for Michigan crops.

Crop	Colonies	Notes
Apple	1-3	The more dwarf varieties need more hives
Sweet cherry	1	Balaton may need more
Pear, Plum, Peach	1	
Blueberry	3	Cultivars vary in their dependence on pollination
Cranberry	3	
Raspberry, strawberry	1	
Grape	0	Wind pollinated
Pickles (hand harvested)	1	
Pickles (machine harvested)	2-3	

Internet resources

- Honey bees as pollinators: <http://cyberbee.net/column/pollinator/beepoll.pdf>
- Bumble bees as pollinators: <http://cyberbee.net/column/pollinator/bumblepoll.pdf>
- Pollination and pesticides <http://cyberbee.net/column/pollinator/pesticides.pdf>

Cited References:

- CCD Working Group. 2007a. Map of CCD distribution.
<http://www.ento.psu.edu/MAAREC/pressReleases/CCDMap07FebRev1-.jpg>
- CCD Working Group. 2007b. Map of CCD distribution. CCD Frequently Asked Questions (FAQ).
<http://www.ento.psu.edu/MAAREC/FAQ/FAQCCD.pdf>
- McGregor, S. E. 1976. Insect pollination of cultivated crop plants. USDA-ARS, Washington, D.C.
- Morse, R. A., and N. W. Calderone. 2000. The value of honey bees as pollinators of U.S. crops in 2000. Bee Culture: 2-15
- Kraus, B. & R.E. Page, Jr. 1995. Effect of *Varroa jacobsoni* (Mesostigmata: Varroidae) on feral *Apis mellifera* (Hymenoptera: Apidae) in California. Environmental Entomology 24: 1473-1480

What Growers Need to Know About Pesticide Safety Around Bees

David Epstein, MSU IPM Program Tree Fruit Integrator, Dept. of Entomology

Honeybees and other bee species (orchard mason bees, alkali bees, alfalfa leafcutting bees, bumblebees, andrenid bees, sweat bees, and carpenter bees) are estimated to contribute \$20 billion to US agricultural production annually by providing pollination services (Clemson University, 2007). Beekeepers have recently been experiencing serious losses with the abrupt disappearance of worker bees from colonies, a phenomenon termed Colony Collapse Disorder (CCD). As agricultural chemicals are suspect in contributing to CCD, a review of the published literature apprising growers to safe use of current pesticides will be presented.

Pesticide toxicity has traditionally been measured in terms LD50, or the acute lethal dosage necessary to kill half of the tested population, and subsequent recommendations on pesticide use were then based on a chemical's lethal dose toxicity to bees. The appearance of large numbers of dead bees at a hive entrance served as the predominant means of determining honeybee poisoning from pesticide use in the field. With the widespread occurrence of CCD, though, recent research in pesticide toxicity to bees has shifted focus to study the sublethal effects of agricultural chemicals on bee physiology and behavior. In addition to direct pesticide contact, sublethal exposure may be due to pesticide uptake by the plant and translocation to pollen and nectar (Bonmatin et al 2005). Chauzat et al (2006) report that the neonicotinoid, Imidacloprid, was found in 49% of pollen samples collected in a broad survey conducted in France. Honeybees store pollen in the hive for feeding developing larvae. Sublethal effects of pesticides currently being investigated include effects on general biochemistry and enzymatic processes that affect development and longevity, immune system function, brain function, olfaction, reproduction, mobility, navigation, feeding, and learning performance (Decourtye et al 2004, Desneux et al 2006, Tasei 2001).

Growers can take measures to help protect bees from pesticide exposure (Clemson 2007, Riedl et al 2006):

- 1) Do not apply insecticides during the bloom period when bees are actively foraging in the field, only while target plants are in the bud stage or just after the petals have dropped. Carbaryl (Sevin), used as a blossom thinner can be hazardous to bees,
- 2) Move hives before spraying. If can't move hives, cover w/wet burlap prior to spray, keep covered 2-3 days. Covering colonies with plastic sheeting can result in overheating, leading to bee suffocation and death.
- 3) Place hives on hilltops to avoid chemical drift,
- 4) Most bee kills from pesticides occur during the 1st 24 hrs after application; if using highly toxic pesticides keep bees out for 48-72 hrs. 4) Observe all label requirements, and observe restrictions that protect bees.
- 5) Apply pesticide when bees are not flying: Bees fly when the air temperature is above 55-60°F and are most active from 8AM to 5PM During most summer evenings, honeybees leave fields by 8PM and do not return until 8AM. the following day.
- 6) Always check a field for bee activity immediately before application. Unusually low temperatures can increase time that toxic residue remains on crop.

- 7) Identify and remove attractive blooms (weeds, such as dandelion) before treating a field with pesticides,
- 8) Do not contaminate standing water with pesticides or drain spray tank contents onto the ground, creating puddles. Bees will consume and bring contaminated water back to the hive,
- 9) Use less toxic compounds and formulations. Granular formulations are the least hazardous to bees. Microencapsulated insecticides are the most toxic formulation to bees. Dusts and wettable powders tend to be **more** hazardous to bees than solutions or emulsifiable concentrates
- 10) Do not use systemic pesticides used before bloom

All label restrictions for honeybees should also be observed for protecting orchard mason, alfalfa leafcutting, alkali, bumblebee, andrenid, sweat, and carpenter bees from pesticides. Orchard bee nests can be removed from the field and stored at 45°F for up to 4 days (Riedl et al 2006). If applying captan, carbofuran, Lorsban, dimethoate, malathion ULV, or Supracide, placement of orchard bee nests in the field should be delayed for 7 days (Riedl et al 2006).

Literature Cited

Bonmatin, J. M., P. A. Marchand, R. Charvet, I. Moineau, E. R. Bengsch and M. E. Colin. 2005. Quantification of Imidacloprid Uptake in Maize Crops. *J. Agric. Food Chem.* 53, 5336-5341.

Chauzat, M. P., J. P. Faucon, A. C. Martel, J. Lachaize, N. Cougoule and M. Aubert. 2006. Survey of Pesticide Residues in Pollen Loads Collected by Honey Bees in France. *J. Econ. Entomol.* 99 (2): 253-262

Clemson University Department of Pesticide Regulation. 2007. How to protect honeybees from pesticides, <http://dpr.clemson.edu/Acrobat/Bulletin%205%20protecting%20honeybees.pdf>

Decourtye, A., C. Armengaud, M. Renou, J. Devillers, S. Cluzeau et al.(2004). Imidacloprid impairs memory and brain metabolism in the honeybee (*Apis mellifera L.*) *Pestic. Biochem. Phys* 78:83-92

Desneux, N., A. Decourtye, and J-M Delpuech. 2007. The sublethal effects of pesticides on beneficial arthropods, *Annu. Rev. Entomol.*, 52: 81-106

Riedl, H, E. Johansen, L. Brewer, and J. Barbour. 2006. How to reduce bee poisoning from pesticides, A Pacific Northwest Extension publication, PNW 591, <http://extension.oregonstate.edu/catalog/pdf/pnw/pnw591.pdf>

Tasei, J-N. 2001. Effects of insect growth regulators on honey bees and non-*Apis* bees. A review, *Apidologie* 32: 527-545.

Native Bee Biology and Bee Conservation Strategies for Michigan Farms

Julianna Tuell and Rufus Isaacs, Department of Entomology, Michigan State University

There are more than 20,000 bee species in the world, more than 4000 in North America, and more than 300 in Michigan alone. What sets bees apart from their close relatives, the wasps, is that they collect pollen and nectar to feed their developing larvae. Bees have specialized hairs on their bodies and legs for gathering pollen. In the act of collecting pollen and nectar, they often transfer pollen from female parts of plants to male parts of plants, which can result in plant pollination and makes them the most important group of insect pollinators.

Most bees dig nests in soil. Others bore holes in wood, or create compartments out of mud, pebbles glued together with resin, cut pieces of leaves or other plant materials in which they lay their eggs. Others will nest in insulated pre-existing cavities such as abandoned rodent burrows and use wax to create compartments to store nectar and to contain developing larvae. Still others use galleries made by beetles under tree bark. They may live solitary lives, with every female laying her own eggs and providing for them, or they may live cooperatively with a few to only one of the females laying eggs and the rest of the members providing for the colony.

Some bees produce only one generation per year and otherwise spend most of the year hibernating in their nests. These bees often emerge in synchrony with a particular set of plants and are said to be specialist pollinators. Other bees produce multiple generations and can form complex social organizations. These bees require longer seasons of flowering plants, usually from across many different plant families, and are said to be generalist pollinators.

While honey bee colonies can be easily transported to crop fields and then away again when no longer needed, native bees live in and around crop fields and are subject to the conditions of the farm habitat. There are several important things to consider with respect to the conservation of native bees in farmland:

- 1) Are there sufficient floral resources before and after crop bloom to support a large and diverse native bee community throughout the growing season? During crop bloom there is likely to be more than enough flowers to provide native bees with the pollen and nectar they need. However, prior to, or after bloom, there may be too few flowers to support them.
- 2) Are there other resources around the farm such as a source of uncontaminated water in times of drought, or nesting boxes that could be installed? Providing man-made nesting straws for mason and leafcutter bees is one way to help increase their number.
- 3) Are precautions taken with regard to the use of insecticides for the control of crop pests? Native bees will be vulnerable to insecticides used against other insects. Measures can be taken to minimize risk to native bees by selecting less-toxic alternatives, and/or applying insecticides when bees are least likely to be active.

In addition to the native bees already living on farmland, there are a few native bee species that are becoming more available as managed alternatives to honey bees in some crops. Bumble bee colonies consist of a queen and a number of workers that provide for the colony. Commercially reared colonies of bumble bees are easily transported to the crop when needed, much like honey bee colonies. Mason or *Osmia* bees are solitary bees that will nest in large aggregations in man-made straws. Thus, hibernating bees in straws can be transported to the crop field where the bees emerge and stay to pollinate the crop if provided with additional straws in which to build their nests. These new nests may be stored in hibernation to be released again the following year during crop bloom.

In summary, semi-natural habitats around crop fields can be seen as reservoirs of naturally occurring pollinators; pollinators that have not had to be rented or purchased. Measures to provide floral and nesting resources and protection from pesticide exposure is likely to result in increased native bee abundance and pollination. For more information about the conservation of native bees, we recently published an extension bulletin titled: *Conserving Native Bees on Farmland* (E-2985). It is available for free as a down-loadable PDF file at the following website: www.nativeplants.msu.edu or for a small fee from the MSU bulletin office.

Selected References

- Bosch, J. and Kemp, W.P. (2001) *How to Manage the Orchard Mason Bee*. Sustainable Agriculture Network, Beltsville, Maryland. pp. 1-88.
- Bullock, J. M., Pywell, R. F., & Walker, K. J. (2007) Long-term enhancement of agricultural production by restoration of biodiversity. *Journal of Applied Ecology* 44: 6-12.
- Desneux, N., Decourtye, A., & Delpuech, J.-M. (2007) The sublethal effects of pesticides on beneficial arthropods. *Annual Review of Entomology* 52: 81-106.
- Johansen, C. A. & Mayer, D. F. (1990) *Pollinator Protection: a Bee and Pesticide Handbook*. Wicwas Press, Cheshire.
- Kells, A. R., Holland, J. M., & Goulson, D. (2001) The value of uncropped field margins for foraging bumblebees. *Journal of Insect Conservation* 5: 283-291.
- Klein, A.-M., Vassière, B. E., Cane, J., Steffan-Dewenter, I., Cunningham, S., Kremen, C., & Tscharntke, T. (2007) Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B* 274: 303-313.
- Long, R. F., Corbett, A., Lamb, C., Reberg-Horton, C., Chandler, J., & Stimmann, M. (1998) Beneficial insects move from flowering plants to nearby crops. *California Agriculture* 52: 23-26.
- Michener, C.D. (2000) *The Bees of the World*. The John Hopkins University Press, Baltimore, Maryland. pp. 1-913.
- Mitchell, T. B. (1960) *Bees of the Eastern United States*. Volume 1. Technical Bulletin No. 141, North Carolina Agricultural Experiment Station. pp. 1-538.
- Mitchell, T. B. (1962) *Bees of the Eastern United States*. Volume 2. Technical Bulletin No. 152, North Carolina Agricultural Experiment Station. pp. 1-557.
- Morandin, L. A. & Winston, M. L. (2003) Effects of novel pesticides on bumble bee (Hymenoptera: Apidae) colony health and foraging ability. *Environmental Entomology* 32: 555-563.
- National Academy of Sciences (2007) *Status of Pollinators in North America*. The National Academies Press, Washington, D.C. pp. 1-322.
- Sampson, B.J., Cane, J.H., Marshall, D.A., Stringer, S.J., and Spiers, J.M. (2003) *Pollinator Conservation Handbook*. The Xerces Society in Association with the Bee Works, Portland, OR. pp. 1-145.
- Shuler, R. E., Roulston, T. H., & Farris, G. E. (2005) Farming practices influence wild pollinator populations on squash and pumpkin. *Journal of Economic Entomology* 98: 790-795.
- Tuell, J. K. (2007) *Ecology and conservation of wild bees associated with highbush blueberry farms in Michigan*. PhD Thesis, Michigan State University.

Making the Farm Bill Work for You

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Pollinators are essential to our environment. It is estimated that 60-80% of the world's flowering plants depend on animals—mostly insects—for pollination. Eighty-seven of the world's 124 most commonly cultivated crops are animal pollinated and insect-pollinated forage plants such as alfalfa and clover provide feed for the animals that give us dairy and meat products. Roughly 35% of global crop production is dependent on pollination by animals. Pollinators also sustain natural plant communities that provide food and shelter for many other animals, such as birds, small mammals, and bears. As one of the most widespread and important ecosystem services on the planet, pollination is “central to all human beings, livestock, and wildlife”.

Honey bees receive all of the credit for crop pollination, yet the number of managed honey bee hives is half of what it was in the 1950s, and this number continues to decline due to disease, pests, the low price of honey, and most recently the mysterious Colony Collapse Disorder. Recent research, however, has demonstrated that native bees make a significant contribution to crop pollination—in some cases providing one hundred percent of the pollination required when sufficient habitat is available.

With the decline in managed honey bees, it is important to diversify the pollinators upon which many growers rely. Actions taken to attract native pollinators to the farm will improve biodiversity conservation, agricultural sustainability and crop security.

How to take advantage of native bees for crop pollination

The diversity and abundance of native bees on a farm, and subsequently their ability to serve as crop pollinators, are strongly influenced by two factors: suitable habitat on the farm and in the surrounding landscape, and pesticide use on the farm. The basic habitat needs of native pollinators in any location are the same: nesting or egg-laying sites, flowers on which to forage, secure overwintering places, and a refuge from pesticides.

We recommend beginning with a three step approach to enhancing crop pollinators:

- 1. Know the habitat on your farm.** Look for areas on and around your farm, such as old snags, bare soil, fallow fields and weedy road edges that can support native bees.
- 2. Protect flowering plants and nest sites.** Once you know where native bees are living and foraging, do what you can to protect these resources from disturbance and pesticides.

3. Enhance habitat with flowering plants and additional nest sites. Adding flowers, leaving areas of soil untilled where possible, and providing bee blocks (tunnels drilled into wood) are all ways to increase the number of native bees on your farm.

It is also important to understand where to protect or enhance pollinator habitat on the farm. The following areas have the potential to be pollinator habitat:

Riparian areas

Natural habitat along streams should contain a diversity of plants. Early-flowering willows, in particular, will jumpstart colonies of bumble bees in the spring before your crops need them.

Snags

Keeping dead trees standing, instead of clearing them, gives native bees shelter. Wood-nesting solitary bees build their nests in abandoned beetle tunnels already in the snag.

Natural Areas

The natural landscape surrounding a farm may offer enough habitat to harbor all the native bees needed to pollinate a farm's crops, drastically reducing the need to import colonies of honey bees. Work with others to safeguard these habitats for your native crop pollinators.

Bolting Crops

Even crops that don't typically flower before they are harvested can provide food for bees. Letting crops such as lettuce, arugula, basil, broccoli, and kale bolt will provide additional nectar and pollen.

Farm Gardens

Your own garden, with its diverse assortment of flowers and flowering plants, is a good source of food for bees. Choose older, heirloom varieties, because often they provide more nectar and pollen than modern hybrids.

Farm Ponds

When you create or dredge a pond or ditch, leave the pile of excavated dirt; ground-dwelling bees may build nests in stable, bare areas of this mounded soil. Planting clumps of native flowers will attract more bees.

Unmanaged Areas

Leave land that is fallow or unsuitable for crops. Like natural habitat around a farm, these areas may provide important resources for native bees, especially if you sow them with native flowers.

Hedgerows

Creating hedgerows is a great way to attract and keep native bees. Hedgerows should contain a wide variety of plants that have overlapping flowering periods, in order to provide bee habitat throughout the season.

Field and Road Edges

Untilled, unsprayed soil in areas next to your fields provides nest sites for ground-nesting bees, as well as flowering plants. Enhance this resource by keeping some areas bare of vegetation and/or planting others with native flowers or cover crops.

Cover Crops

Flowering plants – such as clover, vetch, or alfalfa – will give native bees extra sources of pollen and nectar. These cover crops may be sown anywhere on the farm.

Other steps you can take to encourage native bees to inhabit your farm include building artificial nests and minimizing pesticide use:

Artificial Nests

Constructing artificial nests for wood-nesting bees is an easy way to increase the number of native bees.

Pesticide Use

Because insecticides kill pollinators outright, and herbicides may remove flowers important for food and shelter, minimize your use of pesticides on your farm and in the surrounding areas.

Making Farm Bill Conservation Programs Work For You

The 2002 Farm Bill includes several financial aid programs to help fund conservation on agricultural lands and have a large impact. For example, the Environmental Quality Incentives Program (EQIP) allocated over \$1 billion in financial and technical assistance to farmers in 2006, and the Conservation Reserve Program (CRP) retired over 36 million acres of farmland, 4.5 million of which was specifically for wildlife habitat. Areas set aside as wildlife habitat could be, tailored specifically to benefit pollinators.

The 2007 Farm Bill is currently in development. The House version (passed in July 2007) contains provisions to include pollinators as a conservation target for the EQIP program and the current Senate version (passed committee only in October 2007) includes pollinator conservation as a purpose for the CRP program. Pollinator conservation measures can be incorporated into these programs without language in the Farm Bill, but Farm Bill legislation would facilitate growers using these programs to help pollinators.

Examples of Farm Bill Programs that can be tailored to benefit pollinators include:

Environmental Quality Incentive Program and Wildlife Habitat Incentive Program

The Environmental Quality Incentive Program (EQIP) and Wildlife Habitat Incentive Program (WHIP) are two cost-share financial incentive programs currently operated by the Natural Resources Conservation Service (NRCS). We are working with the NRCS to include pollinators as a priority resource concern in state EQIP and WHIP project funding criteria. In addition, many current Conservation Practices, such as Hedgerow Plantings or Stream Habitat Improvement and Management, may already incorporate pollinator habitat features. We also are encouraging the NRCS to include specific cost-share categories that benefit pollinators, so that growers may be compensated for including habitat features, such as native bee nest blocks, diverse flowering plants (with overlapping bloom periods), butterfly host plants, and areas of semi-bare soil, in their on-farm projects. The Grassland Reserve Program (GRP) and the Wetland Reserve Program (WRP) also can be used to implement these conservation practices.

Conservation Security Program

The Conservation Security Program (CSP) is a production stewardship program where growers are paid for maintaining and enhancing natural resources. We are working with state-level conservation staff at the NRCS to incorporate pollinator habitat (especially diverse forb, legume, and flowering shrub and tree plantings) into the criteria for receiving incentive funds through the CSP. Once this is done, farmers enrolled in the CSP program will be able to ask for additional funding for each acre of habitat they sow with pollinator-friendly plants.

Conservation Reserve Program and Conservation Reserve Enhancement Program

The Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (CREP) are land-retirement programs administered by the Farm Service Agency (FSA). We are working with NRCS and FSA staff to incorporate diverse pollinator plant lists into the state CRP and CREP programs and to add bee blocks as a wildlife nesting structure enhancement.

Farm Bill Pollinator Conservation in Michigan

The Michigan state NRCS is already taking a lead in pollinator conservation efforts. This fall they applied for State Acres for Wildlife Enhancement (SAFE) funds. The SAFE Proposal "Plantings for Native Pollinators" has been sponsored by the Michigan Department of Agriculture and supported by the Cherry Marketing Institute and the Michigan Apple Growers. The proposal was submitted to the Washington Office of the Farm Service Agency for approval and funding. If approved the proposal would assist in the cost-share of the planting plus an annual rental payment for the acres enrolled for a ten year period. The NRCS is also incorporating data on pollinator insect usage of native plants from Michigan State University scientists into their state vegetation guides, and the regional Plant Material Center is interested in developing demonstration sites for creating pollinator habitat.

Case study from California

The Butler Farm used EQIP funds to restore approximately 6,000 feet of ditch (approximately 85 feet wide). The site was graded for flood control and a native plant hedgerow. Two tail water ponds and sedimentation traps were also installed. Pollinator friendly trees, shrubs, and perennial forbs were planted along the entire length of the ditch. Native grasses were drilled into the entire restoration area and a mix of pollinator friendly forb species were seeded into four different test plot areas throughout the site. Four bee blocks, which provide nesting habitat for solitary wood nesting bees, were placed within the restoration site.

Case Study from Oregon

Using WHIP funds, we worked with multiple landowners to develop a buffer hedgerow planting meant to separate a conventionally managed natural area from an organic farm. The hedgerow was designed to provide habitat for pollinators, predators and beneficial parasitoid wasps. It utilized hedgerows, tree and shrub plantings, and was designed to include a diversity of blooming plants so that nectar from flowers is available for these beneficial insects throughout the year. It also included nest blocks that were cost-shared as a wildlife nest site feature.

For guidelines, fact sheets, books and other resources on how you can take steps to conserve native pollinators please visit www.xerces.org.