Department of Agriculture, Trade and Consumer Protection
Division of Agricultural Development
Agricultural Development & Diversification Program (ADD)
Grant Project Final Report

Contract Number: 23006

Grant Project Title: The Development of Alternative Bee Pollinators for Managed Crop Pollination

Amount of Funding Awarded: $15,000

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1) ***What was the original intent of the grant?***
   - ***What did you want to accomplish with the grant?***
   - ***How was it expected to benefit Wisconsin Agriculture?***
   - ***What makes this project work important or significant?***

The original goal of this project was to bring to market alternatives to the domestic honey bee, for managed crop pollination. These alternative bee species are not susceptible to the highly publicized diseases and parasites that have decimated honey bee populations across the United States. We believe the use of these bees will benefit Wisconsin's dairy industry, the cranberry industry, fruit and vegetable growers, native plant nurseries, and honey beekeepers seeking to diversify their existing pollination businesses.

The direct value of bee pollination in the United States has been estimated at $14.6 billion annually. The actual figure however is probably substantially higher.

In Wisconsin bee pollination is essential to the cranberry industry which contributes over $300 million to the state economy and employees over 7,000 people. Bee pollination is also required for the production of alfalfa seed. *Alfalfa is a critical forage source for the state's $20.6 billion dairy industry.* Other agricultural sectors such as fruit and vegetable growers, oil seed producers (including producers of some biofuel crops), and native plant nurseries also depend on bee pollination for the production of their crops.

Despite the importance of bees, America is experiencing a pollination crisis. Currently domestic honey bee (*Apis mellifera*) populations are under serious threat from a syndrome called "Colony Collapse Disorder." While the exact cause of this new syndrome is unknown, it has been documented in at least 24 states, with up to 30% of the nation's bee hives affected. *From 2006 to 2008 some beekeepers lost up to 90% of their honey bees.* This disorder falls on the heels of numerous other diseases and parasites which have affected the honey bee in recent years. These other disorders (parasitic mites, microsporidian dysentery, fungal diseases, and various viruses) have eliminated feral honey bee populations in most parts of the U.S., including here in Wisconsin. To maintain their hives, beekeepers are now forced to rely upon an expensive and environmentally risky chemical cocktail of fumigants, miticides, and antibiotics. This increased expense has been passed on to growers in the form of higher hive rental fees from commercial beekeepers.

As the economics of beekeeping have changed many beekeepers have quit the business entirely. *Since 1950, the number of beekeepers in the U.S. has dropped by 50%.* Increasingly growers requiring bee pollination are left with few options but to pay substantially more for bees (which are now being brought in from as far away as Australia) or to become part-time beekeepers themselves. In some cases bees are not available at all.

While the honey bee has been critical to American agriculture, it is not a native species. Rather they first arrived with European settlers in the mid 1600's. The impact on native pollinators is unknown, however it is widely believed that significant displacement of our native wild bee species has occurred. With the addition of habitat loss and the rise of pesticide use, these native bee populations have substantially declined. *At least one U.S. bumble bee species has gone extinct within the past 5 years*. The status of several other wild bee species is unknown.

Although our wild bee species do not produce honey several of them can effectively be managed as crop pollinators. These alternative species include mason bees, and leafcutter bees, two related groups of solitary, but gregarious, cavity nesting bees.

One such species, the blue orchard mason bee (*Osmia lignaria*), is native to most of the United States but is divided into two distinct subspecies: *Osmia lignaria propinqua* which exists west of the 100th Meridian, and *Osmia lignaria lignaria* which is native to the Eastern United States (including Wisconsin). In the past decade research entomologists and fruit growers in Western states (California, Oregon, Washington, Idaho, and Utah) as well as in Western Canada, have developed commercial procedures for raising managed populations of *O. lignaria propinqua* for commercial fruit pollination. While most attempts to commercially produce the eastern subspecies of *O. lignaria*, have failed, Midori Horticultural Services has, in part through the support of this grant program, successfully produced a managed population here in Wisconsin.

By modifying established rearing procedures for our local climate we have been able to not only maintain a breeding population of these bees, but to increase their numbers and make them available to several Wisconsin growers for crop pollination.

Extensive published research has demonstrated that this species is a more efficient pollinator than the honey bee for early flowering fruit crops—with the ability to transfer larger quantities of pollen between flowers, and to fly even during adverse weather conditions—a factor which is crucial in cold climates like Wisconsin (honey bees in general do not fly when temperatures drop below 50° F, and do not fly on overcast days).

O. lignaria has far fewer diseases than honey bees, and is not affected by colony collapse disorder or the parasitic mites which have decimated honey bees. Fruit growers who have begun using them in other states are able to achieve higher levels of pollination with this native bee. Once established in an orchard, the bees maintain an ongoing population that requires only occasional replenishment. Until this project began, Wisconsin growers did not have access to starter populations of *O. lignaria*, since only the Western subspecies is widely commercially available. The potential environmental consequences of importing the Western subspecies to Wisconsin where it could hybridize with our native subspecies are unknown. This project has helped reduce that possibility.

O. lignaria is a woodland insect that prefers to nest in the cavities left by wood boring insects in mature forests. As old growth forests continue to disappear, nest sites for the bee continue to decline, even when food sources remain adequate. By establishing managed nest systems for this species we are providing it with new opportunities for success, and a new place in our agricultural system. *This type of beekeeping is a win-win situation, providing growers with better pollination, and new habitat for a native insect.*

We also maintain active breeding populations of several other bee species. Among these is *Megachile pugnata*, commonly called the sunflower leafcutter bee. This bee is a distant relative of the blue orchard bee, and is most active at different times of the year. While the lifecycle is similar between the two species, *M. pugnata* is

historically a prairie species that is now extirpated in some areas due to habitat loss. In the 1980s the USDA Bee Research Laboratory in Logan, Utah maintained an active population of this species and successfully used it as a pollinator of hybrid sunflower. In field trials, *M. pugnata* has demonstrated excellent management potential. For instance, a study of pollination efficiency measured nearly one seed fertilized per second during flower visits by the bee. In comparison, honey bees averaged much lower at only 0.05 seeds per second. Currently, to the best of our knowledge, Midori Horticultural Services currently maintains the only captive population of the sunflower leafcutter bee in North America.

Midori Horticultural also maintains the only populations of the alfalfa leafcutter bee (*Megachile rotundata*), and the horn-faced mason bee (*Osmia cornifrons*) in the state of Wisconsin.

The alfalfa leafcutter bee, is considered to be the preeminent pollinator of alfalfa for seed production, which, due to its unique flower structure, is not effectively pollinated by honey bees (who may visit the flowers for nectar, but do not transfer significant amounts of pollen). *Despite being the 3rd largest alfalfa hay producer in the U.S. (behind California, and South Dakota), Wisconsin produces virtually no alfalfa seed of its own. Lack of effective pollination is one of the major reasons for this.* Currently the top alfalfa seed producing regions are in the Pacific Northwest and the Canadian prairie—areas with an established tradition of leafcutter bee management. The alfalfa leafcutter bee is also an effective pollinator of cranberries and blueberries, and in fact these uses are currently being recommended by the Canadian government and by several extension agencies in New England.

The horn-faced mason bee (*Osmia cornifrons*), is another close relative of the blue orchard bee and an equally excellent pollinator of spring and early summer fruit crops (including cherries, apples, raspberries, and strawberries). There is a tremendous demand for this bee among fruit growers in the Eastern U.S.—demand far exceeding the current available supply—and its use is being promoted by Michigan State University's Northwest Horticultural Research Station.

All of the bees we raise are also extremely docile and rarely sting. The protective equipment required for keeping honey bees (bee suits, etc.), is unnecessary when working with these species. As a result growers prefer these alternatives on small acreage, and near urban areas where they are not a threat to workers or to the general public. These bee species represent an opportunity to maintain an active pollinator reservoir where none currently exists.

2) What steps did you take to reach your goal?

- ***What worked?***
- ***What challenges did you face?***
- ***What would you do differently?***

The approach of this project was to focus on outreach efforts to disseminate the necessary management technology for others to maintain their own population of these bee species. We accomplished this by:

1. Developing a workshop curriculum, including video and PowerPoint media;
2. Conducting a workshop at the UW Arboretum;
3. Constructed a field demonstration site at a apple orchard where workshop participants could observe the bees and their nests first hand during the apple bloom;
4. Produced an instructional manual;
5. Made that manual freely available on the web (www.midorihorticultural.com);
6. Offered follow-up support to workshop participants;

Facilitating these efforts was in-kind support offered by the Xerces Society for Invertebrate Conservation, a national organization focused on pollinator conservation issues. The Xerces Society Pollinator Conservation staff provided scientific oversight on the development of the instructional manual, and donated additional fact sheets and publications to workshop participants.

A second project partner was the Great Lakes Integrated Conservation Training Program conducted through the University of Wisconsin Extension Service. Program staff managed the logistics of locating and reserving the workshop location, developing a web and telephone-based registration system for workshop participants, and providing refreshments for the event.

Third, the Upper Midwest Organic Tree Fruit Growers Association, the Midwest Organic and Sustainable Education Service (MOSES), and the University of Wisconsin's Center for Integrated Agricultural Systems, all helped with the promotion of the final workshop/field day through newsletter announcements, website postings, and emails to constituent audiences.

Finally, Jim Lindemann, a McFarland-based apple grower contributed his orchard as the demonstration site location. This contribution required him to accommodate a large field shelter housing the bee nests, and to make his property available to more than 30 workshop participants.

Overall these efforts were extremely successful, however several challenges did arise. The first of these was that we needed more time for construction of the bee nests and field shelter than we had originally planned for due to an emphasis on outreach deliverables (the training manual, and workshop curriculum). In fact the nests themselves, and the bees occupying them are themselves part of the outreach plan in their role as demonstration items, and we should have anticipated more time to devote to the management of them.

An additional challenge was the scheduling and location of the workshop and demonstration site. In retrospect, several workshops and demonstration sites around the state would have been preferable, allowing more people to attend, and giving the project more statewide exposure. For example, the day of the workshop was rainy, and slightly inhibited bee flight (although good numbers of bees were still observed actively nesting and visiting the blooming crop). That said, many workshop participants were willing to travel, with two individuals (commercial blueberry growers) even driving from Indiana to attend!

3) What were you able to accomplish?

- ***What are the results from this project?***
- ***Include any analysis of data collected or materials developed through project work.***

As a result of this project more than 30 people have received training in how to develop and manage their own leafcutter and mason bee populations. These individuals who attended our workshop and field day included commercial cranberry, blueberry, vegetable and apple growers, UW Extension staff, graduate students in entomology and agro-ecology, honey beekeepers (including members of the Dane County Beekeepers Association), DATCP employees (Ursula Peterson), DNR staff, Master Gardeners, and staff from the University of Wisconsin Arboretum.

Each of these participants received a full color 50-page training manual that describes the recommended management protocols, parasite and disease mitigation information, and habitat management guidelines.

Other direct results of this project include:

1. Many workshop participants have already begun developing their own leafcutter and mason beekeeping efforts;
2. The UW Arboretum is creating a pollinator demonstration site (including signage and print materials) to illustrate this type of bee management. This project has direct involvement with Kevin McSweeny, the Arboretum Director, a participant of the workshop;
3. Workshop participant Savannah Conradt, an employee of the UW West Madison Ag Research Station is developing a demonstration project and training session for Master Gardeners to teach this beekeeping method;

4. Hannah Gaines, a UW grad student in entomology was able to directly apply this management system to modify her existing field research practices, investigating native bee pollination of cranberries;
5. Beekeepers employing the methods promoted through this project, will be supporting native pollinators, reducing the environmental risks associated with importing non-native bees, and eliminate the chemical-based beekeeping methods associated with honey bee management.

4) What conclusions can you make based on project work?

Prior to this project no instructional workshops related to keeping leafcutter bees or mason bees have been conducted anywhere in the United States. Regional workshops for beginning honey beekeepers routinely draw hundreds of participants from a broad geographic area. The University of Minnesota, for example, provides an annual 2 day honey beekeeping workshop with more than 150 participants attending from as far away as Vermont and Canada.

With participants to this event traveling from as far away as northern Wisconsin, and the state of Indiana, there is clearly a large, unmet demand for this type of information. News reports of ongoing honey bee declines, and new proposed expansions to major bee pollinated crop industries (notably cranberries), illustrate a new found awareness of the need for alternative pollinators. As a "train-the-trainer" pilot-project, this was an overwhelming success. The core conclusion from this effort is that demand exists not simply for alternative pollinators, but for additional first-hand training on how to manage these alternatives.

5) What do you plan to do in the future as a result of this project?

An unexpected result of this project is that our own managed population of mason bees (maintained at the demonstration site) nearly tripled in a single season, making this the most productive beekeeping year in our history. This newly expanded population will be maintained for another season at multiple sites as a safeguard against unexpected losses, and excess bees will be sold in future years.

The outreach infrastructure developed through this project will be maintained through at least 2009, allowing people free access to the instructional manual, supporting web resources, and email support in their own beekeeping efforts. This web-based outreach will be conducted through www.midorihorticultural.com. In addition through this project we have developed a close working relationship with the UW Center for Integrated Ag Systems, and will be working with them to promote this type of beekeeping through their existing network of farmer-partners.

6) What information or additional resources are needed to commercially develop this enterprise?

Prior to this project, the importance of crop pollination has been largely ignored in Wisconsin. Research and development has languished behind the rest of the country. The USDA previously operated a national bee research laboratory in Madison, however the program was terminated in 1986.

Similarly, the University of Wisconsin until recently has not had a bee research program within the Department of Entomology. This has changed with the work of Hannah Gaines, a graduate student examining the contribution of native bees to cranberry pollination. Hannah attended this workshop and field event, and has maintained an ongoing dialog with the project partners.

To commercially develop this enterprise it is essential that the University remain engaged in the subject, and be positioned to conduct necessary research to support Wisconsin beekeepers, and growers of bee-pollinated crops. To this end we shall provide ongoing support to Hannah, and work with the UW Center for Integrated Agricultural Systems on future research and outreach efforts.

7) ***How should the agricultural industry use the results from your grant project?***

We believe there is a tremendous market opportunity for additional development and production of these alternative pollinators in Wisconsin. Due to historically low honey prices, the most profitable aspect of American beekeeping is now the "pollination for hire industry." Beekeepers providing this service typically rent their bees to a grower for the duration of the bloom period. *The bees we raise fit this role perfectly and there is an enormous unmet demand for them not just regionally, but nationwide.*

The direct economic impact of this project could be twofold. Beekeepers who diversify their existing pollination business with these alternative species will have higher profit margins (due to lower operating costs—such as a reduced need for bee medications). Growers requiring bees for pollination will also pay less in rental fees.

As an example, current apple pollination guidelines provided by the USDA Agriculture Research Service recommend stocking orchards at a rate of 2 honey bee hives per acre (with each hive containing an average of 20,000 bees), or 250 female blue orchard mason bees per acre. This enormous discrepancy is possible due to the fact that mason bees are significantly more efficient pollinators than honey bees. As honey bees become increasingly scare some growers around the country are now beginning to pay as much as $150 per hive. Because mason bees are so much more efficient, they are priced on a per bee basis, currently averaging $1.00 each. On this per bee basis, the beekeeper makes significantly more money renting mason bees to apple growers than honey bees (at a rate of $0.0075/per bee). The grower in this scenario has also reduced his operating costs by $50 per acre. Wisconsin currently has approximately 7,400 acres devoted to apple production. If state honey bee rental rates continue to climb, matching other regions of the country, mason bees alone could save state apple growers $370,000 annually.

Equally compelling numbers exist for other sectors dependent on bee pollination including forage crop producers (such as alfalfa and clover), vegetable growers, berry and pumpkin farms, and native plant growers.

These economic models provide, we believe, a compelling justification for the agricultural industry to embrace diversification of their pollination services and support bee conservation efforts broadly.

Workshop and Field Day Photos (May 15, 2009)