Factsheet 3:

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Risks to Pollinators on Ontario Farms

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Credit: Nigel E. Raine

Dedicated to

To Ontario's honey bees, givers of honey, beeswax, and crop pollination services because they have been the canaries in the coal mine.

This factsheet is also available online at http://farmsatwork.ca/pollinators/resources.

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Many factors may be contributing to the decline of wild pollinators in Ontario, including disease, climate change, pesticide exposure, and loss of habitat. Disease and pests affects all organisms, including bees. Although a lot is known about diseases of honey bees, there is very little information about disease in most wild bee species, although there is some concern among researchers that diseases are spreading from managed bee populations to wild bee populations. Climate change may cause certain types of wild bees to decline and other types of wild bees to become more common and widespread. These changes are important because they may reduce biodiversity and impact pollination services to farms.

Of greatest importance on farms are the risk to bees of **loss of habitat** and **pesticide exposure**, both of which can be successfully addressed by individual farms.

Habitat Loss on the Farm:

Habitat loss on farms may be related to herbicide use or mowing which eliminates flowering weeds.

- Reducing the use of herbicides and managing mowing so that weeds are allowed to go to flower but not set seed on field margins and in uncropped areas may help to reduce foraging habitat loss.
- However, in natural areas directly adjacent to cropped fields where neonicotinoid insecticides are regularly used, it may be best to mow weeds because there is growing concern that neonicotinoid residues are being found in the nectar and pollen of weeds in these circumstances.

You can reduce or reverse habitat loss by creating and maintaining new pollinator habitat on your farm.

- To learn more about creating pollinator habitat on your farm, information is provided in Factsheet 2: Creating Pollinator Habitat on Farms in Ontario.
- You can find many examples of how Ontario farmers have begun to address pollinator habitat loss here.

Risk to Pollinators of Exposure to Pesticides on Farms:

Risk of exposure to pesticides on farms is more complicated than it first may appear to be. There are many classes of pesticides with different **modes of action**, **methods of application** and **lengths of potency period**. *It is important to read and understand both pesticide labels and the associated SDS for pesticides that you use on the farm*. Of particular concern to bee health are insecticides, although there is evidence that the interactions between some insecticides and fungicides may also have negative effects on bee health.

Insecticides can be

- contact insecticides that are sprayed directly on the surface of plant tissue and pests and are relatively quickly broken down in the environment. These insecticides are not translocated throughout the tissues of the plant;
- systemic insecticides that are applied as seed coatings, soil drenches, and as foliar sprays. These insecticides are translocated throughout the tissues of the plant and can end up in the nectar and pollen of flowers. These pesticides tend not to break down quickly.

The risks for bees associated with insecticides depend upon the

- Routes of exposure, for example whether or not bees come in contact with the insecticide, either by consumption in food or by contact with plant surfaces or in soil;
- Dose of the insecticide, which can be a killing/lethal dose or a sub-lethal dose that may have negative effects that do not directly kill the individual bee but may substantially affect their normal behaviour; and
- Length of time over which insecticide exposure occurs. This can be acute exposure (brief) or chronic (longer term) exposure.

Routes of exposure for bees to insecticides used on farms are by

1. direct contact with insecticides as they are being applied;
2. direct contact with insecticide residues on the plant or soil surface shortly after spray application or with residues in planter dust during field crop seed planting;
3. consuming nectar and pollen that contain residues of systemic insecticides; and
4. for bees that are ground-nesters, by contacting insecticide residues that persist in soil during the period when nests are being constructed.

The **Lethal Dose** (LD_{50}) is the dose at which half of bees exposed to a pesticide in a laboratory setting will die within a prescribed period of time, usually 24-72 hours.

- Different pesticides have different lethal doses. The lower the lethal dose, the more toxic the pesticide is to bees. For example imidacloprid (LD_{50} honeybee, contact, 72hr = 0.15 µg/bee) is more toxic to bees than chlorantraniliprole (LD_{50} honeybee,contact, 48hr = 12.5 µg/bee).
- Lethal doses can be different for bees exposed by contact (LD_{50} honeybee, imidacloprid, contact, 24 hr = 0.047 µg/bee) or by eating the pesticide in their pollen or nectar sources (LD_{50} honeybee, imidacloprid, oral, 24 hr = 0.0054 µg/bee).
- Lethal doses for the same insecticide can be different for different species of bees. For example, carbaryl is less toxic to bumble bees (LD_{50} bumblebee, oral = 3.85 µg/bee) than it is to honey bees (LD_{50} honeybee, oral = 0.23 µg/bee).

Length of exposure matters to bee health. A one-time exposure is considered an acute exposure, a repeated exposure to sub-lethal doses throughout a bee's life is considered chronic exposure. Acute exposure can happen

- when pesticides are being applied during the activity periods of bees, including onto crops not normally associated with bees, such as corn when it is in tassle. The only time when there will not be any bees active on your farm during the growing season is *after dark*. See Factsheet 1: Introduction to Native Pollinators on Farms in Ontario to learn more about activity periods of bees.

- during the period when the pesticide remains active on the surface of foliage, flowers or soil in cropped areas or in natural areas where the pesticide has drifted.

Most bees are not exposed to lethal doses of pesticides because Ontario farmers manage the timing and method of pesticide application to minimize that risk. Recent concerns of acute honey bee deaths resulting from exposure to neonicotinoid-impregnated dust from corn planters has largely been resolved by changes to machinery design.

However, there is a growing concern about the negative effects on honey bees and wild bee populations of chronic exposure to sub-lethal doses of pesticides mainly in nectar, pollen, and soil. This is the most common type of exposure, and unless it is monitored, it could go unnoticed until bee populations collapse.

Sub-lethal exposure is exposure to pesticides at doses below the lethal dose. Both laboratory and field studies have shown that sub-lethal exposure can result in negative impacts on

- foraging
- reproduction
- learning
- nest initiation
- ability to pollinate crops (e.g. apples)

How Can Farms Protect Bees from Exposure to Insecticides?

Reduce insecticide use to a minimum. Application of insecticides should only be done when pest populations reach an economic threshold. Application below this threshold is expensive and probably unnecessary. Use of trained crop scouts, monitoring traps, and attention to OMAFRA bulletins can provide the information needed to make best decisions about the application of insecticides for your crop and area. Prophylactic use of systemic insecticides to prevent pests is not a good practice because it does not consider the economic threshold and may put bees and other non-target organisms at risk.

Rotate classes of insecticides. Avoid using the same insecticide, especially systemic insecticides, on the same field year after year, even if the crop is rotated. This will reduce the amount of persistant systemic insecticides in the soil, which is an important route of exposure for ground-nesting bees.

Rotate crops. Pest pressure can be reduced by crop rotation. This effect and other beneficial effects are enhanced by increasing the length of your rotation and by incorporating a perennial forage phase into your rotation.

Figure 2 *Pumpkin seed treated with neonicotinoid insecticide. (Credit: Bea Chan)*

Avoid systemic insecticides. Systemic insecticides are popular for control of sucking and biting insects because they can be applied as a seed coating and will translocate to all parts of the plants. However, as a result, low doses of systemic insecticides residues end up in nectar and pollen of crop plants and even in flowering weeds adjacent to cropped areas where these insecticides have been applied. Neonicotinoid systemic insecticides are of particular concern. See http://www.omafra.gov.on.ca/english/crops/field/news/croptalk/2013/ct-0913a1.htm

Choose the Least Toxic Insecticides. Ask your insecticide supplier to tell you what the bee LD_{50}s are for the various registered insecticide options that you have for your crops. Choosing insecticides with higher LD_{50} numbers will reduce potential risk to managed honeybees and wild bees.

Avoid Unintended Exposure. Mow weeds directly adjacent to cropped areas in which systemic insecticides are used. This will prevent bees from being exposed to systemic insecticides that are taken up from the soil by weeds and translocated into their nectar and pollen.

Never apply insecticides when a crop is in flower. Avoid insecticide application during or just prior to bloom in the crops you grow because bees (including honey bees and wild bees) pollinating your crop may be harmed if you do. Under the Ontario Bee Act (https://www.ontario.ca/laws/statute/90b06) it is illegal to spray fruit trees when they are in bloom because it puts pollinators at risk. Once flowering begins, even if you apply insecticides at night when bees are not present, residues will remain on the flowers into the next day (and beyond) when both honey bees and native bees can come in contact with them.

Avoid the use of soil drenches. Soil drenches may leave high insecticide residues in the soil where many wild bees nest. Treated seed may represent a lower impact alternative if care is taken at seeding time to avoid dispersing lubricants containing insecticide residues.

Consider alternatives to insecticides. For some crops and in some circumstances, there are viable mechanical, biological and physical pest control alternatives. Explore those alternatives to determine if they would work on your farm within an intergrated pest management framework.

Figure 3 *Rowcover is commonly used on farms as a physical protection against pests. (Credit: S. Chan)*

Figure 4 *Insecticide-free zone on natural lands beside a drainage ditch on Rocky Lane Farm, Selwyn (Credit: Jay Adam)*

Create insecticide-free zones. Insecticide-free zones can be created on natural lands away from conventional cropping areas (particularly those in which systemic insecticides are used). These insecticide-free zones can become excellent bee foraging habitat if the plants in them are in bloom throughout the growing season. You can learn to create bee foraging habitat by reading Factsheet 2: Creating Pollinator Habitat on Farms in Ontario.

For more information on the factors contributing to the decline of wild pollinators in Ontario, including disease, climate change, pesticide exposure, and loss of habitat, please go to the Raine lab website (www.1in3mouthfuls.org) and take a look at our recent report on the "Status and Trends of Pollinator Health in Ontario" (https://rainelab.files.wordpress.com/2015/12/status-and-trends-of-pollinator-health-in-ontario-march-8-2017-tagged.pdf).

Other factsheets in this series are available at http://farmsatwork.ca/pollinators/resources