Radio-tagged bees, radioactive plants:

New approaches to track honey bee movement in agricultural environments

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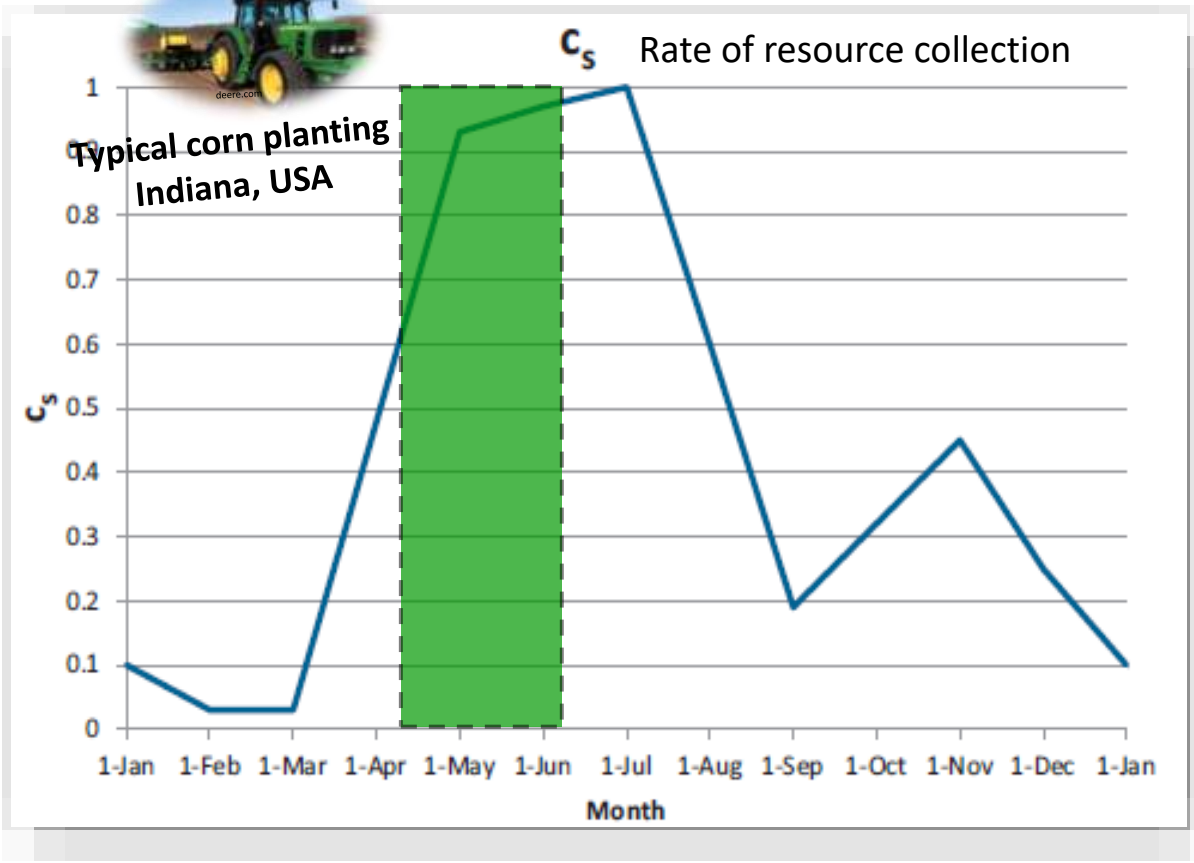
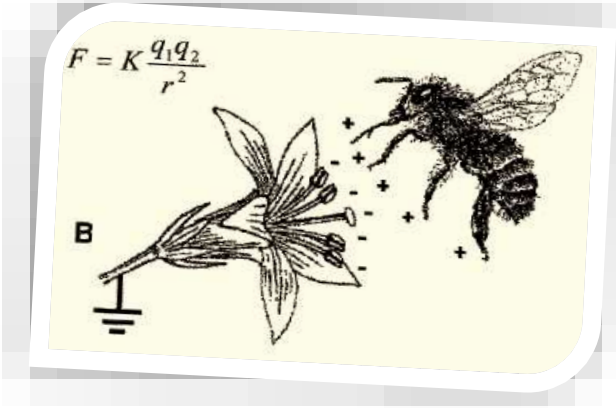
Honey bees in the Midwest: must cross ag fields

Bees are 'charged' in flight!

Typical corn planting
Indiana, USA





Vaknin et al. 2000

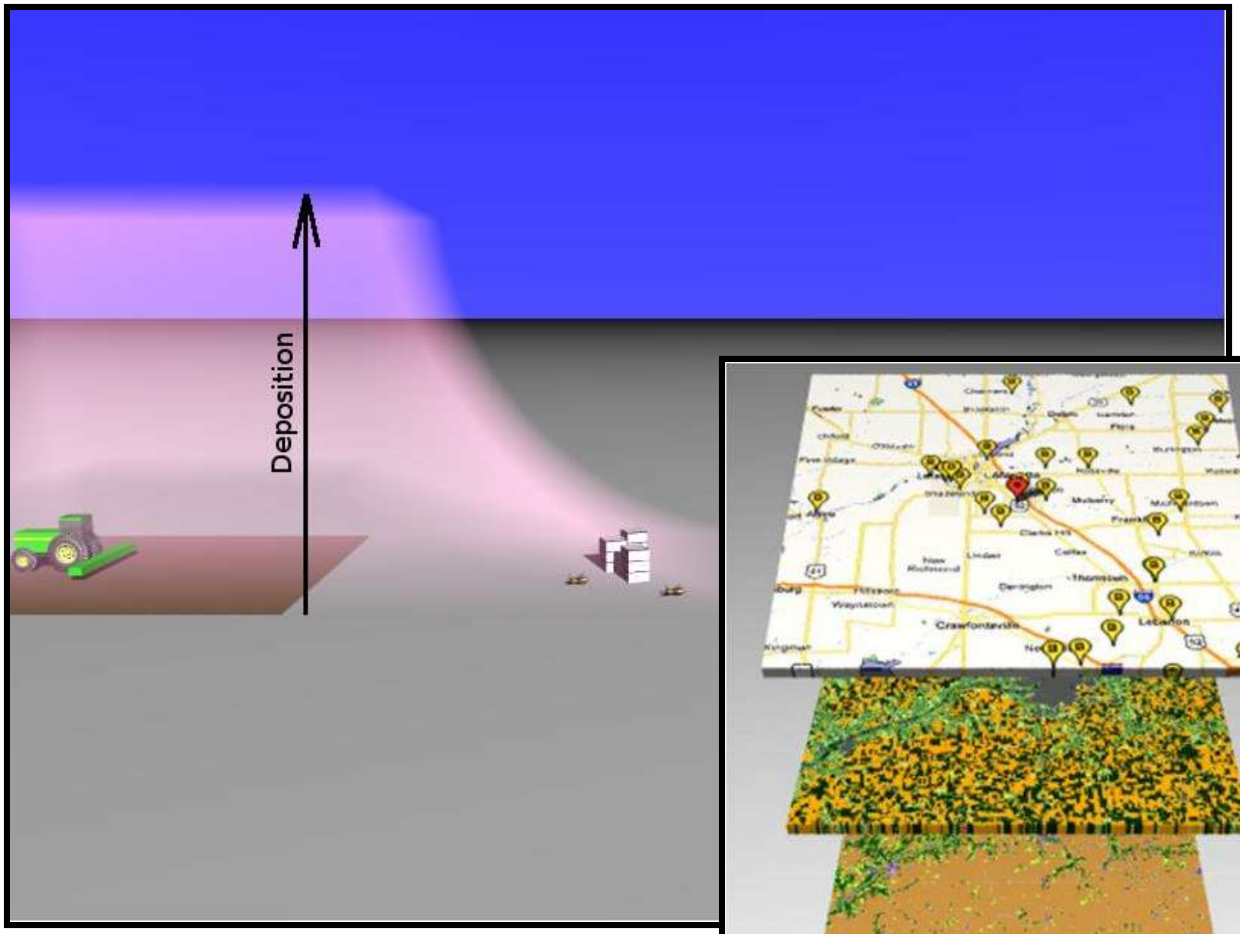
Russell et al. 2013 Ecol. Modelling. https://doi.org/10.1016/j.ecolmodel.2013.06.005

Planting treated seeds requires lubrication (talc/graphite)

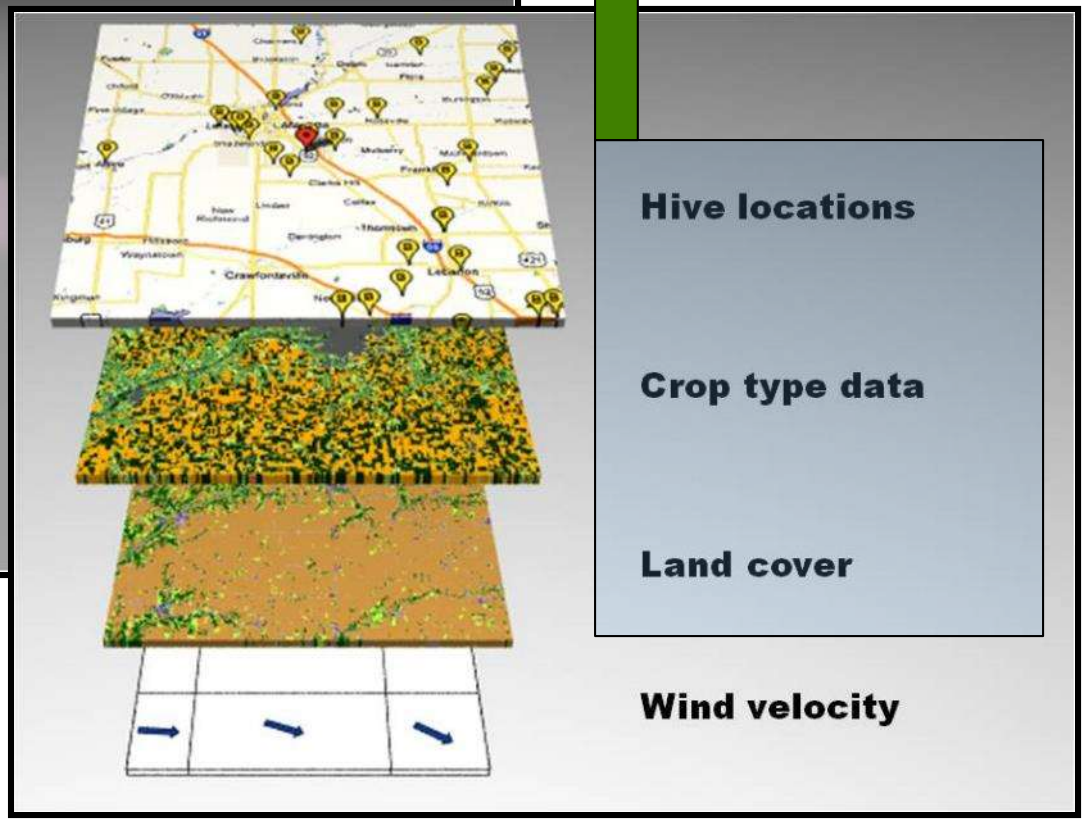
Bee kills do occur during corn planting, colony death is uncommon

Are we missing important information, beyond numbers of dead bees?

Risk map development



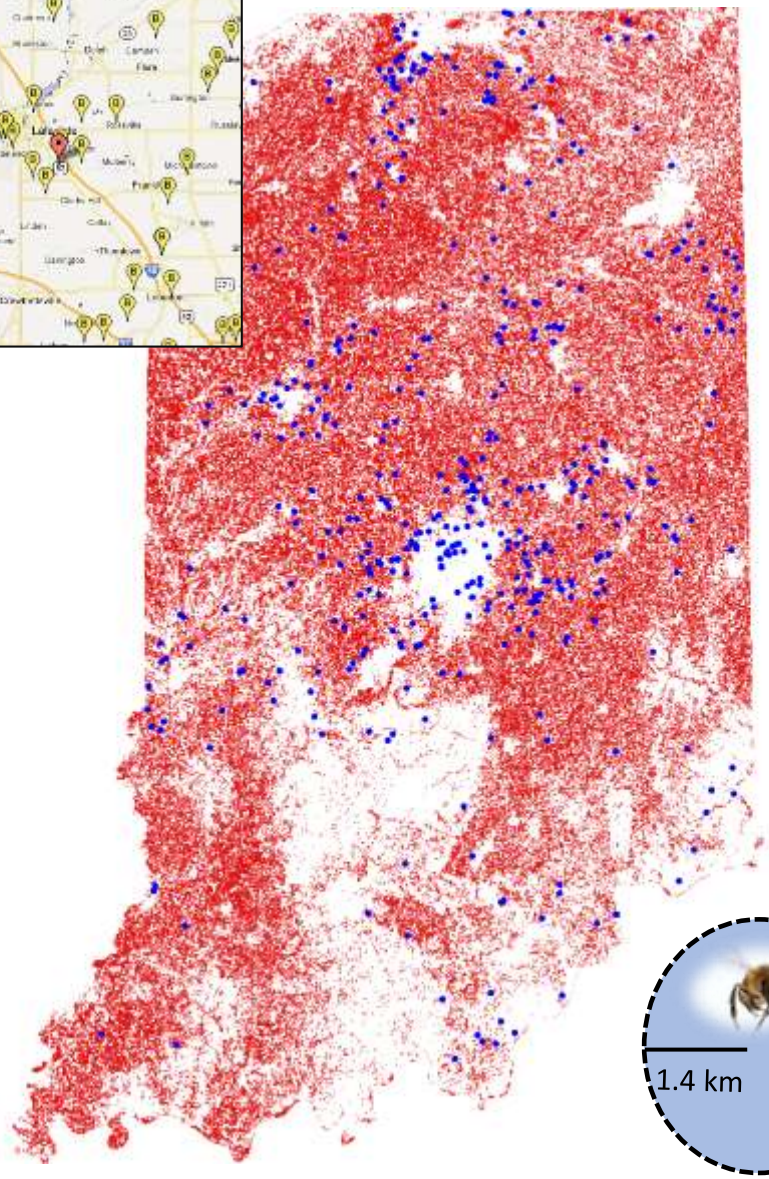
Available at:
Fieldwatch.org
USDA-NASS
USGS

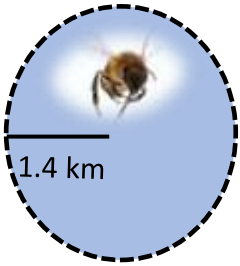


*Krupke et al. 2017. J. Appl. Ecol.
DOI:10.1111/1365-2664.12924

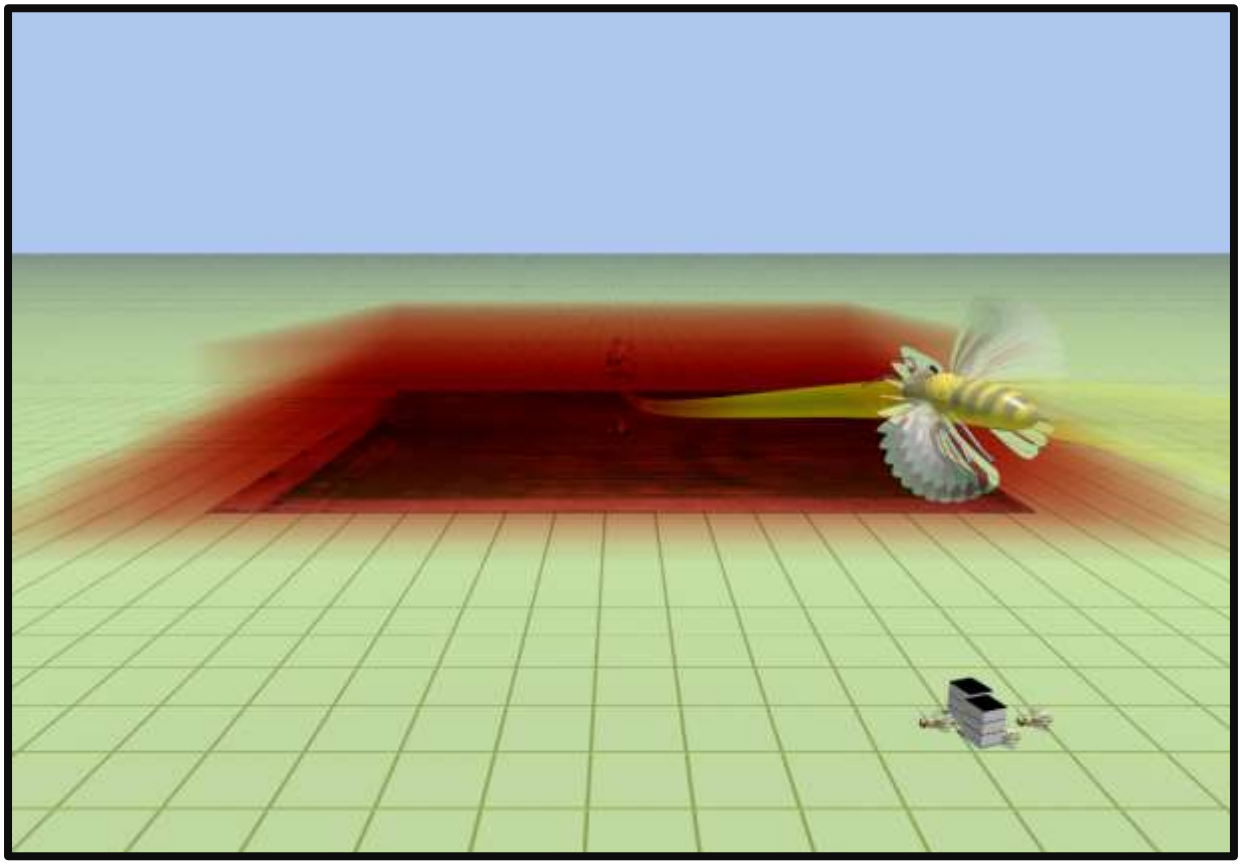
Foraging bees are *moving* across the landscape… this makes exposure estimates difficult

- Assume 1.4 km foraging radius* around each colony
- Can model exposures, but ideally require manipulative experiments





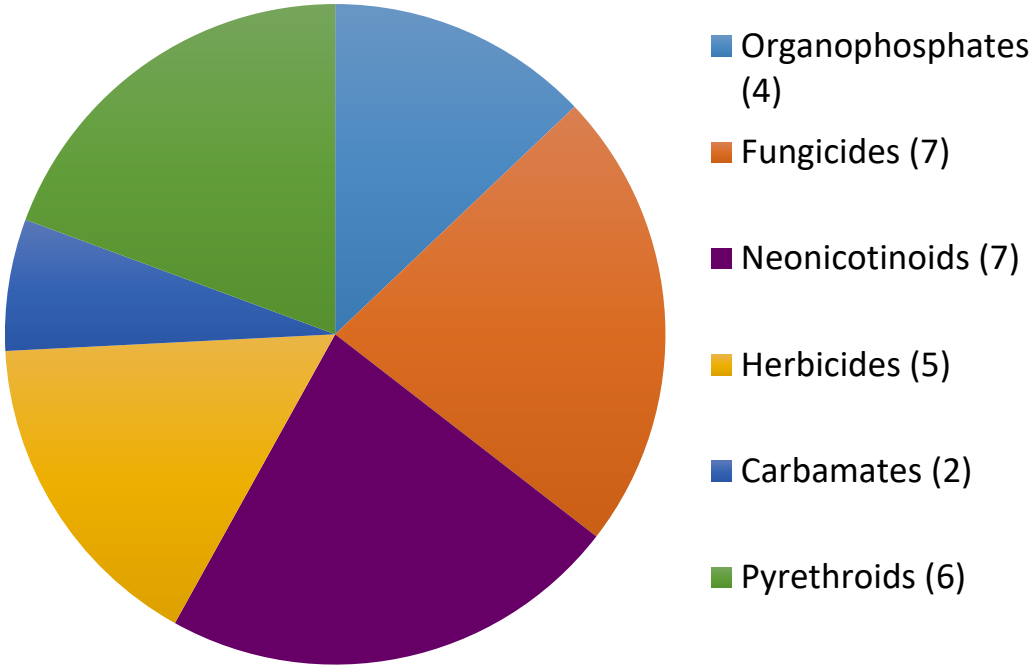
Forager exposure calculations



- What happens when a bee crosses a corn or soybean field? During planting, during flowering etc? Multiple pesticides?
- The solution requires technology

Honey bees are *never* exposed to single compounds, at a steady rate

- Indiana field study demonstrates many compounds, throughout season found in pollen



Long and Krupke, 2016
https://www.nature.com/articles/ncomms11629

Honey bees use corn pollen as a food source when it is available

- Corn pollen contains sub-lethal levels of seed treatment insecticides: Poncho (clothianidin) and/or Cruiser (thiamethoxam)
- Most corn is also treated with fungicide (Headline AMP, pyraclostrobin +metconazole) at R1 growth stage

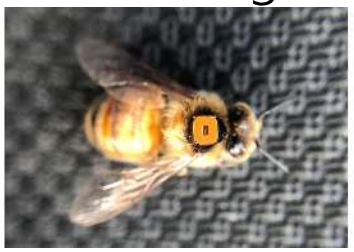
Tagging a bee

Chill Bee

Shave Bee

Glue On

Place Tag



UV On

How an RFID system can experimentally measure foraging

Hive

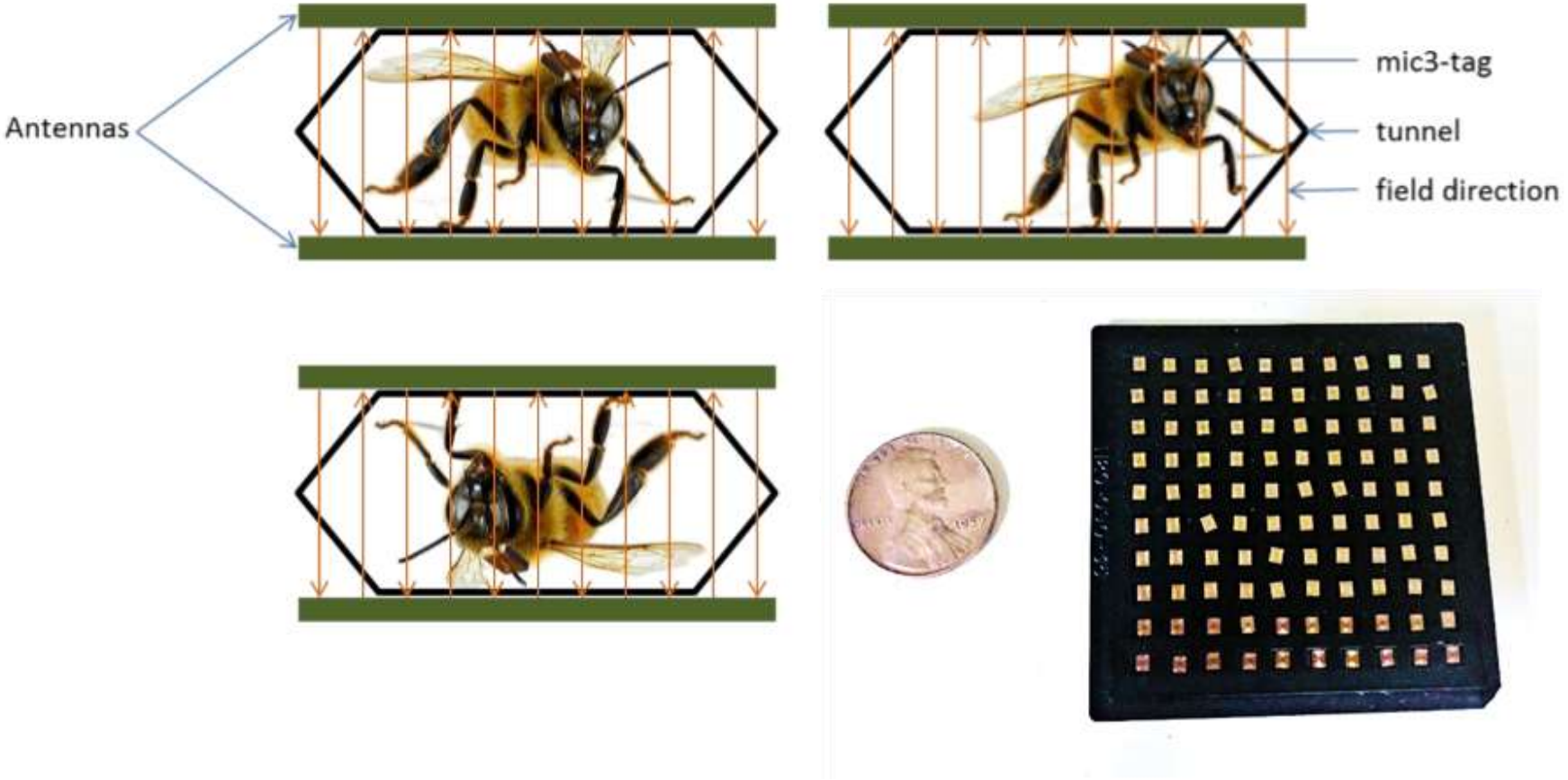
RFID system can track:

- Time arrived at an RFID reader
- Direction away from a location

- Direction into a location
- Foraging bouts

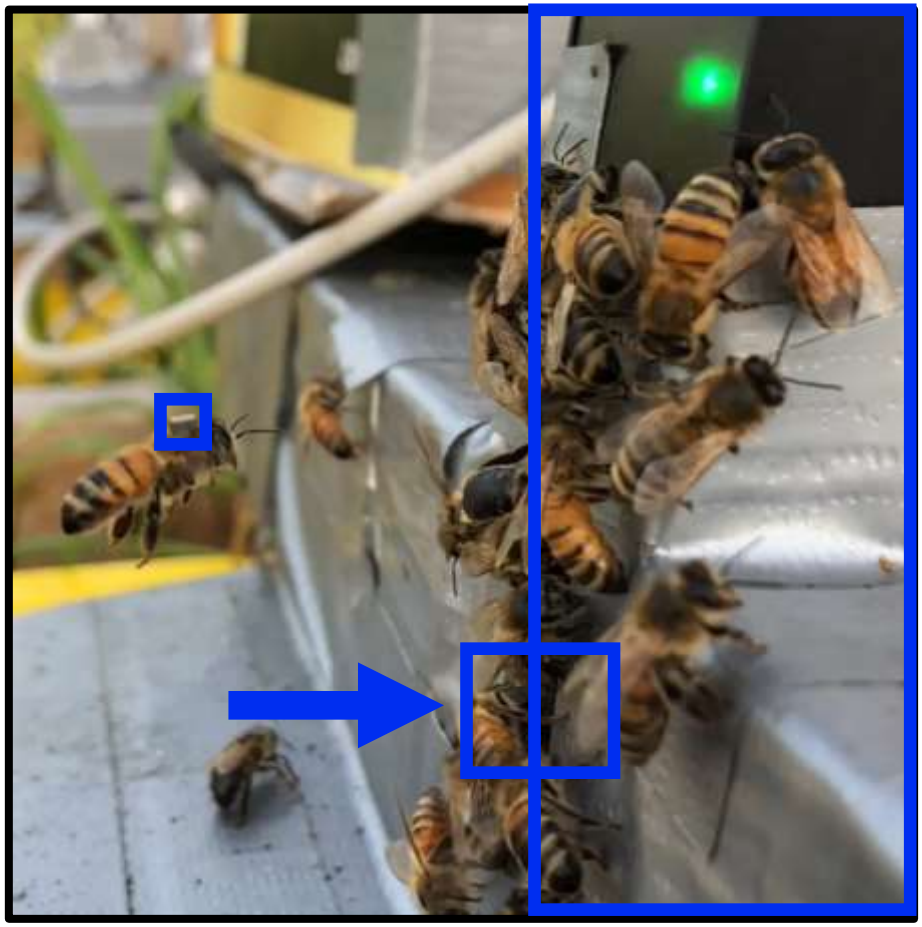
Trained Feeder

RFID tracking



RFID Technology

- RFID tag reader
  - Green light shows when an RFID tag is being read
  - Red light shows when reader is functioning but no tag is being read
- Hive entrance
- RFID tag on a foraging bee returning to the hive

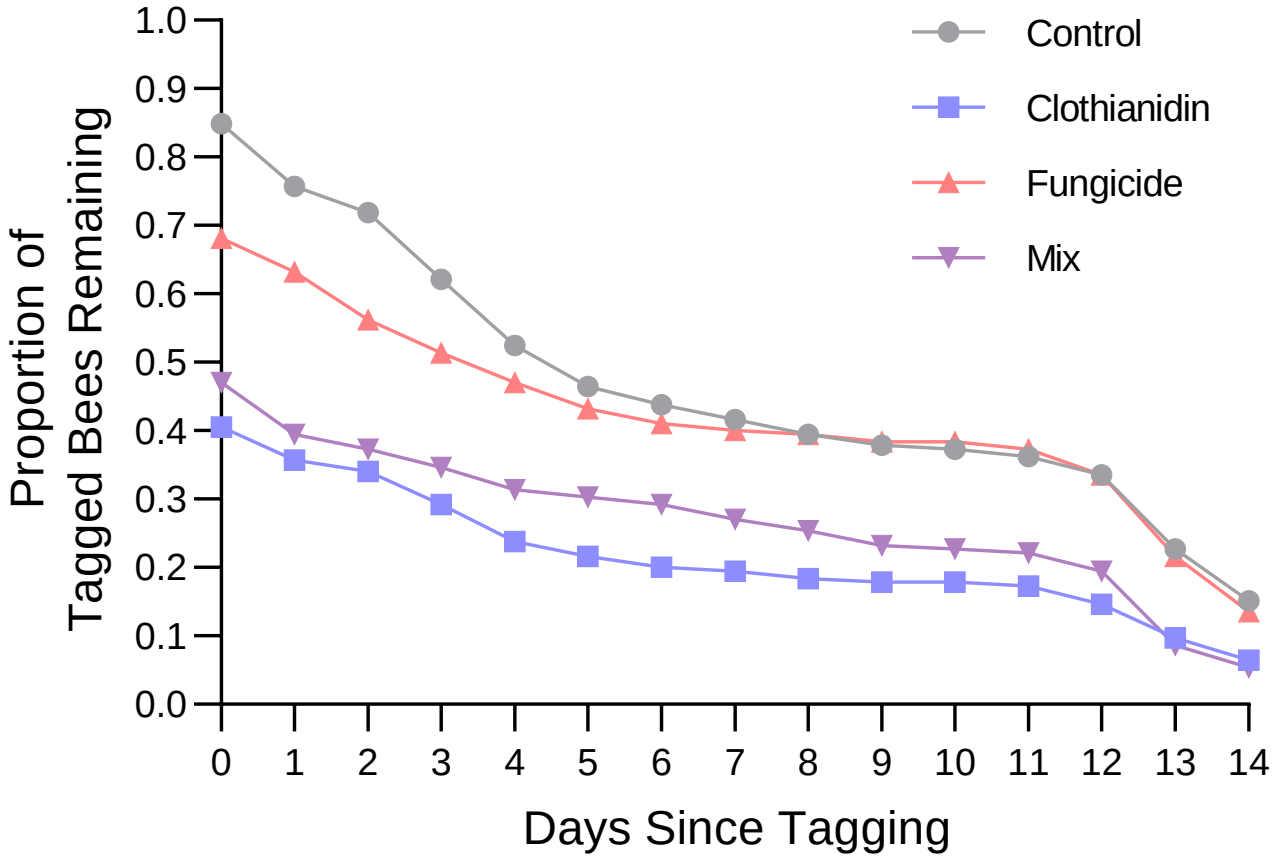


RFID tracking to measure foraging behavior:
High tunnels are ideal for semi-field studies

Inside high tunnel showing wildflower mix

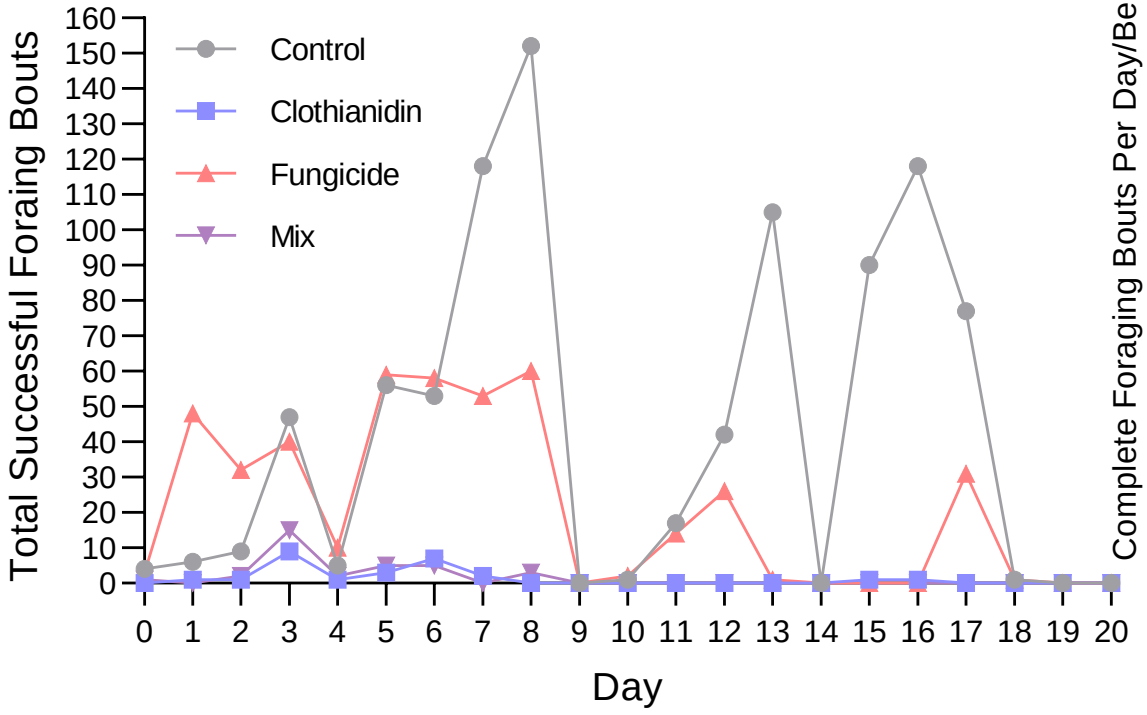
Sugar feeder mounted near hive entrance

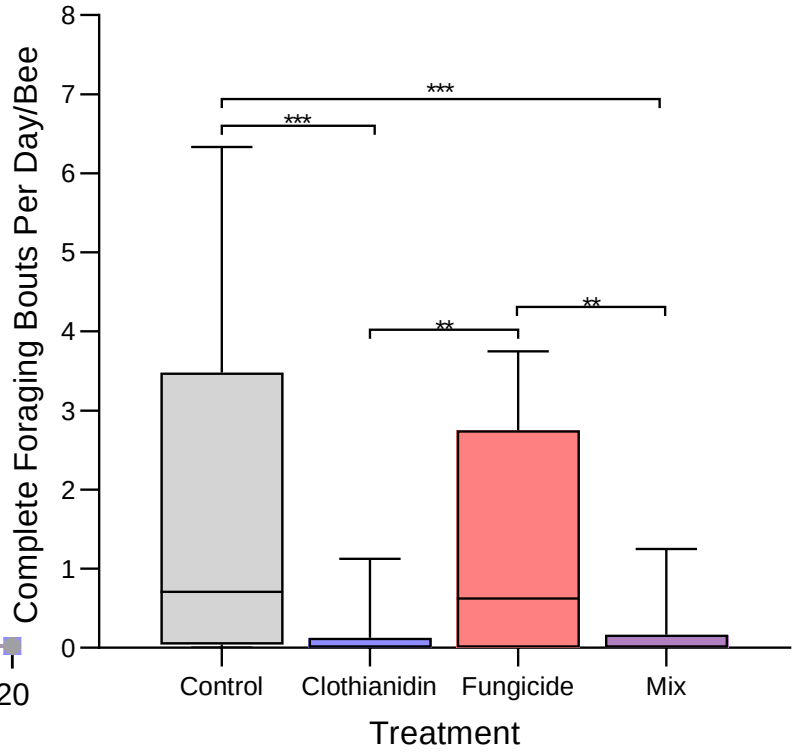
Early results:
Neonicotinoid exposure reduces forager longevity



Neonicotinoid exposure reduces foraging bouts

Clothianidin and Mix reduce bouts compared to Control and Fungicide (KW: P=0.0002)





Step 2: Field studies to support high tunnel work

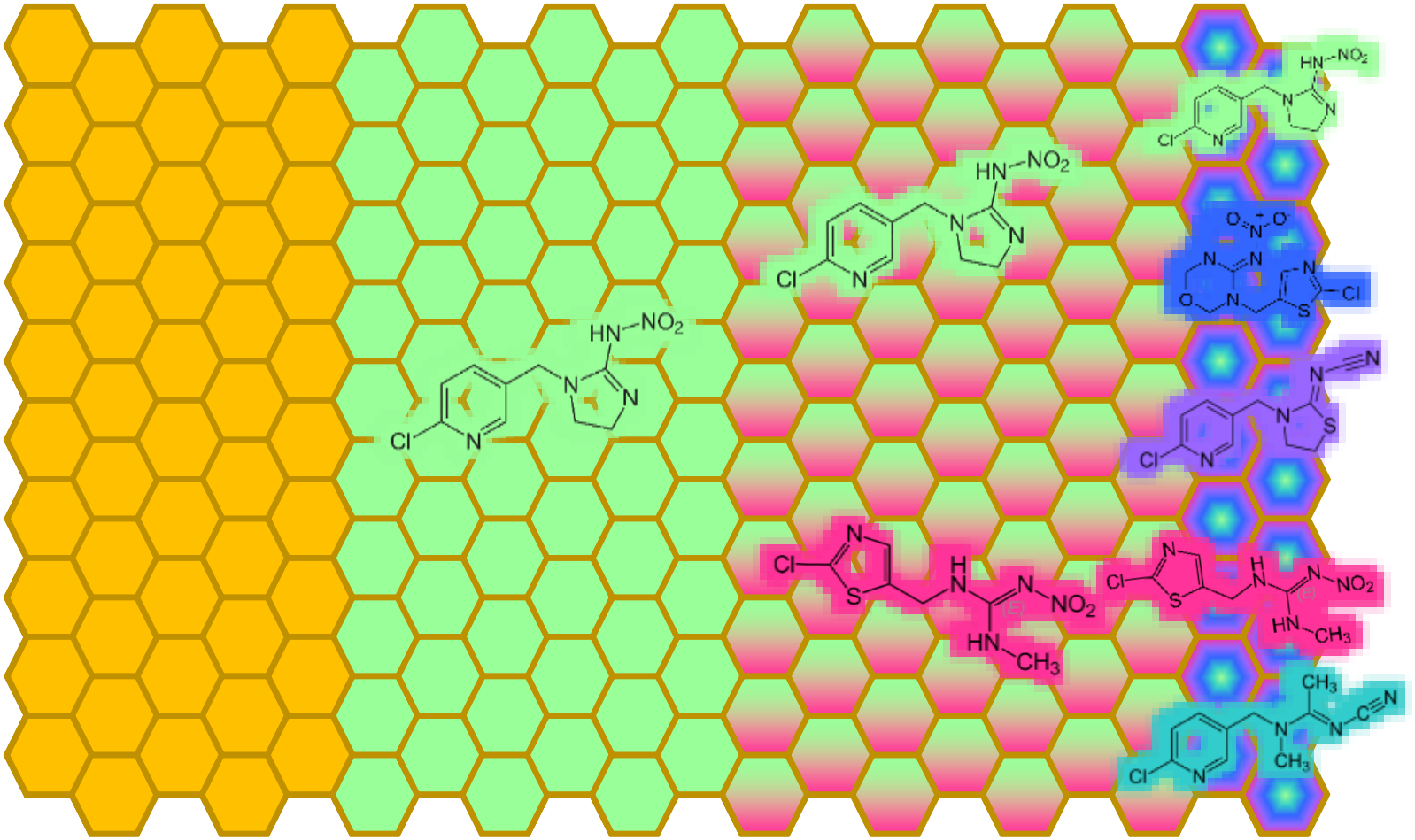
Marking plants with stable isotopes

- All plants must uptake elements including nitrogen (N) and carbon (C).
- Uncommon stable isotopes of N (N^{15}) and C (C^{13}) can be synthesized and added to plant sprays and fertilizers
- We can use these isotopes label plants, while we spray them

Dr. Sebastian Shepherd stands happily amidst his flowers

Previous research: neonics in honey

- Mitchell et al. 2017 collected honey from 6 continents
- 75% of samples contained 1 neonicotinoid
- 45% contained 2 • 10% contained 4 or 5



What's inside the colony? Are pesticides found inside, or any effects on bee products?

Stored pollen, or "bee-bread"

Stored nectar/honey

What's inside the colony? Are pesticides found inside, or any effects on bee products?

We don't know yet - stay tuned!

The End