

# BEEHAVE & BumbleBEEHAVE (Vanessa Roeben, Bayer)





# **BEEHAVE and BumbleBEEHAVE plus ecotox: Tools for linking standard lab studies to colony dynamics**

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03/17/2026



# Why bee modeling in the regulatory context



## Bridging the gap between lab and field



## Support mechanistic understanding

- // Investigate a.i. fate and population level effects
- // Enables better planning of (semi-)field studies
- // Support reduction of uncertainty



## Regulatory requirements

- // Colony-level studies  
time and resource  
intense with high  
variability
- // Model translating  
→ exposure  
→ ind. effects in the lab  
→ colony/population  
outcomes in the field

*the*



*model*



# The BEEHAVE model



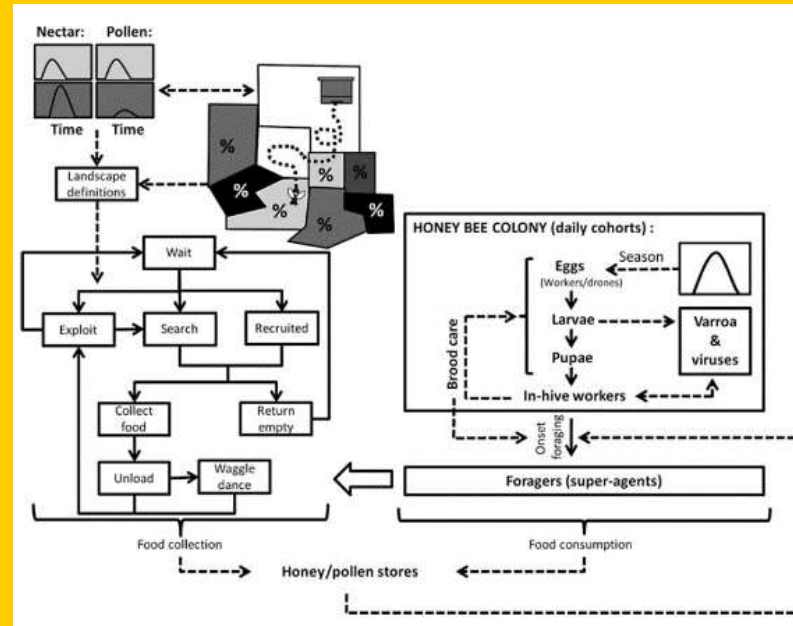
Colony and population dynamics



Simulating multiple factors



Foraging



Landscape and forage availability

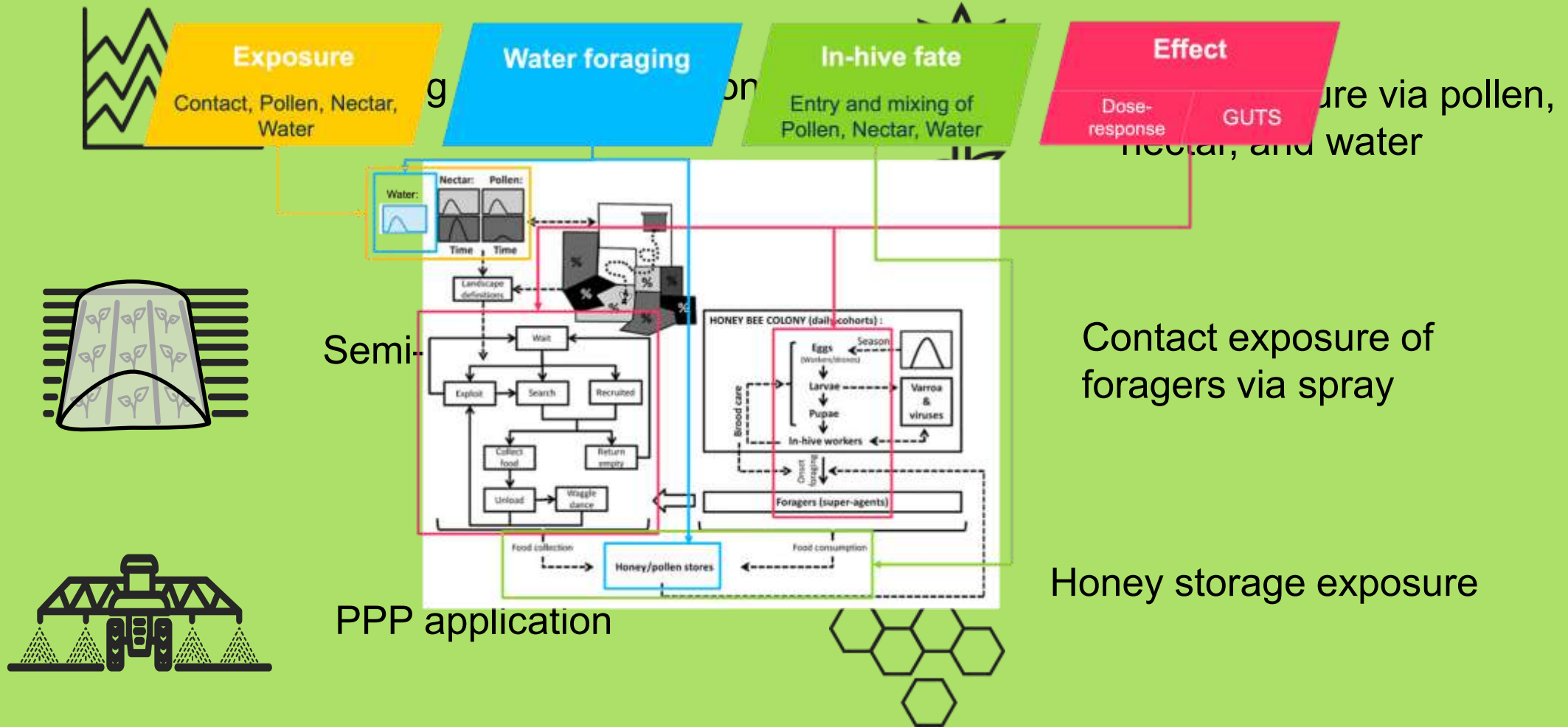


Broodcare



Varroa and beekeeping

# The BEEHAVEecotox model



# Exposure & in-hive fate – honeybees

Dose is emergent property

Foraging



Nectar (with a.i.)

$\text{daily dose} = f(\# \text{ of trips, distance, concentration, consumption})$

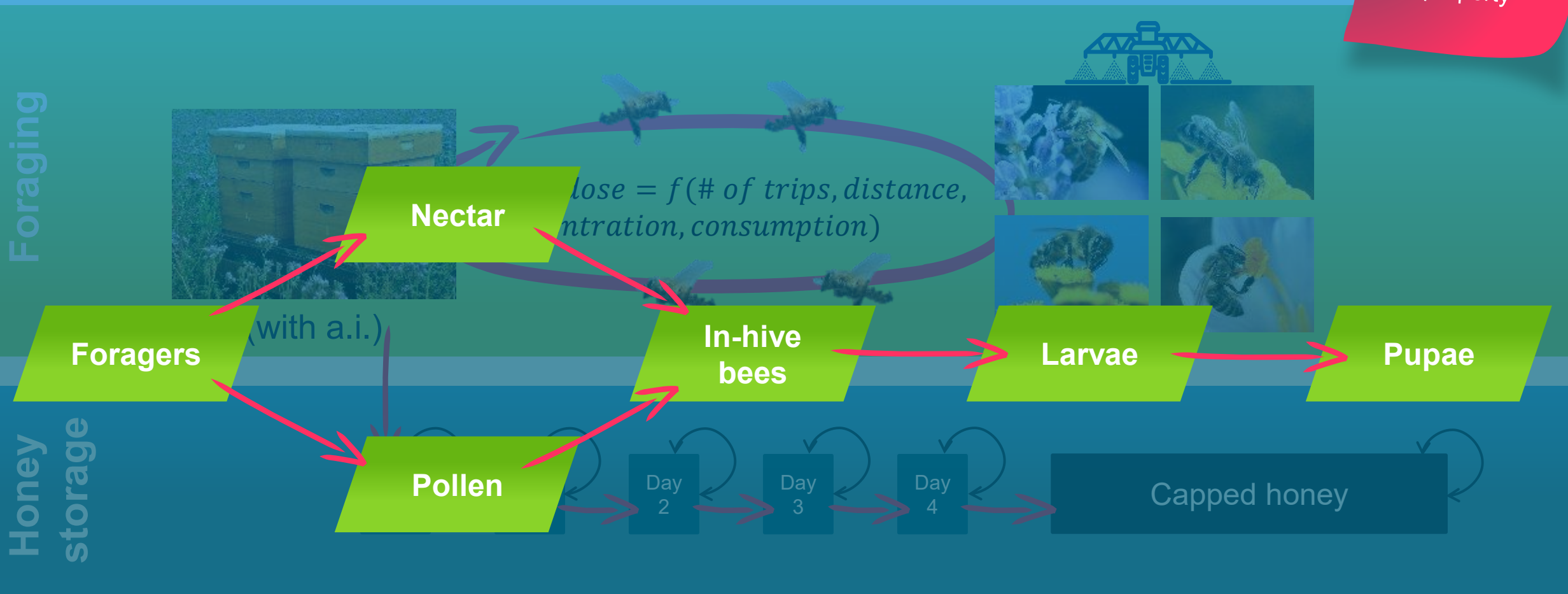


Honey storage



# Exposure & in-hive fate – honeybees

Dose is emergent property





# Data requirements – honeybees

 data available in a typical bee ERA dossier

- // Application scenario (crop, timing, application rate)
- // Weather data
- // Landscape/foraging structure
- // Colony starting configuration
- // Toxicity data
  - // Dose-response functions from lab tests or TKTD parameters





# Data requirements – honeybees

## Tier 1 - Laboratory

### Testsystem

### Implementation

// **Contact exposure**



Adult bees  
OECD 214 – 48 h

// **Oral uptake**



Adult bees  
OECD 213 (acute) – 48 (96) h  
OECD 245 (chronic) – 10 d

// **Larvae**



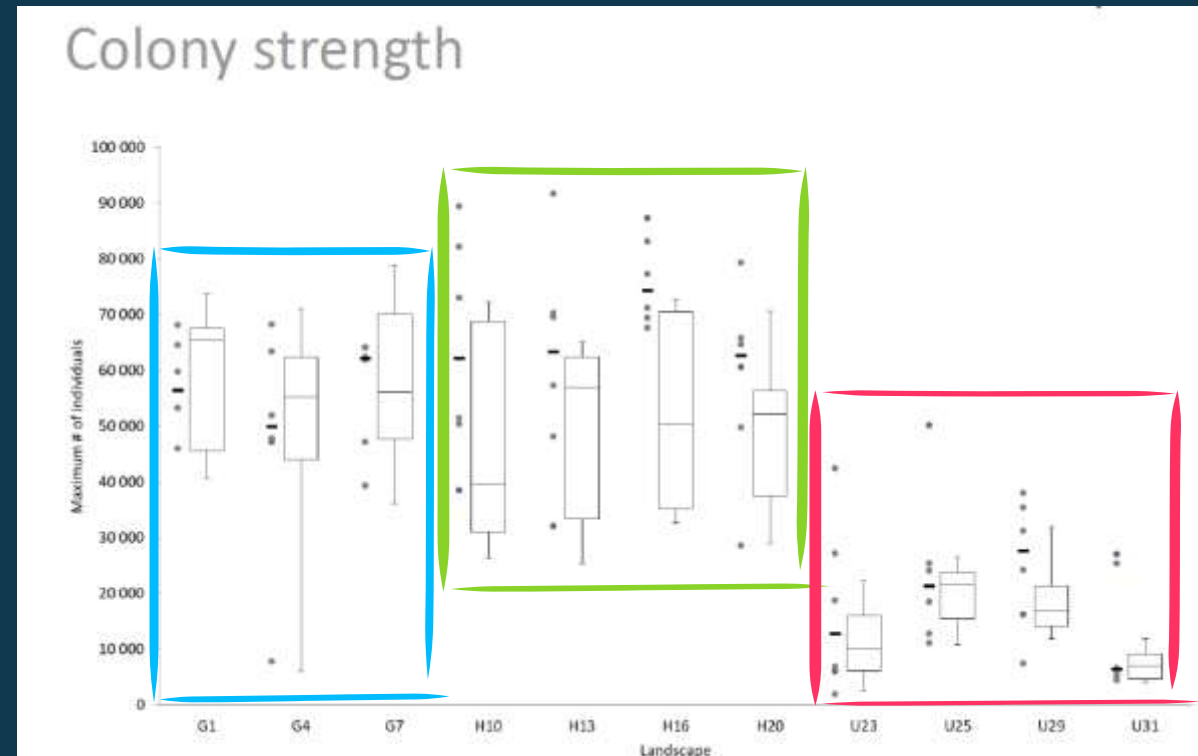
From larvae to adult  
OECD 239 – 22 d

Data based on  
standard  
regulatory studies

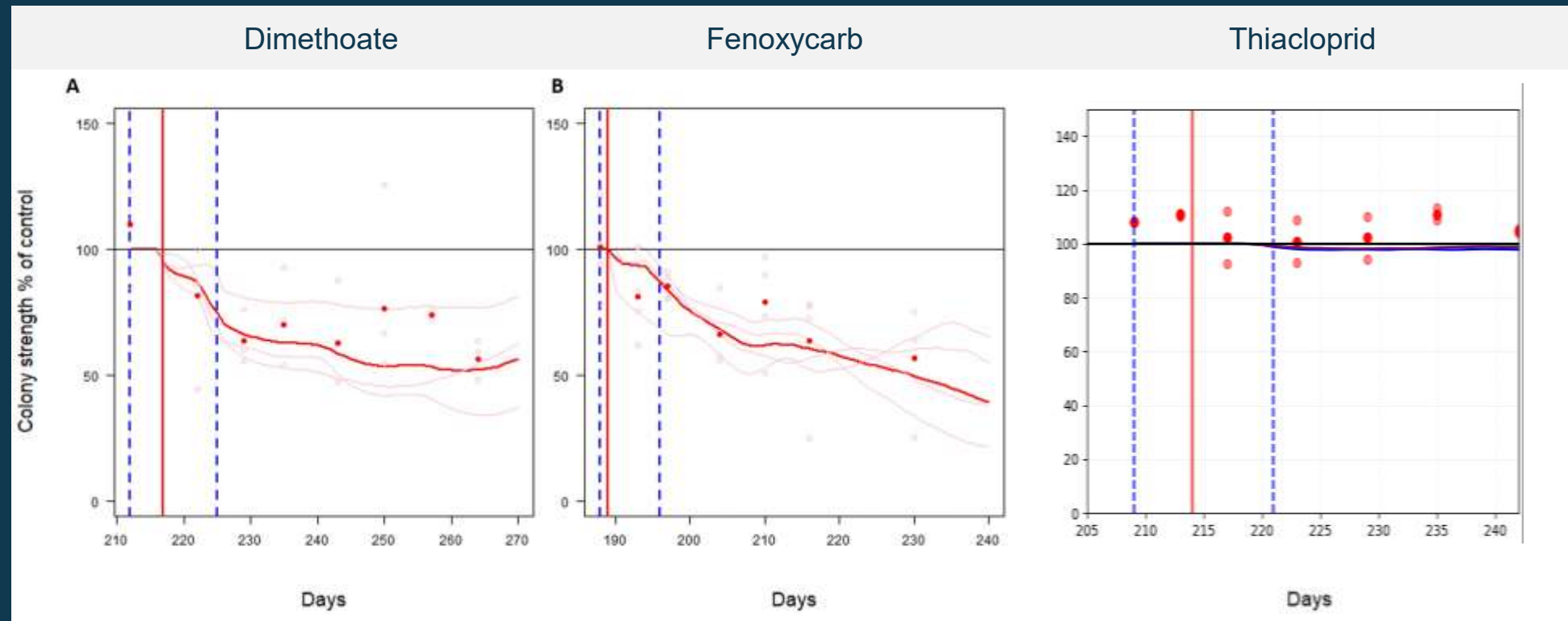


**TKTD  
(GUTS)**

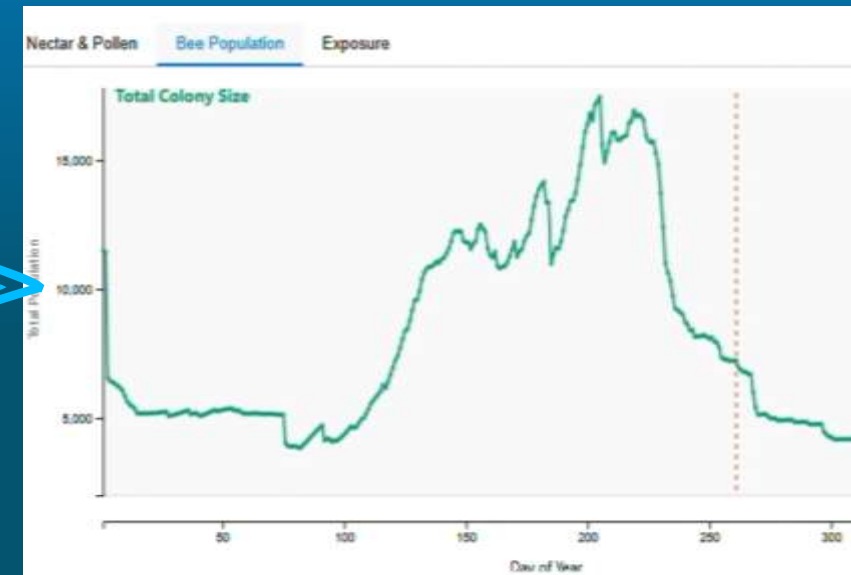
# Colony dynamics predictions without and with PPP application



# Colony dynamics predictions without and with PPP application



# Colony dynamics predictions in large landscape context - xPollinator





# And other bees?



Non-Apis bees potentially have

- // Different life cycle
- // Different exposure dynamics
- // Different (ecological) endpoints

→ Different biology → different ERA needs



Universität  
Osnabrück

*the*



*model*



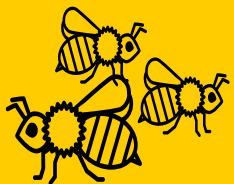
# The BumbleBEEHAVE model



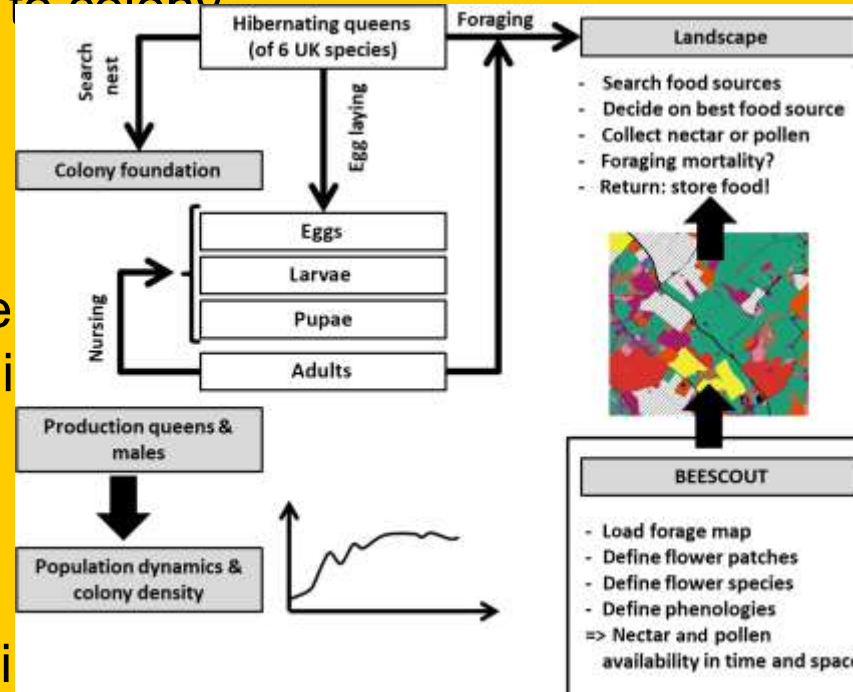
Population dynamics  
from solitary to colony



Landscape  
forage avail



Multispecies i  
via competition



Broodcare and weight  
development



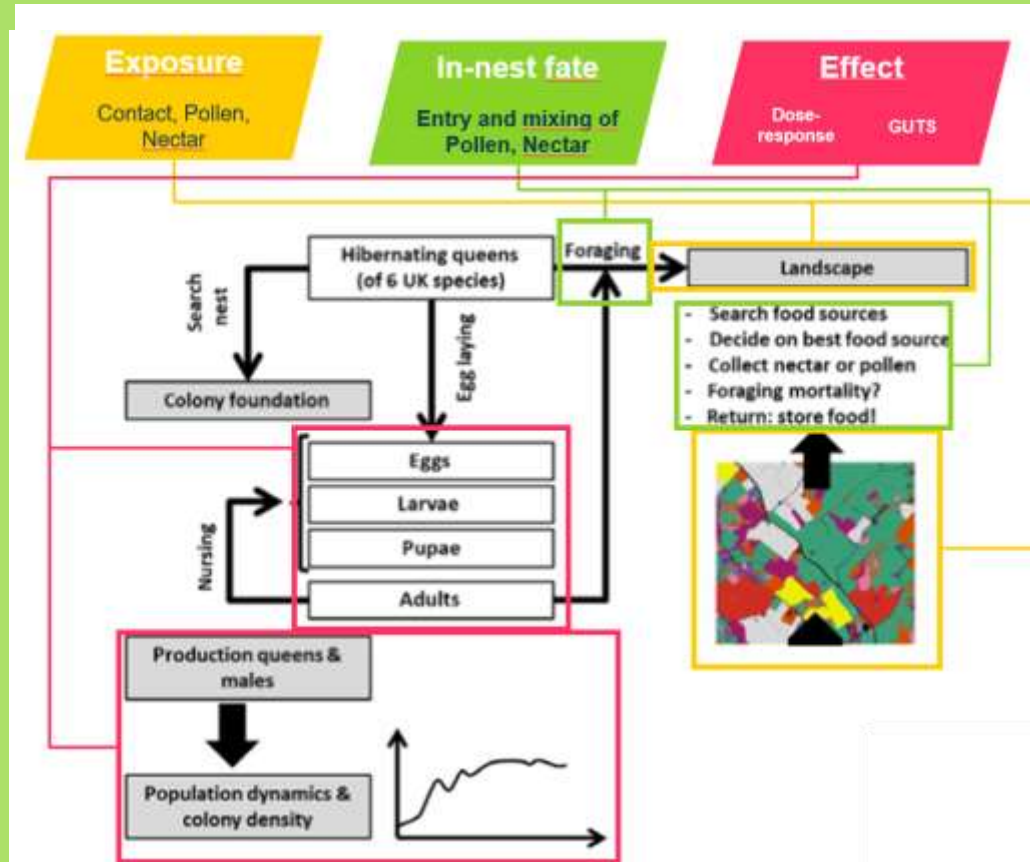
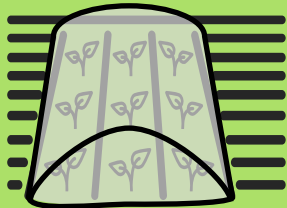
Species and plant  
specific foraging



Simulating multiple  
factors



# The BumbleBEEHAVEecotox model



PPP application

Oral exposure via pollen and nectar

Contact exposure of foragers via spray and potential soil exposure during nesting

ecotox module:  
Dose-response & GUTS



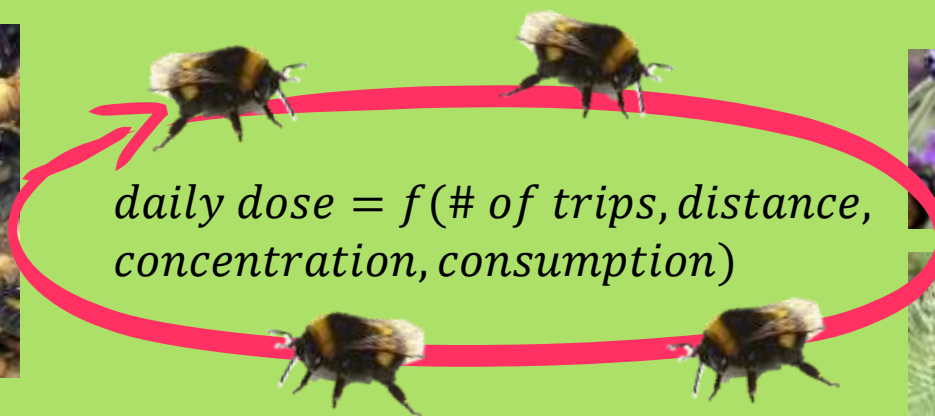
# Exposure & colony fate – bumblebees

Dose is emergent property

Foraging



Nectar (with a.i.)



Food storage

Nectar and pollen storage

# Colony dynamics predictions without PPP application

// Colony composition in terms of #

// eggs

// larvae

// pupae

// workers

// males

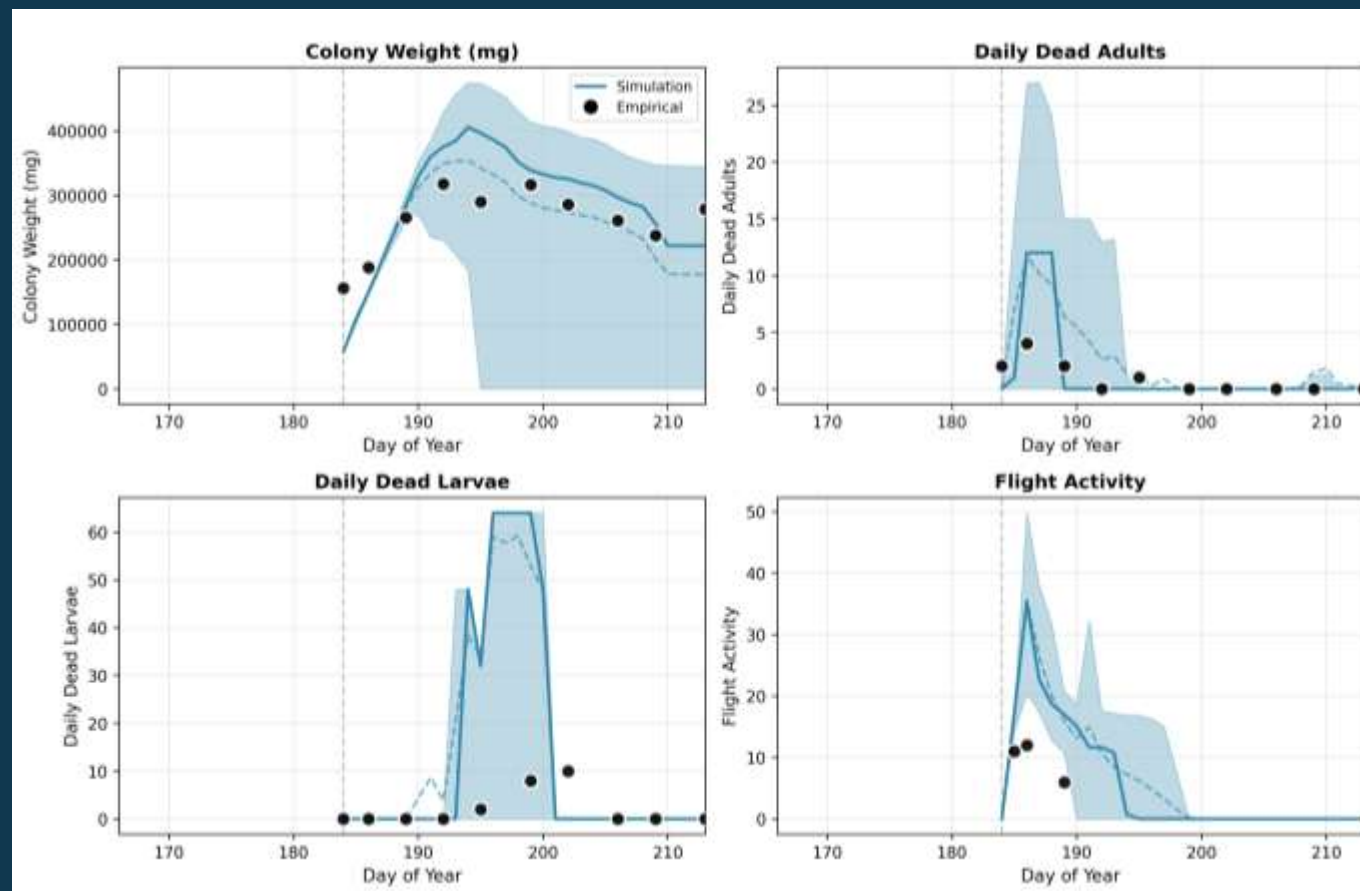
// queens

// food storage

// Reproductive output

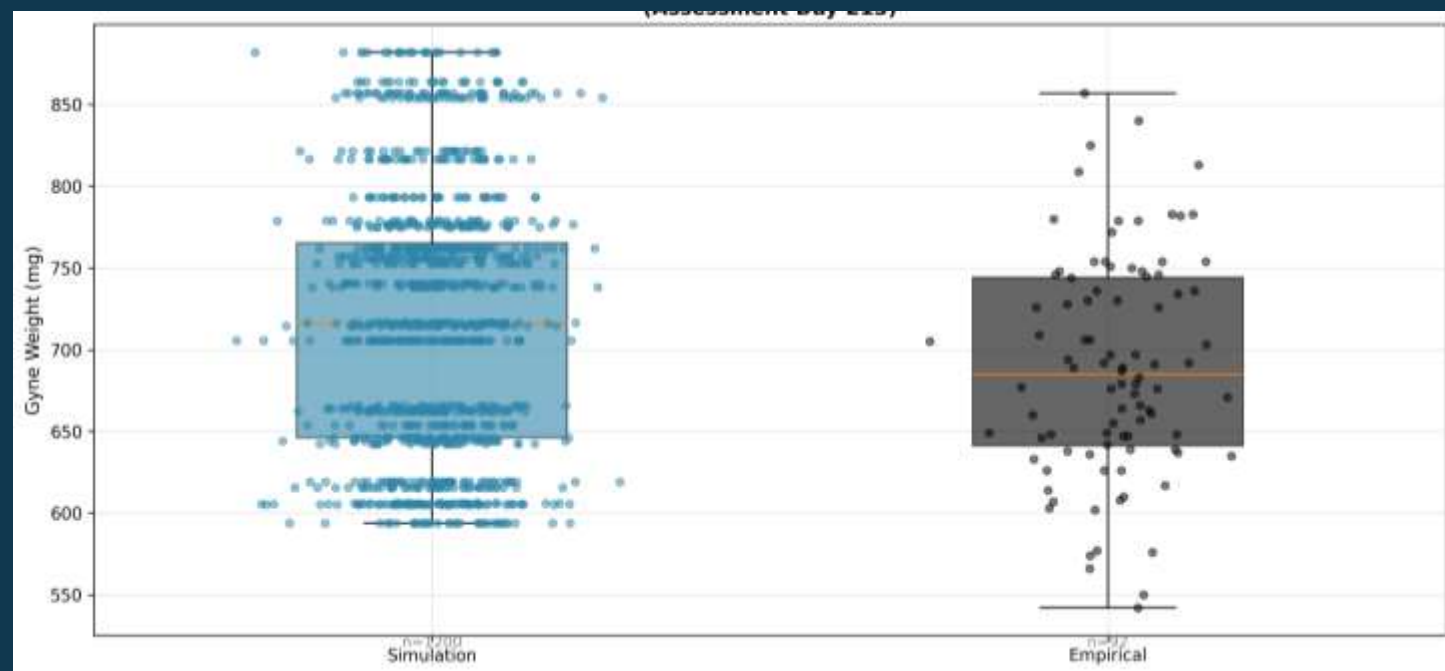
// # gynes

// weight of gynes



# Colony dynamics predictions without PPP application

- // Colony composition in terms of #
  - // eggs
  - // larvae
  - // pupae
  - // workers
  - // males
  - // queens
- // food storage
- // Reproductive output
  - // # gynes
  - // weight of gynes





# Summary & key messages



Mechanistic bee models turn exposure & lab studies into colony/population outcomes



Models use familiar data already generated for ERA



Outputs align with regulatory protection goals

Models, code, and documentation are **open source** and **FAIR**

BEEHAVE & BumbleBEEHAVE with active scientific community (>28 publications)



**Thank** You  
for be(e)ing  
here!



[Vanessa.Roeben@bayer.com](mailto:Vanessa.Roeben@bayer.com)

*Coffee*

**Break**

