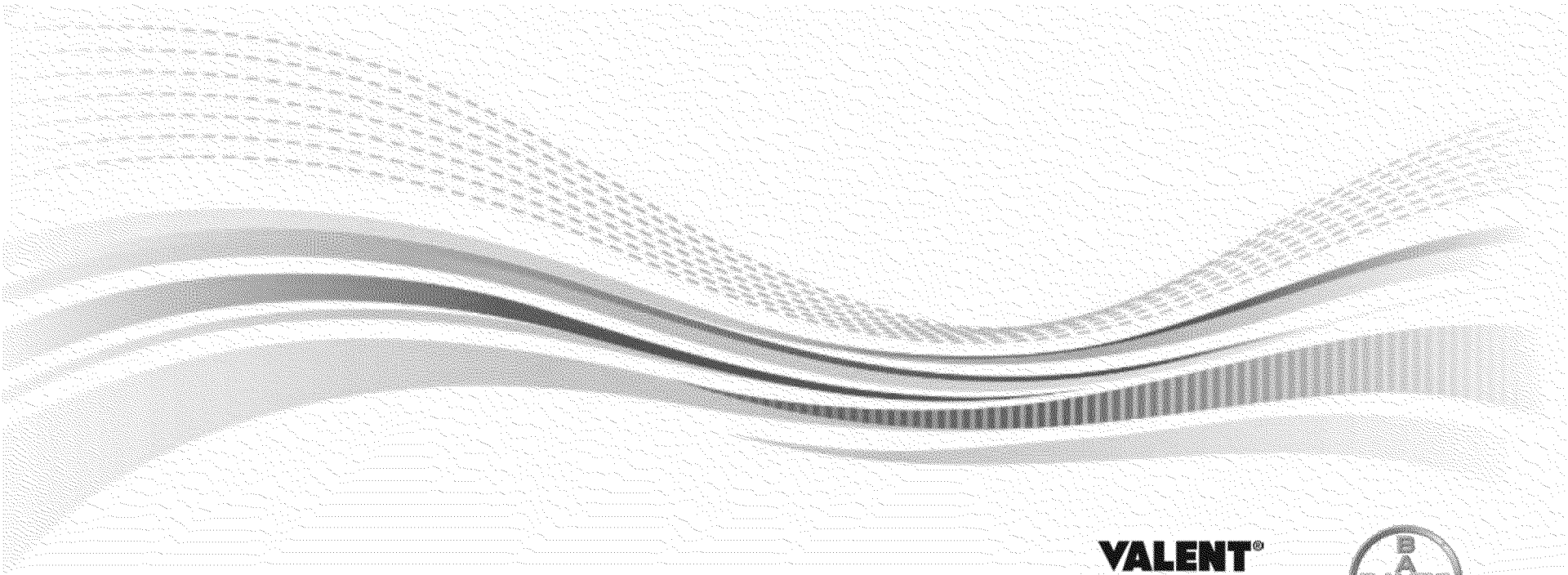
Using Colony Feeding Studies to inform population models (BEEHAVE)



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Overwintering losses in controls

- Unlike in the imidacloprid CFS in 2013, overwintering losses in control in clothianidin and thiamethoxam studies were high in 2014

- Based on expert judgment, control colony losses could be explained by other stressors, solely or in interaction, e.g. late feeding timing and/or prolonged winter in 2014

Overwintering losses in controls

- Ecological/population models could help in interpreting colony losses in control

- E.g. BEEHAVE model (Becher et al 2014) could be a suitable tool to investigate this complexity because it integrates in-hive processes and foraging activities to simulate interactions between colony and environment

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BEEHAVE model

- The model consists of 4 modules:
  1. **Landscape module**: define a landscape of nectar and pollen in food patches
  2. **Colony module**: an age-based cohort model including processes such as nursing and care of brood
  3. **Foraging module**: an individual-based model calculating the foraging activities on a particular day and the quantity of both nectar and pollen brought back into the hive
  4. **Varroa and virus module**: simulating the population dynamics of the Varroa mite and the transmission of viruses
  5. **Pesticide module underway**: to ensure correct implementation of exposure routes from flower, via forager, into the colony

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BEEHAVE model

- BEEHAVE includes a number of factors which may be key to understanding how different stressors can impact the colony at any one time, as would be happening to real colonies in the field:
  - Landscape dynamic and weather providing the potential for climate or location-specific simulations
  - Foraging dynamics (including the flow of energy in the form of honey stores) and Varroa and virus
- It could be compared with other alternative Bee models, e.g. PCBEEPOP (Bromenshenk et al 1991)

Scope of Valent&BCS proposal

Setting the BEEHAVE simulations in the context to empirical evidences from the data gathered from the CFS studies: overwintering losses, hive conditions, food sources, environmental conditions, etc

Benefits:

1. Check if simulations can predict similar impact levels as yielded in controls in the studies – calibration of the model
2. Identify in a quantitative way the contribution of different stressors in overwintering losses
3. Help in better designing future CFS/Field studies