



Pesticides and risks to bees



Dr. Jens Pistorius

Programa de conferencias



- *Miércoles 6 de febrero* a las 17 hs
 “Pesticides and risks to bees” en Facultad de Química
- *Jueves 7 de febrero* a las 17 hs
 “Pesticide testing methodologies for bees” en IIBCE
- *Viernes 8 de febrero* a las 16 horas
 “Routes of exposure for bees and pesticide risk assessment” en Facultad de Química
- *Viernes 8 de febrero* a las 17.15 horas
 “Bee poisoning incidents and international activities to protect pollinators”
- *Lunes 11 de febrero* a las 10 hs
 - **“Bees and beekeeping ”** en INIA (a definir)

A life without bees would be sad



Foto: Louis Masai Michel

Bee pollination improves quality, quantity and shelf life



Your produce choices
with bees

(Whole Foods
Market 2014,
Folien: Goss

Bee pollination improves quality, quantity and shelf life



Your produce choices
without bees

(Whole Foods
Market 2014,
Folien: Goss

Pollination: Essential for Quantity and Quality

- e.g. Fruit formation, nutrients

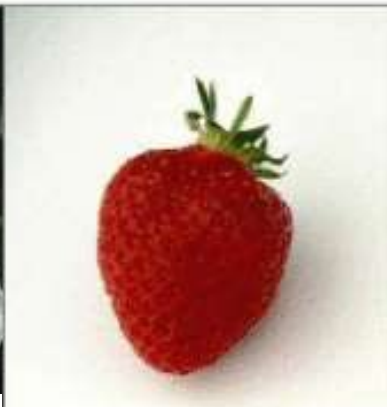


Bee-pollinated

Self/wind-pollination



Photo: C. Westphal



Photos Strawberries: M. Krewenka

vs.

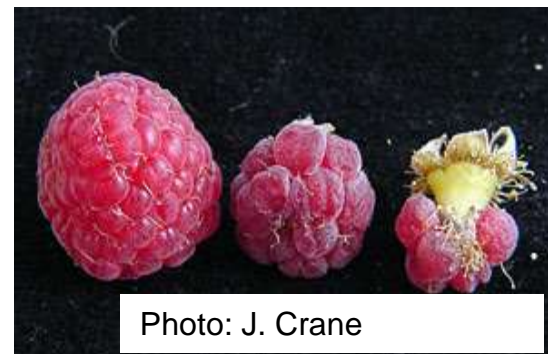
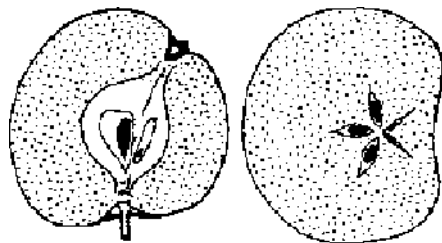
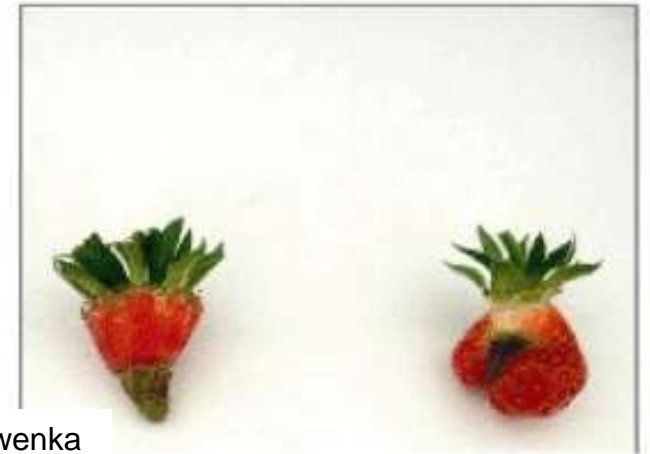


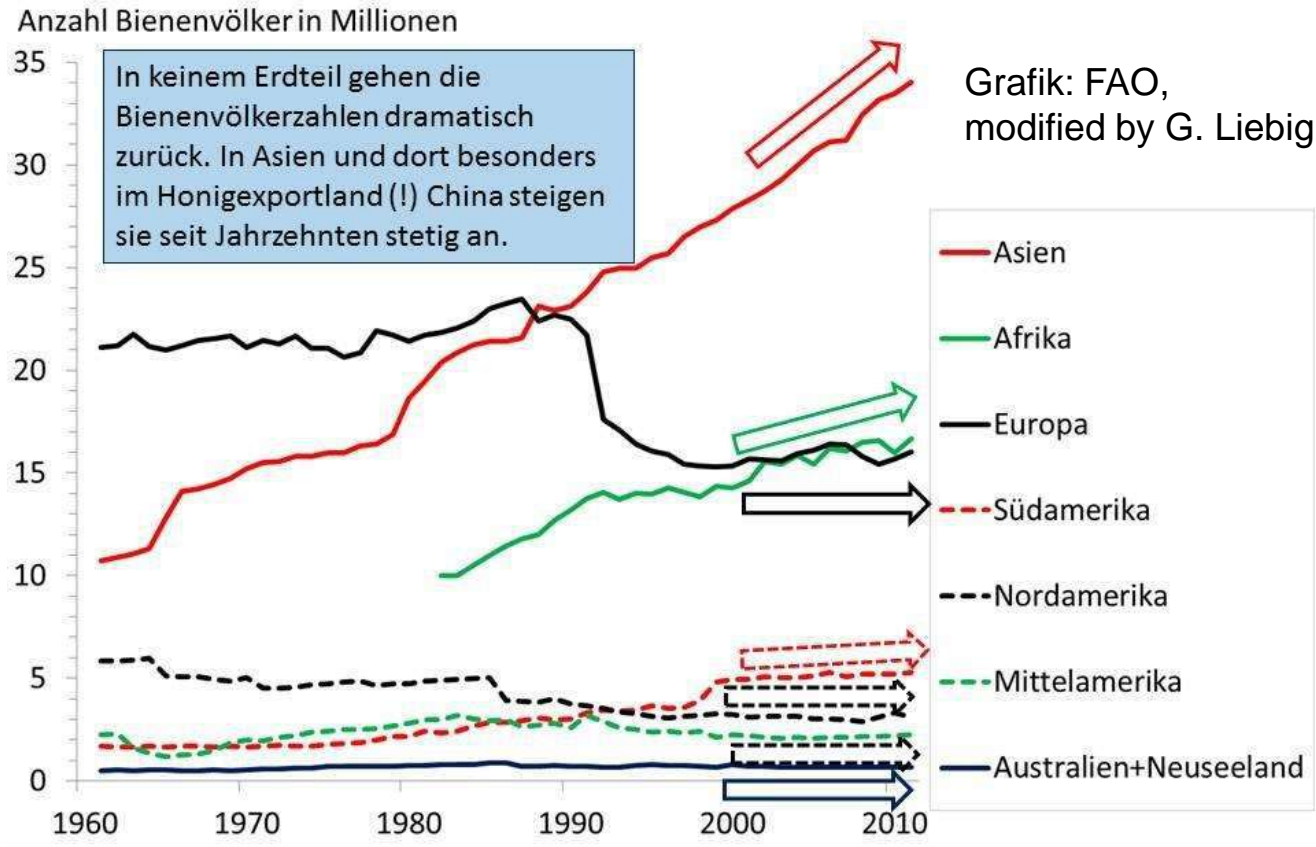
Photo: J. Crane

If pollination was not done properly, small or poorly developed fruit are the consequence

(u. a. Leuenberger, 1933; Krewenka et al. 2006; Klein et al 2007)

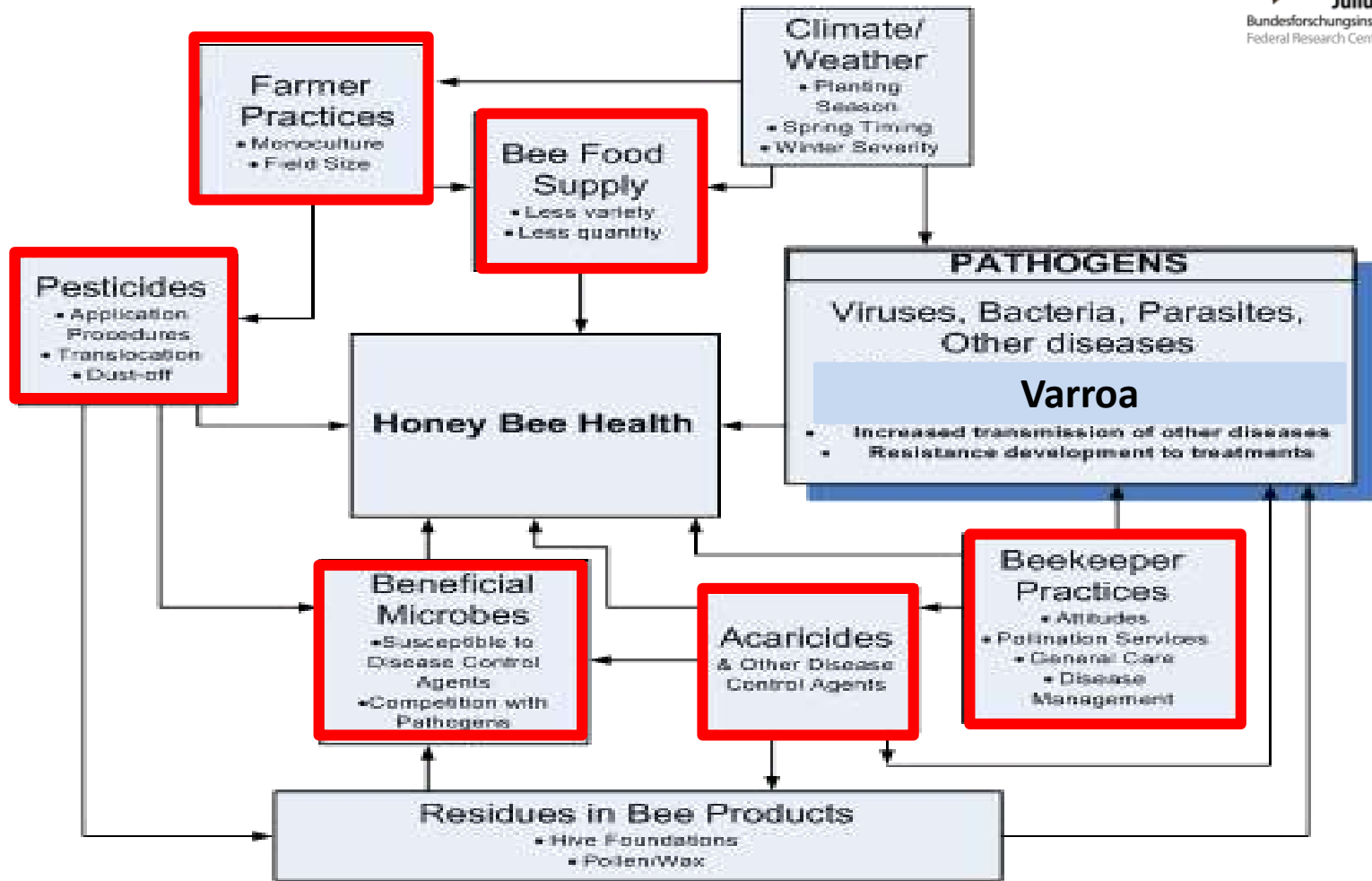
Decline of honey bees?

Entwicklung der Völkerzahlen in den Erdteilen 1961-2011
(Quelle: FAO)



There is no such thing as a general decline for honey bees – but frequent winter losses, pesticide poisoning, sometimes poor development- but no „Bienensterben“

Multiple threats to bee health



Interrelationship of bee health Stressors Adapted from Le Conte *et al.*, 2010

... and what about other pollinators?

**z.B. IPBES,
2016: Global
Pollinator
assessment**



„BEE protection“ ??

> 560 bee species in Germany



→ „commercially used pollinators“ (Germany): Honey bee, bumble bee, red mason bee)





Photo: Jürgen Gräfe/fotocommunity.de



Photos: Roland Günther



JKI- Bundesforschungsinstitut für Kulturpflanzen

Julius Kühn-Institut
10 Jahre

1898 * 2008 * 2018

120 Jahre

Forschung für Kulturpflanzen von morgen

Federal Research Centre for Cultivated Plants

federal risk assessment authority and research institute

Mandated by legislation (Pflanzenschutzgesetz,
Gentechnikgesetz, Chemikaliengesetz)

- 17 subinstitutes at 10 different locations
- 600 hectares research field area
- ca. 35.500 m² greenhouses
- ca. 20.000 m² laboratorys



Bundesministerium
für Ernährung
und Landwirtschaft

Institute for Bee Protection Braunschweig & Berlin



Brunswick



Groß Lüsewitz

Braunschweig

Berlin / Kleinmachnow

Münster

Quedlinburg

Dresden-Pillnitz

Darmstadt

Dossenheim

Siebeldingen

Berlin



Research

**Scientific
assessment**

Policy-Advice

● JKI head office
● JKI sites

The team: Institute for Bee protection



2 locations: Braunschweig (Bee trials, Risk assessment) & Berlin (Analytics)
Staff currently 32 Persons

„Stakeholder- Bee Protection“

- Bee keeper ass.
- Bee Keepers
- Bee Keeping Advisors
- NGOs/Env. Groups
- Agricultural ass.
- Farmers
- PPP-Producers
- Plant Protection Services
- Contract Labs
- Scientific world
- Authorities
- Policy makers
- Ministries



Institute for Bee Protection

Tasks and field of work



- Risks for pollinators and pollination services
- Risk mitigation: (Chemical) Plant Protection, Cropping systems
- Interaction of bees and: Agriculture, Horticulture, Forestry, Wine and Fruit production, Urban green
- Bee protection/ promotion of bee-wellbeing, also in urbanized areas
- Benefits of bees for agriculture

Research

**Scientific
assessment**

Policy-Advice

Institute for Bee Protection

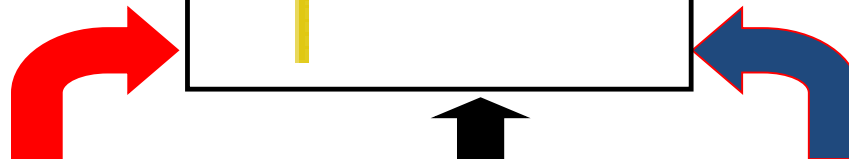
Tasks related to: Plant Protection Products (PPP)



- I. Risk assessment of plant protection products/bees
- II. Examination center for bee poisoning incidents
- III. Research on risks of pesticides to bees



Risk management authority →



Risk assessment authorities: JKI, UBA, BFR



Commercially used
pollinators (Honeybees,
Bumblebees, Solitary Bees)



Risk for Health



Wild living Bees

Risk assessment: Dose – Response: risk, hazard, risk mitigation

Plant Protection Product:

- Active Substance
- (Toxicity, Mode of Action, Properties)
- Content of A.S.
- Formulation (Additives etc.)
- Crop
- Application, Timing
- Amount of A.S. or Product per ha?



Toxicity LD₅₀ (in µg/Bee):

<1 µg / Bee = highly toxic

1 – 10 µg / Bee = toxic

10 – 100 µg / Bee = moderately toxic

– > 100 µg / Bee = not toxic



Higher tier Risk Assessment



Bee classification

B1: No application on flowering crops

B2: Application after daily flight until 11 pm

B3: Intended use-> no unacceptable exposure

B4: Application during Beeflight ok



I- Risk assessment

- Performing risk assessment to bees
- Linked with Incident Investigation (II) & Research activities (III)
Defining and refining methodologies, improving risk assessment and risk mitigation strategies
- Involvement in all relevant gremia, such as ICPPR, OECD, FAO....



Institute for Bee Protection
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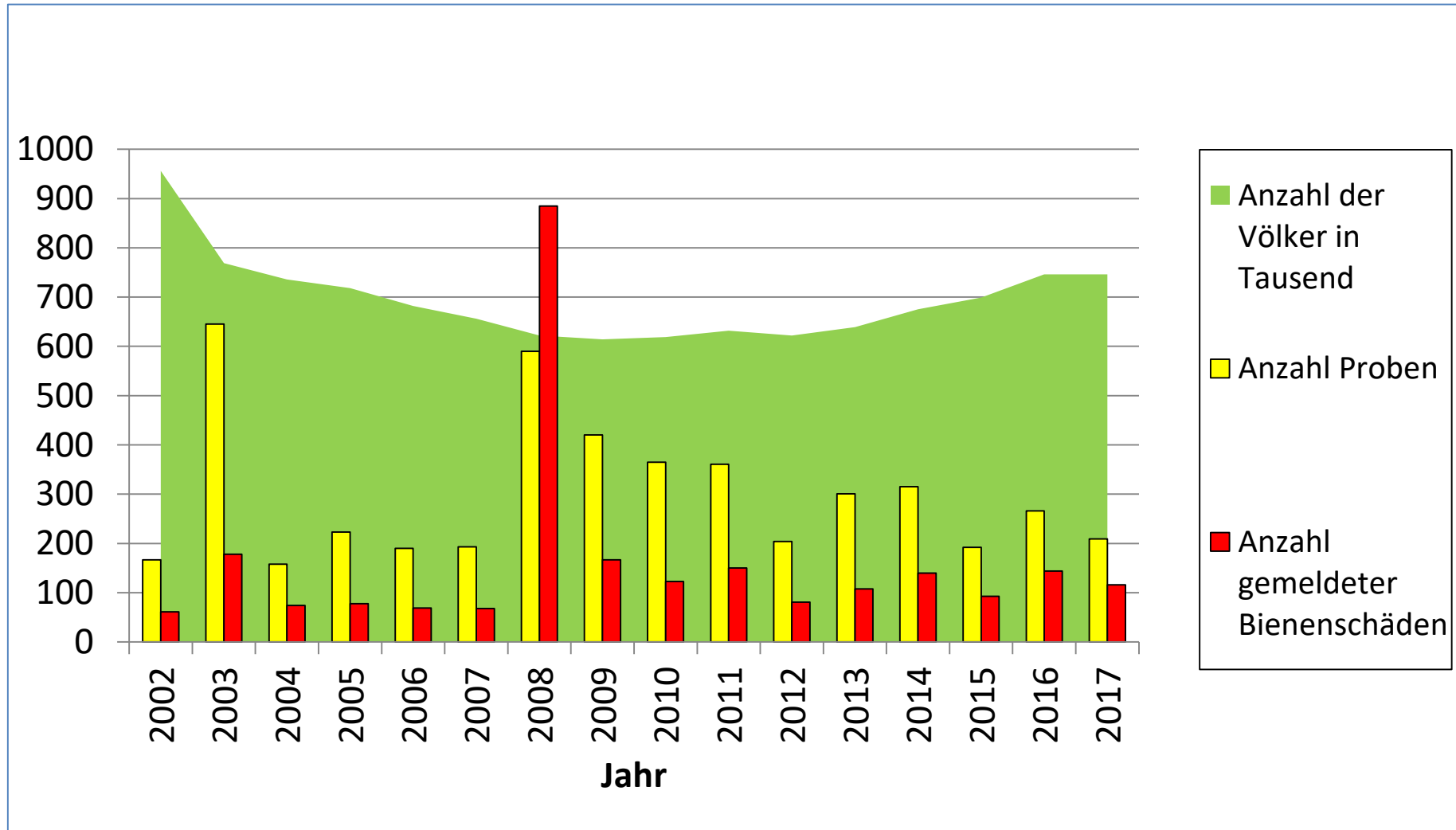
„ I have an incident“ – what is the cause?



Methodology & examination of bee incidents biological and chemical analyses → poisoning or other causes e.g. diseases?



Bee colonies in Germany, Reported incidents, number of samples 2002 - 2017



Institute for Bee Protection
Tasks related to:
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pesticide exposure: routes, levels, effects?

Seed treatments

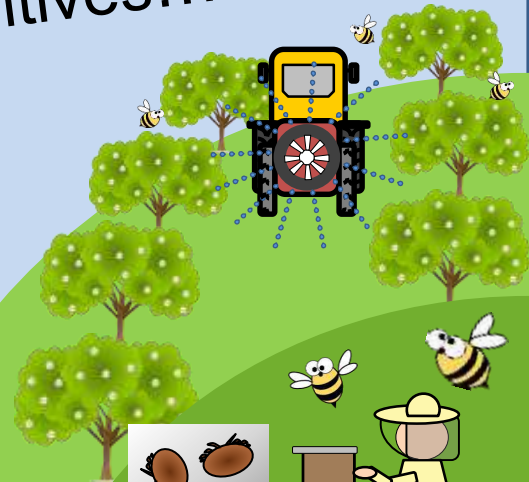
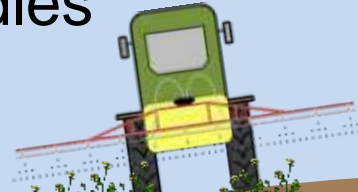
Spray applications



Spray drift
dust drift
(during sowing)

Systemic residues,
Nectar & Pollen,
Guttation,
water puddles

Spray applications:
Overspray, bees,
flowers, honeydew,
tank mixtures,
additives....



Example research activities: Dusts....

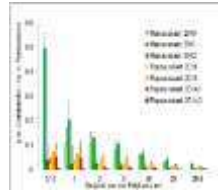


I: Drift trials (realistic sowing OSR & Maize)

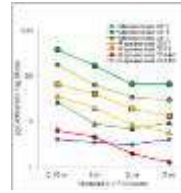
Heubach a.s.



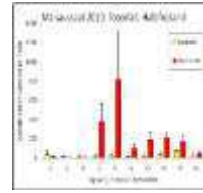
Petrischalen



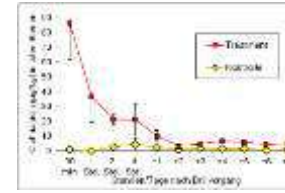
Blüten



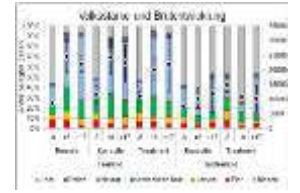
Mortalität



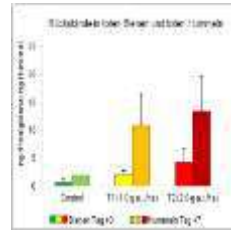
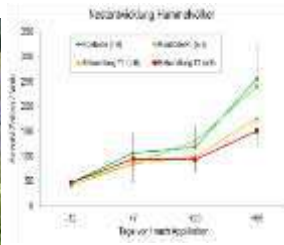
Rückstände Nektar,
Pollen, tote Bienen



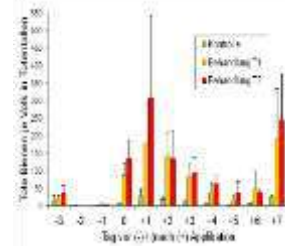
Volks- und
Brutentwicklung



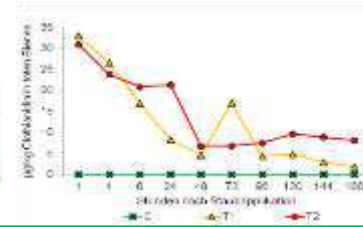
II: Application-Trials: Appl. defined amounts



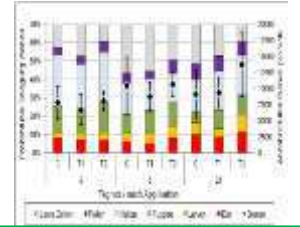
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Rückstände Nektar,
Pollen, tote Bienen

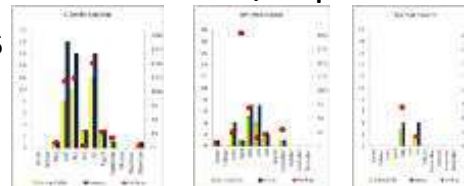


Volks- und
Brutentwicklung

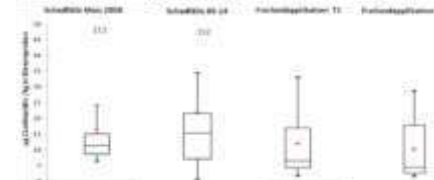


III: Analyses Bee Poisoning incidents With potential p. from Maize/OSR dust drift

Schadfälle Mais/Rapsaussaat



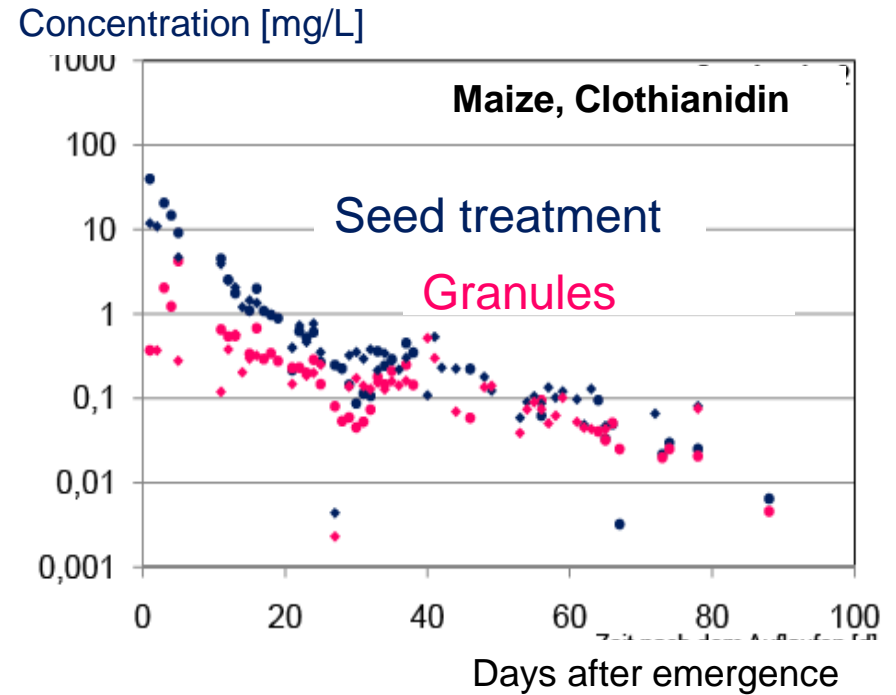
Rückstände in toten Bienen



Example II: Guttation – hazard: yes, but risk?



Photo: Wallner, 2009



**Maize up to 100 mg/L, Cereals up to 5, Canola (WOSR) up to 1 mg/L.
For Clothianidin ~ 4 μ L water contain = LD50**

Example III- Apis, Bombus, Osmia Canola-systemic residues nectar/pollen

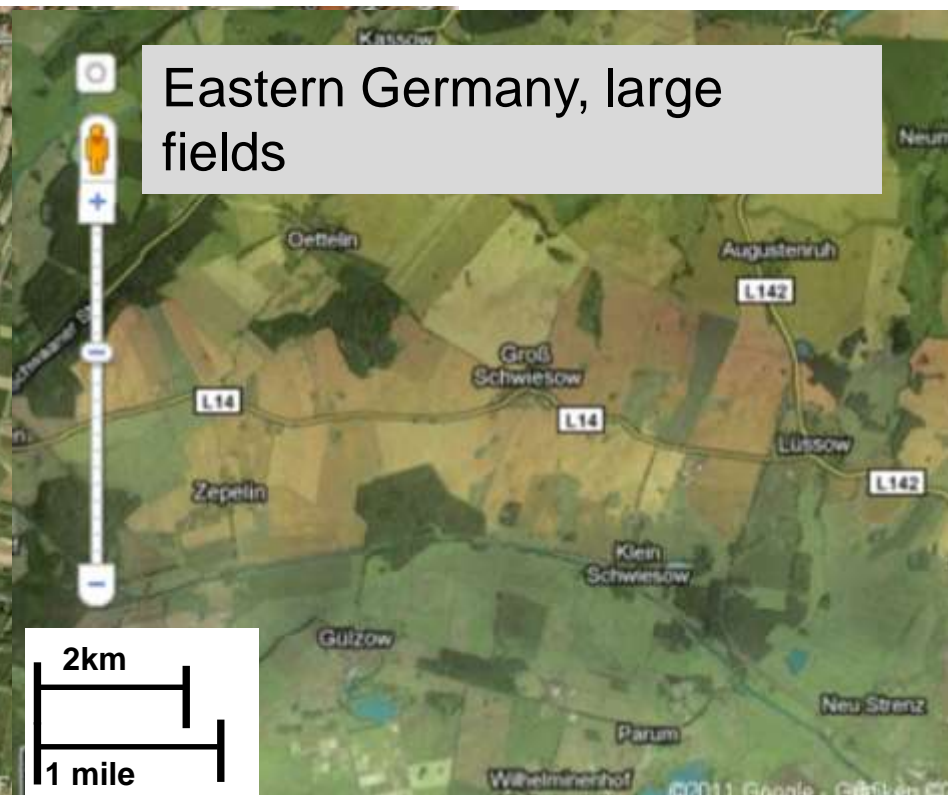
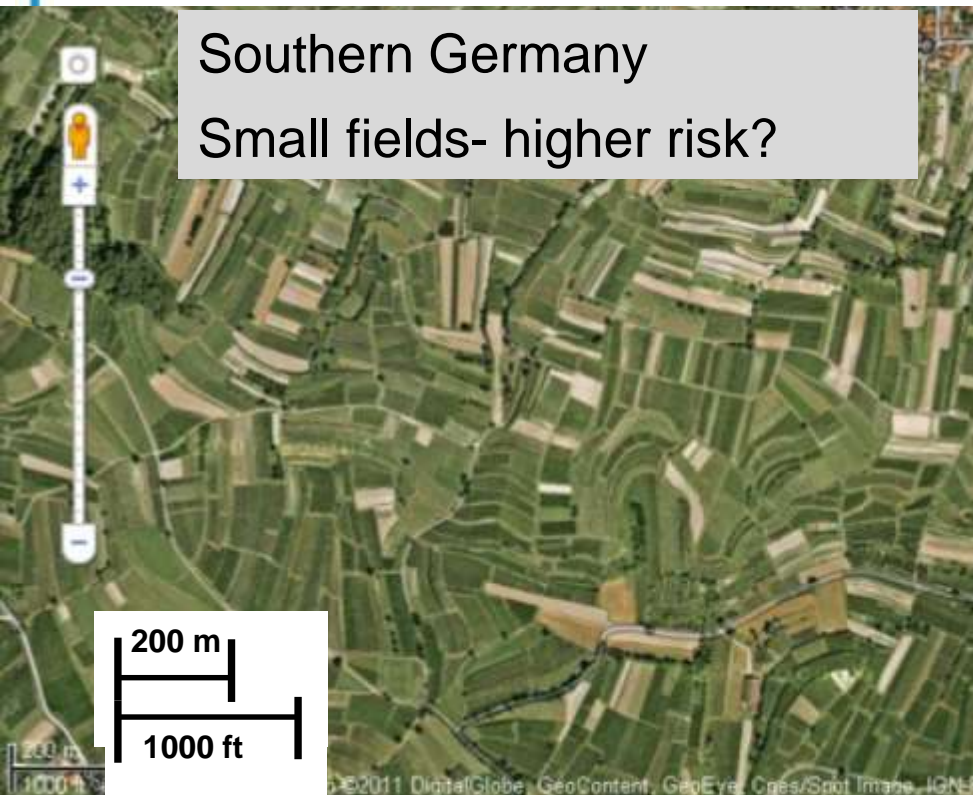


- **Replicates: at 5 bee institutes, 2 years**
- Beekeeping State Association Bantin
- Ruhr-Universität Bochum, Department for Biology and Biotechnology
- Bavarian State Institute for Viticulture and Horticulture, Department of Honeybee Research and Beekeeping, Veitshöchheim
- Apicultural State Institute, University of Hohenheim, Stuttgart
- JKI, Brunswick



Risk may also depend on the landscape

Small fields- structures with many field edges, heterogenic agricultural structur- WOSR surrounded by many maize fields... Scenarios that need to be covered by Risk Assessment



German Bee Monitoring- residues in bee bread (stored pollen) – number of detections

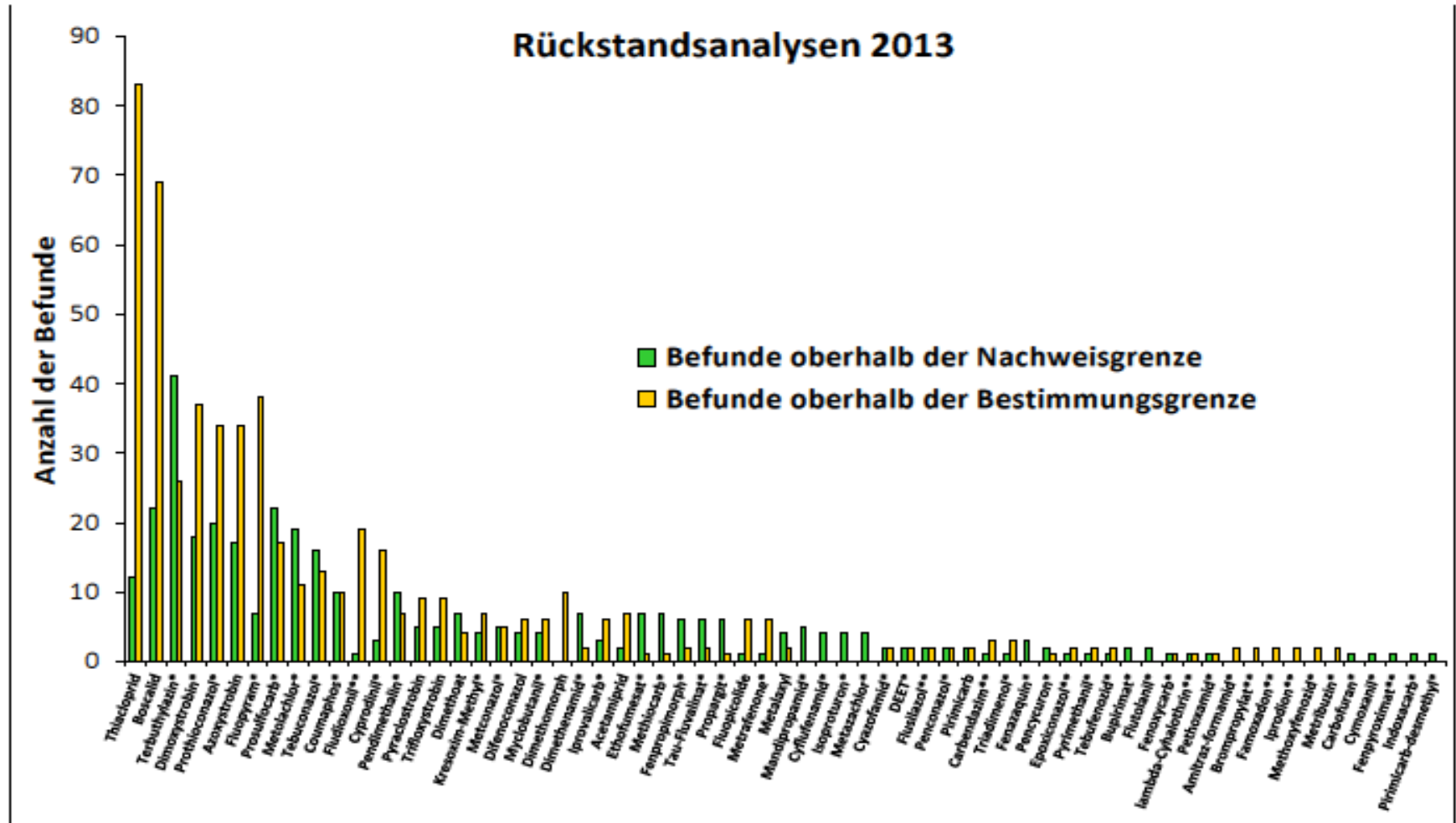


Abbildung 4: Rückstandsanalysen im Bienenbrot 2013 mit LC-MS/MS an der LUFA Speyer; Bestimmungsgrenzen: 3, 5* und 10** µg/kg; untersucht wurde auf 400 Wirkstoffe resp. deren Metabolite, von denen 73 im Bienenbrot gefunden wurden

German Bee Monitoring- residues in bee bread (stored pollen) – max-values

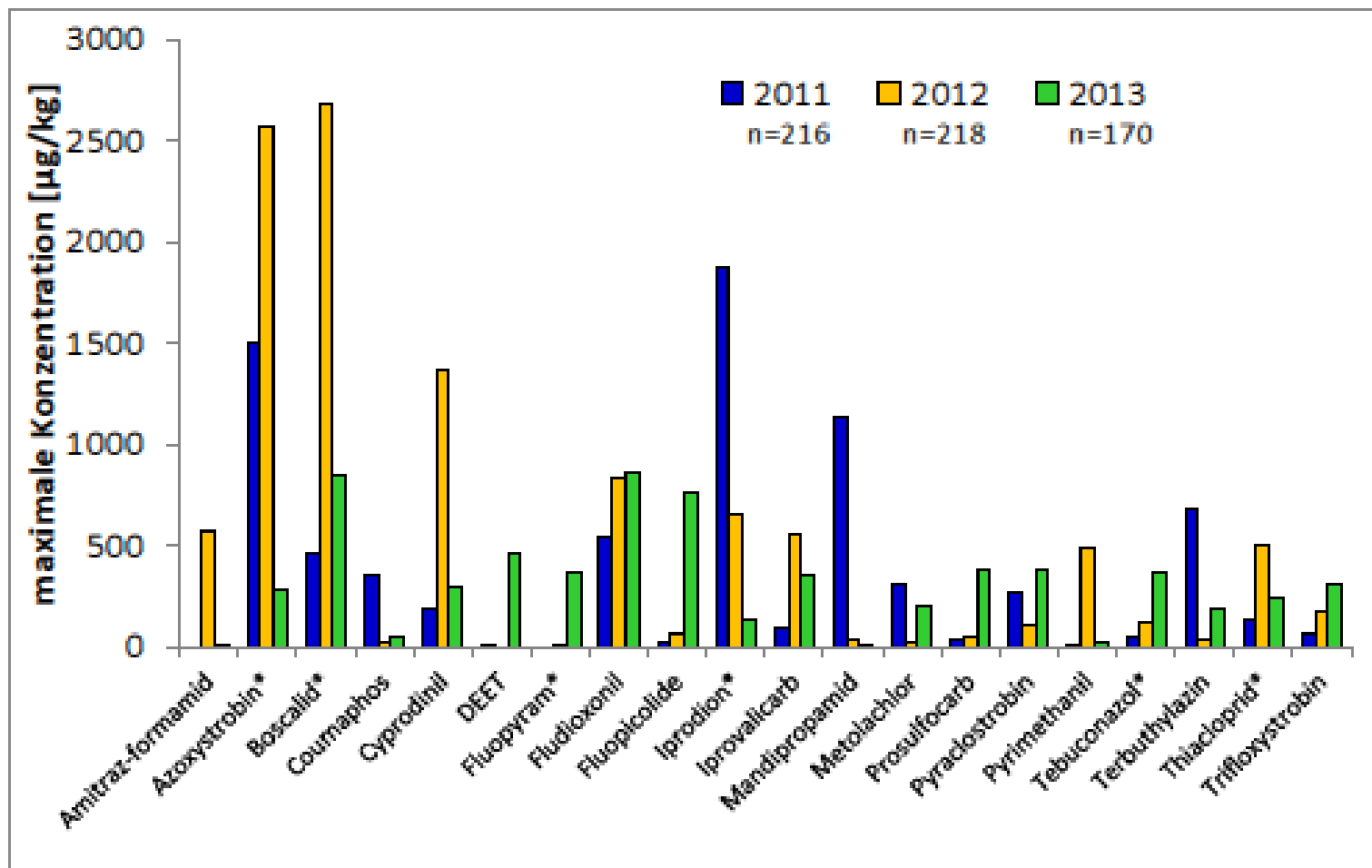


Abbildung 5: Maximale Konzentrationen der gefundenen Wirkstoffe 2011 – 2013. Rapsbehandlungsmittel sind mit * gekennzeichnet.

German Bee Monitoring Number of a.s. per sample

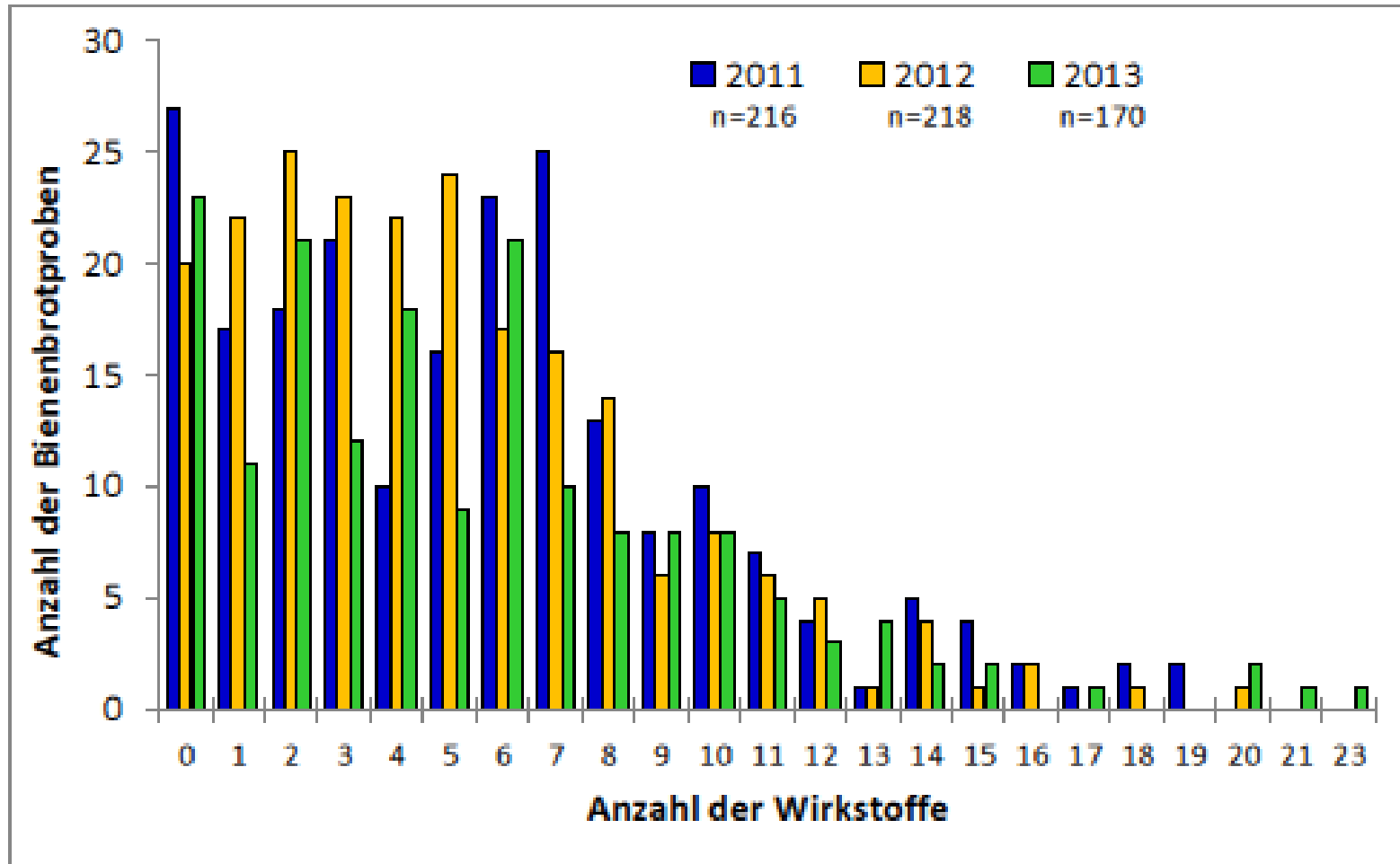


Abbildung 6: Häufigkeiten der Belastungen 2011 - 2013

Graph: German Bee Monitoring

Tank mixtures



- Application of tank mixtures- several PPP in the same sprayer
- For some combinations additive, for some even synergistic effects are known
- Also adjuvants, additives, fertilizers can be added
- Number of potential combinations too high to be tested- strategic approach necessary to identify critical combinations
- Some combinations e.g. Pyrethroids* EBI-Fungicides, or Neonicotinoids Acetamiprid/Thiacloprid * EBI-Fungicides are known. The combined application leads to a change of the bee classification (from non hazardous to application after bee flight or no application on flowering crops)

Accurate farming and obeying law is key for bee protection!



- State Plant Protection services
 - give advise to farmer
 - responsible for surveillance, have the legal power for inspection of farm, farmer practices, samples of tank and plants
 - May mandate fines
 - Assist beekeeper if there is an incident
- Machine testing – listed and approved machinery for PPP application only

Bees and agriculture- conclusions



- There are numerous and important research issues related to pesticides and bees
- All mankind activities influence what bees encounter as environment
- Agriculture certainly has an influence – this includes and goes beyond PPP
- Discussion on PPP should come (back) to (more) rational grounds (in Europe..)
- Also discussion on “detected residues” and relevant amounts should be rational!
- Increases and decreases are observed for numbers of Non-Apis pollinators but these can also not be linked to single causes

Work on pesticides, agriculture and bees and improvement of their co-existence is important.

But: keeping pesticides as the only issue in focus is inappropriate.

The efforts in society and agriculture need to be broader.

Agriculture and Apiculture are synergists!



- Protecting bees and pollinators from adverse side effects has positive impact on crop yield
- Bees and other pollinators are good environmental indicators, also- and especially – thanks to beekeepers- who know the health of their bees
- Plant protection is/may be necessary in some cropping systems – wise activity benefits farmer´s profit long-term
- Many plant protection activities are uncritical, high(er/est) concern are insecticides
- Reducing exposure is always helpful - also for non-toxic substances
- → Be **wise and precise**: protecting crops **and** bees is possible

Thank you for your attention!



Exposure during plant growth cycle

Insecticidal seed abrasion
dust drift
during sowing
→
contamination
of wild flowers,
neighboring
flowers

Guttation

spray during flower- during,
before, after daily bee flight?

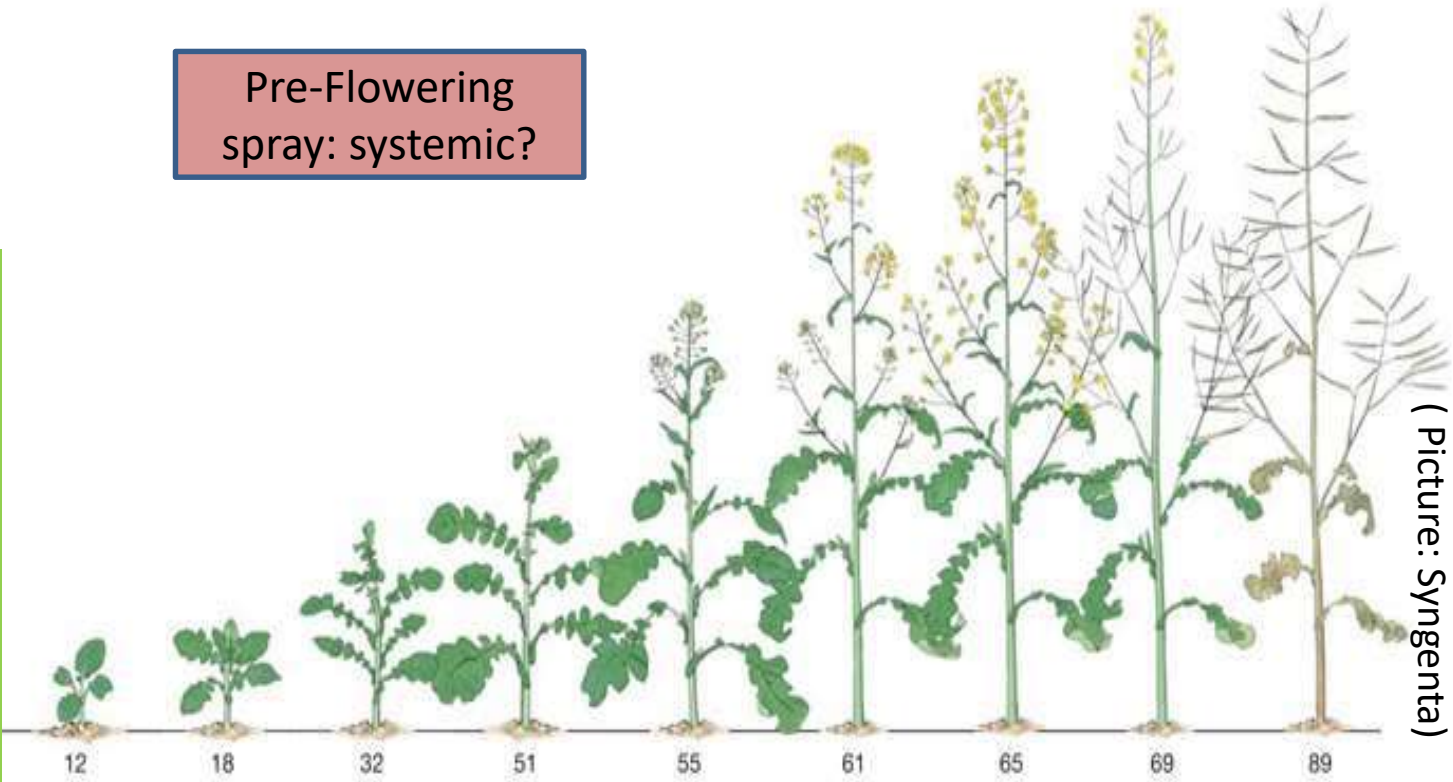
Flowering
weeds?

Systemic translocated residues
from seed treatment

Pre-Flowering
spray: systemic?

OSR:
Sown in August
Overwinters
Flowers ~ April

**Highly bee
attractive-
Nectar &
Pollen**



(Picture: Syngenta)

Risk assessments needs surrogate species



- Honey bees: manageable species, Pros and cons for RA
 - Studies with honey bees well established for ~a century, many specific tests available
 - Other bees have a different, highly variable biology
 - Some may be more sensitive - but is exposure the same?
 - Smaller flight range – effects different than honey bees?
 - Most wild bees in Germany are solitary and unmanaged
 - no communication of nice forage to other bees → Exposure may be critical for those directly adjacent to a treated field while population in the area maybe relatively unaffected
- To which extent is the honey bee a suitable surrogate species
- How can

Exposure profile



- Crop dependend- every crop has a specific profile
 - Crop attractivity – Nectar (Flower/extrafloral nectaries) and/or Pollen
 - Plant protection Product (PPP) and active substance-properties, systemicity, persistence, mode of action
 - Application type:
 - Spray – before, during or after flower
 - Seed treatment - time from seed to flower, crop type
 - Trunk/Stem injection
 - Mode of application:
 - Type of sprayer, upward/downward application,
 - Nozzles and drift reduction
 - Sowing machinery, deflectors
- Residue levels in bee relevant matrices

Principle of the tiered approach in Risk assessment Laboratory, Semi-field, Field

„Triggervalue“ – when to proceed to which test?

Bundesforschungsinstitut für Kulturpflanzen

1. Laboratory, Toxicity (LD_{50} , ...): Adult oral, contact, chronic, Larvae



2. Triggers (ETR, PEC) exceeded → (Semi-) Field

Below Trigg.: B4, B3

Semi-field / Tunnels with small
bee colonies



.... And/Or..... Field- studies with normal
bee colonies

Final decision: B1 (Bienengefährlich), B2, B3, B4 (bienenungefährlich)