Melanie KAH

Nanopesticides

State of knowledge and implications for regulatory exposure assessment

universität wien

Acknowledgements


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Nanopesticides concept and specificities

NANO

→ Small
→ New properties

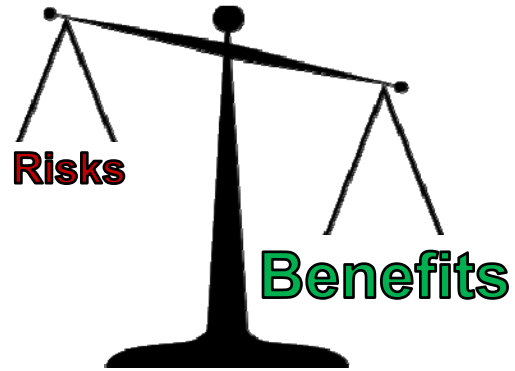
+

PESTICIDES

→ **Intentionally** applied
→ Very large quantities
→ **Toxic**

More intelligent agrochemicals?

→ More targeted effect and delivery
→ Less risk to non-target organisms

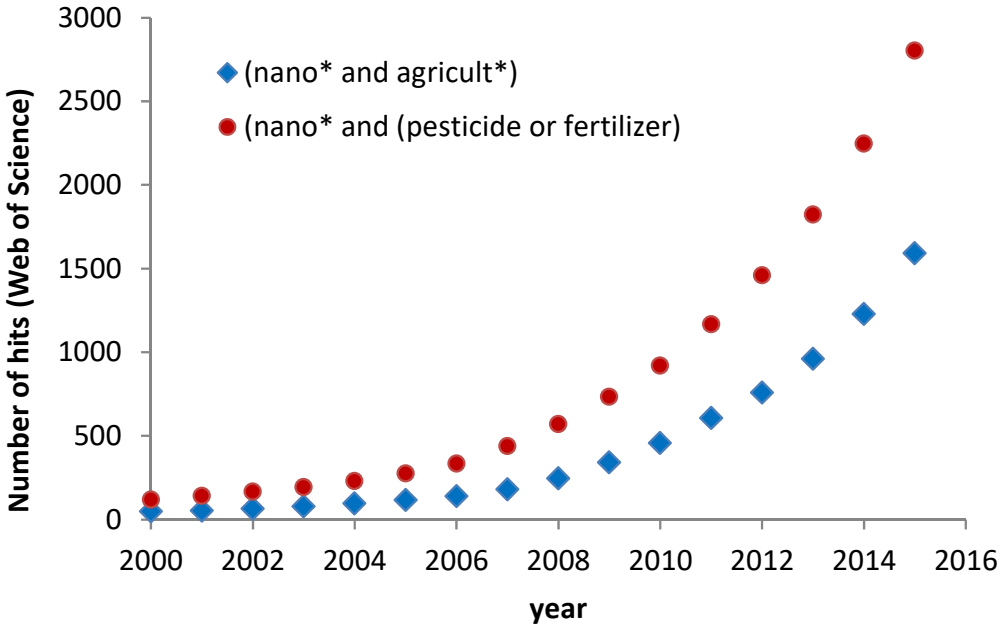


More **sustainable** production of **healthier** food in sufficient **quantity**

Nanoagrochemicals in publications

Reports

Publications



Many communities with different perceptions

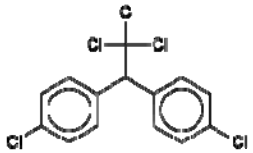
ENVIRONMENTAL SCIENTISTS

NANO COMMUNITY

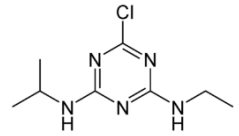
Intentional and diffuse source of toxic nanoparticles

→ Emerging **contaminants**

PESTICIDE COMMUNITY



DDT



atrazine

→ One **solution** for mitigation

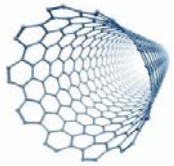
REGULATORS

Risk or **Risk/Benefit** assessment

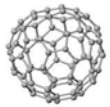
Types of nanopesticides

First generation

Carbon Nanotubes



C60



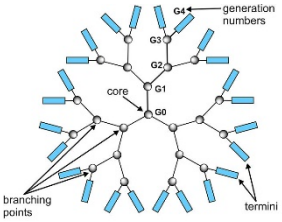
metal/metal oxides

Second generation

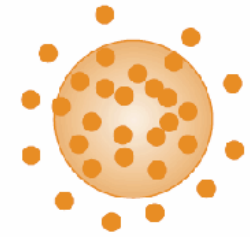
Nanocarrier loaded with an active substance:

- Existing (→ reformulation)
- Novel (e.g. pheromones, RNAi)

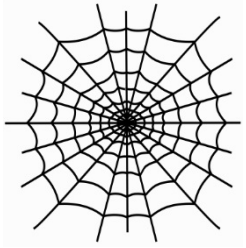
Nano-capsules



Dendrimers



Hydrogels



Electrospun fibers (~spider webs)

Porous Silica

Kah et al. (2013) Crit.Rev.ES&T; Kah and Hofmann (2014) Env. Intern.

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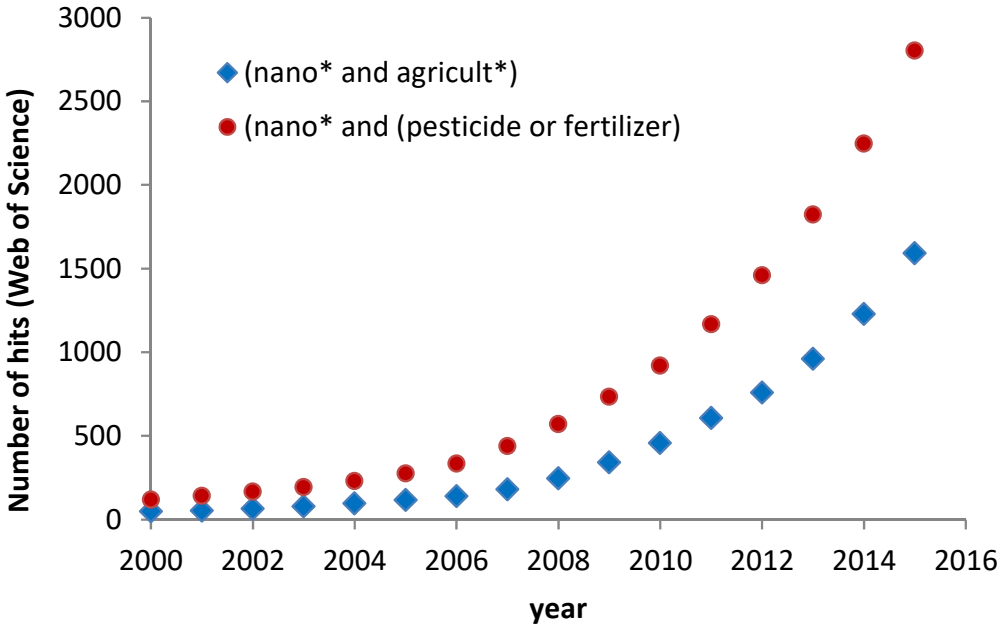


Market

world: > US$50 billion in 2012
(US-EPA, 2017)

Products are reaching the market

Vive Crop Protection Receives EPA Registration for Allosperse Fungicide Formulation

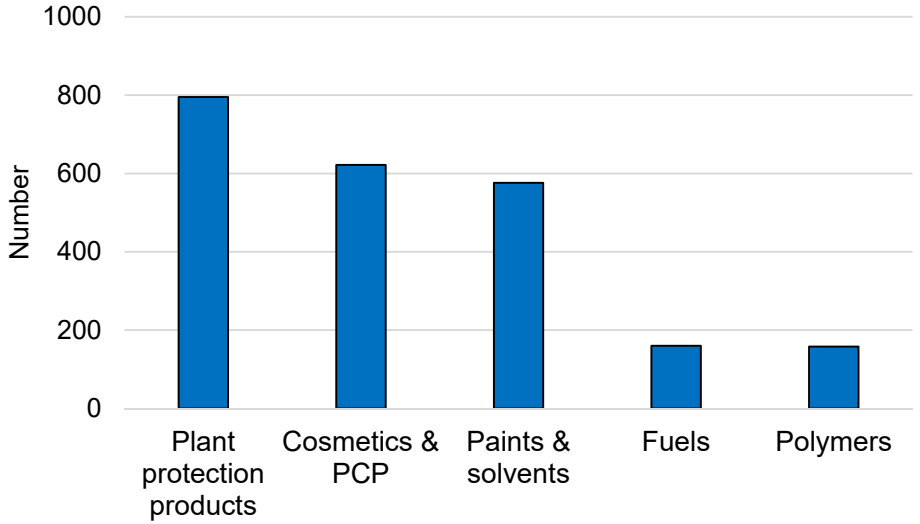
June 11, 2015

Vive Crop Protection Receives First EPA Approval for Flowable Bifenthrin Insecticide

August 6, 2013

(www.vivecrop.com)

Nanoproducts produced, imported or distributed in France
(declared in 2015, www.r-nano.fr)



Dendrimer Glyphosate Formulation – Recent Field Trial Data

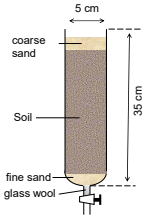
Also more effective in hard-to-kill weeds than comparable marketed formulation (www.starpharma.com)

Risk Assessment

NANOTECH + **PESTICIDES**

FATE

Sorption **Degradation** **Leaching**



EFFECT

Efficacy **Hazard**

CAN WE ASSESS THE NEW RISKS & BENEFITS?
IS FRAMEWORK READY?

IUPAC and APVMA sponsored project

International Union of Pure and Applied Chemistry
Secretariat: P.O. Box 13757, Research Triangle Park, NC 27709-3757, USA
TEL: +1-919-485-8700 FAX: +1-919-485-8706 EMAIL: secretariat@iupac.org

Workshops with Researchers, Academia, Industry and Regulators

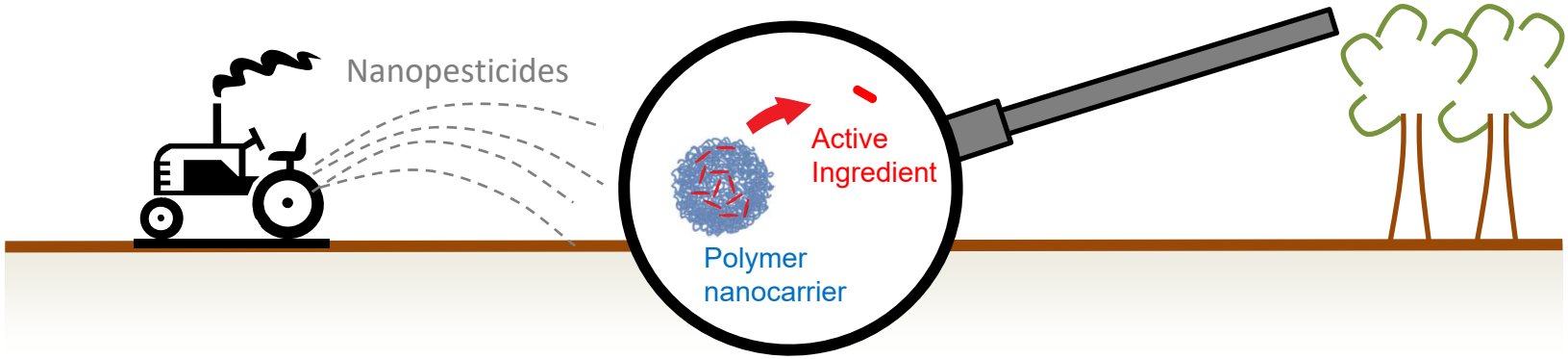
Objective

To develop a set of guiding principles to facilitate a harmonized approach for the ecological risk assessment of nano-pesticides

→ Paradigms are ok
→ Need for additional metrics

Kookana et al. (2014) JAFC; Walker et al., 2017

The concept of durability



What happens ?
How to measure?

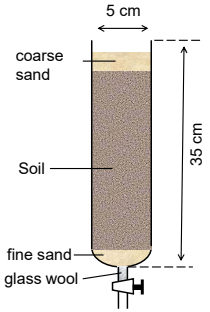
Durability
(or release rate)

Nano
Size, surface charge, stability

Pesticide

Sorption
OECD 106

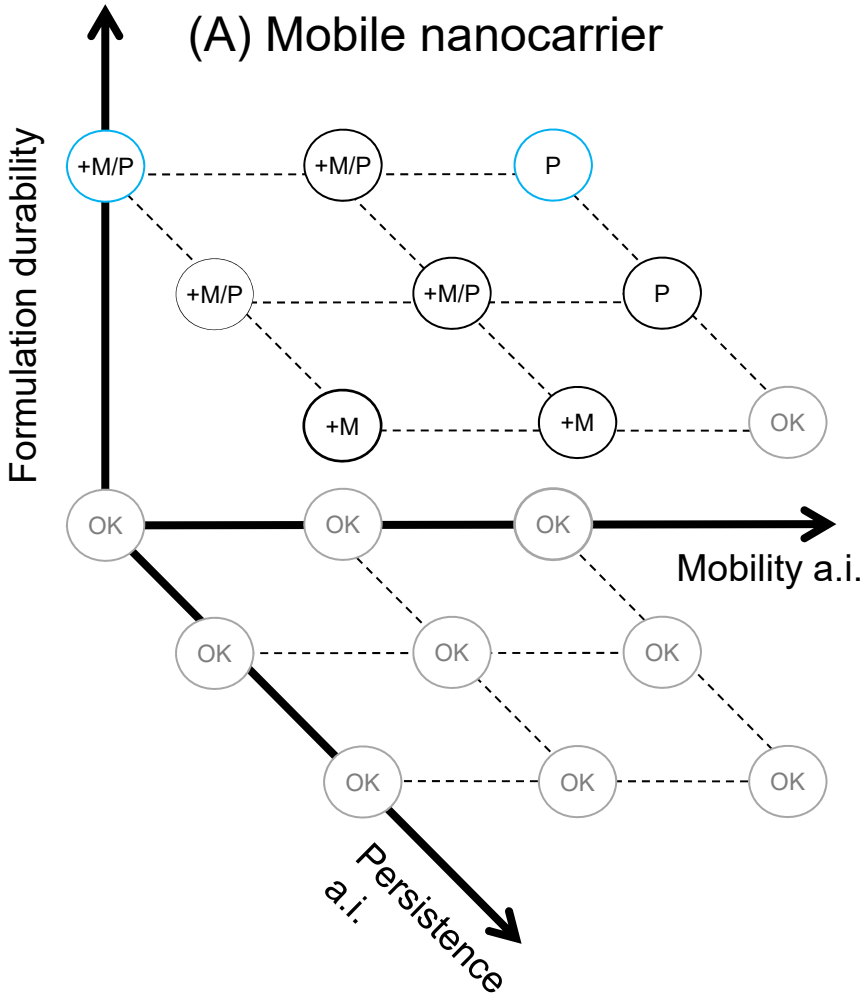
Leaching
OECD 312



Degradation
OECD 307

Proposed approach for regulators

Relative assessment of exposure



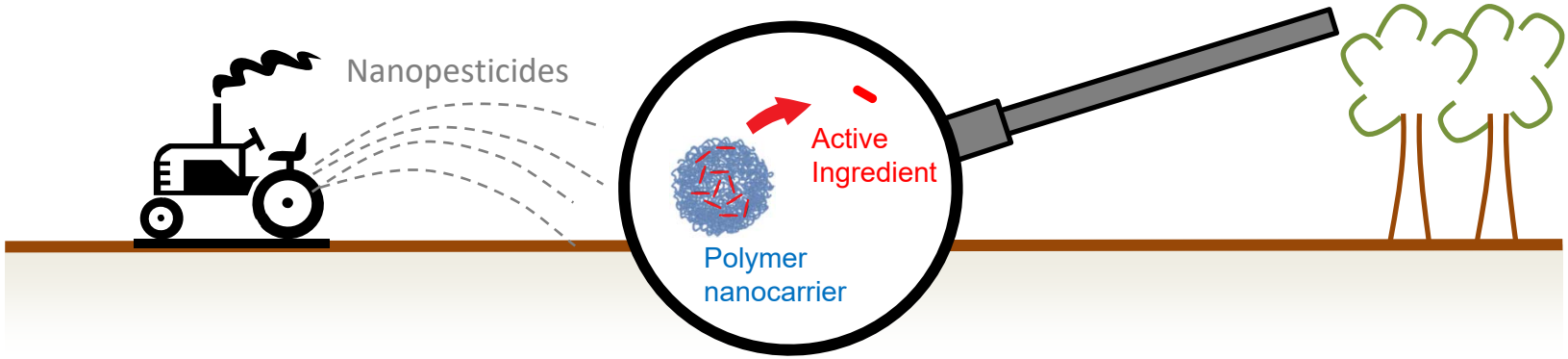
OK — No major changes in the location/duration of exposure

P — **Prolonged persistence** leading to longer exposure periods (possibly to lower concentration)

+M — **Enhanced transport** possibly leading to greater concentration in surface and groundwater

-M — **Retarded transport** possibly leading to greater concentration in soil

Current challenges



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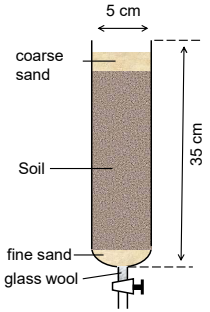


Degradation
OECD 307

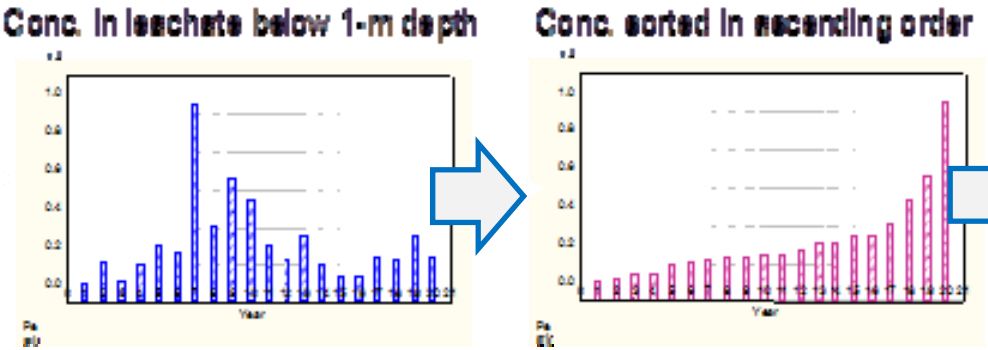
Kah et al. (2014) Env Sc. Pol .Res. ; Kah et at. (2016) ES&T

Exposure modelling across Europe

- Impact on Tier 1 **leaching assessment** (PEARL 4.4.4)
- **9 soil–climate scenarios** (realistic worst-case)

Application every year

6-year pre-run
+
20-year run



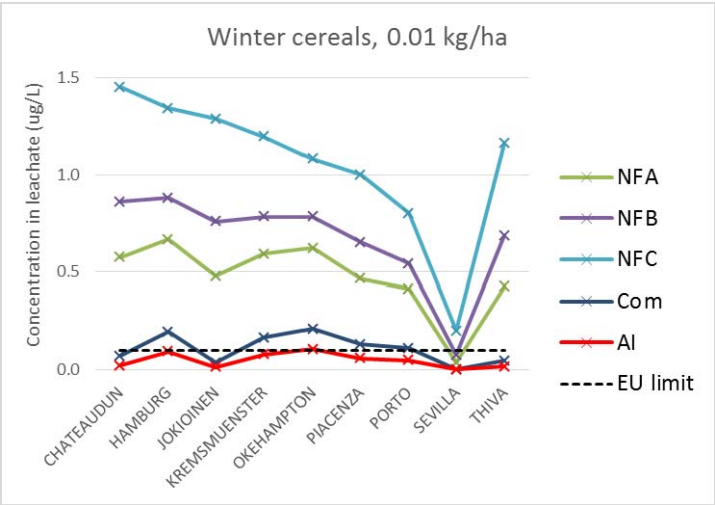
90th percentile

Direct input	vs	**Slow release**
of measured fate parameters		(2 sequential first order kinetics)

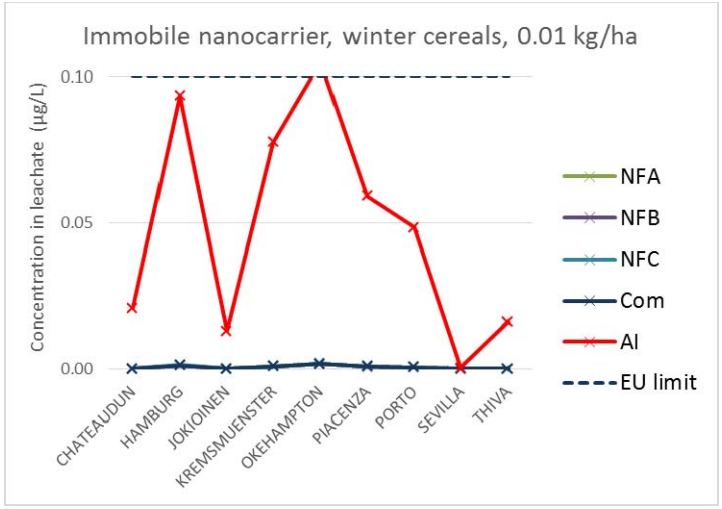
Kah et al. (2016) ES&T

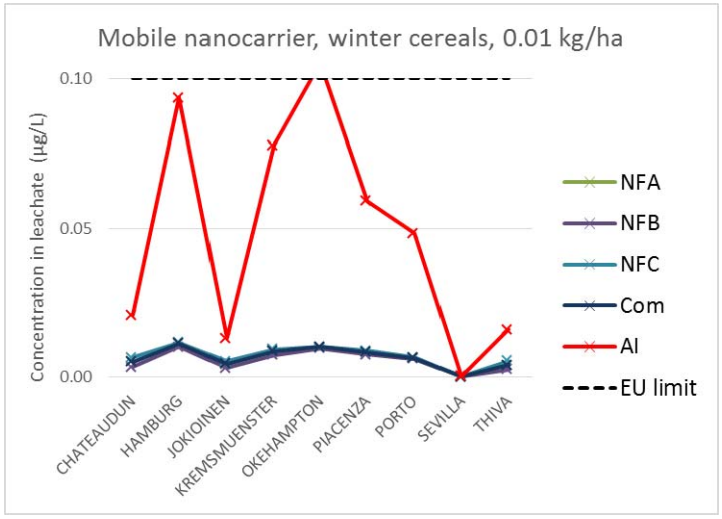
Exposure modelling

Direct input



Slow release





Direct input:

NF had lower sorption and greater persistence

→ more leaching of nano vs AI

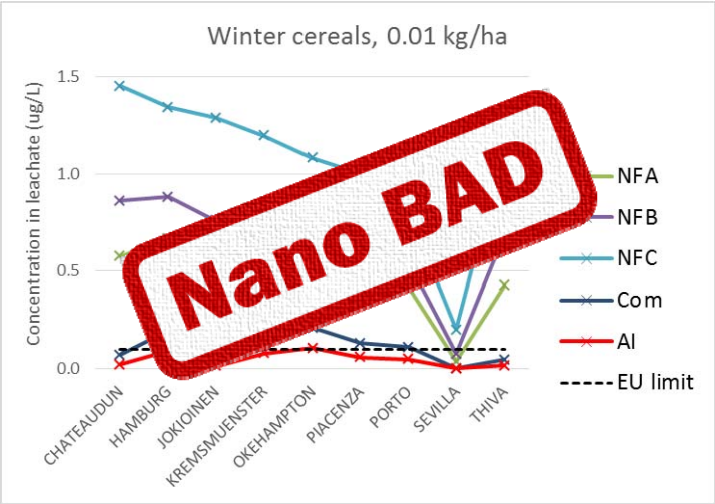
Slow release taken into account

→ Nanocarrier (mobile or immobile) may reduce losses to ground water

Kah et al. (2016) ES&T

Exposure modelling

Direct input



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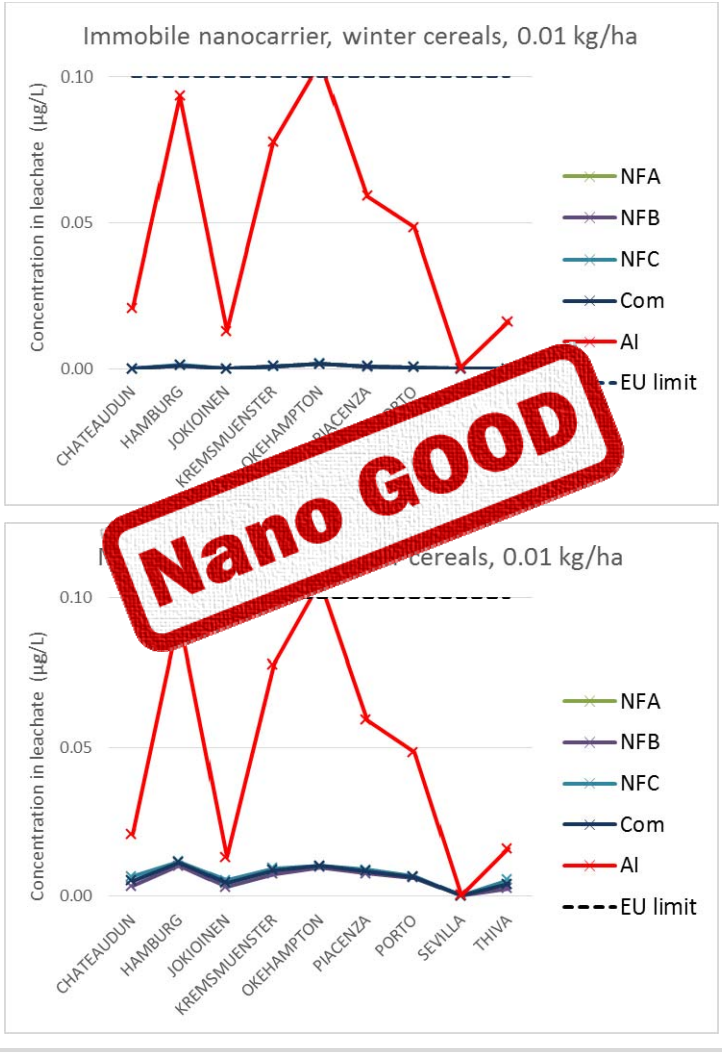

Kah et al. (2016) ES&T

Wrap up and take home messages

- The nanopesticide revolution has not come (yet)
- **Reformulation** of existing active ingredients
- Real potential to reduce application → solution to mitigate risks
- This will require:

  → more **collaborations** to orientate product development

  → adequate **assessment** relative to existing products

  adaptations, more global risks & benefits analysis