SPRINT Conference

Brussels – 25 June 2025

SPRINT

SUSTAINABLE PLANT PROTECTION TRANSITION

Exposure assessment in SPRINT: An overview

Daniel Martins Figueiredo PhD Eng

Assistant Professor, IRAS, Utrecht University, the Netherlands

Connect with us @SPRINTh2020

www.sprint-h2020.eu

Funded by the European Union

Dietary and non-dietary exposure modelling

Wristbands – Measurements

Duplicate Portion Analysis

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by
the European Union

Dietary and non-dietary exposure modelling

Wristbands – Measurements

Duplicate Portion Analysis

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by
the European Union

Modelled exposure

- **Dermal Contact with Air**

$$DERMpart = \frac{Jsp \times SA \times Fsa \times ED}{BW}$$

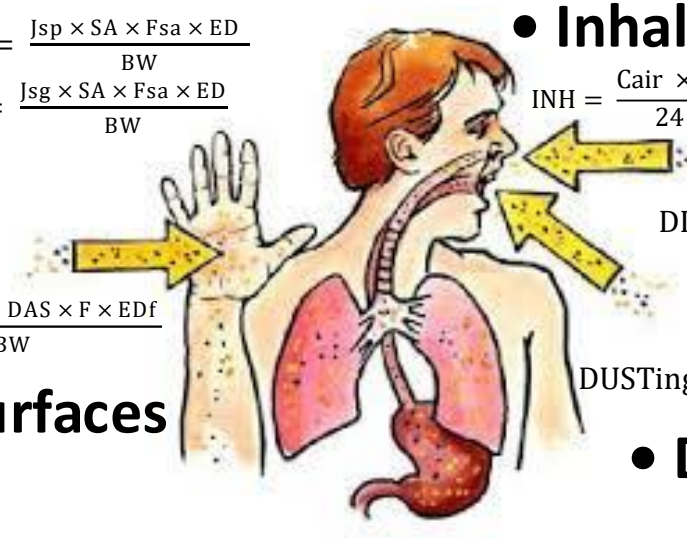
$$DERMgas = \frac{Jsg \times SA \times Fsa \times ED}{BW}$$

- **Inhalation**

$$INH = \frac{Cair \times IR \times ED}{24 \times BW}$$

$$DIETexp = \frac{DPAres \times Sw}{BW}$$

- **Dietary Exposure**



$$DERMct = \frac{Cdust \times SA \times DAS \times F \times EDf}{BW}$$

- **Dermal Contact with Surfaces**

$$DUSTing = \frac{Cdust \times DI \times EDf}{BW}$$

- **Dust Ingestion**

Simulations done at CSS level -> for each individual SPRINT participant
At population level -> by simulation using variability in age, weight, and other parameters

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

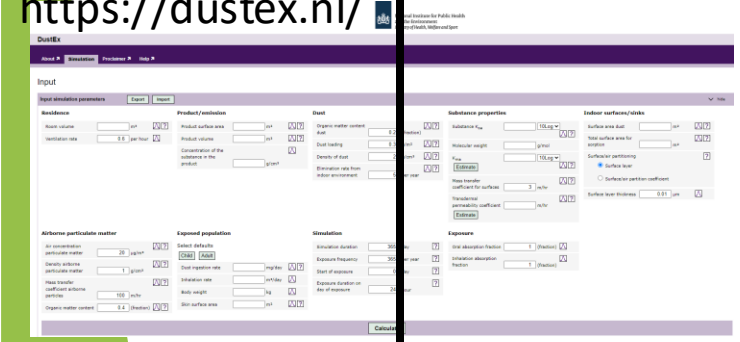
Funded by the European Union

Modelled exposure

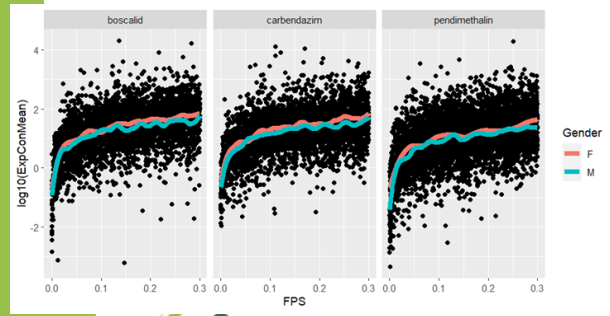
OBO

Research on exposure of residents to pesticides in the Netherlands

https://dustex.nl/



Manuscript - R package in preparation



Inhalation

Inhalation rates [in m^3/day] (collected from the US EPA exposure factors handbook).

! Assumption: Cout = Cin. (Realistic)

Dust ingestion

Dust ingestion rates same as above.

! Assumption: All pesticides present in dust are bioaccessible (Worst-case)

Dermal contact

Frequency of contact with contaminated surfaces, % of dust that adheres to skin and fraction absorbed by the skin

! Several assumptions made: fraction absorbed by skin -> lacking data (Realistic)

Dermal from airborne

Shi & Zhao (2013) formulations for seasonal variation effects on deposition velocity onto human body surfaces.

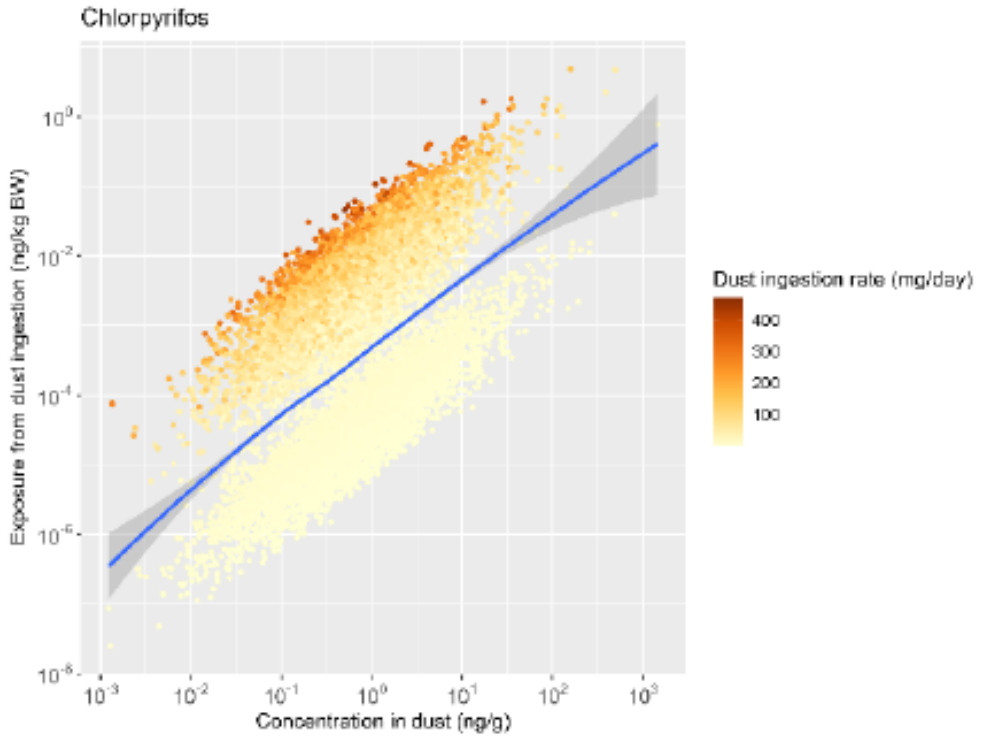
Assumption: No clothing barrier, as proposed by Morrison et al. (2016). (Realistic)

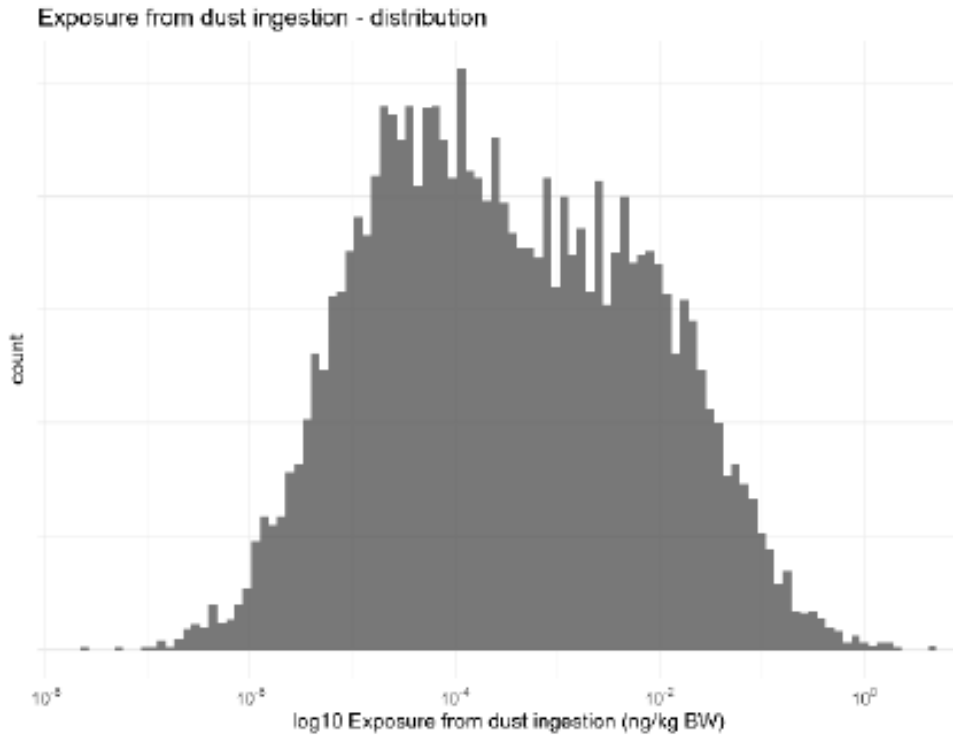
SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by the European Union

Modelled exposure: Dust ingestion

For uncertainty analysis we allowed the model to sample values from a defined truncated normal distribution for each age category from the revised US-EPA exposure factor handbook on **dust ingestion/hand-to-mouth patterns** (Table 5.12, EPA 2017).



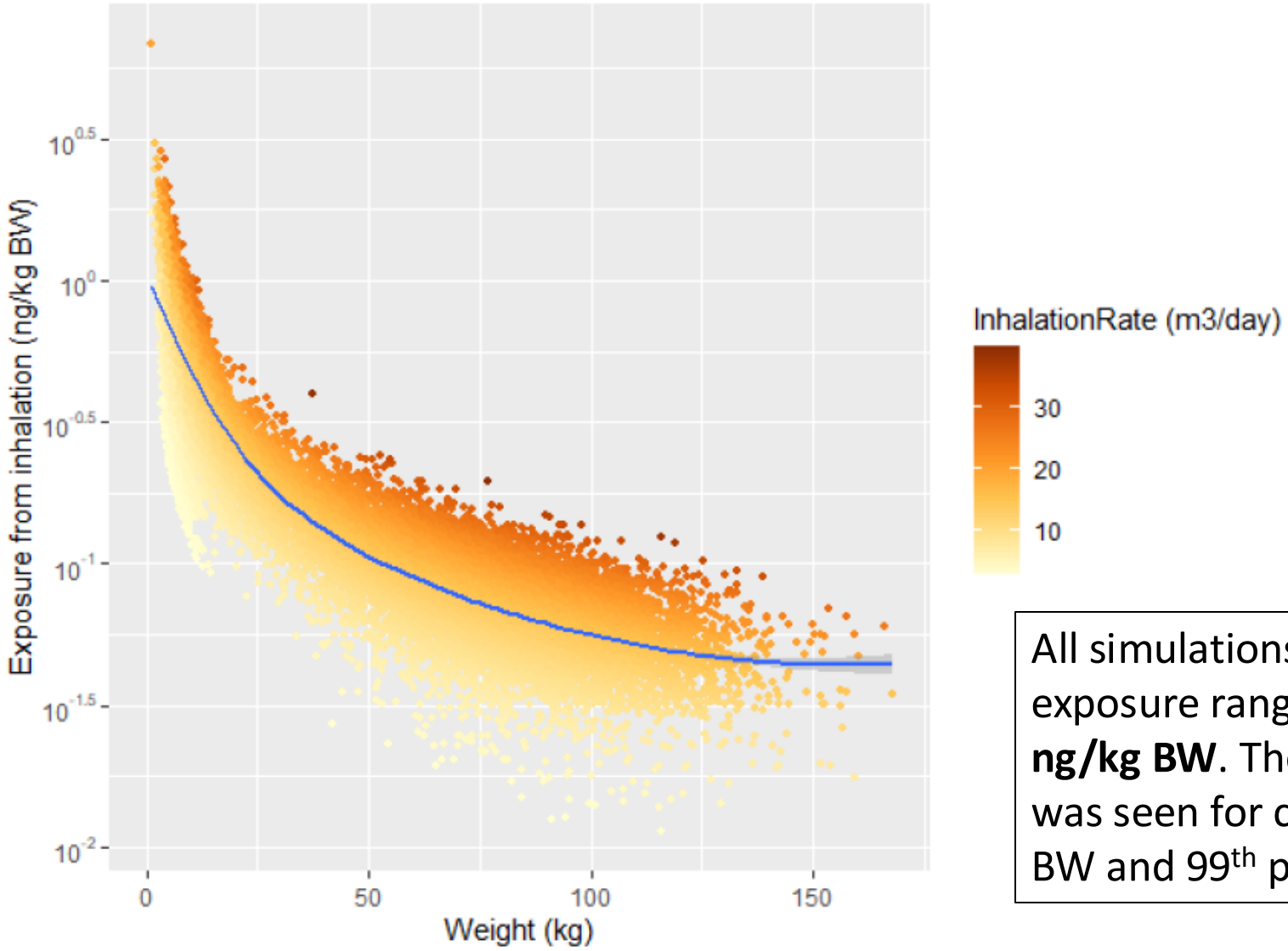


For dust ingestion the max value corresponded to 1% of ADI

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by
the European Union

Modelled exposure: Inhalation



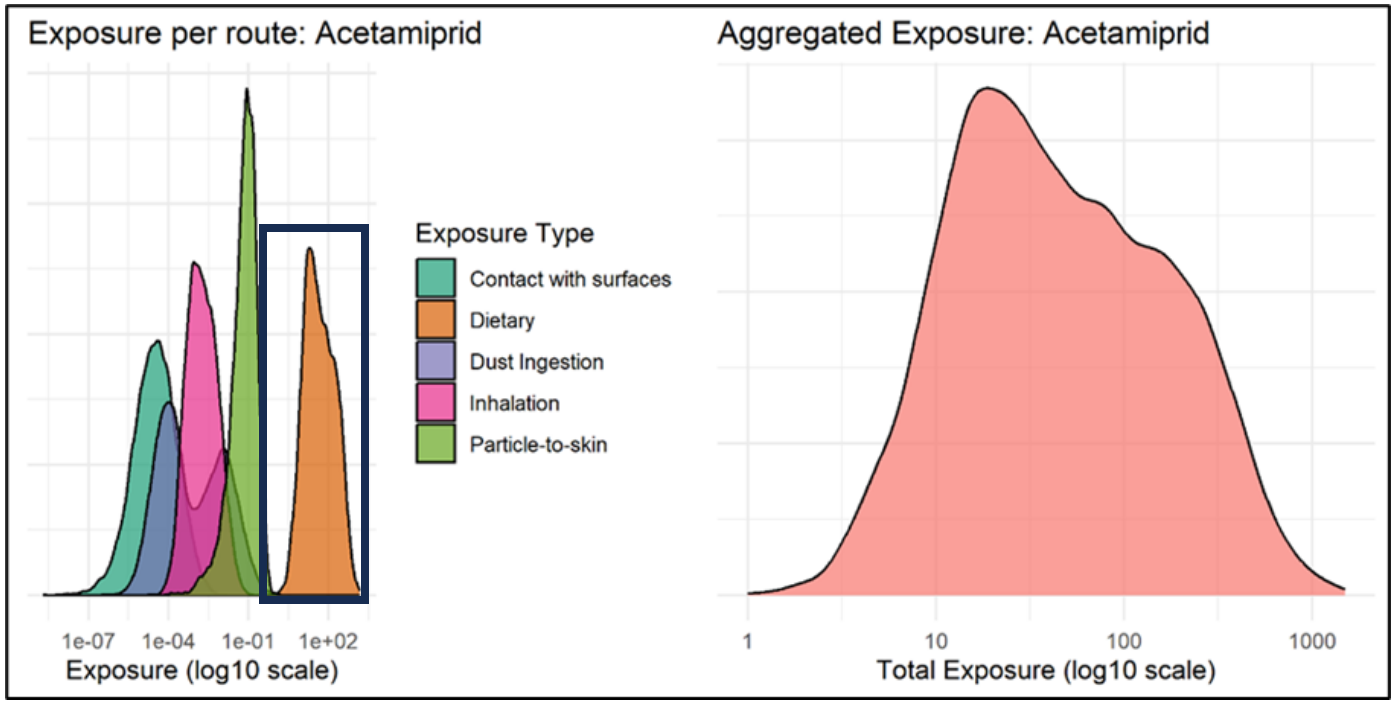
All simulations for inhalation led to exposure ranges from **10^-5 and 10^2 ng/kg BW**. The max value of 100 ng/kg BW was seen for combination of 5th percentile BW and 99th percentile inhalation rate

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by the European Union

Aggregated exposure

Simulated pesticides
Acetamiprid
AMPA
Chlorpyrifos
Cypermethrin
Cyprodinil
DDD p.p.
DDE p.p.
Deltamethrin
Fluopyram
Glyphosate
Hexachlorobenzene
Imazalil
Lambda-Cyhalothrin
Metalaxyl-M
Piperonyl butoxide
Pirimiphos-methyl
Propamocarb (hydrochloride)
Tebuconazole



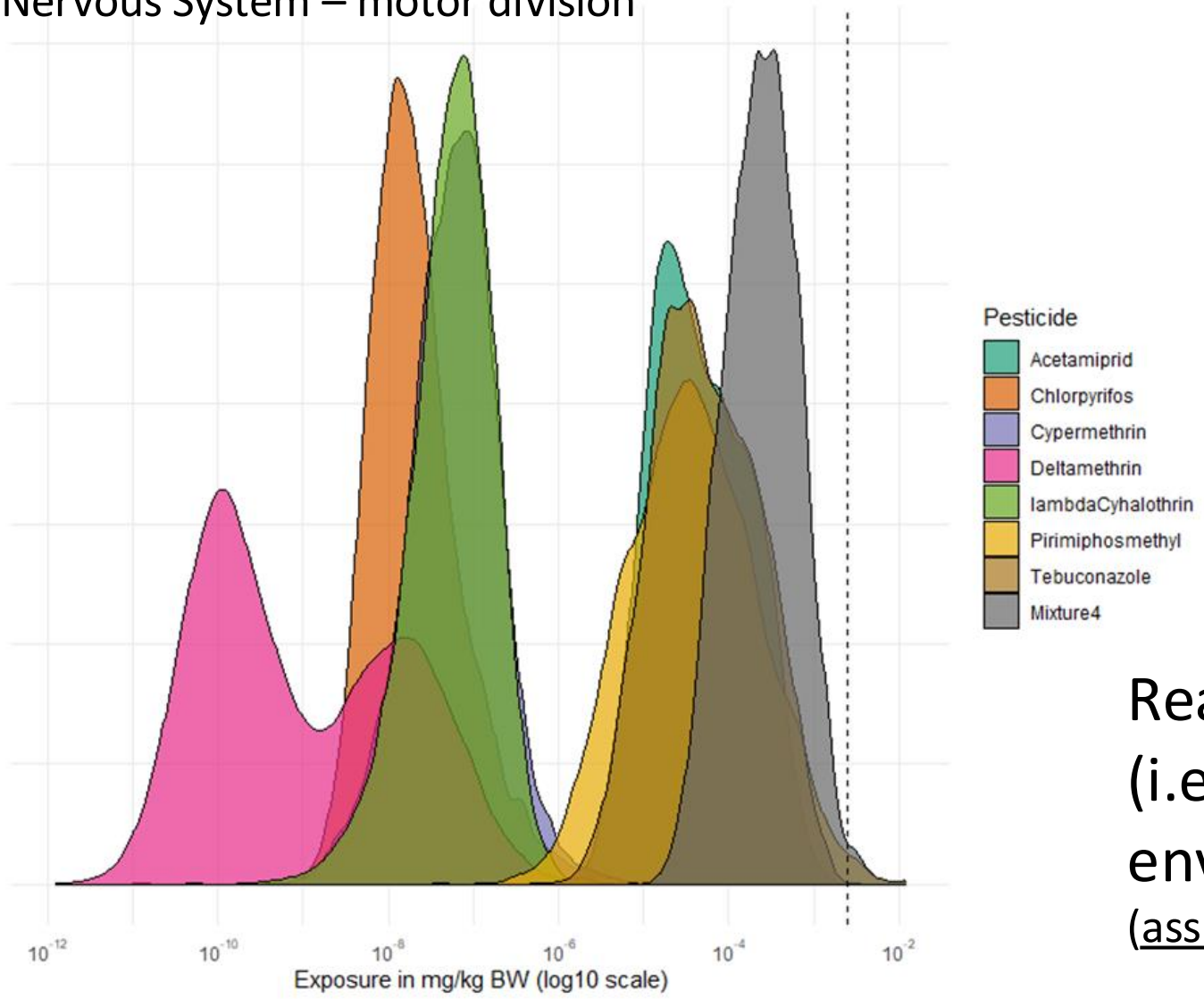
Exposure in mg/kg BW in x-axis

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by
the European Union

Aggregated + Cumulative exposure

CAG2: Nervous System – motor division



Potency Factor (RPF) approach

Vs.

Lowest NOAEL without adjustment (conservative)?

Realistic “worst-case” exposures (i.e. high exposure from diet and environment) indicates risk (assuming equal pesticide potency)

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by the European Union

Dietary and non-dietary exposure modelling

Wristbands – Measurements

Duplicate Portion Analysis

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by
the European Union

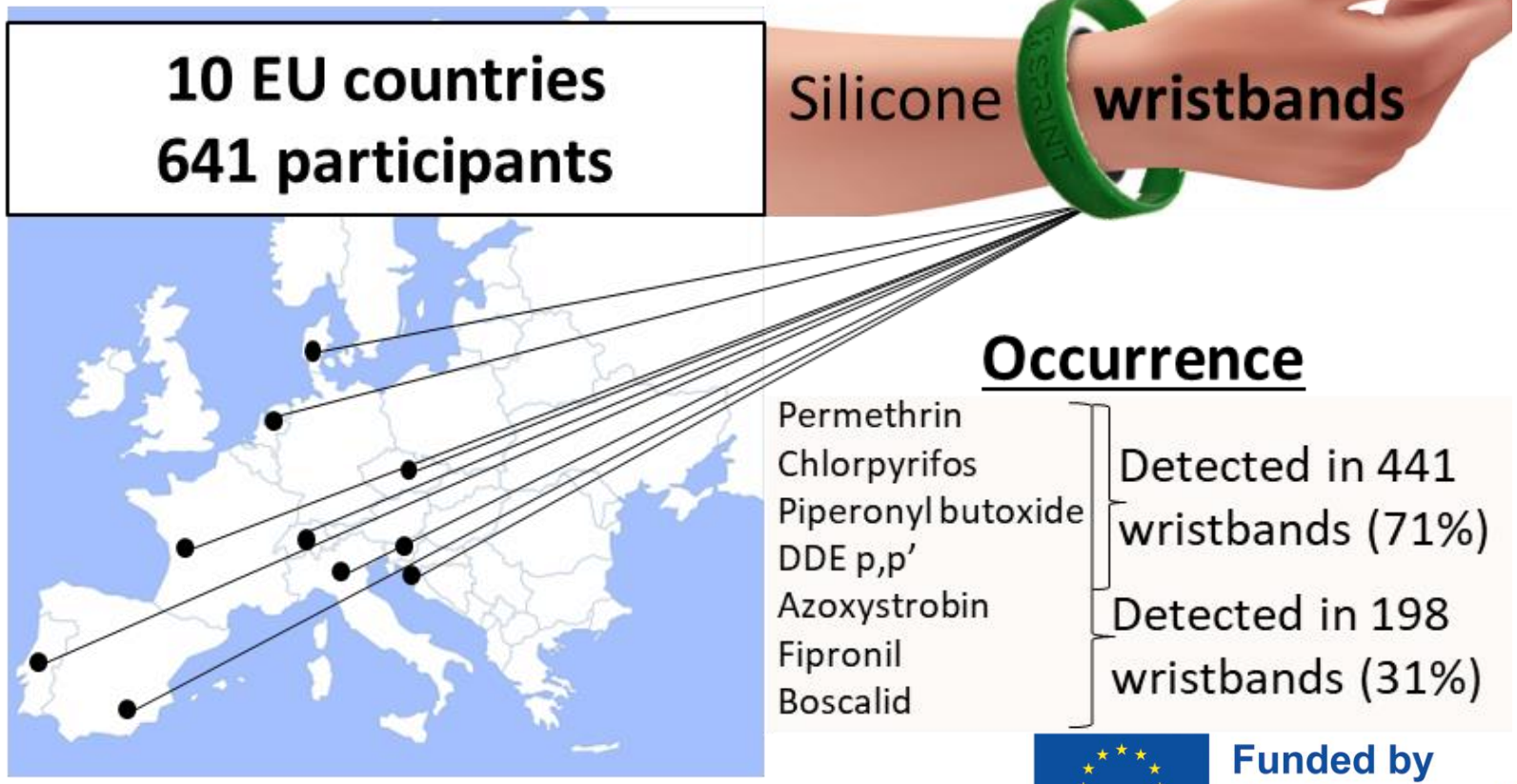
Wrist band results for pesticide mixtures

Measurement principle: **diffusion** into silicone medium (and also possible losses) provides indication of **non-dietary sources/routes**

Sample collection:

- During growing season of 2021
- For 7 days continuously
- Subgroups:
  - Farmers,
  - neighbours, and
  - consumers

193 pesticides analysed -> 173 detected



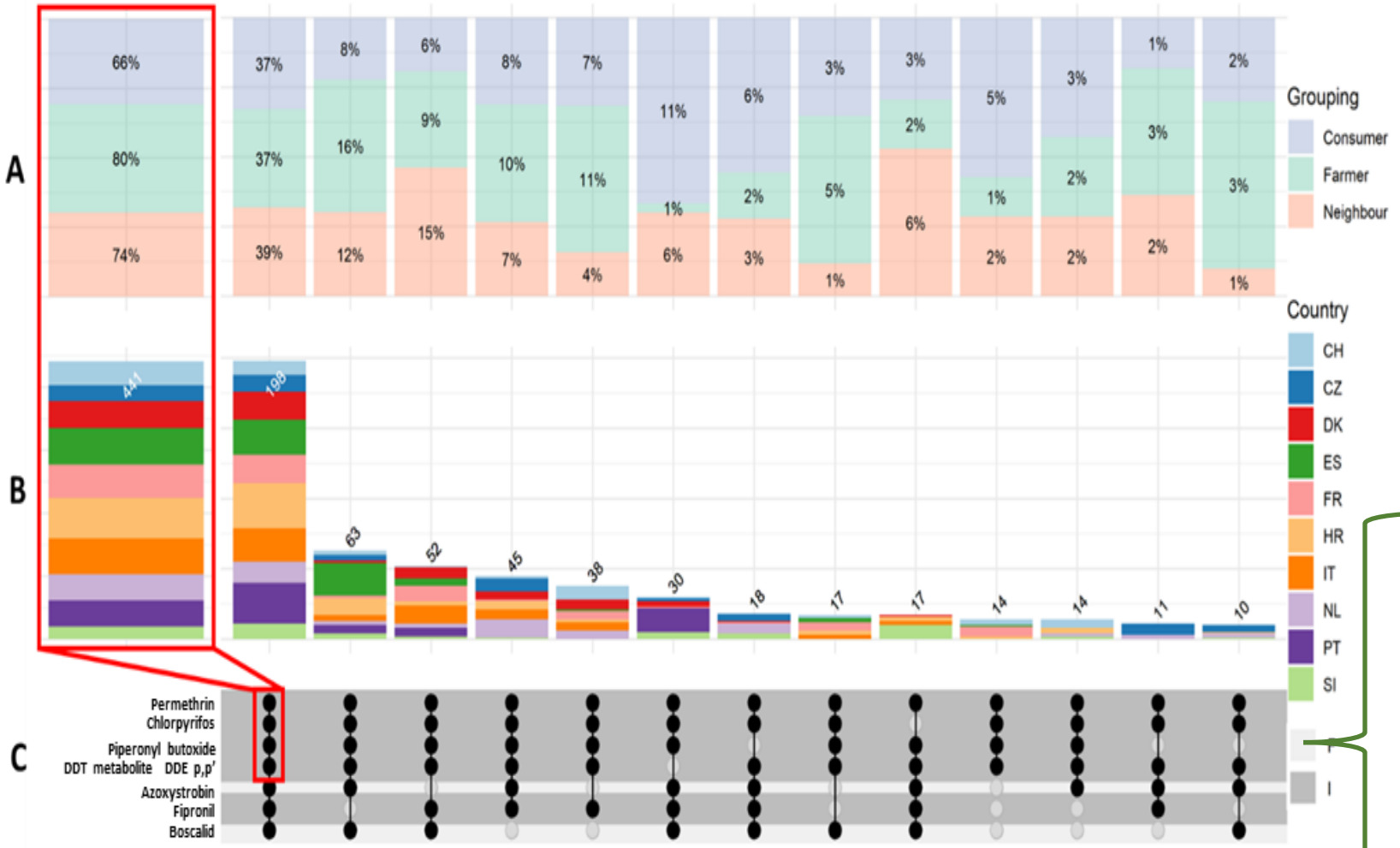
Occurrence

Permethrin Chlorpyrifos Piperonyl butoxide DDE p,p' Azoxystrobin Fipronil Boscalid	Detected in 441 wristbands (71%) Detected in 198 wristbands (31%)

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by the European Union

Wrist band results for pesticide mixtures



A Frequency in which these mixtures occur within each subgroup (farmers, neighbors and consumers).

B Number of occurrences by country

C Top 7 predominant mixtures across all samples:

Permethrin (insecticide)
Chlorpyrifos (insecticide)
Piperonyl butoxide (synergist
DDE o,p' (DDT metabolite)
Azoxystrobin (fungicide)
Fipronil (insecticide)
Boscalid (fungicide)

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by the European Union

Measured: Silicone Wristbands

- Wristband analysis give **insight into prevalent** environmental pesticide **mixtures**
- Wristbands from **organic farmers contained lower pesticide levels**
- Ownership of **pets explained pesticides used as biocides** to be found in wristbands
- **Banned pesticides are prominent** and confirm persisting non-dietary occurrence
- **Consumer's wristbands never contained higher levels** than farmers or neighbours

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by
the European Union

Dietary and non-dietary exposure modelling

Wristbands – Measurements

Duplicate Portion Analysis

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by
the European Union

Duplicate-portion analysis (DPA)

Collect all consumed (processed* and fresh) food and beverages **for 24 hours**

*Processing: e.g. peeling, boiling, grilling

Extraction from the food portions → **Analysis for the occurrence of pesticides *(+ metabolites)***

203 analyzed parent compounds (food portions)
46 analyzed metabolites (urine samples)

Participants were recruited from:

- Spain
- Portugal
- Croatia
- Slovenia
- The Netherlands
- Denmark
- Argentina

Farmer

Neighbour

Consumer

43 participants

SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

Funded by the European Union

DPA Results

Metalaxyl-M (100% >LOQ)

Piperonyl butoxide (91% >LOQ)