

# Agricultural Operator Exposure Model (AOEM)

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# Introduction

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- Current situation:**
- different models used in risk assessment for PPPs
  - mainly based on data for outdated equipment and practices



- Scope:**
- use of new exposure data
  - statistical approach, fully transparent
  - main outdoor application scenarios
  - applicable for authorisation

# Quality criteria for exposure studies

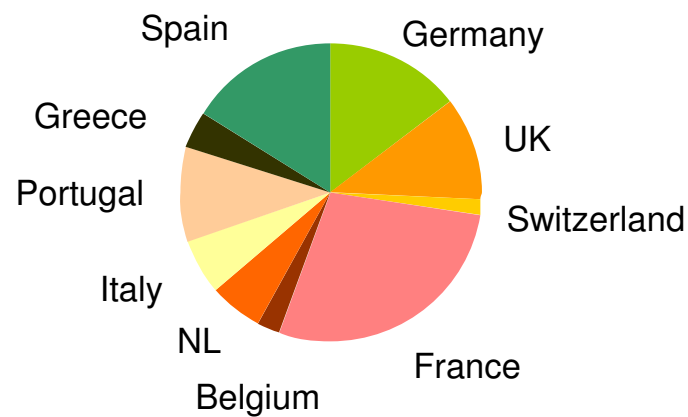
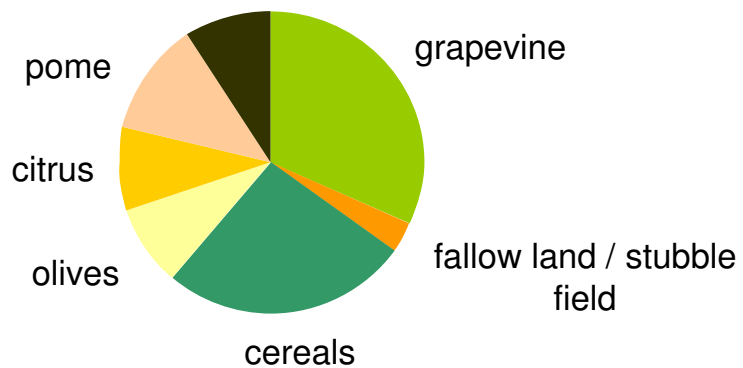
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- compliance with OECD Series No. 9
- trained operators working in accordance with Good Agricultural Practice
- data recording and observations according to current scientific knowledge
- compliance with GLP
- consistent field recovery
- suitable data form
- whole body dosimetry for dermal exposure
- appropriate inhalation fraction samplers for inhalation exposure
- representative application methods and application techniques

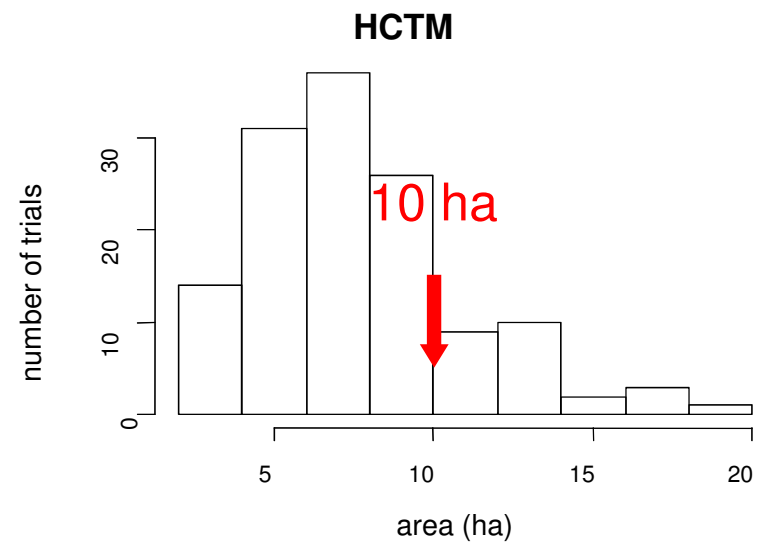
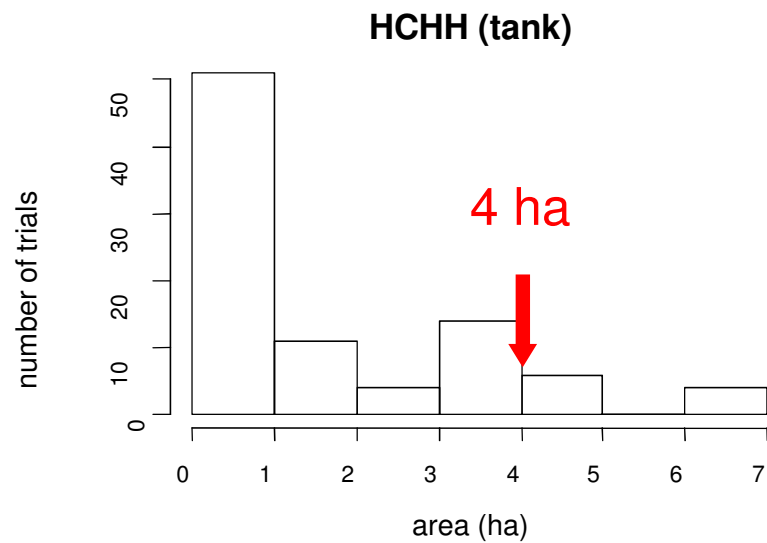
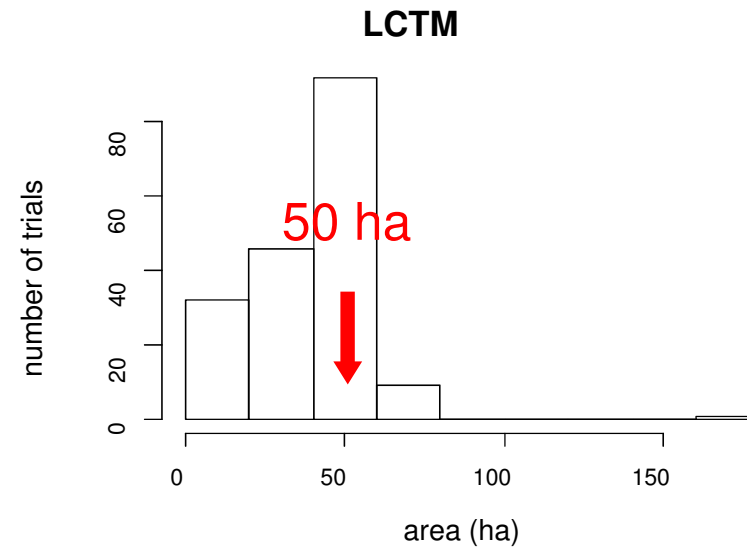
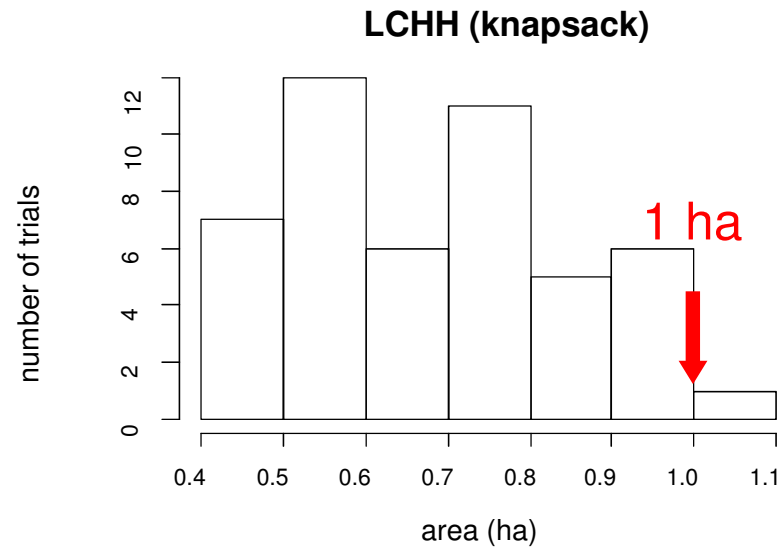
# Database

	Replicates		Cabin		Formulation				Equipment	
	M/L	A	yes	no	WG	WP	EC/EW	SC/SL	tank	knapsack
LCTM	108	97	93	4	34	-	63	41	138	-
HCTM	79	109	54	55	55	-	12	66	133	-
LCHH	49	48	-	-	19	-	60	9	-	88
HCHH	44	90	-	-	-	60	14	60	134	-
<b>all</b>	<b>280</b>	<b>344</b>	<b>147</b>	<b>59</b>	<b>108</b>	<b>60</b>	<b>149</b>	<b>176</b>	<b>405</b>	<b>88</b>

potatoes / sugarbeets

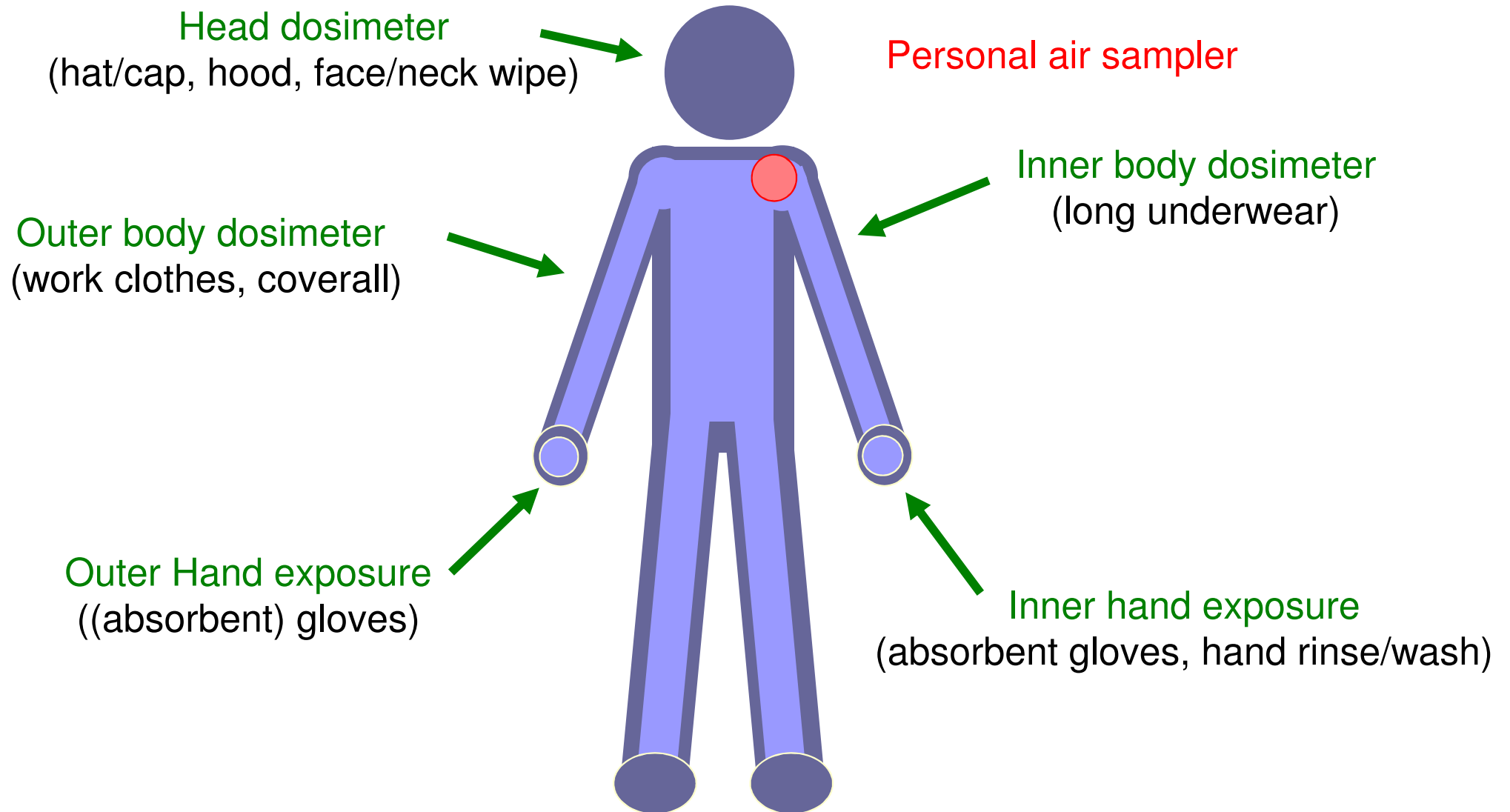


# Database



# Types of dosimeters

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# Exposure data

	Mixing/Loading						Application					
	Inhalat.	Hand	Glove	Body <sub>inner</sub>	Body <sub>outer</sub>	Head	Inhalat.	Hand	Glove	Body <sub>inner</sub>	Body <sub>outer</sub>	Head
LCTM	77	96	108	56	57	57	66	85	74	45	46	46
HCTM	52	66	77	41	41	40	83	97	92	72	72	71
LCHH	40	49	49	40	40	40	39	48	20	39	39	39
HCHH	32	44	44	32	32	32	90	90	90	90	90	90
<b>all</b>	<b>201</b>	<b>255</b>	<b>278</b>	<b>169</b>	<b>170</b>	<b>169</b>	<b>278</b>	<b>320</b>	<b>276</b>	<b>246</b>	<b>247</b>	<b>246</b>

# Exposure variables

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## Potential body exposure:

sum of deposits on outer and inner body dosimeters

## Actual body exposure:

deposits on inner body dosimeters (below one layer of clothing)

## Potential hand exposure:

sum of deposits on protective gloves and hands

## Actual/protected hand exposure:

deposits on protected hands (inner gloves, hand rinse/wash)

## Head exposure:

deposit on the head dosimeter corrected for the whole head

## Inhalation exposure:

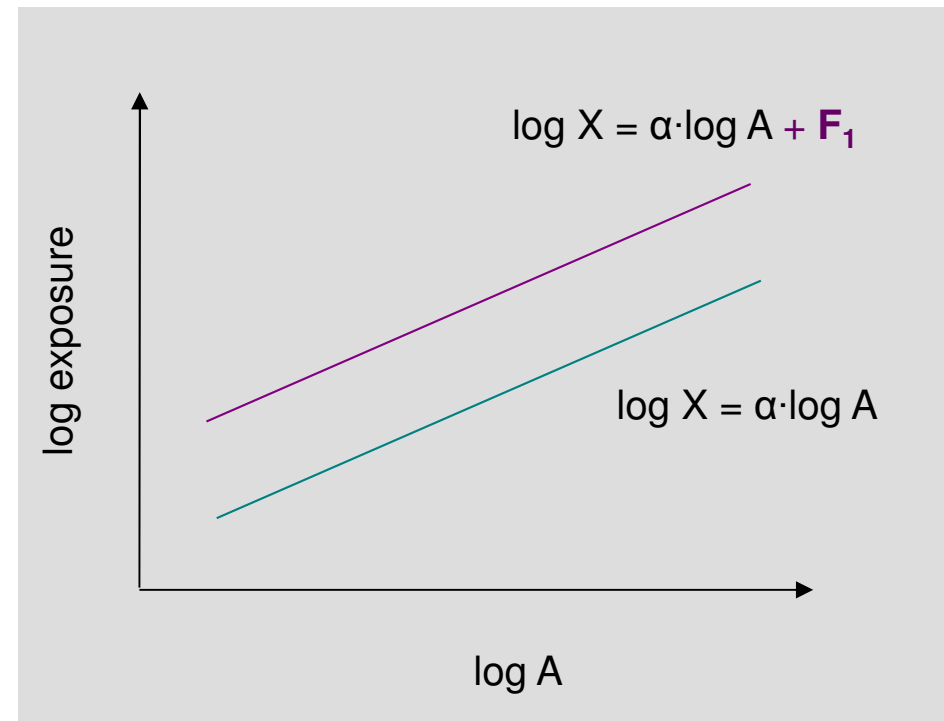
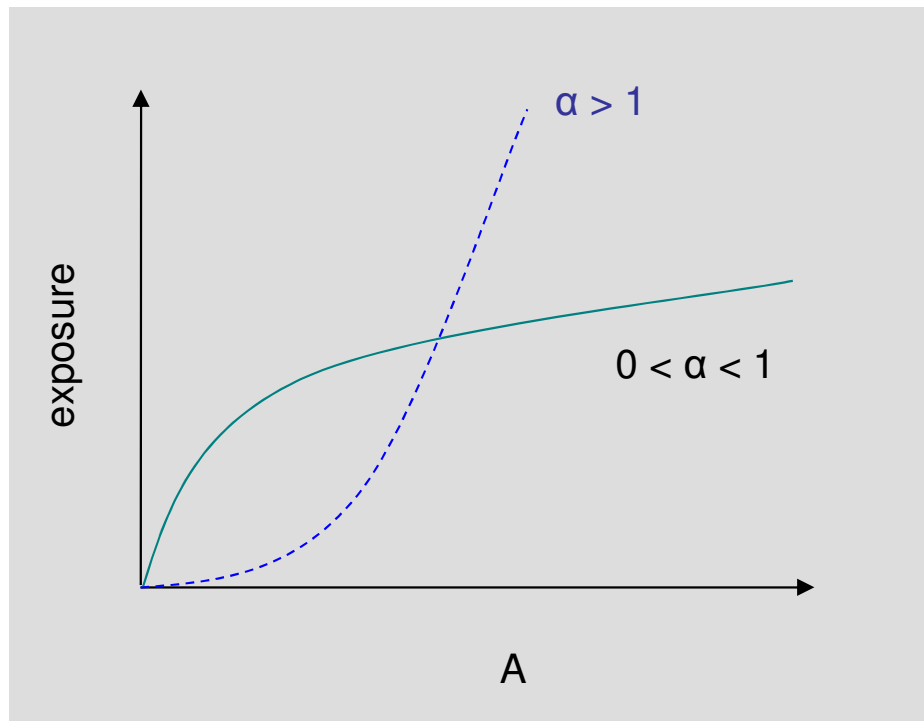
amount collected by air sampling corrected for respiratory rate



# Model

log-linear model:  $\log X = \alpha \cdot \log A + \sum [F_i]$   $0 < \alpha \leq 1$

$$X = A^\alpha \cdot \prod c_i$$



# Statistical analysis

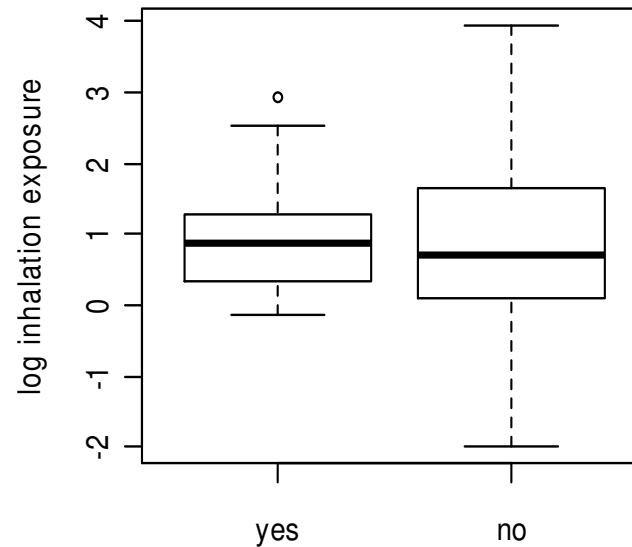
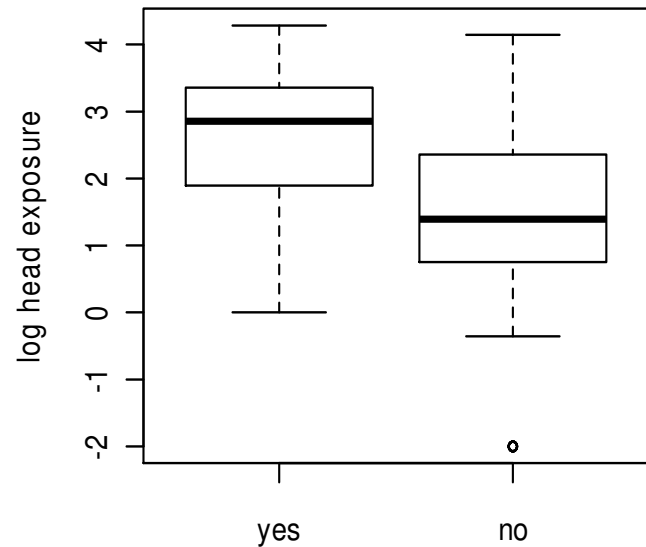
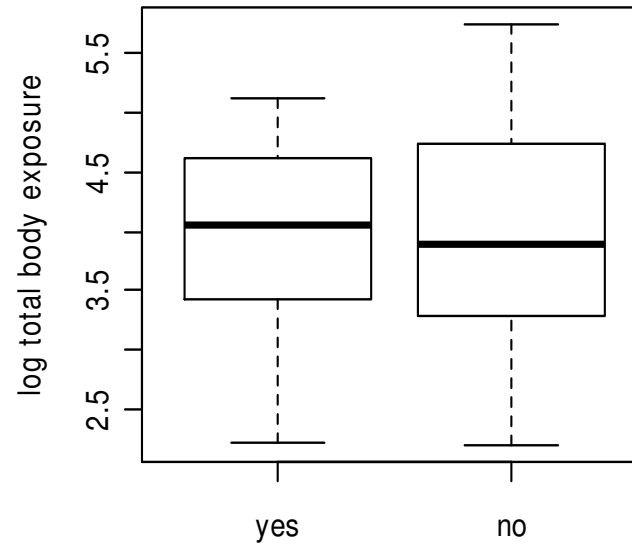
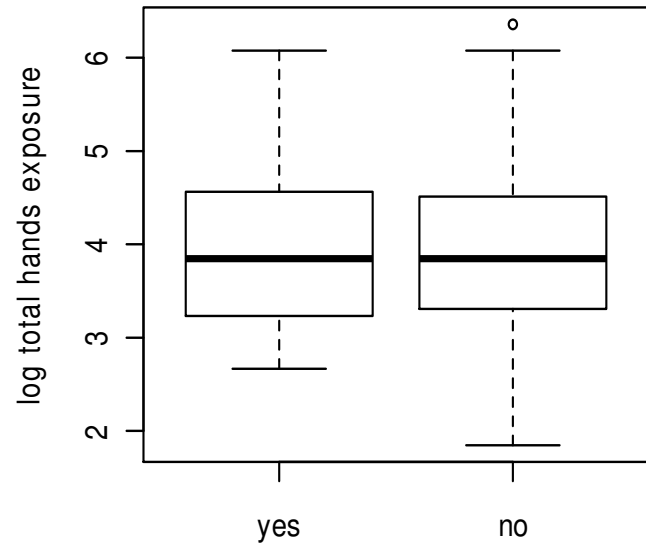
## M/L task

- formulation type
- total amount a.s. used per day
- number of containers handled
- number of M/L tasks
- concentration of a.s.
- equipment (induction hopper)
- duration of M/L

## Application task

- formulation type
- total amount a.s. used per day
- concentration of a.s. in spray solution
- equipment (cabin)
- size of area treated
- spray droplet size
- cleaning
- duration of cleaning

# Induction hopper

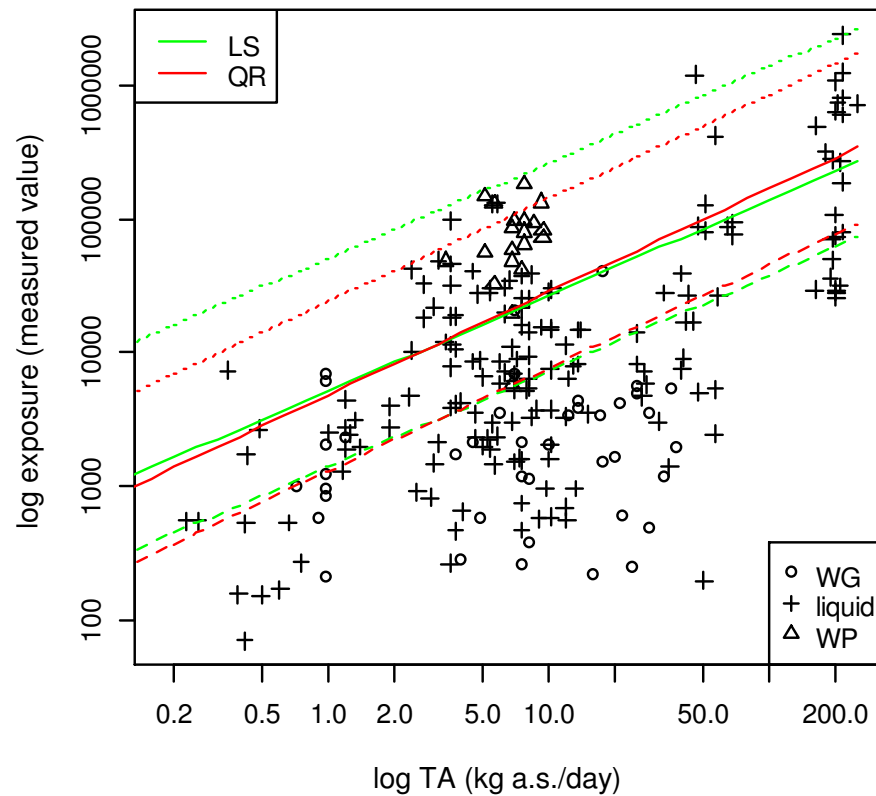


→ no impact

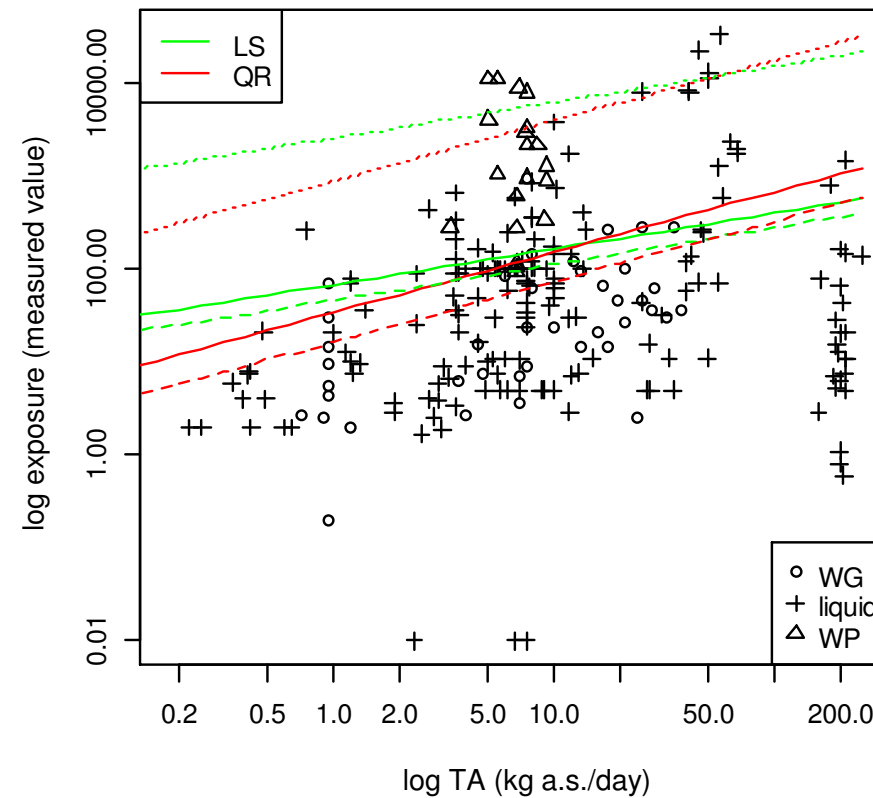
# Model

Method: Quantile Regression

### Potential Hands tank M/L

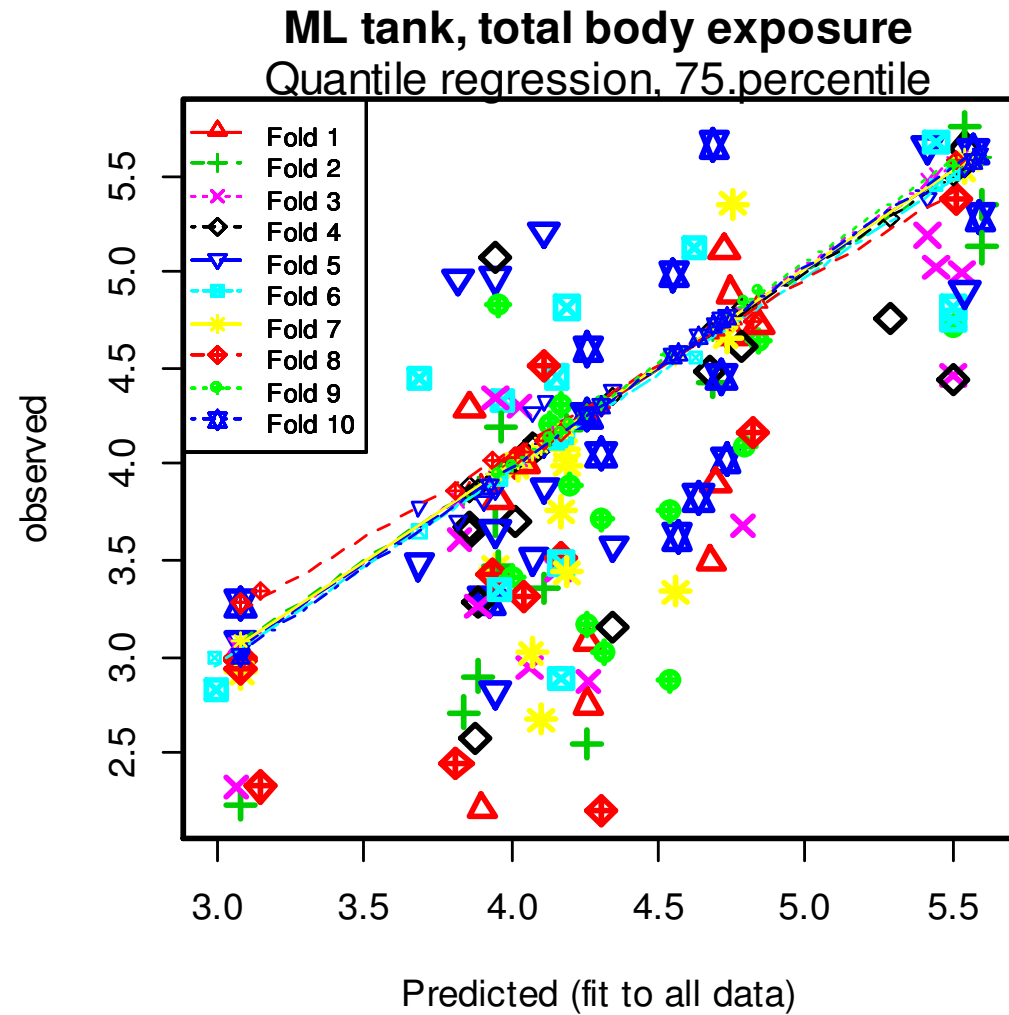


### Protected Hands tank M/L



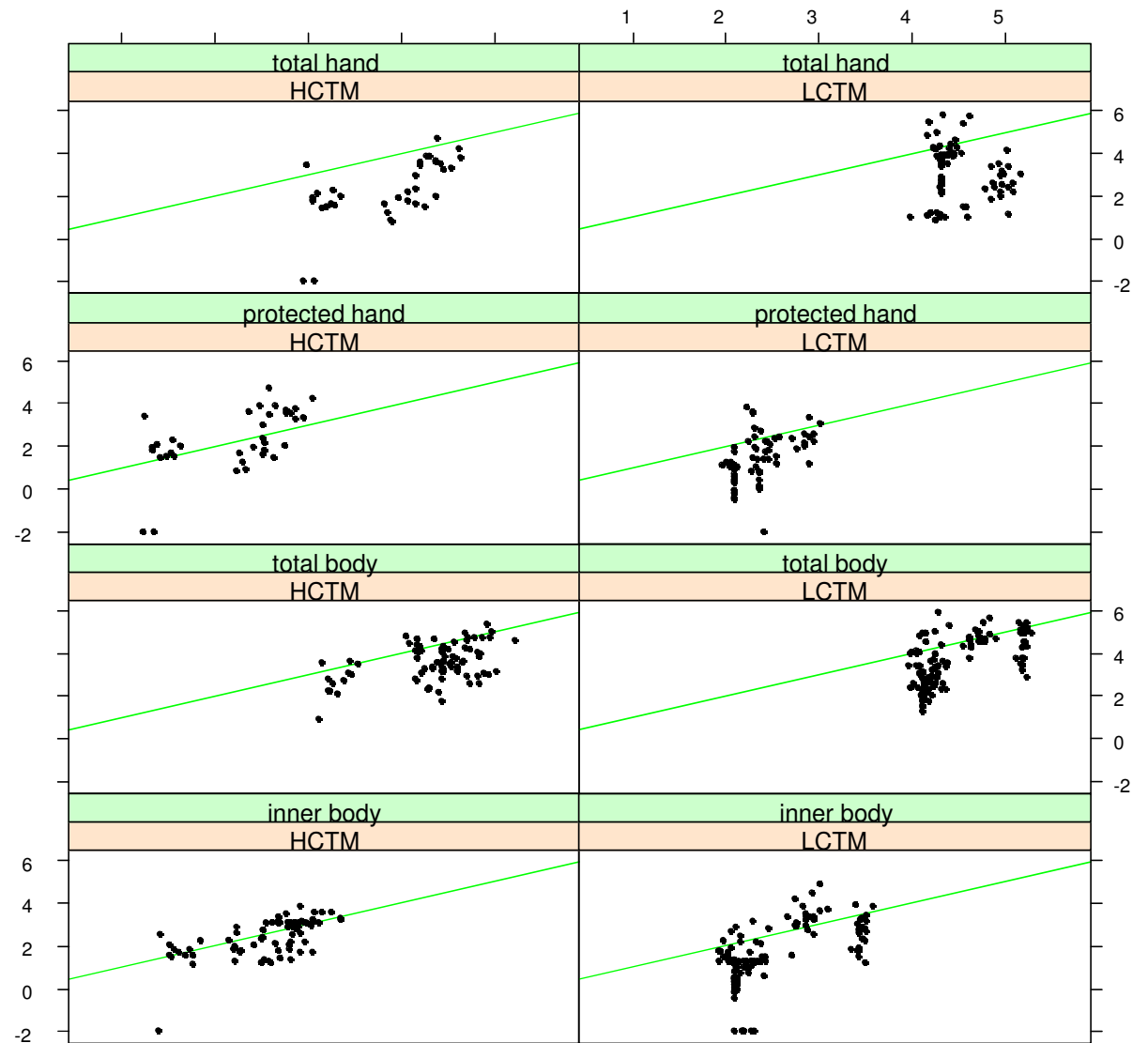
# Validation

- Robustness (Cross validation)
- Prediction (MLA data)



# Validation

- Robustness (Cross validation)
- Prediction (MLA data)



# Model

<b>Mixing/loading – tank</b>	potential hands	$\log D_{M(H)} = 0.77 \log TA + 0.57 [\text{liquid}] + 1.27 [\text{WP}] - 0.29 [\text{glove wash}] + 3.12$
	protected hands	$\log D_{M(Hp)} = 0.65 \log TA + 0.32 [\text{liquid}] + 1.74 [\text{WP}] + 1.22$
	total body	$\log D_{M(B)} = 0.70 \log TA + 0.46 [\text{liquid}] + 1.83 [\text{WP}] + 3.09$
	protected body	$\log D_{M(Bp)} = 0.89 \log TA + 0.11 [\text{liquid}] + 1.76 [\text{WP}] + 1.27$
	head	$\log D_{M(C)} = \log TA + 0.90 [\text{liquid}] + 1.28 [\text{WP}] + 1.79 [\text{no face shield}] - 0.98$
	inhalation	$\log I_M = 0.30 \log TA - 1.00 [\text{liquid}] + 1.76 [\text{WP}] + 1.57$
<b>Mixing/loading - knapsack</b>	potential hands	<b>75<sup>th</sup> percentile (above 1.5 kg a.s. linear extrapolation)</b>
	protected hands	
	total body	
	protected body	
	head	
	inhalation	
<b>Downward spraying – vehicle mounted</b>	potential hands	$\log D_{A(H)} = \log TA + 0.37 [\text{normal droplets}] - 1.04 [\text{normal equipment}] + 2.84$
	protected hands	$\log D_{A(Hp)} = 0.54 \log TA + 1.11 [\text{normal droplets}] + 0.29 [\text{normal equipment}] - 0.23$
	total body	$\log D_{A(B)} = \log TA + 0.81 [\text{normal droplets}] - 1.43 [\text{normal equipment}] + 2.54$
	protected body	$\log D_{A(Bp)} = \log TA + 0.70 [\text{normal droplets}] - 1.09 [\text{normal equipment}] + 0.74$
	head	$\log D_{A(C)} = \log TA + 0.88 [\text{normal droplets}] - 0.53 [\text{normal equipment}] + 0.24$
	inhalation	$\log I_A = 0.50 \log TA + 0.01 [\text{normal droplets}] - 0.71 [\text{normal equipment}] + 0.72$

# Model

<b>Upward spraying – vehicle mounted</b>	potential hands	$\log D_{A(H)} = 0.89 \log TA + 0.28 [\text{no cabin}] + 3.12$
	protected hands	$\log D_{A(Hp)} = \log TA - 1.55$
	total body	$\log D_{A(B)} = \log TA + 0.48 [\text{no cabin}] + 3.47$
	protected body	$\log D_{A(Bp)} = \log TA + 0.23 [\text{no cabin}] + 1.83$
	head	$\log D_{A(C)} = \log TA + 1.89 [\text{no cabin}] + 1.17$
	inhalation	$\log I_A = 0.57 \log TA + 0.82 [\text{no cabin}] + 0.99$
<b>Downward spraying – hand-held</b>	potential hands	<b>75<sup>th</sup> percentile (above 1.5 kg a.s. linear extrapolation)</b>
	protected hands	
	total body	
	protected body	
	head	
	inhalation	
<b>Upward spraying – hand-held</b>	potential hands	$\log D_{A(H)} = 0.84 \log TA - 0.83 [\text{normal culture}] + 4.26$
	protected hands	$\log (D_{A(Hp)} = \log TA - 0.88 [\text{normal culture}] + 2.26$
	total body	$\log D_{A(B)} = 0.16 \log TA - 1.29 [\text{normal culture}] + 6.08$
	protected body	$\log D_{A(Bp)} = - 1.64 [\text{normal culture}] + 4.65$
	head	$\log D_{A(C)} = 0.32 \log TA - 1.09 [\text{normal culture}] + 3.27$
	inhalation	$\log I_A = 0.83 \log TA - 0.26 [\text{normal culture}] + 2.17$



# Protection factor

Actual hand



Actual body



		Protective gloves	Work clothes
		75 <sup>th</sup> percentile	75 <sup>th</sup> percentile
<b>ML</b>	Tank WG	0.03	0.04
	Tank WP	0.05	0.04
	Tank liquid	0.02	0.02
	Knapsack	0.01	0.07
	all	<b>0.02</b>	<b>0.04</b>
<b>A</b>	LCTM	0.11	0.05
	HCTM	0.11	0.04
	HCHH	0.02	0.03
	LCHH	0.03	0.15
	all	<b>0.03</b>	<b>0.04</b>

Mixing/Loading: Face shield

# AOEM in risk assessment

## Comparison with German model and UK POEM

Example: 300 g a.s./L; 5 L container (45 or 63 mm); 1 kg a.s./ha; 100 % dermal absorption; AOEL: 1 mg/kg bw

		German model coverall	UK POEM long shirt + trousers	AOEM tank workwear	AOEM knapsack workwear
<b>FCTM</b> 400 L/ha	liquid	130	343	183	
	WG	116	653	59	
	WP	232	1324	910	
<b>HCTM</b> 400 L/ha	liquid	160	556	103	
	WG	155	650	67	
	WP	201	852	314	
<b>LCHH</b> 200 L/ha 15 L tank	liquid		921	71	33
	WG		1137	53	33
	WP		1139	176	33
<b>HCHH</b> 200 L/ha 2.5 L tank	liquid	351	1019	<b>117</b>	<b>125</b>
	WG	88	905	<b>111</b>	<b>125</b>
	WP	131	907	<b>155</b>	<b>125</b>

# Conclusions

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- new model for typical outdoor scenarios
- exposure factors selected by statistical analysis
- log linear model (Quantile Regression)
- validation
- tiered approach possible
- updating of the model if new data become available

<http://www.bfr.bund.de/cm/350/joint-development-of-a-new-agricultural-operator-exposure-model.pdf>

<http://www.springerlink.com/openurl.asp?genre=article&id=doi:10.1007/s00003-013-0836-x>

**Thank you for your attention**

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