

# How to measure dermal hand exposure in occupational exposure studies - New methodology to assess applicability of hand-wash method and cotton gloves

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## INTRODUCTION

Assessment of agricultural worker exposure to pesticides comprises measurement of external dermal exposure to plant surface residues and inhalation exposure. Measurement of dermal exposure using working-clothing as outer and cotton underwear as inner dosimeter is well established but different methodologies are used to assess actual hand exposure.

**Either standardized hand-washes are conducted after the work task or cotton gloves are worn throughout the task.**

**There is an ongoing debate of the comparability and appropriateness of these two dosimeter types.**

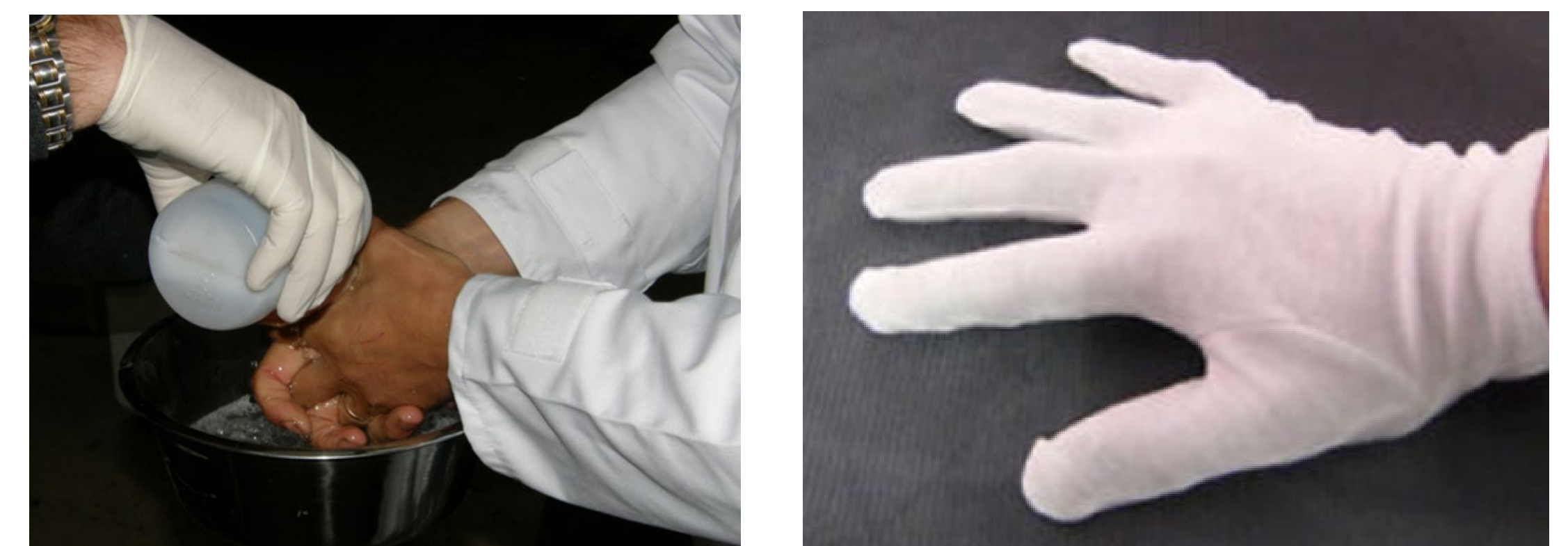


Figure 1: Dosimeters to measure hand-exposure in agricultural worker exposure studies

## MATERIALS & METHODS

- Experiments according to the principles of the OECD 428 dermal penetration in vitro with dry residue method adoption<sup>1</sup>
- Test substance: Representative spray dilution of a (radiolabeled) pesticide
- Skin or Cotton fabrics over skin mounted in Franz-like diffusion cells
- Spray dilute application: 10 µL pipetted on skin surface
- Dried residue application:
  - Preparation of dried residues: 10 µL on Teflon coated transfer device dried for 24h
  - Prewetting with artificial sweat: Skin surface (10 µL) Cotton fabric (40 µL), dried with blotting paper
  - 3 x gentle clockwise turning of transfer device on skin surface or cotton fabric
- Dermal exposure: Aqueous spray dilution versus dried residues skin / cotton fabric
- Skin wash at the end of exposure and at the end of the post exposure period
- Transfer rate, absorption through the skin and mass balance

## OBJECTIVES

A modified in vitro dermal absorption study<sup>1</sup> design was developed to allow the comparable application and assessment of the behaviour of dried pesticide residues on the skin surface or on the surface of cotton glove fabric covered skin.

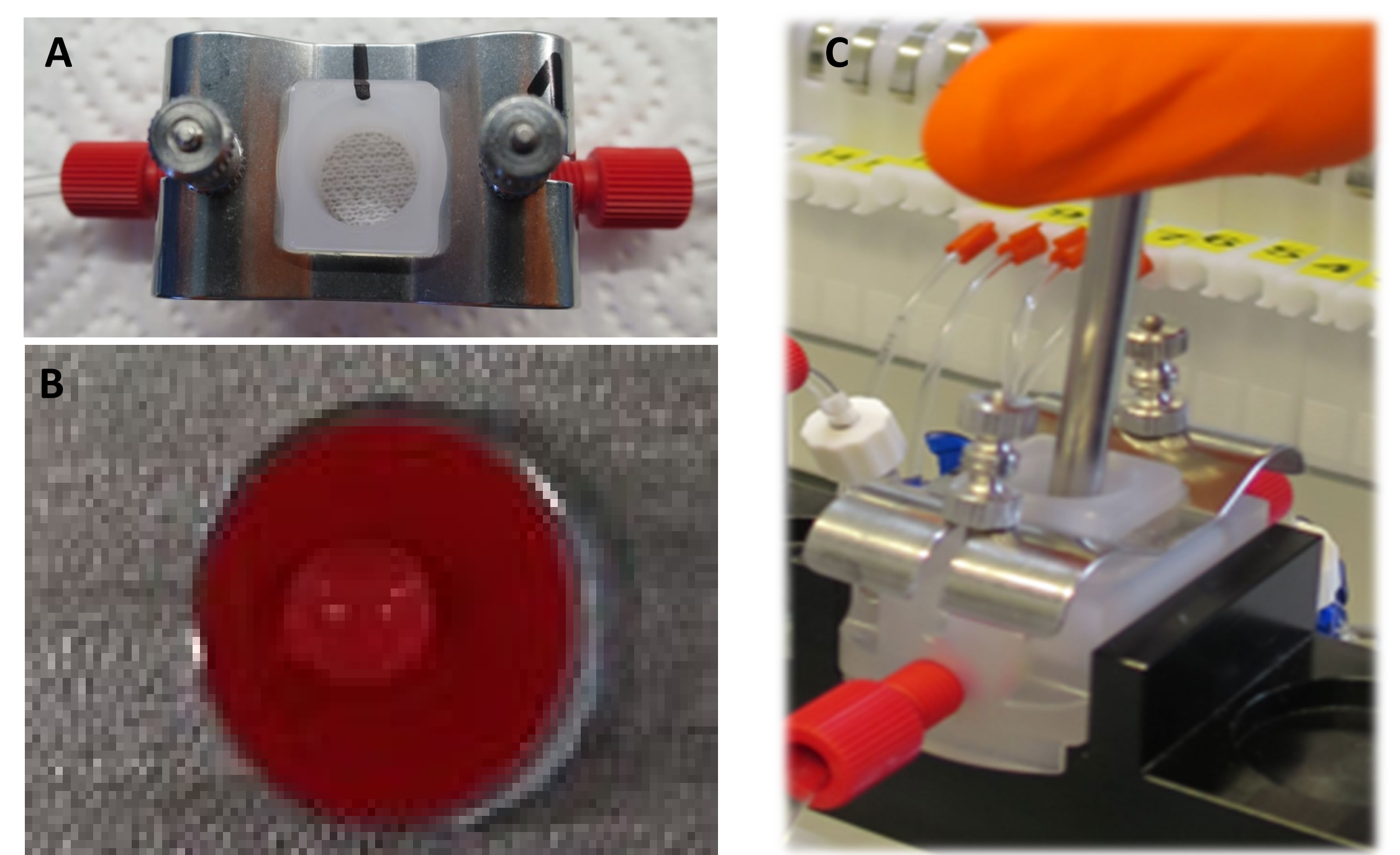


Figure 2: A: Diffusion cell with cotton fabric covered skin, B: Dried residue transfer device, C: Illustration of dried residue transfer

**Table 1:**  
**Dried residues on skin versus cotton fabric covered skin**  
Dermal absorption mass balance distribution after 4 hour exposure

Dose group	Human skin		Cotton fabric covered skin	
	amount of test substance [µg]	% of applied dose	amount of test substance [µg]	% of applied dose
Target concentration	0.5 mg/mL		0.5 mg/mL	
Target dose level of test substance	5.0 µg/cm <sup>2</sup>		5.0 µg/cm <sup>2</sup>	
Mean nominal applied dose	2.3 µg/cm <sup>2</sup>		4.4 µg/cm <sup>2</sup>	
<b>Dislodgeable dose</b>				
Membrane washing after 4 hours	2.019 ± 0.324	89.56 ± 3.26	0.378 ± 0.155	8.63 ± 3.59
Donor chamber washing	0.0118 ± 0.0058	0.57 ± 0.41	0.0028 ± 0.0018	0.06 ± 0.04
Cotton glove	-	-	3.4751 ± 0.2668	79.23 ± 5.64
<b>Sum</b>	<b>2.031 ± 0.32</b>	<b>90.13 ± 3.57</b>	<b>3.855 ± 0.149</b>	<b>87.92 ± 3.08</b>
Dose associated to tape strips	0.0023 ± 0.0011	0.10 ± 0.04	0.0028 ± 0.0024	0.06 ± 0.06
Dose associated to remaining skin	0.215 ± 0.109	9.09 ± 3.27	0.212 ± 0.107	4.83 ± 2.40
<b>Absorbed dose</b>				
Sum receptor samples 0 - 4 h	0.001 ± 0.001	0.03 ± 0.03	0.005 ± 0.001	0.11 ± 0.03
Receptor fluid	0.0008 ± 0.0005	0.03 ± 0.02	0.08 ± 0.0327	1.82 ± 0.71
Receptor chamber washing	0 ± 0	0.00 ± 0.00	0 ± 0	0.00 ± 0.00
<b>Sum</b>	<b>0.0015 ± 0.001</b>	<b>0.06 ± 0.04</b>	<b>0.0849 ± 0.0331</b>	<b>1.93 ± 0.72</b>
<b>Total mass balance</b>	<b>2.25 ± 0.42</b>	<b>99.38 ± 1.43</b>	<b>4.155 ± 0.152</b>	<b>94.74 ± 2.58</b>

n=5 for human skin, n=6 for cotton fabric covered skin; mean ± sd

**Table 2:**  
**Spray dilution versus dried residues on skin**  
Dermal absorption mass balance distribution after 8 hour exposure + 16 h post-exposure

Dose group	Dried residues		Spray dilution	
	amount of test substance [µg]	% of applied dose	amount of test substance [µg]	% of applied dose
Target concentration	0.08 mg/mL		0.08 mg/mL	
Target dose level of test substance	0.8 µg/cm <sup>2</sup>		0.8 µg/cm <sup>2</sup>	
Mean nominal applied dose	0.6 µg/cm <sup>2</sup>		0.9 µg/cm <sup>2</sup>	
<b>Dislodgeable dose</b>				
Membrane washing after 8 and 24 hours	0.567 ± 0.054	95.84 ± 2.39	0.806 ± 0.038	93.82 ± 5.13
Donor chamber washing	0 ± 0	0.04 ± 0.08	0.0011 ± 0.0018	0.13 ± 0.21
<b>Sum</b>	<b>0.567 ± 0.054</b>	<b>95.88 ± 2.42</b>	<b>0.798 ± 0.042</b>	<b>93.95 ± 5.81</b>
Dose associated to tape strips	0 ± 0	0.01 ± 0.01	0 ± 0	0.05 ± 0.12
Dose associated to remaining skin	0 ± 0	0.007 ± 0.016	0.0017 ± 0.0031	0.199 ± 0.356
<b>Absorbed dose</b>				
Sum receptor samples 0 - 4 h	0 ± 0	0 ± 0	0.006 ± 0.005	0.72 ± 0.61
Receptor fluid	0 ± 0	0 ± 0	0 ± 0	0.012 ± 0.015
Receptor chamber washing	0.0014 ± 0.0011	0.23 ± 0.18	0.036 ± 0.0329	4.21 ± 3.8
<b>Sum</b>	<b>0.0014 ± 0.0011</b>	<b>0.23 ± 0.18</b>	<b>0.0423 ± 0.0382</b>	<b>4.94 ± 4.41</b>
<b>Total mass balance</b>	<b>0.569 ± 0.054</b>	<b>96.12 ± 2.54</b>	<b>0.843 ± 0.007</b>	<b>99.14 ± 1.58</b>

n=8 for both dose groups; mean ± sd,

## RESULTS & DISCUSSION

- Dermal uptake from dried residues on skin was about 20 times lower than for liquid spray dilution application.
- Transfer rates of dried residues were higher for cotton fabric covered skin: Range 34-56% for uncovered skin and 85-90% for fabric-covered skin
- Amounts retained in skin compartments are comparable
- Mean absorption of applied dose from dried residue was about 30-fold higher for cotton-fabric covered skin: 0.06% for uncovered skin 1.82% for cotton fabric covered skin.

## CONCLUSION & OUTLOOK

- We show that the two dosimeters can be, in principle, compared by the OECD 428 TG method
- Initial data indicates that both residue transfer and absorption are higher for cotton covered skin than for uncovered skin
- Results emphasize the need to adequately understand the impact of the selected dosimeter hand-wash versus cotton-glove for the retained residues on the dosimeter as well as for the actual exposure resulting thereof