Octubre 30 - 31
Noviembre 1
Medellín
2019

25a Semana de la Salud Ocupacional

Transformación Social desde la SST

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XXXIX Congreso de Ergonomía, Higiene, Medicina y Seguridad Ocupacional.
18° Congreso Colombiano de Ergonomía: Perspectivas de la Ergonomía en el Trabajo Actual.

Pesticide Exposure in Agricultural Settings

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25ª Semana de la Salud Ocupacional

November 1, 2019

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National Institute for Occupational Safety and Health

The findings and conclusions in this presentation are those of the author and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.

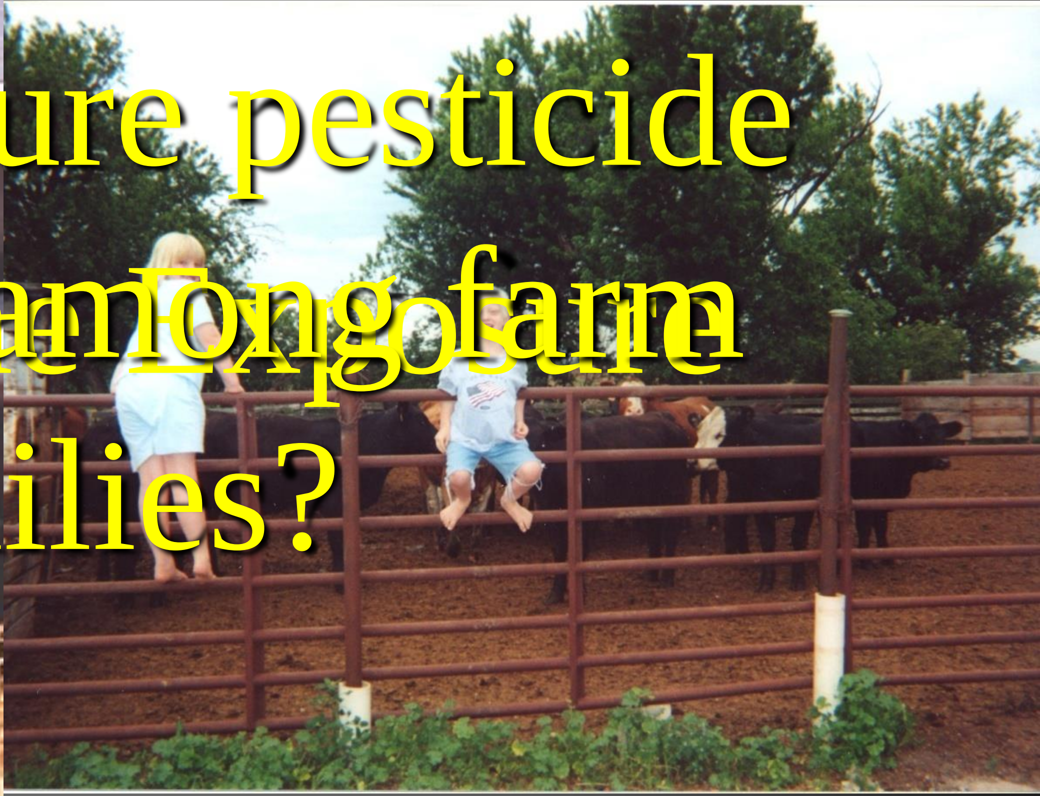
Outline

- Take home exposure
- Tobacco harvesters
- Sugarcane harvesters

Take Home Exposure

Why measure pesticide exposure among farm families?

Take-Home Exposure



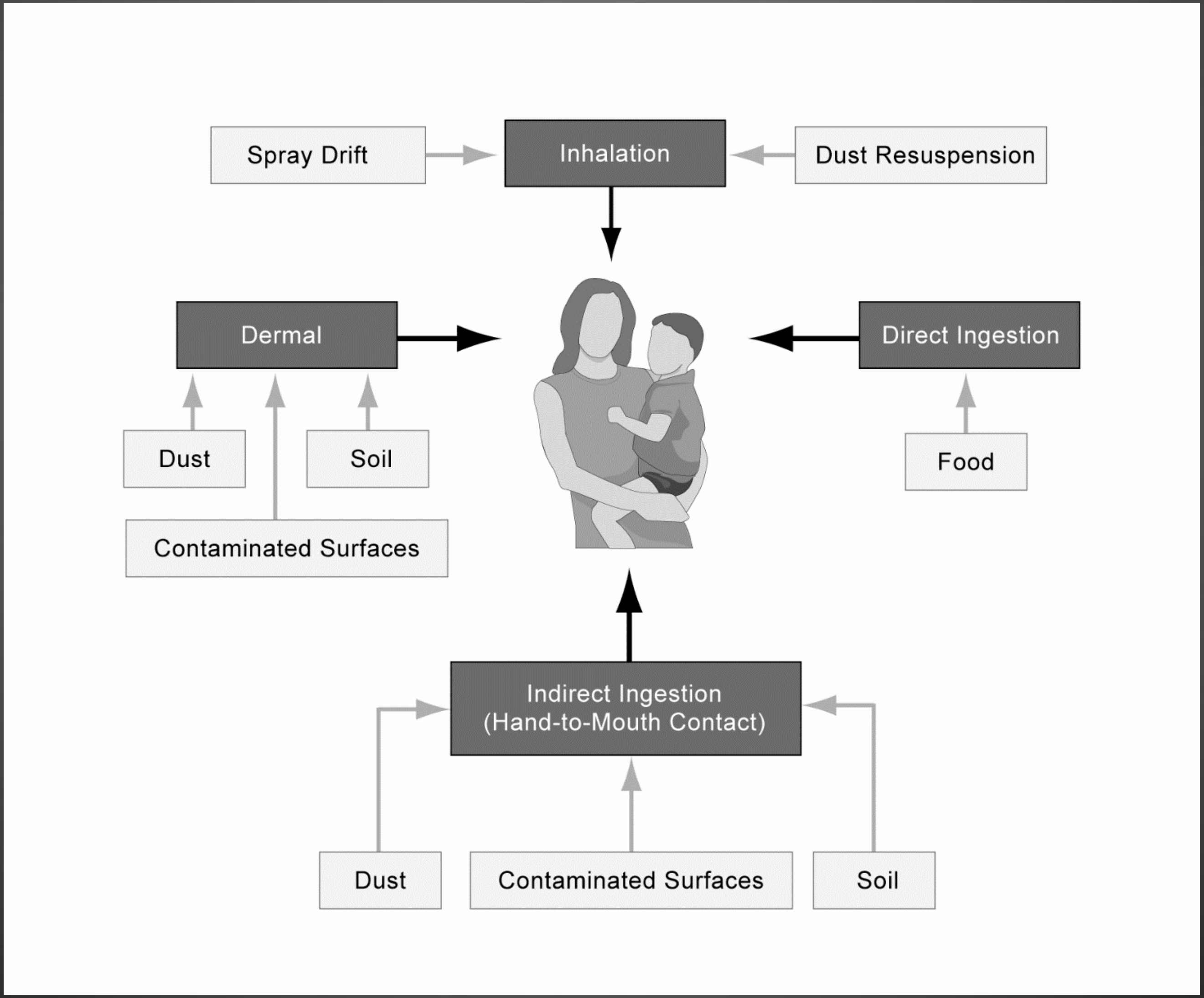
Background

- Take-home exposure a worldwide problem
  - Death and health effects reported in 28 countries
- Death and neurological effects from pesticides
  - Acute poisoning cases

Background

- Farmers are the biggest users and most highly exposed group to pesticides.
- Children are thought to be more susceptible to pesticide exposure
- Parental occupation involving pesticide application and household use may be associated with cancers

Sources of Exposure for Farm Family Members



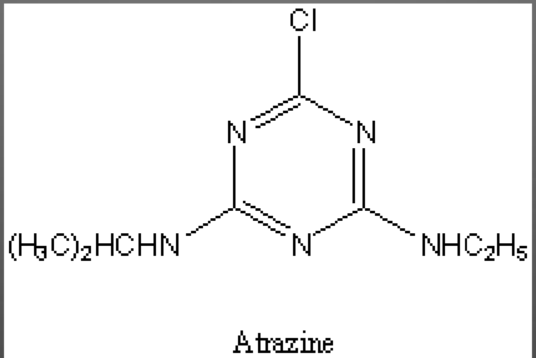
Other Studies

- Pesticide track-in has been demonstrated after lawn applications (Nishioka et al, 1999, 2001; Lewis et al, 2001
- Pesticides in house dust associated with farm work and pesticide application (Simcox et al, 1995; Bradman et al, 1997; Lu et al, 2000; Fenske et al 2002; McCauley 2003; Coronado et al, 2004)
- Parental pesticide application or household pesticide use may be associated with childhood cancers (Ma et al, 2002; Flower et al, 2004)

Objectives

1. Evaluate pesticide contamination and exposure in farm homes and families.

2. Identify potential environmental and behavioral risk factors.



Study Population

- 25 Farm households
  - Must be using one of the target pesticides
  - 24 farmers, 24 spouses
  - 66 children (29 female and 37 male)

- 25 Non-farm households
  - Must live on non agricultural land and not work in agriculture
  - 23 farmers, 24 spouses
  - 51 children (19 female and 32 male)

Pesticides of Interest

- Atrazine (atrazine mercapturate
- Alachlor (alachlor mercapturate)
- Acetochlor (acetochlor mercapturate)
- Metolachlor (metolachlor mercpaturate)
- 2,4-D (parent 2,4-D)
- Glyphosate (parent glyphosate)
- Chlorpyrifos (trichloropyridinol)

Methods

- Personal samples
  - Hand wipes, urine
- Environmental samples:
  - Dust, hard surface wipes, air, tap water
- Interview
- Two sample sets, 4 weeks apart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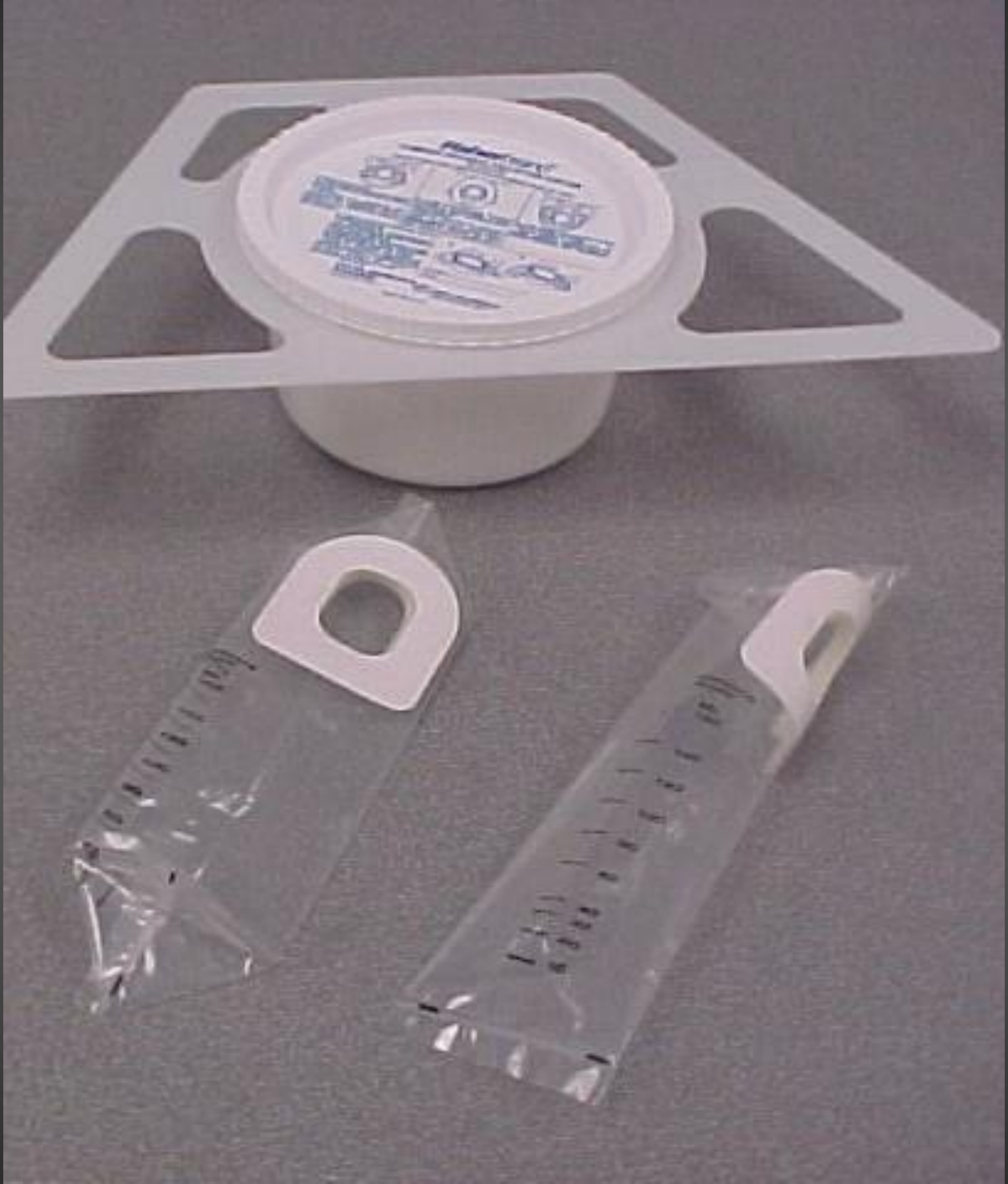
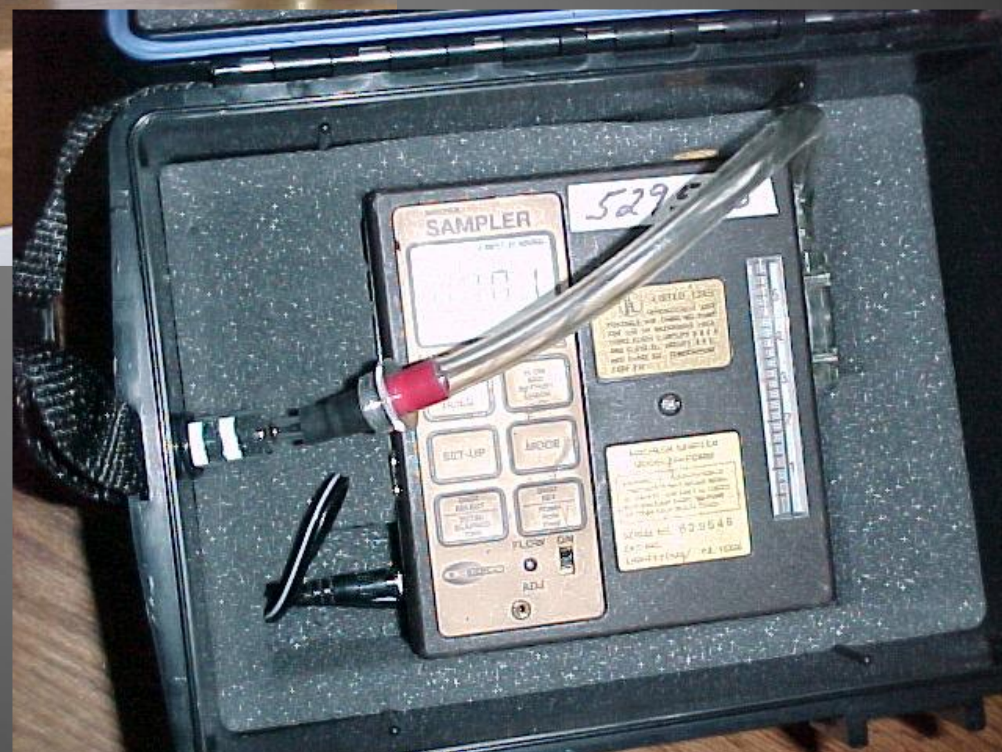
Sampler
Serial No.
1879
MAGNEHELIC




SAMPLER
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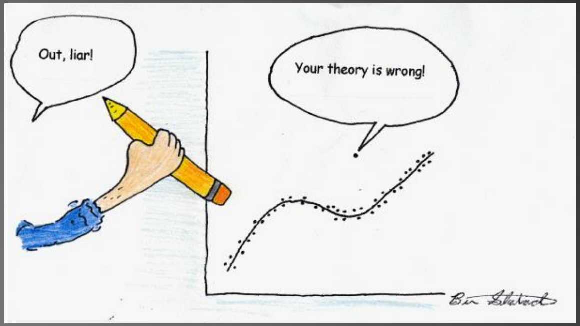
Samples

- Dust - 295
- Surface wipes - 356
- Hand wipes - 424
- Air - 197
- Water - 102
- Urine - 785
- ***Total - 2159***

Data Analysis



- Mixed effects models using SAS 9.1.
- Fixed effects included household type, visit, room, urinary creatinine, age, and sex (for children).
- Non-detects replaced with ½ LOD or lowest reported value.

Results (environmental)

- Farm homes have more samples with detectable pesticides than non-farm homes.
- More dust samples with detectable pesticides than wipe or air samples.
- No detectable wipe samples for glyphosate and 2,4-D; 92 % (48/52) dust positive for glyphosate and 100% (65/65) dust positive for 2,4-D.
- Most air samples were non detect.

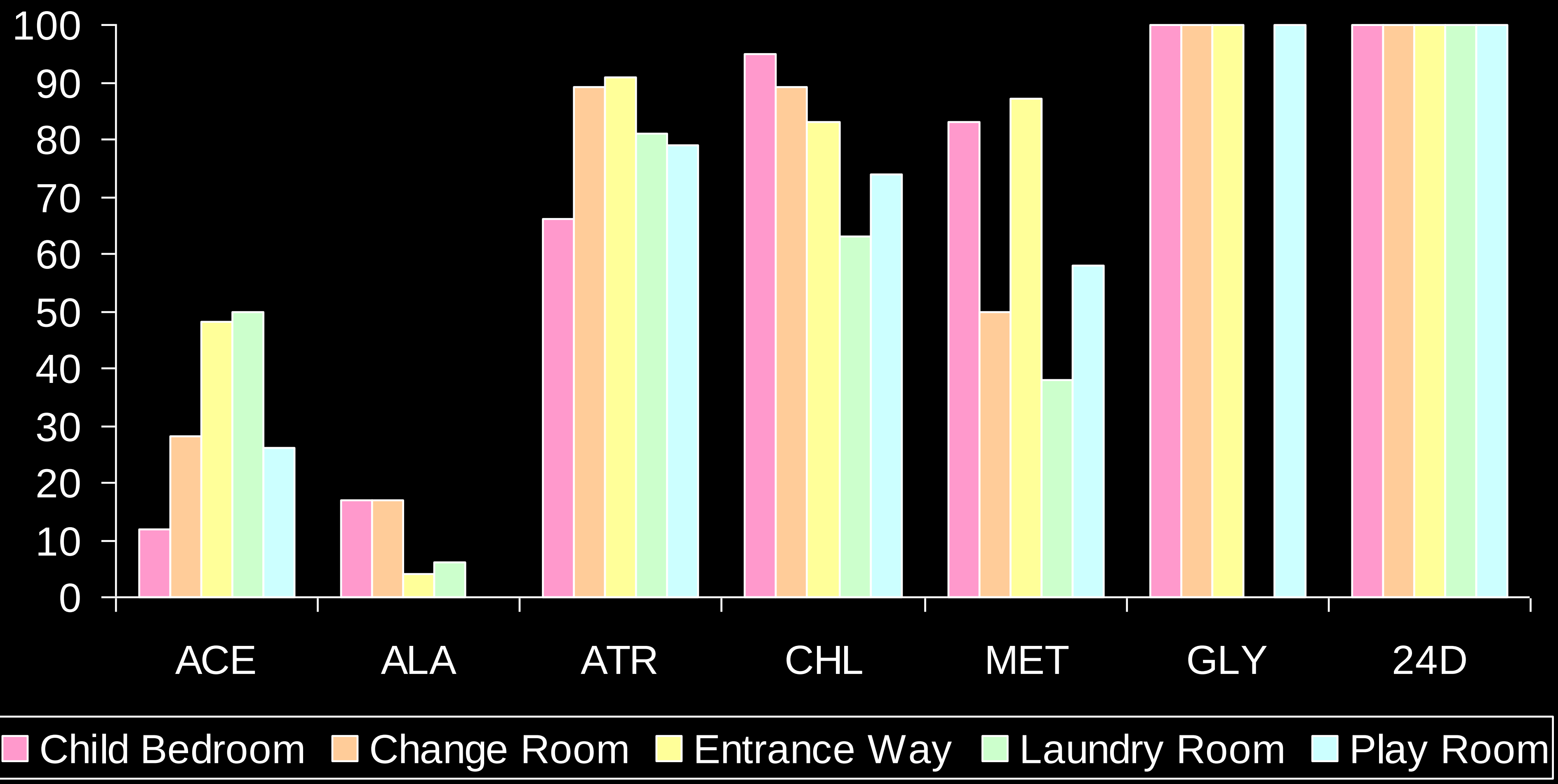
Results (environmental)

- For all pesticides, dust samples from farm homes had higher amount of pesticide residue than non-farm homes.
- In farm homes, atrazine, acetochlor and metolachlor levels in dust were significantly higher when they were applied prior to visit.
- Distance to a field did not significantly effect pesticide levels in dust or # of detectable dust samples.
- Home characteristics did not impact pesticide levels in dust

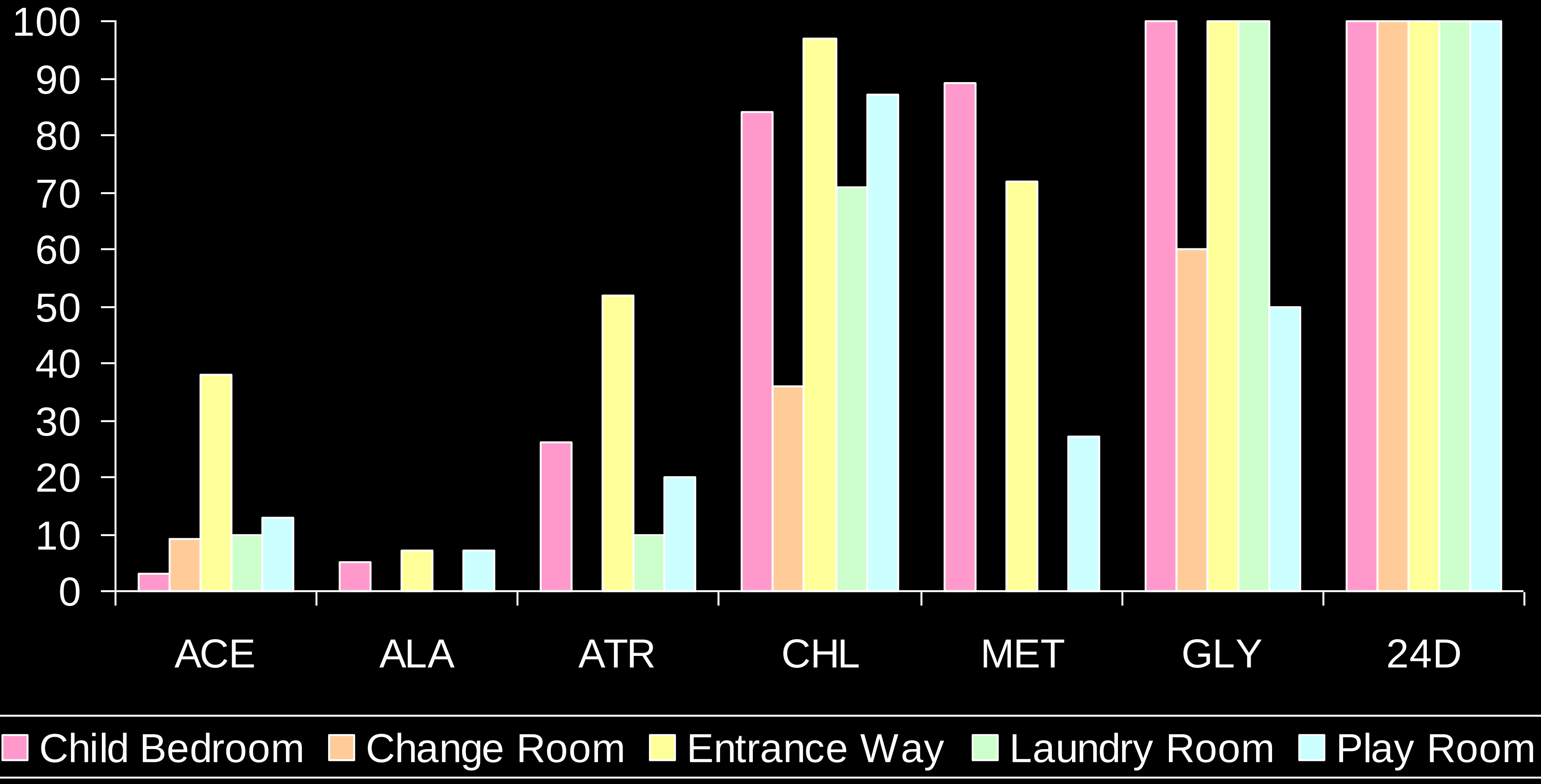
Percent of Samples with Detectable Pesticides

	Dust		House Wipe		Vehicle Wipe		Air	
	F	NF	F	NF	F	NF	F	NF
Atr	**78**	**26**	0	1	4	0	0	0
Met	**69**	**52**	4	0	**12**	**1**	1	0
Chlor	84	81	24	20	21	8	**9**	**2**
Acet	**29**	**15**	**6**	**0**	13	5	1	0
Ala	10	4	0	0	3	1	0	0
Gly	100	85	0	0	0	0	n/a	n/a
2,4-D	100	100	0	0	0	0	0	0

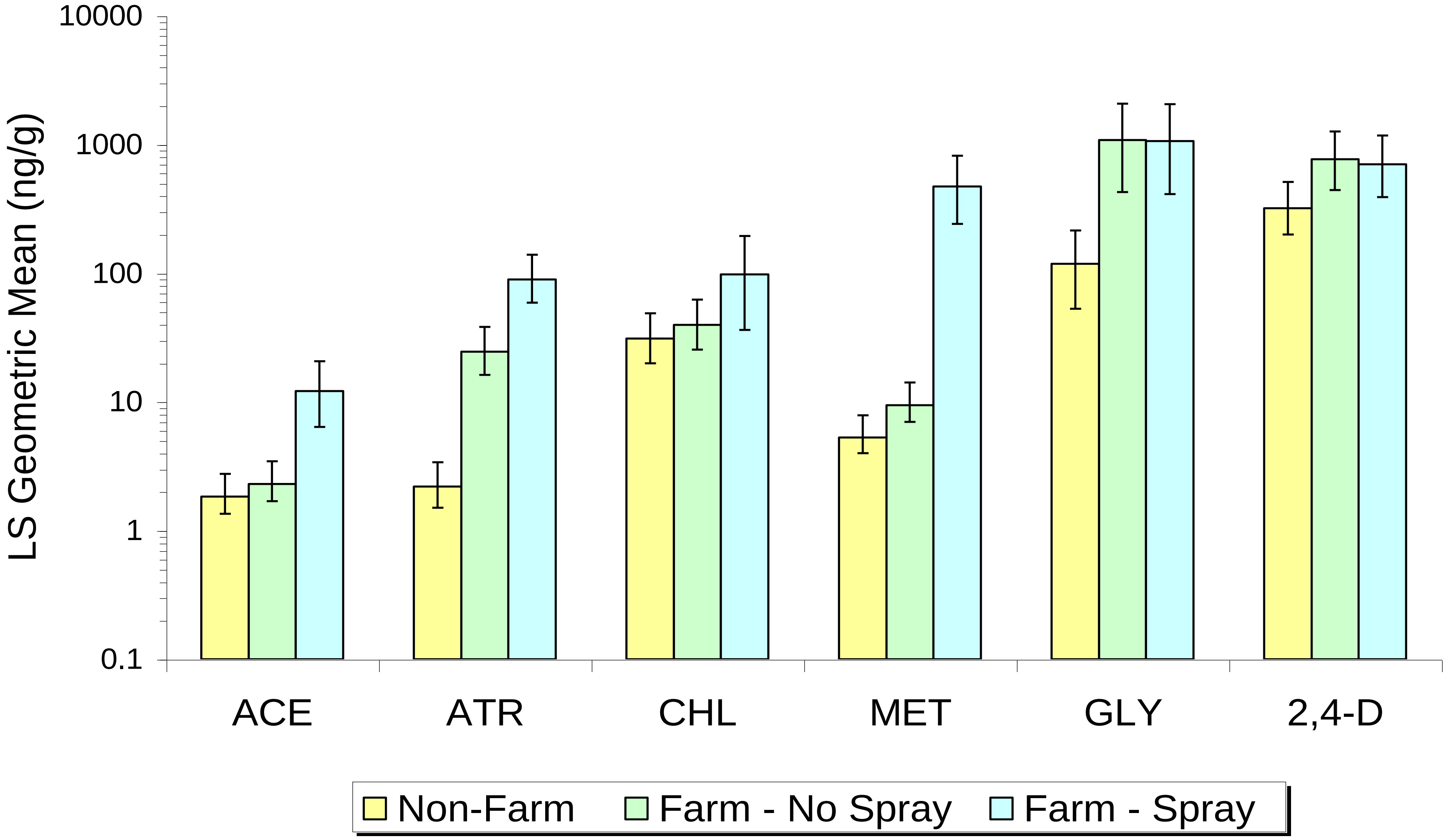
Percent Detectable Dust Samples in Farms



Percent Detectable Dust Samples in Non-Farms



Pesticide in Dust (ng/g)



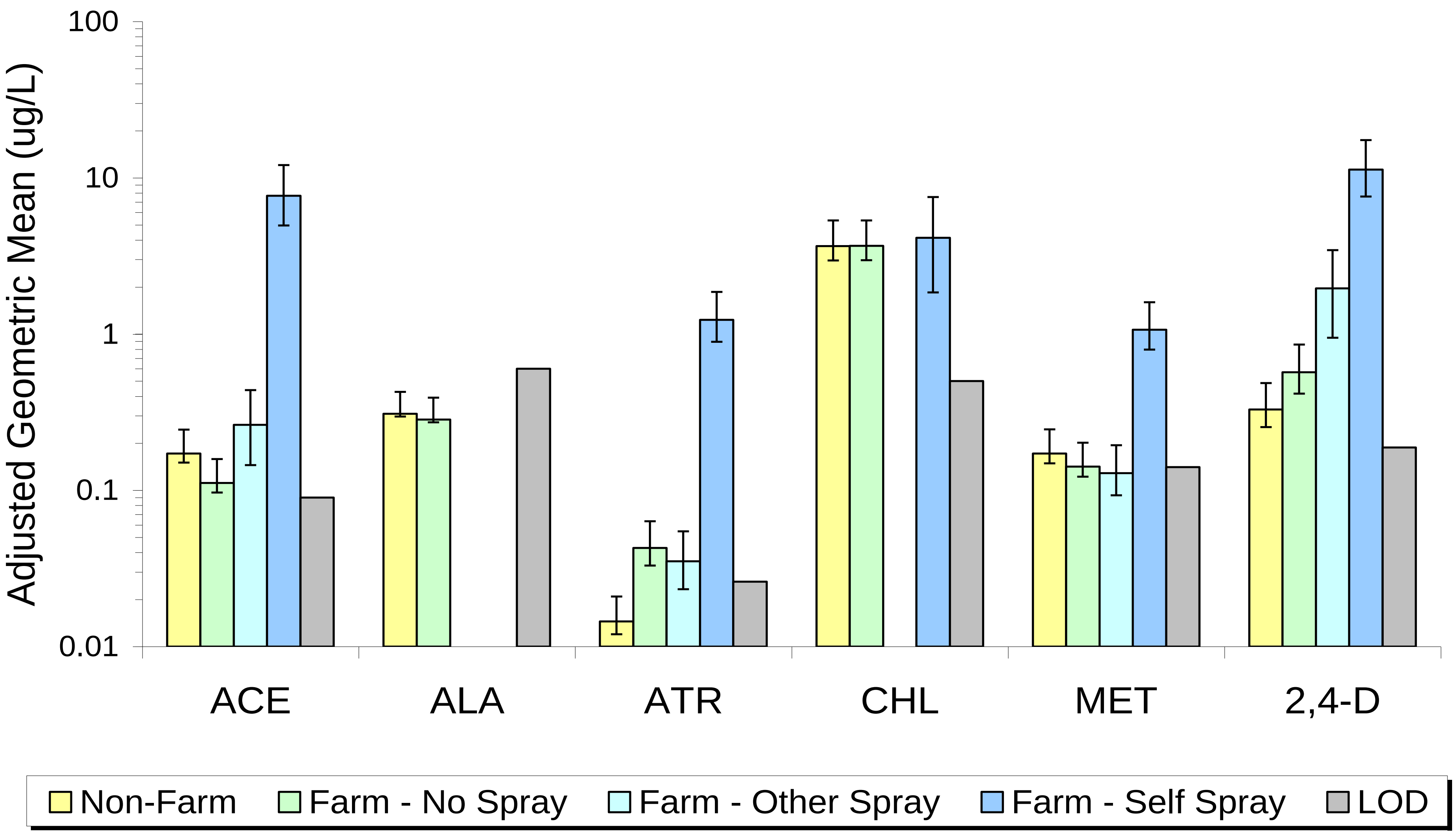
Results
(Farmer Urine)

- Farmers who sprayed the pesticide had significantly higher urinary metabolite levels.

- No difference in urinary metabolite levels among non-farmers, farmers who did not spray the pesticide, or farmers who had the pesticide sprayed commercially.

- May be an association with time since application, amount of pesticide applied, and acres applied.

Father Pesticide in Urine (µg/L)



Results (Farmer Urine Atrazine)

- Urine levels marginally negatively associated with days since spraying (r = -0.48, p-value = 0.07)
- Urine levels marginally positively associated with farm size (r = 0.47, p-value = 0.08)
- Use of closed cab tended to be associated with higher urinary levels, but not significantly
- Urine levels not correlated with amount of pesticide sprayed, acres sprayed, or PPE use

Results (Farmer Urine 2,4-D)

- Urine levels marginally negatively associated with days since spraying ($r = -0.43$, p-value = 0.09)
- Urine levels positively associated with amount of pesticide sprayed, ($r = 0.58$, p-value = 0.04) and acres sprayed ($r = 0.60$, p-value = 0.04)
- Use of closed cab tended to be associated with higher urinary levels, but not significantly
- Urine levels not correlated with farm size or PPE use

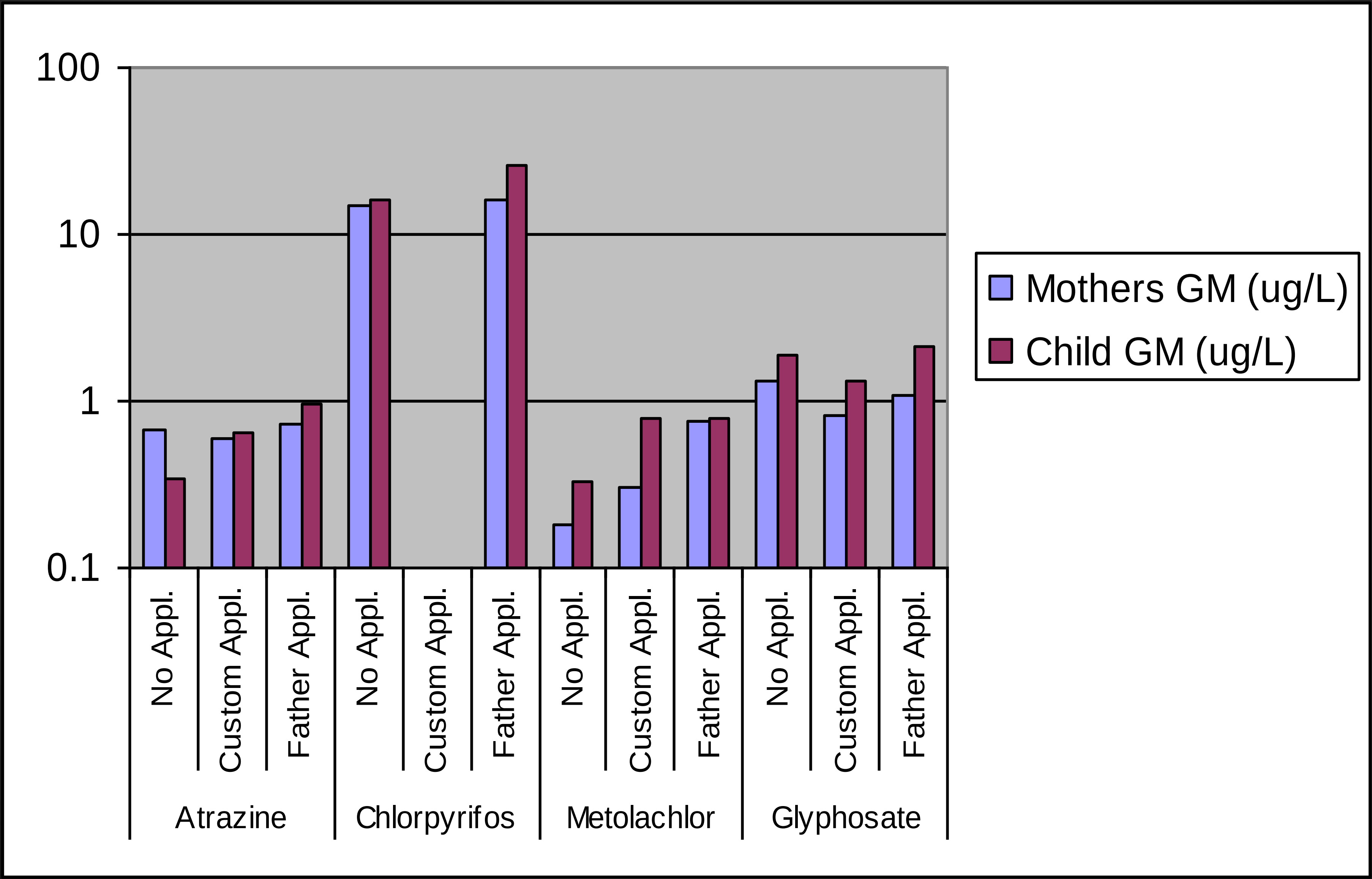
Results (Children and Spouse Urine)

- Farm children and spouses had higher exposures than non-farm children and spouses for atrazine, chlorpyrifos, and metolachlor, but statistically significant only for atrazine.
- Farm children had higher exposures for atrazine and chlorpyrifos when applied by father
- Trend of decreasing exposure with increasing age but not significant

Mother and Child Pesticide in Urine (µg/L)

Pesticide Subject	Group	Adjusted		
		GM (µg/L)	95% CI	P-value
Atrazine Mother	Non-farm Farm	0.031 0.65	0.010 – 0.096 0.41 – 1.0	<0.0001
Child	Non-farm Farm	0.054 0.60	0.020 – 0.15 0.38 – 0.93	<0.0001
Chlorpyrifos Mother	Non-farm Farm	11 14	9.6 – 14 12 – 17	0.052
Child	Non-farm Farm	15 17	13 – 18 15 – 19	0.27
Metolachlor Mother	Non-farm Farm	0.17 0.21	0.090 – 0.34 0.11 – 0.41	0.68
Child	Non-farm Farm	0.24 0.39	0.14 – 0.40 0.24 – 0.65	0.17
Glyphosate Mother	Non-farm Farm	1.2 1.1	0.91 – 1.6 0.71 – 1.8	0.73
Child	Non-farm Farm	2.5 1.9	2.1 – 3.1 1.3 – 2.5	0.082

Urinary Concentrations by Application Status



Results (Children and Spouse Urine)

- Significant associations with pesticide urinary levels and dust concentrations among non-farm children.
- No associations with tap water pesticide concentration, farm size, number of acres applied, amount of pesticide applied, number of days since last application, farm chores, or playing in treated fields.
- Father’s urinary metabolite levels more correlated with family members in farm families.

Association between urinary and dust pesticide level.

Pesticide Subject	Group	n	σ^2 w/o dust	σ^2 w/ dust	% Var	B	P-value
Atrazine Mother	Non-farm Farm	35 38	15.93 1.31	16.45 1.34	0 0	0.01 -0.02	0.98 0.75
Atrazine Child	Non-farm Farm	79 102	10.28 3.18	9.26 3.22	9.9 0	0.64 0.09	**0.03** 0.43
Chlorpyrifos Mother	Non-farm Farm	35 38	0.28 0.23	0.27 0.21	1.5 8.5	0.05 0.07	0.31 0.1
Chlorpyrifos Child	Non-farm Farm	79 102	0.18 0.20	0.16 0.16	11.5 19.2	0.06 0.09	**0.08** **0.004**
Metolachlor Mother	Non-farm Farm	35 38	3.37 2.97	2.76 2.8	18.1 5.8	0.41 0.19	**0.009** 0.26
Metolachlor Child	Non-farm Farm	79 102	2.06 2.57	1.76 2.48	14.6 3.3	0.29 0.17	**0.008** 0.13
Glyphosate Mother	Non-farm Farm	12 10	0.73 1.09	0.77 1.2	0 0	0.02 0.24	0.88 0.61
Glyphosate Child	Non-farm Farm	17 20	1.06 0.57	1.11 0.67	0 0	0.04 0.14	0.76 0.68

Dose Calculation

$$ADD(\mu g/kg/day) = \frac{(C)(Cn)(CF)(R_{mw})}{BW}$$

$$Cn(g/day) = \left(\frac{CnER \times 1440\,\text{min/ } day}{1.73}\right) \times BSA \times \frac{1g}{1000mg}$$

$$CnER = 0.035 \times age(yrs) + 0.236$$

$$BSA(m^2) = \left(\frac{ht(cm) \times wt(kg)}{3600}\right)^{0.5}$$

Results (Child Dose)

- GM dose for farm children was higher than non-farm children for all pesticides except glyphosate
- The highest dose estimates for farm children were 0.085, 1.96, 3.16 and 0.34 µg/kg/day for atrazine, chlorpyrifos, metolachlor and glyphosate, respectively.
- The highest dose estimates for non-farm children were 0.040, 1.36, 0.072 and 0.33 µg/kg/day for atrazine, chlorpyrifos, metolachlor and glyphosate, respectively.

Results (Child Dose)

- No child had an overall dose estimate that exceeded the EPA chronic reference values for atrazine, metolachlor and glyphosate.
- Every child's overall dose estimate exceeded the EPA population adjusted chronic reference value for chlorpyrifos.
- A trend of decreasing dose with increasing age for all children combined was observed for chlorpyrifos ($p < 0.0001$).
- Pesticide doses were similar for male and female children.

Geometric Mean Pesticide Doses

Pesticide	Number				Absorbed daily dose (µg/kg/day)		
House type	Homes	Child	samples	% < LOD	Range	Mixed GM[b]	P-value
Atrazine							
Farm	25	65	235	74%	0.002-0.085	0.011	<0.0001
Non-farm	25	50	180	88%	0.000-0.040	0.001	
Chlorpyrifos							
Farm	25	65	235	<1%	0.27-1.96	0.68	0.071
Non-farm	25	50	180	0%	0.24-1.36	0.58	
Metolachlor							
Farm	25	65	235	37%	0.000-3.16	0.015	0.10
Non-farm	25	50	180	42%	0.000-0.072	0.008	
Glyphosate							
Farm	25	65	235	19%	0.013-0.34	0.10	0.23
Non-farm	25	50	180	12%	0.037-0.33	0.12	

EPA Reference Doses

Pesticide	Acute RfD (µg/kg/day)	Chronic RfD (µg/kg/day)
Atrazine	10	1.8
Chlorpyrifos	.05	0.03
Metolachlor	n/a	100
Glyphosate	n/a	2000

Percent of Children with Estimated Doses Exceeding EPA Reference Doses

RfD	Atrazine		Chlorpyrifos		Metolachlor		Glyphosate	
	F	NF	F	NF	F	NF	F	NF
NOAEL	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
Acute RfD	0 %	0 %	0 %	0 %	n/a	n/a	n/a	n/a
Acute PAD	0 %	0 %	83 %	74 %	n/a	n/a	n/a	n/a
Chronic RfD	0 %	0 %	97 %	92 %	0 %	0 %	0 %	0 %
Chronic PAD	0 %	0 %	100 %	100 %	n/a	n/a	n/a	n/a

n/a = not available; RfD = reference dose; PAD = population adjusted RfD

Conclusion

- Farm homes are more contaminated with pesticides than non-farm homes.
- Dust is a better sample matrix for pesticides in the home.
- Farmers have greater exposure to pesticides when applying themselves. No difference between non-farmers and farmers who do not apply the pesticide or have it commercially applied.

Conclusion

- In general, farm children and spouses had higher exposures.
- Father’s urinary metabolite levels were often more correlated with family members in farm families.
- Children's urinary pesticide levels were often higher when father applied the pesticide.

Conclusion

- All chlorpyrifos dose estimates for both farm and non-farm children were above the EPA population adjusted chronic reference dose
- Although inconclusive, results suggest take-home exposure may be occurring.
- Small sample size, large exposure variance; data needs to be interpreted with caution.

Tobacco Harvester Pesticide Exposure

Introduction

- EPA Worker Protection Standard
- Hands often account for greatest amount of pesticide exposure
- PPE not often worn

Objectives

- 1) Determine the extent of acephate residue on the hands of tobacco harvesters.
- 2) Determine the effectiveness of hand washing with soap and water at removing acephate from the hands.

Study Population

- 1 tobacco farm, Kinston, North Carolina
- 12 tobacco harvesters – 2 crews of six
- Hispanic males

Tobacco Harvesting

- Each crew used a tobacco harvesting machine, 5 fields harvested
- Bottom 3 or 4 leaves from flue-fired tobacco
- 4 harvesters on bottom of machine collecting leaves
- 2 harvesters on top of machine placing leaves in bin

Methods

- Hand wipe samples collected from each harvester
- 96 samples total were collected at the lunch break and end of the work day over 2 days
- 15 leaf wipe samples collected from tobacco plants

Methods (cont)

- Wipes were performed using 4” x 4” gauze sponge moistened with alcohol
- Two wipes per hand
- Randomly wiped left or right hand before wash, wiped other hand after wash

Methods (cont)

- 10 cm x 20 cm area wiped on tobacco leaves, 2 leaves per plant combined into one sample
- 4 of 5 fields harvested had leaf samples
- 3 plants sampled from each field, except one large field which had 6 plants sampled

Methods (cont)

- Samples analyzed with GC/MS
  - LOQ = 50 ng/sample; LOD = 30 ng/sample
- Data analyzed with SAS 8.2
- Acephate levels modeled with MIXED procedure using method of restricted maximum likelihood (REML)

Results

- Mean acephate level for leaf wipes is 1.4 ng/cm^2 (Range 0.9-2.7 ng/cm^2)
- Substantial amount of acephate is being transferred to the hands
- Hand washing removes ~ 96 % of acephate residue
- Acephate on hands tends to accumulate over time

Results (cont)

- Hand wipe acephate levels were positively related to leaf wipe levels for both pre-wash (p-value=0.001) and post-wash (p-value=0.01) samples.

- No significant difference between hands

- Job had a significant effect on pre-wash acephate levels on hands but not on post-wash levels

Summary statistics for measured leaf wipe acephate levels by field

Field	n	AM (ng/cm^2)	SD (ng/cm^2)	Range (ng/cm^2)
1	6	1.3	0.4	0.7 - 1.7
2	3	0.9	0.4	0.4 - 1.3
3	3	1	0.4	0.6 - 1.4
4	3	2.7	1	2 - 3.8
5	0	NA	NA	NA
Overall	15	1.4	0.8	0.4 - 3.8

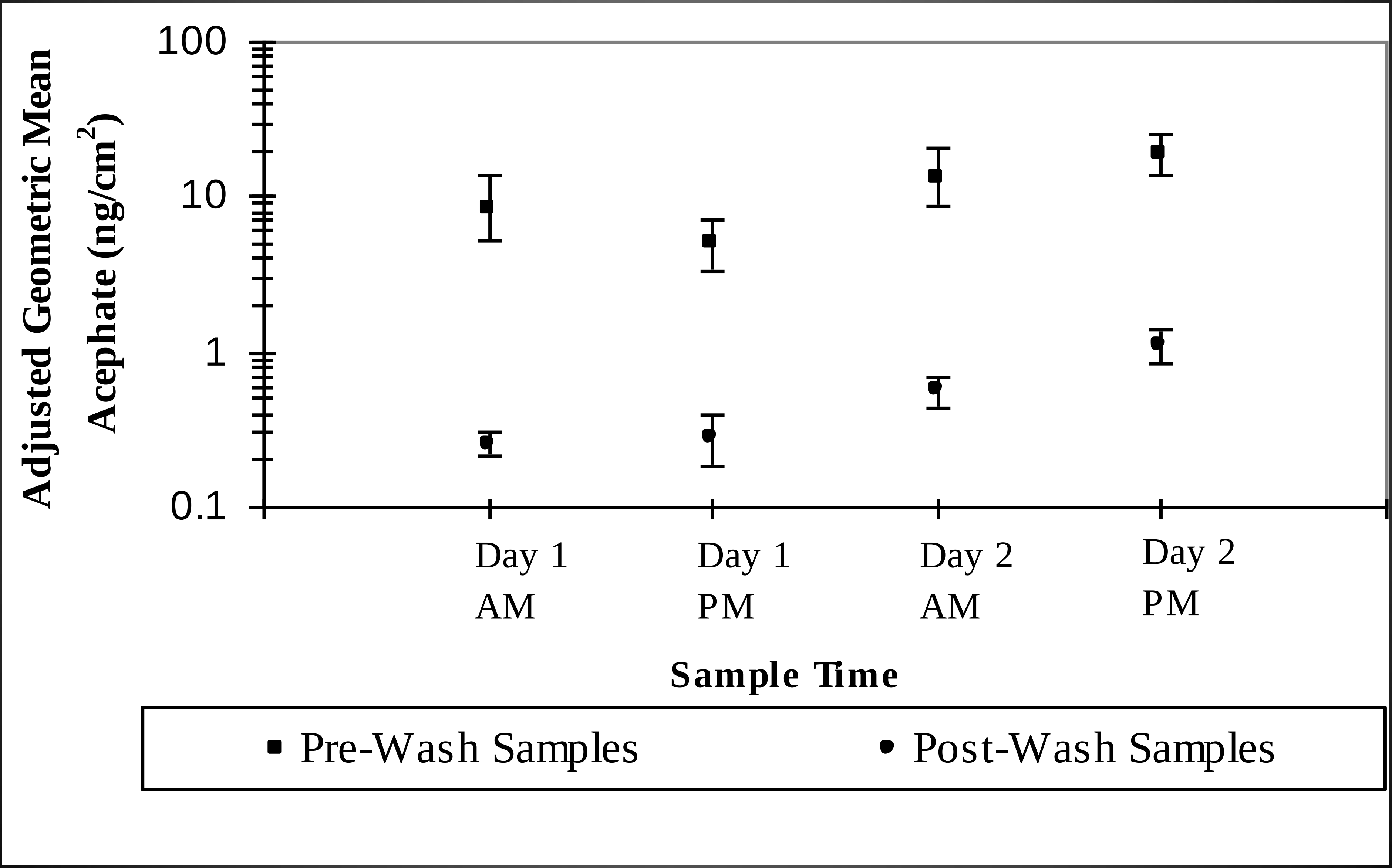
Summary statistics for measured hand wipe acephate levels.

Day	Time	Sample Order	n	GM	GSD	Range
1	AM	Pre-wash	12	9.1	5.6	0.07 - 46.5
		Post-wash	12	0.1	2.3	0.06 – 1
1	PM	Pre-wash	12	4.8	4.4	0.6 - 103
		Post-wash	12	0.3	3.6	0.04 - 1.2
2	AM	Pre-wash	12	10	5.2	0.36 - 44.9
		Post-wash	12	0.4	2.3	0.07 – 1
2	PM	Pre-wash	12	27.7	3.6	1.5 - 257
		Post-wash	12	1.4	2.4	0.13 - 3.67
Overall		Pre-wash	48	10.5	5.1	0.07 - 257
		Post-wash	48	0.4	3.7	0.04 - 3.8

Summary statistics for measured pre-wash and post-wash hand wipe acephate levels by field.

Field	Sample Order	n	GM (ng/cm^2)	GSD	Range (ng/cm^2)
1	Pre-wash Post-wash	18 18	6.6 0.2	4.0 3.2	0.6 – 103 0.04 – 1.2
2	Pre-wash Post-wash	12 12	12.6 0.7	4.2 2.8	0.5 – 64.7 0.07 – 2.4
3	Pre-wash Post-wash	6 6	8.1 0.4	5.3 1.6	0.4 – 36.6 0.2 – 0.68
4	Pre-wash Post-wash	6 6	59.0 2.3	2.3 1.3	32.1 – 257 1.7 – 3.7
5	Pre-wash Post-wash	6 6	6.5 0.1	10.3 1.7	0.07 – 46.5 0.06 – 0.2

Adjusted geometric mean pre and post wash hand acephate levels



Adjusted geometric mean acephate levels (ng/cm^2) for hand wipe samples (excl. leaf wipe)

Effect		Adjusted Geometric Mean		
		Pre-wash	Post-wash	P-value
Hand	Right	5.8	0.39	0.0001
	Left	10.9	0.32	0.0001
	P-value (R vs L)	0.16	0.45	
Job	Top	4.6	0.28	0.0001
	Bottom	13.5	0.44	0.0001
	P-value (T vs B)	0.07	0.33	
Sample Time	Day 1, AM	5.6	0.12	0.0001
	Day 1, PM	3.8	0.23	0.0001
	Day 2, AM	8.8	0.41	0.0001
	Day 2, PM	20.8	1.29	0.0001
	P-value (linear trend)	0.0075	<0.0001	

Adjusted geometric mean acephate levels (ng/cm^2) for hand wipe samples (incl. leaf wipe)

Effect		Adjusted Geometric Mean		
		Pre-wash	Post-wash	P-value
Hand	Right	5.0	0.46	0.0001
	Left	12.610.9	0.34	0.0001
	P-value (R vs L)	0.0024	0.20	
Job	Top	4.6	0.31	0.0001
	Bottom	13.6	0.50	0.0001
	P-value (T vs B)	0.037	0.27	
Sample Time	Day 1, AM	6.1	0.21	0.0001
	Day 1, PM	3.9	0.24	0.0001
	Day 2, AM	8.88.8	0.51	0.0001
	Day 2, PM	13.1	0.97	0.0001
	P-value (linear trend)	0.037	<0.0001	

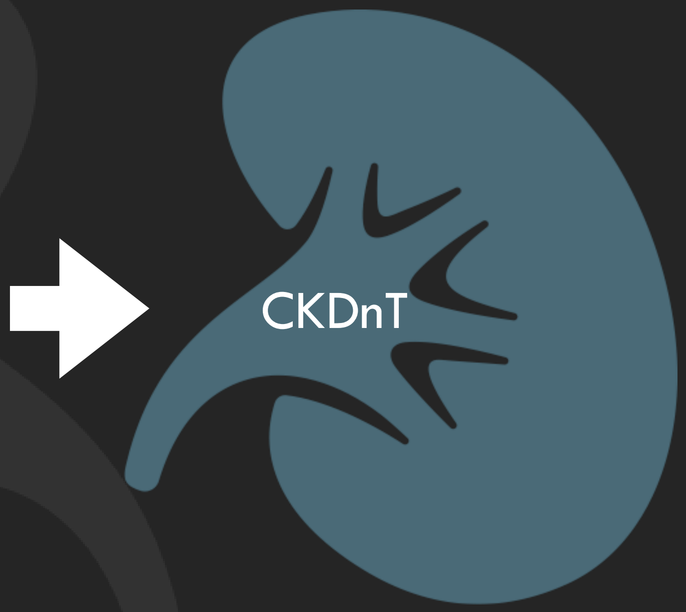
Conclusions

- Substantial amount of acephate is transferred to the hands during tobacco harvesting.
- Hand washing with soap and water reduces a large amount of acephate residue from the hands.
  - Around 96%
- Not all acephate is removed.
  - Acephate tended to accumulate over time.

Sugarcane Harvester Pesticide Exposure

POTENTIAL RISK FACTORS FOR CKDU.

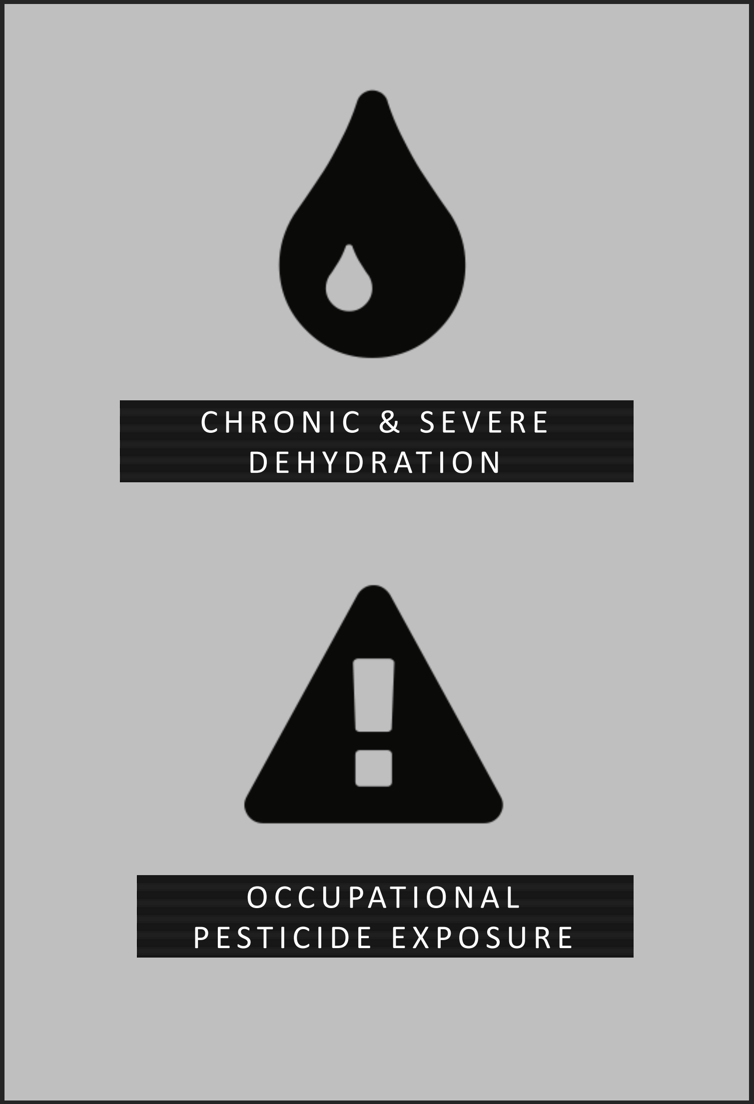
- Dehydration
- Excessive workload and heat stress
- Toxicant Exposures
- Anti-inflammatory consumption
- Infectious disease



Chronic and severe dehydration can amplify the impact of toxicants. Proper hydration gives the kidneys a chance to do their job.

El Salvador legislature proposed banning 53 pesticides.

NIOSH is working to identify if pesticides are a danger to sugarcane workers.

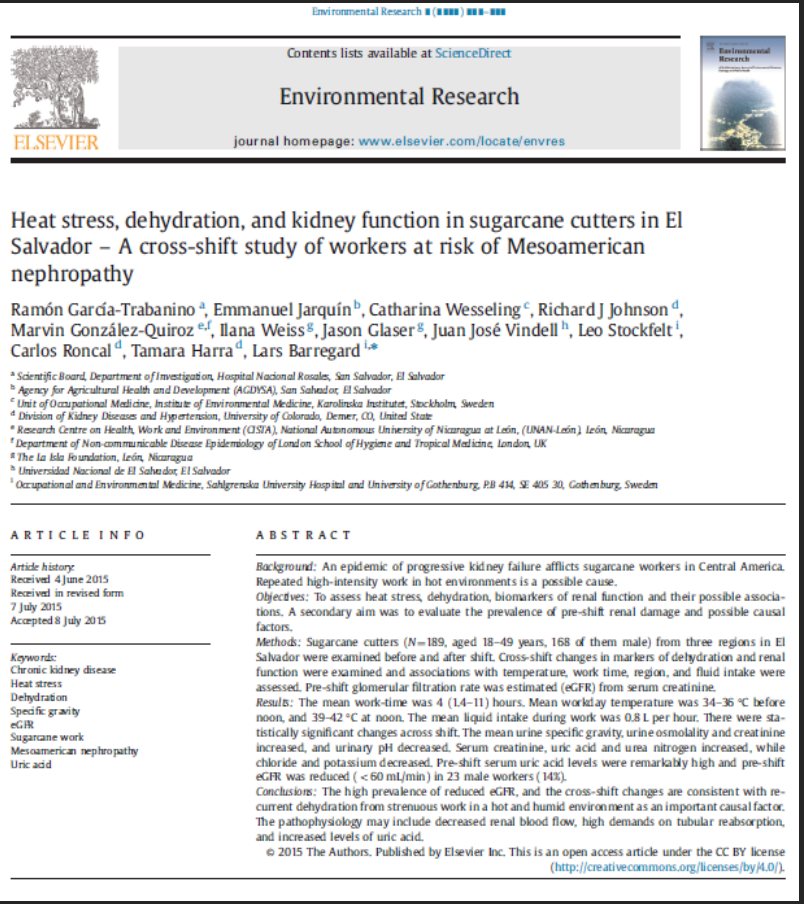


Sugarcane Harvesting Process

- Typical harvest (zafra) in El Salvador is November to April
- Harvesting is done manually, though increasingly mechanized.
- Glyphosate may be applied to sugarcane prior to harvest to speed up sugarcane ripening and increase sugar content.
  - In the U.S. it is advised to apply glyphosate as a ripening agent 28-49 days prior to harvest.
- Sugarcane is burned just prior to harvesting, from a few days to the night before.

Recent Research

- One occupational risk considered by some to be a potential etiologic factor in CKDu in Sri-Lanka and Central America, is pesticide exposure. (Jayasumana, et al., 2014a; Ordunez, et al., 2014a; Ordunez, et al., 2014b)
- One hypothesis is that glyphosate in conjunction with arsenic and hard water, may be a potential cause of CKDu among agricultural workers in Sri Lanka. (Jayasumana, et al., 2014b)
- Self-reported carbamate pesticide use was more common among workers with a decrease in eGFR (74% versus 29% of the remaining workers). (García-Trabanino, et al., 2015)
- In the United States, a recent study found positive exposure response trends between exposure to six pesticides and end-stage renal disease. (Lebov, et al., 2015)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Heat stress, dehydration, and kidney function in sugarcane cutters in El Salvador – A cross-shift study of workers at risk of Mesoamerican nephropathy

Ramón García-Trabanino [a], Emmanuel Jarquín [b], Catharina Wesseling [c], Richard J Johnson [d], Marvin González-Quiroz [e,f], Ilana Weiss [g], Jason Glaser [g], Juan José Vindell [h], Leo Stockfelt [i], Carlos Roncal [d], Tamara Harra [d], Lars Barregard [i,*]

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ARTICLE INFO

Article history:
Received 4 June 2015
Received in revised form
7 July 2015
Accepted 8 July 2015

Keywords:
Chronic kidney disease
Heat stress
Dehydration
Specific gravity
eGFR
Sugarcane work
Mesoamerican nephropathy
Uric acid

ABSTRACT

Background: An epidemic of progressive kidney failure afflicts sugarcane workers in Central America. Repeated high-intensity work in hot environments is a possible cause.
Objectives: To assess heat stress, dehydration, biomarkers of renal function and their possible associations. A secondary aim was to evaluate the prevalence of pre-shift renal damage and possible causal factors.
Methods: Sugarcane cutters ($N=189$, aged 18–49 years, 168 of them male) from three regions in El Salvador were examined before and after shift. Cross-shift changes in markers of dehydration and renal function were examined and associations with temperature, work time, region, and fluid intake were assessed. Pre-shift glomerular filtration rate was estimated (eGFR) from serum creatinine.
Results: The mean work-time was 4 (1.4–11) hours. Mean workday temperature was 34–36 °C before noon, and 39–42 °C at noon. The mean liquid intake during work was 0.8 L per hour. There were statistically significant changes across shift. The mean urine specific gravity, urine osmolality and creatinine increased, and urinary pH decreased. Serum creatinine, uric acid and urea nitrogen increased, while chloride and potassium decreased. Pre-shift serum uric acid levels were remarkably high and pre-shift eGFR was reduced (< 60 mL/min) in 23 male workers (14%).
Conclusions: The high prevalence of reduced eGFR, and the cross-shift changes are consistent with recurrent dehydration from strenuous work in a hot and humid environment as an important causal factor. The pathophysiology may include decreased renal blood flow, high demands on tubular reabsorption, and increased levels of uric acid.

NIOSH Pesticide Sampling Among Sugarcane Workers in El Salvador – March, 2016.

Sampling Methods.

- 40 sugarcane cutters (male and female) in 2 locations.
  - Inland and coastal, 20 cutters each location.
- Sampling on 3 consecutive workdays per location.
- Area air, hand wipe, urine, and water samples collected.
- Analyzed for glyphosate and 2,4-D.

Security was an issue. The State Department required armed guards.

Hand wipe sampling of sugarcane cutters.

Urine collection

Air Sampling

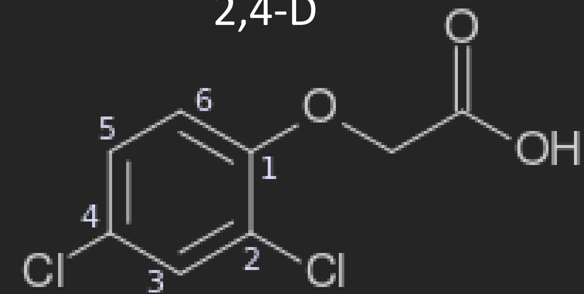
Families sometimes come to the fields for breakfast when close to home.

Hard labor and hot conditions.

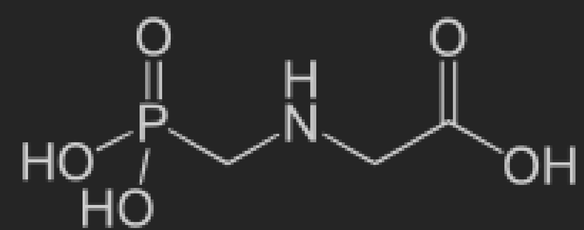
Results

- All air samples were ND for glyphosate and 2,4-D
  - LOD: Gly 0.08 ug/sample; 2,4-D 1 ug/sample
- All air samples were ND for respirable dust
    - LOD: Resp dust 40 ug/sample
- All hand wipe samples were ND for glyphosate and 2,4-D
  - LOD: Gly 0.8 ug/sample; 2,4-D 0.5 ug/sample

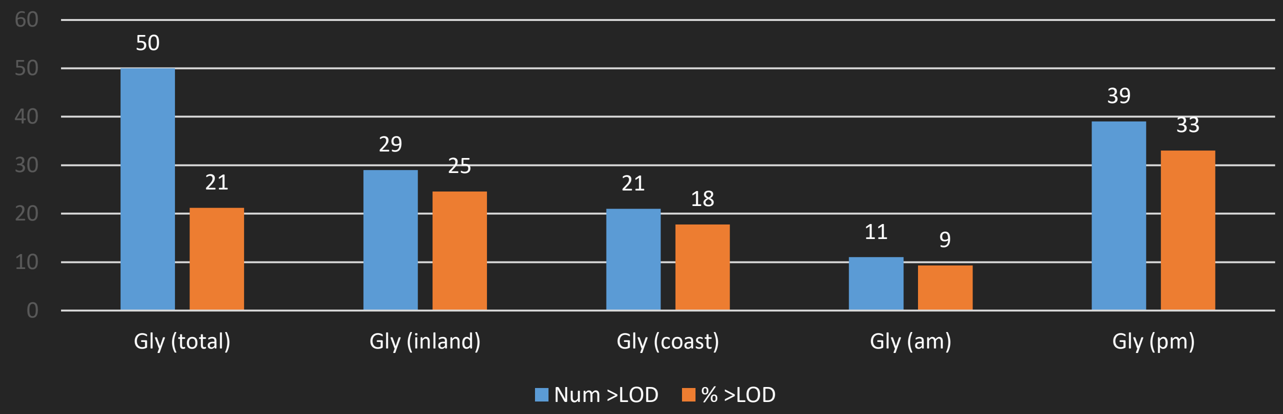
2,4-D



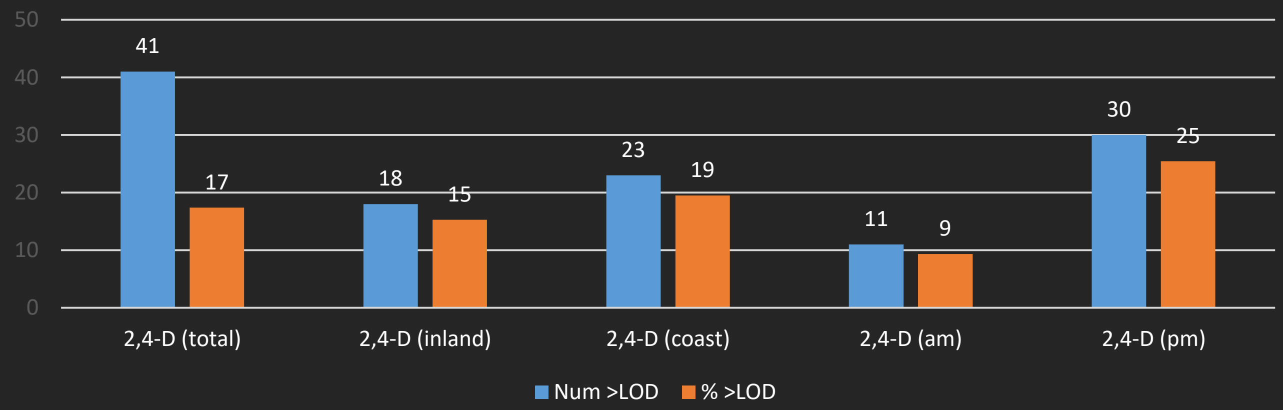
Glyphosate

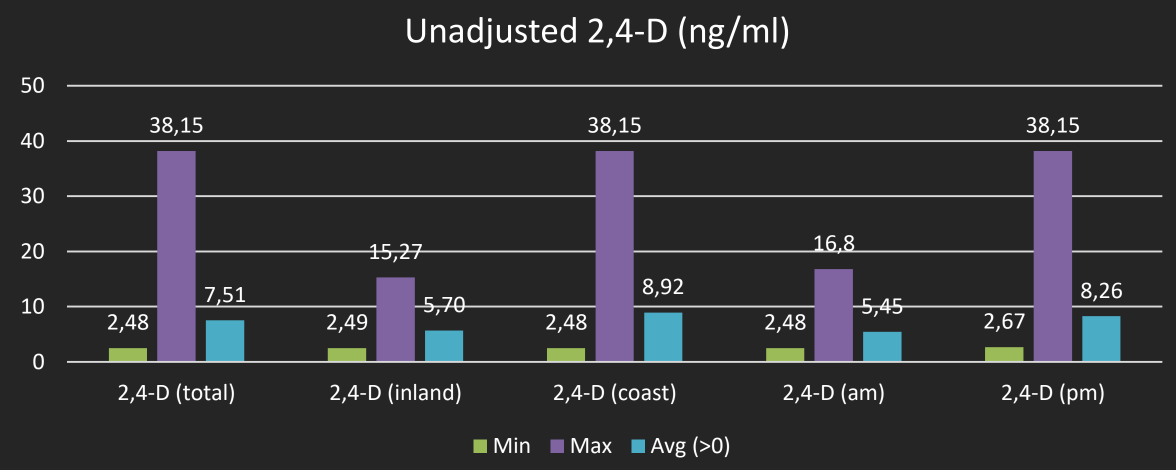


Urine Glyphosate Samples Above LOD

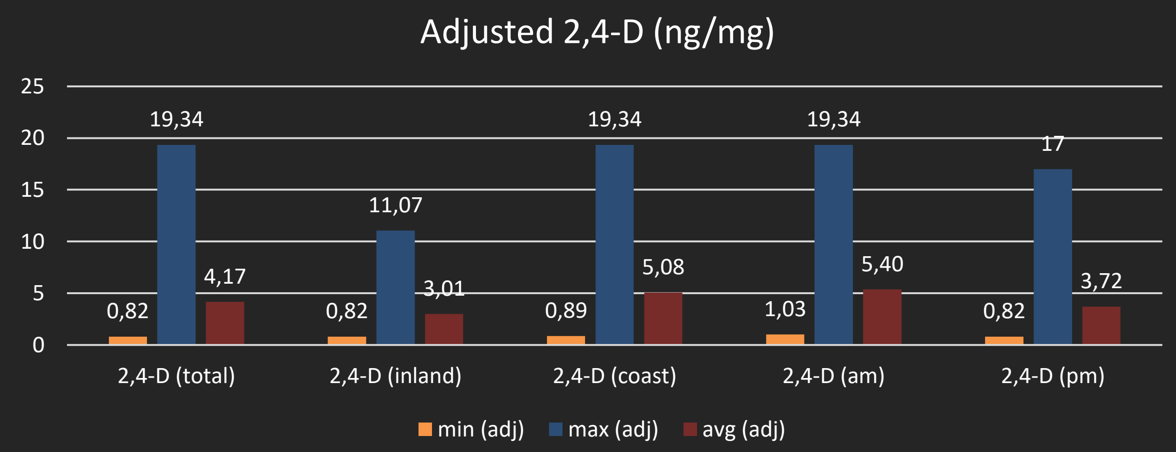


Urine 2,4-D Samples Above LOD

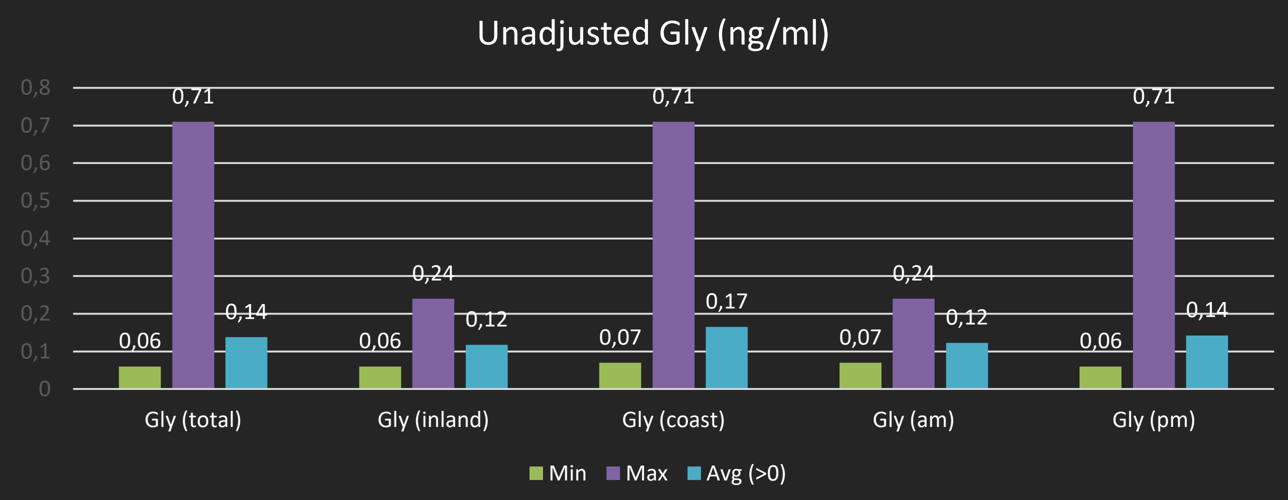


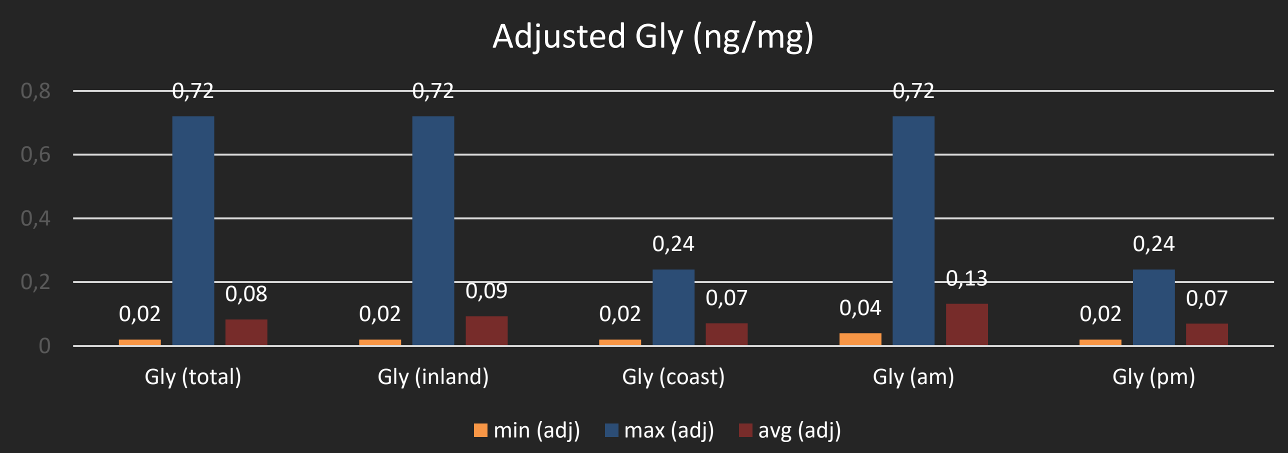


Unadjusted 2,4-D (ng/ml)
50
40
30
20
10
0
38,15
7,51
2,48
15,27
5,70
2,49
38,15
8,92
2,48
16,8
5,45
2,48
38,15
8,26
2,67
2,4-D (total)
2,4-D (inland)
2,4-D (coast)
2,4-D (am)
2,4-D (pm)
Min
Max
Avg (>0)



Adjusted 2,4-D (ng/mg)
25
20
15
10
5
0
19,34
4,17
0,82
11,07
3,01
0,82
19,34
5,08
0,89
19,34
5,40
1,03
17
3,72
0,82
2,4-D (total)
2,4-D (inland)
2,4-D (coast)
2,4-D (am)
2,4-D (pm)
min (adj)
max (adj)
avg (adj)


Unadjusted Gly (ng/ml)
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
0,06
0,71
0,14
0,06
0,24
0,12
0,07
0,71
0,17
0,07
0,24
0,12
0,06
0,71
0,14
Gly (total)
Gly (inland)
Gly (coast)
Gly (am)
Gly (pm)
Min
Max
Avg (>0)


Adjusted Gly (ng/mg)
0,8
0,6
0,4
0,2
0
0,02
0,72
0,08
0,02
0,72
0,09
0,02
0,24
0,07
0,04
0,72
0,13
0,02
0,24
0,07
Gly (total)
Gly (inland)
Gly (coast)
Gly (am)
Gly (pm)
min (adj)
max (adj)
avg (adj)

Conclusions

- Pesticide exposure appears to be minimal
- However… there is some exposure
- But … not likely from cutting cane
- Caveat: one sampling period late in the harvest season

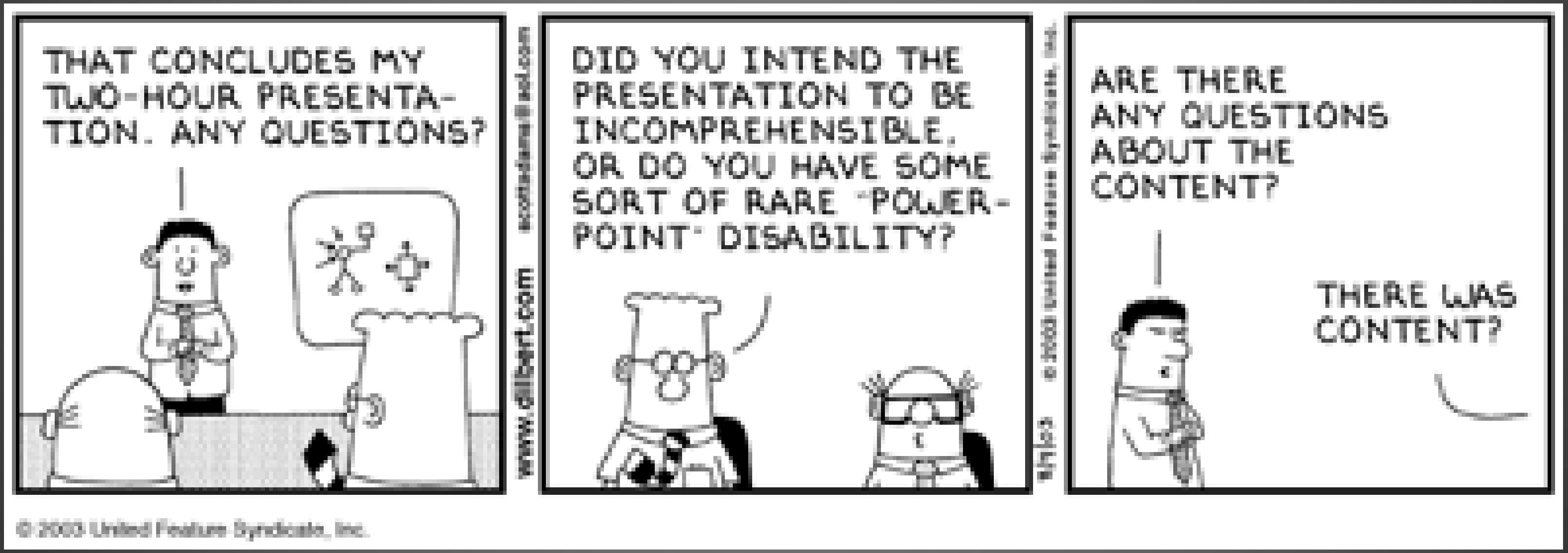
Acknowledgements

- Misty Hein, NIOSH, U.S.
- Cindy Striley, NIOSH, U.S.
- Wayne Sanderson, University of Kentucky, U.S.
- Marcia Nishioka, Battelle Memorial Institute, U.S.
- Dana Barr, Emory University, U.S.
- Dick Heederick, Utrecht University, NL
- Hans Kromhout, Utrecht University, NL
- Stephen Reynolds, Colorado State University, U.S.
- Michael Alavanja, National Cancer Institute, U.S.

Acknowledgements

- Ilana Weiss, La Isla Network, U.S.
- Jason Glasser, La Isla Network, U.S.
- Catharina Wesseling, Karolinska Institutet, Sweden
- David Wegman, University of Massachusetts, Lowell
- Alberto Garcia, NIOSH, U.S.
- Aaron Sussell, NIOSH, U.S.
- Cynthia Striley, NIOSH, U.S.
- Jerome Smith, NIOSH, U.S.
- Debbie Sammonds, NIOSH, U.S.
- Emmanual Jarquin, AGDYSA, El Salvador
- Ramon Trabinino, Hospital Nacional Rosales, El Salvador

Questions?


THAT CONCLUDES MY TWO-HOUR PRESENTA-TION. ANY QUESTIONS?
DID YOU INTEND THE PRESENTATION TO BE INCOMPREHENSIBLE, OR DO YOU HAVE SOME SORT OF RARE "POWER-POINT" DISABILITY?
ARE THERE ANY QUESTIONS ABOUT THE CONTENT?
THERE WAS CONTENT?
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Estimated correlations between Family members

Analyte	Non-farm households					Farm households			
Atrazine		Child	Father	Mother			Child	Father	Mother
	Child	1	0.54	0.55		Child	1	0.36	0.28
	Father		1	0.70		Father		1	0.43
	Mother			1		Mother			1
Chlorpyrifos		Child	Father	Mother			Child	Father	Mother
	Child	1	0.25	0.25		Child	1	0.62	0.54
	Father		1	0.62		Father		1	0.61
	Mother			1		Mother			1
Metolachlor		Child	Father	Mother			Child	Father	Mother
	Child	1	0.56	0.68		Child	1	0.63	0.54
	Father		1	0.55		Father		1	0.66
	Mother			1		Mother			1
Glyphosate		Child	Father	Mother			Child	Father	Mother
	Child	1	0.34	0.27		Child	1	0.62	0.55
	Father		1	0.37		Father		1	0.59
	Mother			1		Mother			1

Number of homes using non-agricultural pesticides in the home, on the lawn, and in the garden

Area of Use	Method of Application	Farm	Non-Farm	P-value[a]
Home	Commercial	4 (16%)	1 (4%)	0.35
	Personal	12 (48%)	9 (36%)	0.57
	Combined	16 (64%)	9 (36%)	0.09
Lawn	Commercial	2 (8%)	3 (12%)	1.00
	Personal	8 (32%)	12 (48%)	0.39
	Combined	10 (40%)	14 (56%)	0.40
Garden[b]	Commercial	0 (0%)	1 (8%)	0.36
	Personal	10 (48%)	4 (33%)	0.49
	Combined	10 (48%)	5 (42%)	1.00

Active ingredients applied by farmers to corn and soybeans and frequency of use

Pesticide	Number (Percent)	**Pesticide**	Number (Percent)
Atrazine	20 (80)	Flumetsulam	6 (24)
Glyphosate	16 (64)	Flufenacet	6 (24)
2,4-D	15 (60)	Nicosulfuron	6 (24)
Dicamba	11 (44)	**Acetochlor**	5 (20)
Isoxaflutole	8 (32)	Picloram	4 (16)
Metolachlor	7 (28)	**Chlorpyrifos**	2 (8)
Dimethanamid	7 (28)	Rimsulfuron	2 (8)
Clopyralid	6 (24)	Cyfluthrin	2 (8)

Active ingredients applied by farmers to corn and soybeans and frequency of use

Pesticide	Number (Percent)	**Pesticide**	Number (Percent)
Tebupirimfos	2 (8)	ADEAC	1 (4)
Malathion	2 (8)	Cyhalothrin	1 (4)
Permethrin	2 (8)	Primsulfuron-methyl	1 (4)
Tefluthrin	2 (8)	Diflufenzopyr	1 (4)
Metribuzin	2 (8)	Pendimethalin	1 (4)
Triclopyr	1 (4)	Terbufos	1 (4)
Acephate	1 (4)	Bromoxynil	1 (4)
ADBAC	1 (4)	**Alachlor**	0 (0)

Results (Farmer Hand Wipe)

- Majority of hand wipe samples were below the LOD
- For all pesticides except 2,4-D, farmers had more detectable samples than non-farmers
    - Acetochlor and atrazine significant
- Detectable atrazine on hand wipe associated with urinary metabolite above median. No association with acetochlor and chlorpyrifos

Hand Wipe Samples

Pesticide		Hand wipe concentration (ng/cm^2)				
	Subject	n	N	N > LOD (%)	p-value	Range
Acetochlor	Non-farmer	34	17	2 (12)		0.36 – 0.48
	Farmer	39	20	9 (45)	0.04	0.71 – 480
Alachlor	Non-farmer	34	17	0 (0)		---
	Farmer	39	20	2 (10)	0.5	1.2 – 1.2
Atrazine	Non-farmer	34	17	0 (0)		---
	Farmer	39	20	9 (45)	0.002	24 – 4300
Chlorpyrifos	Non-farmer	34	17	4 (24)		0. 36 – 0. 99
	Farmer	39	20	7 (35)	0.5	0. 36 – 19
Metolachlor	Non-farmer	34	17	0 (0)		---
	Farmer	39	20	4 (20)	0.1	2.4 – 6000
2,4-D	Non-farmer	12	6	0 (0)		---
	Farmer	9	5	0 (0)	n/a	---

Association between hand wipe level and urinary pesticide level.

	Hand wipe	Urine level [a]			
		Low (< median)	High (≥ median)	Total	P-value [b]
Acetochlor	Non-Detect	9 (35 %)	17 (65 %)	26	
	Detect	7 (64 %)	4 (36 %)	11	0.15
	Total	16	21	37	
Atrazine	Non-Detect	26 (93 %)	2 (7 %)	28	
	Detect	0 (0 %)	9 (100 %)	9	< 0.0001
	Total	26	11	37	
Chlorpyrifos	Non-Detect	14 (54 %)	12 (46 %)	26	0.17
	Detect	3 (28 %)	8 (72 %)	11	
	Total	17	20	37	

Urine Results (unadjusted)

	Gly (total)	Gly (inland)	Gly (coast)	Gly (am)	Gly (pm)
Min (ppm)	0.06	0.06	0.07	0.07	0.06
Max (ppm)	0.71	0.24	0.71	0.24	0.71
Avg (ppm)	0.14	0.12	0.17	0.12	0.14

	2,4-D (total)	2,4-D (inland)	2,4-D (coast)	2,4-D (am)	2,4-D (pm)
Min (ppm)	2.48	2.49	2.48	2.48	2.67
Max (ppm)	38.15	15.27	38.15	16.8	38.15
Avg (ppm)	7.51	5.70	8.92	5.45	8.26

Urine Results (adjusted)

	Gly (total)	Gly (inland)	Gly (coast)	Gly (am)	Gly (pm)
Min (ppm)	0.02	0.02	0.02	0.04	0.02
Max (ppm)	0.72	0.72	0.24	0.72	0.24
Avg (ppm)	0.08	0.09	0.07	0.13	0.07

	2,4-D (total)	2,4-D (inland)	2,4-D (coast)	2,4-D (am)	2,4-D (pm)
Min (ppm)	0.82	0.82	0.89	1.03	0.82
Max (ppm)	19.34	11.07	19.34	19.34	17
Avg (ppm)	4.17	3.01	5.08	5.40	3.72