Pesticides in Dust from Homes in an Agricultural Area

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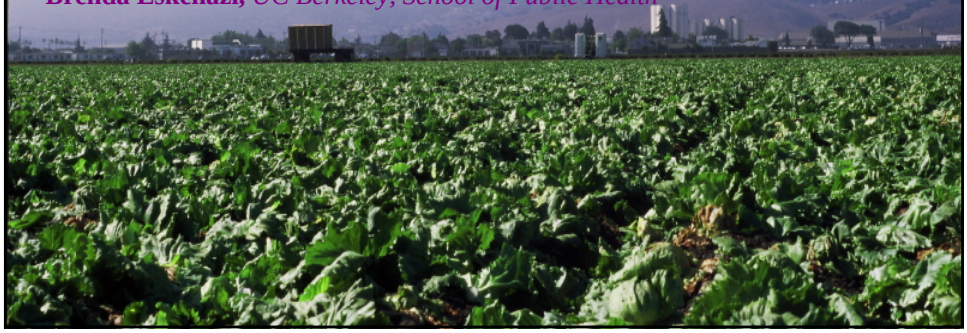

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- Please visit http://pubs.acs.org/journal/esthag
- Or email to request a copy:

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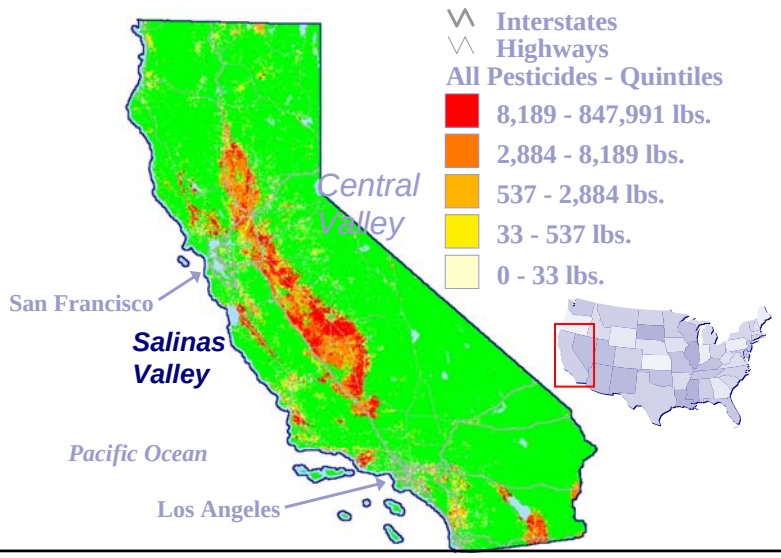
Annual Average Pesticide Use (lbs. per square mile) in California



CHAMACOS
CENTER FOR THE HEALTH ASSESSMENT OF MOTHERS AND CHILDREN OF SALINAS

Two of five study aims:

- To estimate sources and pathways of pesticide exposures to children living in an agricultural community.
- To determine relationship of pesticide exposure and:
  - neurodevelopment
  - growth
  - respiratory disease

Data Collection: 1999-2001

	Enrollment	26-Weeks	Delivery	6-Months	12-Months	
Questionnaire	✓	✓	✓	✓	✓	
Neurodevelopment & Growth Assessments			✓	✓	✓	
Home environmental samples: e.g., dust	✓			✓	✓	
Biological Specimens	Urine	Urine Blood	Urine Blood Cord Blood Breastmilk	Urine Breastmilk	Urine Blood	

Why House Dust ?

1) Children have opportunity for direct exposure

Why House Dust?

2) House Dust is a “sink” or reservoir for pesticides that adhere to soil particles.

3) Inside homes, little opportunity for environmental breakdown of pesticides, i.e., little sunlight.

4) Pesticides have been found in house dust in many urban and rural areas, e.g., Los Angeles, Minnesota, Washington State.

5) More pesticides detected in dust than in to other media, e.g., air.

Salinas Valley: Intensive Farming of Row Crops

Strawberries

Lettuce

Broccoli

Some "PESTS"

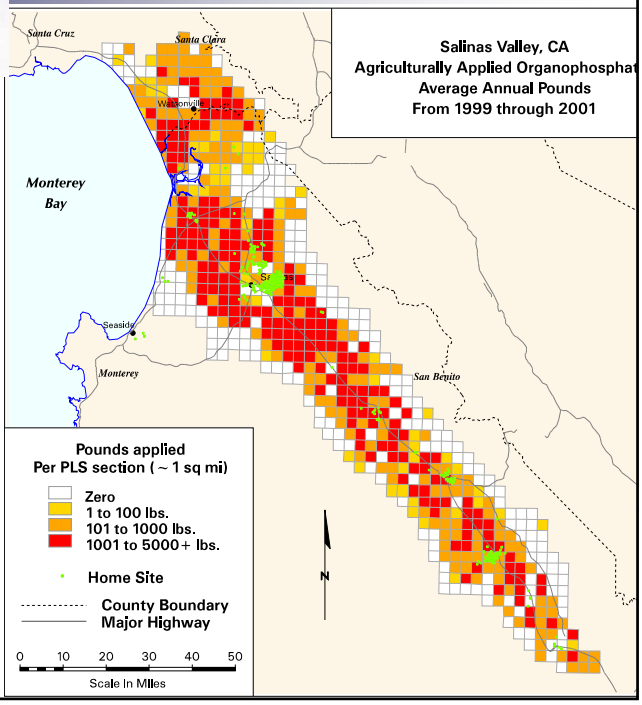
WEEDS

BUGS

Pictures from the University of California, Davis, Agriculture and Natural Resources Department. Integrated Pest Management Database

CHAMACOS

Salinas Valley: Annual Pounds of Organophosphates applied in Salinas Valley: 450,000



Housedust: Objectives

CHAMACOS is largest study to date of dust from homes in an agricultural community.

Objectives:

1) What pesticides are present in dust and at what levels?

House dust: Objectives (2)

2) What are the predictors of pesticides in house dust?

- Drift from Agricultural Fields?
- Worker Carry Home?
- Pesticide Use in Home?
- Housing Characteristics, e.g., Housing Density?

Study Homes

House dust was collected when:

- the pregnant woman was enrolled in the study
- child was 6 months old
- child was 12 months old

Of 601 participants, 168 were randomly selected for dust analysis.

168 X 3 = 504 dust samples sent to laboratory.

Dust Sampling Method

- Square meter in living area or living/kitchen area
- High Surface Volume sampling, i.e., collection efficiency of 99.9% of carpet dust.
- Questionnaire, including inventory of pesticide products (and EPA registration number) in home, garage, or yard.

DEMOGRAPHIC VARIABLES

QUESTIONNAIRE VARIABLES	
Potential Agricultural Sources	**% Yes**
Farmworkers in home	76%
Farmworker store shoes in home	22%
Farmworers store clothes in home	52%
OP product stored in home	3%
Pyrethroid product in home	27%
Other Household Charracteristics	
Housing Density, 2+/room	25%
Home less clean	72%
Air conditioner in home	8%

Selection of Pesticides for Laboratory Analysis

Pesticide	Class	Pounds used agriculturally in Salinas Valley in 2001
Diazinon	OP	133,537
Malathion	OP	96,520
DCPA (aka: Dacthal)	*Herbicide*	*74,349*
Methomyl	*Carbamate*	*65,366*
Oxydemeton	OP	57,859
Chlorpyrifos	OP	54,945
Iprodione	*Fungicide*	*45,700*
Bensulide	OP	32,669
Permethrin	*Pyrethroid*	*30,187*
Phosmet	OP	3,166
Fenamiphos	OP	1,839
Methamidophos	OP	769
Azinphosmethyl	OP	124

Frequently Detected Pesticides in CHAMACOS dust samples

	method	Solvent QLs (ng/g)	N	% Detected	95th Percentile (ng/g)	Maximum (ng/g)
Permethrin-trans	GC/MS	5-50	504	**97%**	7040	221866
Permethrin-cis	GC/MS	5-50	504	**96%**	5427	149795
DCPA	GC/MS	2-20	504	**92%**	268	1401
Chlorpyrifos (OP)	GC/MS	2-20	504	**82%**	1050	7175
Diazinon (OP)	GC/MS	2-20	504	**82%**	457	9808
Oxydemeton (OP)	LC MS	5-50	427	**62%**	43	100
Iprodione	GC/MS	10-100	504	**42%**	748	8808
DDT	GC/MS	10-100	504	**40%**	332	1849
DDE	GC/MS	2-20	504	**35%**	93	305
Methomyl	LC MS	60-600	427	**32%**	146	518
Bensulide (OP)	LC MS	30-300	427	**22%**	98	537

Methods: GC/MS is Gas Chromatography / Mass Spectroscopy
LC/MS is Liquid Chromatography coupled with Electrospray Tandem Mass Spectrometry
Quantification Limits (QL) differ for different sample collection amounts

Dust Samples: Pesticides Detected with Low Frequency (< 12%)

	method	Solvent QLs (ng/g)	N	% Detected	95th Percentile (ng/g)	Maximum (ng/g)
Malathion (OP)	GC/MS	10-100	504	**11%**	235.91	2984
Methamidophos (OP)	LC MS	5-50	427	**11%**	19.00	115
Phosmet (OP)	GC/MS	10-100	504	**7%**	88.62	7785
Azinphosmethyl (OP)	GC/MS	200-2000	504	**4%**	NQ	8555
Fenamiphos (OP)	LC MS	5-50	427	**3%**	NQ	459
Vinclozoline	GC/MS	10-100	504	**3%**	NQ	502
Acephate (OP)	GC/MS	40-400	504	**3%**	NQ	9189
Methidathion	GC/MS	10-100	504	**2%**	NQ	721
Fonofos (OP)	GC/MS	4-40	504	**1%**	NQ	44

Methods: GC/MS is Gas Chromatography / Mass Spectroscopy
LC/MS is Liquid Chromatography coupled with Electrospray Tandem Mass Spectrometry
Quantification Limits (QL) differ for different sample collection amounts

Statistical Analysis of Pesticide Levels

1) Selected those seven pesticides:

- Detected in > 5% of samples
- Very Good QA/QC, e.g., average recovery between 85-115%.

2) Selected a Cross-Sectional Sample of Unique Salinas Homes:

- Because some participants moved between visits, the 168 participants had lived in 241 unique homes.
- Of these 241, in laboratory batches with marginal QA/QC (65-75% surrogate batch recoveries) were removed from the dataset (n=197).

Pesticides in Dust from Unique Salinas Homes (n=197): Pesticides selected for statistical analysis

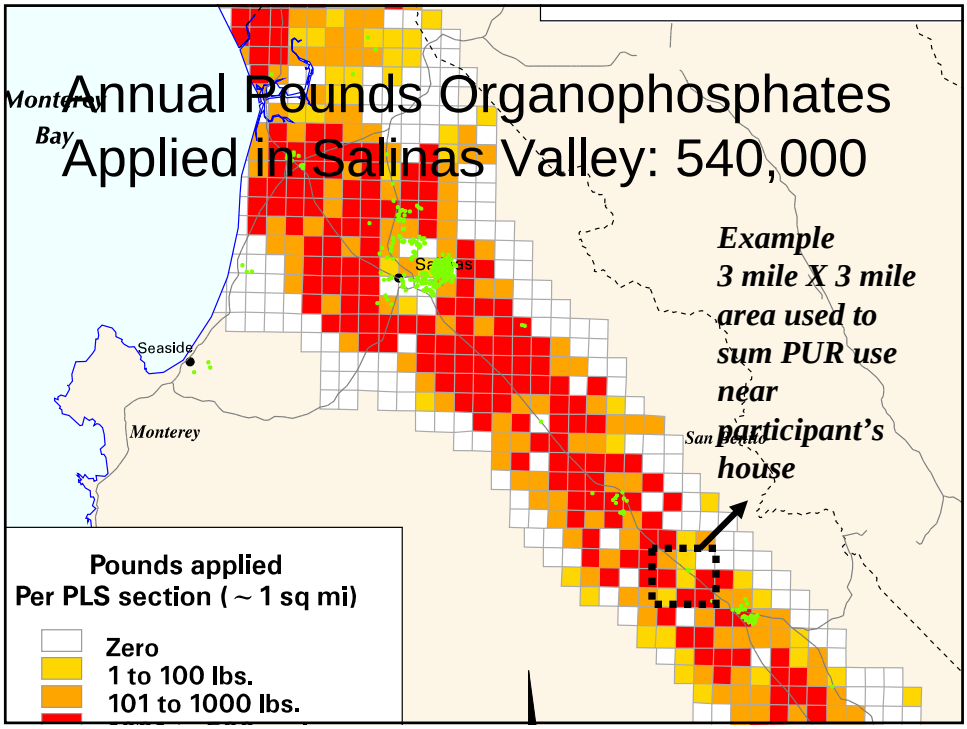
Concentrations ppb (ng/g)

Analyte	PUR: Ag Use (lbs/yr)	% Quanti-fied	50th Pctl	**95th Pctl**
Permethrin-trans	**26,326**	98%	467	**7410**
Chlorpyrifos	**57,128**	91%	74	**1130**
Iprodione	**49,478**	49%	NQ	**566**
Diazinon	**126,153**	87%	26	**273**
Phosmet	**2,607**	7%	NQ	**159**
DCPA	**76,744**	94%	22	**124**

Statistical Analysis of Relationship of Predictor Variables with Dust Levels

Predictor Variables Included:

- Agricultural Pesticide Use (PUR)
- Weather Parameters
- Questionnaire and Home-Visit Information



Correlation with Dust Concentrations and Agricultural Use: Multivariate Tobit Regressions (n=197, models include PUR variables plus weather and questionnaire variables)

PUR AG use prior to dust sample collection:	Chlorpyrifos	Diazinon
prior days 1-3	-0.01	-0.01
month (prior days 4-33)	0.37**	-0.01
season (prior days 34-133)	0.01	0.00
*** p<0.001, **p<0.01, *p<0.05		

Cell entry is the proportional change per lb pesticide applied / day in 3 X 3 mile area near home.

Why is Chlorpyrifos associated with Ag Use but Diazinon is not?

Environmental Persistence?

Log Kow= Octanol/water coefficient (a physical-chemical property indicting ability to adhere to fat/soil).

DDT has a Log Kow of 6.9

Pesticide Concentrations, Agricultural Use, and Environmental Persistence

	Chlorpyrifos	Diazinon	Permethrin-trans
Median DustConc (ppb) n=197	74	26	407
Average Annual Ag Use (lbs)	57,128	126,153	26,326
Log Kow=	5.0	3.3	6.1
Urinary Metabolite % detected in CHAMACOS women (n=544):	Detected in 76%	Detected in 2%	

Association with Dust Concentrations and Agricultural Use: Multivariate Tobit Regressions (n=197, models include PUR variables plus weather and questionnaire variables)

Ag Use in the period prior to dust collection	DCPA	Iprodione	Trans-permethrin
days (days 1-3 prior)	-0.01	-0.22	0.07
month (days 4-33 prior)	0.04	0.15**	0.24
season (days 34-133 prior)	0.09**	0.22**	-0.13

*** p<0.001, **p<0.01, *p<0.05

Cell entry is the proportional change per lb pesticide applied / day in 3 X 3 mile area near home

Dust and PUR correlations: Environmental Persistence

- *DCPA (aka chlorthal-dimethyl or Dacthal):* dust levels associated with ag use in the season (days 34-133) prior to dust collection.
  - Estimated air half-life: 60 days
- *Iprodione:* dust levels correlated with ag use in the month and season prior to dust collection.
  - Very Low Vapor Pressure: In air, exists solely as particulate. Correlation with dust levels suggests particulate drift from agricultural fields may occur.

Variables Associated with Dust Levels: Multivariate Tobit Regressions (models include 11 questionnaire variables plus PUR and weather variables).

Cell entry is proportional change in dust loadings

QUESTIONNAIRE VARIABLES (coded 1=Yes, 0=No)	% Yes	Chlorpy-rifos	Dia-zinon	DCPA	Ipro-dione	Perme-thrin
Potential Agricultural Sources						
Farmworkers in home	76%	0.05	0.69	0.49	10.12*	-0.36
Farmworker store shoes in home	22%	2.2**	1.5*	1.19*	-0.37	1.36*
Farmworker store clothes in home	50%	0.42	0.40	-0.1	1.16	1.3*
OP stored in home	3%	0.73	14.7*	NA	NA	NA
Pyrethroid used in home	26%	NA	NA	NA	NA	0.16
Other Household Characteristics						
Housing Density, 2+/room	25%	-0.1	1.2*	0.33	-0.61	0.12
Home less clean	72%	1.9**	0.29	0.98*	1.21	0.73
Air conditioner in home	8%	-.88**	-0.8*	0.00	-0.71	2.18

*** p<0.001, **p<0.01, *p<0.05

Summary of Findings (1 of 4):

Finding: Multiple pesticides were detected in house dust from an agricultural area, many of which are restricted to agricultural use. Residents of an agricultural area may be exposed to a variety of pesticides through contact with house dust.

Public Health Response: Supports the use of safer alternatives to pesticides and reduced use.

Reducing use has been successful in lowering house dust concentrations of pesticides

In Washington State, discontinued use of parathion (an OP) led to a 10-fold decline in house dust levels in 3 years.

Fenske RA, Lu C, Barr D, and Needham L. Children's Exposuree to Chlorpyrifos and Parathion in an Agricultural Community in Central Washington State. *Environmental Health Perspectives* 110 (5): 549-553.

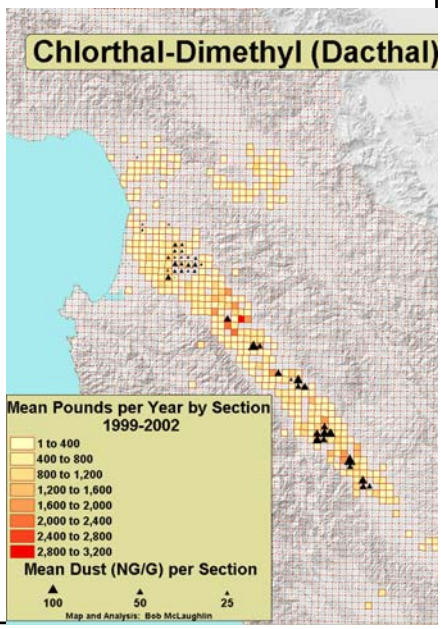
Summary of Findings (2 of 4):

Finding: Agricultural uses of:

- Chlorpyrifos (an OP),
- Chlorthal dimethyl, DCPA (a herbicide)
- Iprodione (fungicide)

are significantly associated with dust concentrations.

Public Health Response: All of these compounds are on Cal-EPA's/CDPR list of high priority pesticides for potential listing as Toxic Air Contaminants. These results support that listing.



DACTHAL® FLOWABLE HERBICIDE

AGRICULTURAL HERBICIDE

ACTIVE INGREDIENT:	By Wt.
DCPA (dimethyl tetrachloroterephthalate)	54.9%
INERT INGREDIENTS:	45.1%

Engineering Controls

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in Worker Protection

Off-Site Movement Under California Growing Conditions: Current research indicates a propensity for off-site movement of certain soil-applied pesticides in California's unique growing conditions. Pesticides, such as DACTHAL FLOWABLE, may be moved off-site through a process called co-distillation. This phenomenon has been shown to occur where bare soil is treated (crops not present) and the soil surface is very hot. The pesticides, though not highly volatile, appear to be carried from the soil surface with water molecules during rapid evaporation that occurs immediately after irrigation. Banding applications of preemergence herbicides, such as DACTHAL FLOWABLE, significantly reduces the potential for off-site movement by reducing the amount of product used to treat a given crop area.

Band herbicide applications.

Summary of Findings (3 of 4): "Sources" of Pesticides in Dust

Finding: *Ag worker wearing shoes in house* associated with dust levels of 4 of 5 pesticides examined.

Public Health Response: Additional health educational messages are warranted. Current US. EPA messages do not include information on shoes.

United States Environmental Protection Agency | Office of Prevention Pesticides, and Toxic Substances (H7506C) | EPA 735-B-06-001 Revised June 2006 (Spanish)

EPA

Protect Yourself from Pesticides– Guide for Agricultural Workers (Spanish)

How can you protect yourself from pesticides?
¿Cómo puede protegerse de los pesticidas? 2

■ **Keep dirty work clothes away from non-work clothes and from the family laundry.**

Pesticides may get on your clothes at work. Wash your work clothes, including your cotton gloves before using them again.

❑ **Mantenga y lave separada la ropa de trabajo sucia. No la junte con su otra ropa sucia o la de su**

Summary of Findings (4 of 4): Environmental Persistence

Finding: Compounds with high Kow, (i.e., tendency to absorb to soil particles) showed highest concentrations or association with agricultural pesticide use.

Public Health Response: Researchers have long suggested that Kow be more fully incorporated into policy. For example, Thomann RV. *Environmental Health Perspectives*, 1995, 103, 53-57.

FUNDERs: THANK YOU

CHAMACOS Funders:

U.S. Environmental Protection Agency

National Institute of Environmental Health Sciences

Publications

- Please do visit www.chamacos.org for externally peer-reviewed articles.
  - **M Harnly, R McLaughlin, A Bradman,M Anderson, and R Gunier Environmental Health Perspectives: 113:1184-1189 (2005) *Correlating agricultural use of organophosphates with outdoor air concentrations: a particular concern for children.* ***Brief:*** Agricultural uses of chlorpyrifos and diazinon are significantly associated with *air* concentrations.**
  - **R Castorina, A Bradman, TE McKone, DB Barr, M Harnly, B Eskenazi. *Cumulative organophosphate pesticide exposure and risk assessment among pregnant women living in an agricultural community.* Environ. Health Perspect. 2003, 111, 1640-1648. ***Brief:*** Among women living in an agricultural area, urinary metabolites of organophosphorous insecticides may exceed health guidance levels.**