

Agricultural Food Processes and Human Health

Jenna Armstrong, MPH, PhD

Environmental and Occupational Hygiene

Department of Environmental and Occupational Health



National Geographic, 2011

Agricultural Landscapes of the Future?

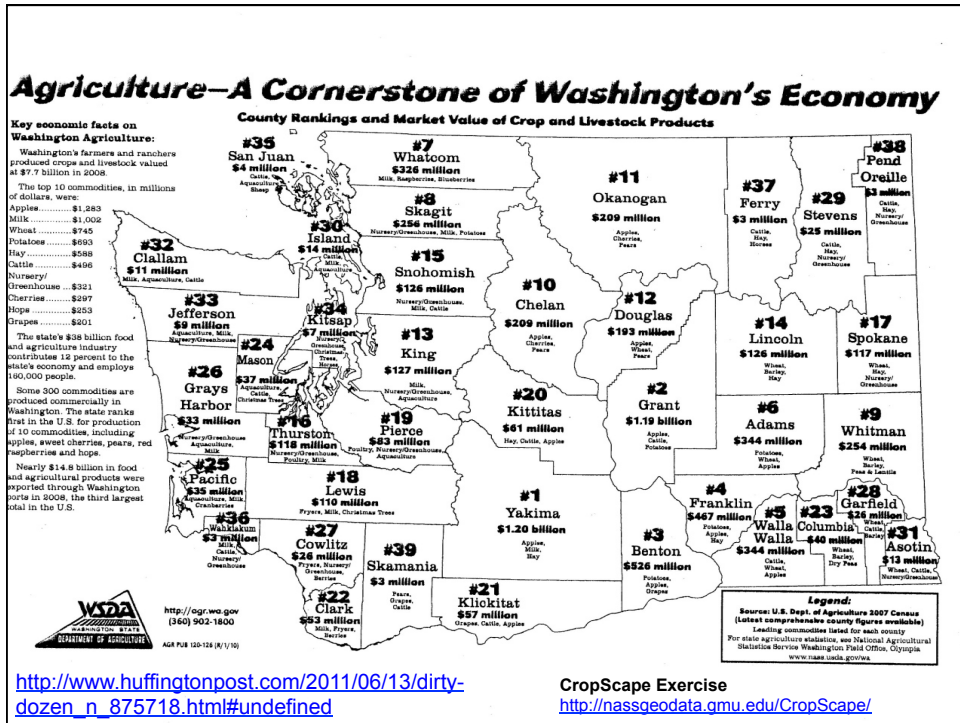


Outline

- Agricultural Health and Safety
- Human Health Effects
 - Pesticides
 - GMOs
- Terms
 - Environmental Justice
 - Precautionary Principle
- My Research: Rural Air Quality
 - Climate Change

Definitions

- **Food Safety:** Protection from foodborne illnesses, which are diseases usually either infectious or toxic in nature, caused by agents that enter the body through the ingestion of food.
- **Food Security:** The ready availability of nutritionally adequate and safe foods, and an assured ability to acquire acceptable foods in socially acceptable ways (without resorting to emergency food supplies, scavenging, stealing, or other coping strategies). *(USDA, 2006)*
- **Agricultural Health and Safety:** Focus on human health and safety of agricultural workers, near-by residents, and rural communities that are the sustenance of the agricultural economy.



http://www.huffingtonpost.com/2011/06/13/dirty-dozen_n_875718.html#undefined

CropScape Exercise
<http://nassgeodata.gmu.edu/CropScape/>

Pesticides

- Substances intended for preventing, destroying, repelling, or mitigating and pest or intended for use as plant regulator (Moeller, 2005)
- Fungicides for the control of fungi
- Herbicides for the control of weeds
- Insecticides (e.g. organochlorines, organophosphates, carbamates, and pyrethroids).
- Rodenticides



Mechanisms:	Health effects:
<ul style="list-style-type: none"> ▪ Organophosphate pesticides account for as much as 70 % of the pesticide use in U.S. ▪ Works by interfering with the nervous systems of insects, but have similar effect in mammals, including humans. ▪ Most people in the U.S. have residues of the products in their urine. ▪ Children, farmworkers, and genetically susceptible individuals are highest at risk populations. 	<ul style="list-style-type: none"> ▪ Acute poisonings ▪ Neurological and birth defects (ADHD, Autism, Developmental Delays) ▪ Non-Hodgkin lymphoma and leukemia (carcinogens) ▪ Ongoing studies on Parkinson’s Disease

Health effects: Organophosphate Exposures in the US - Longitudinal Analysis of Incidents Reported to Poison Centers

TABLE 2

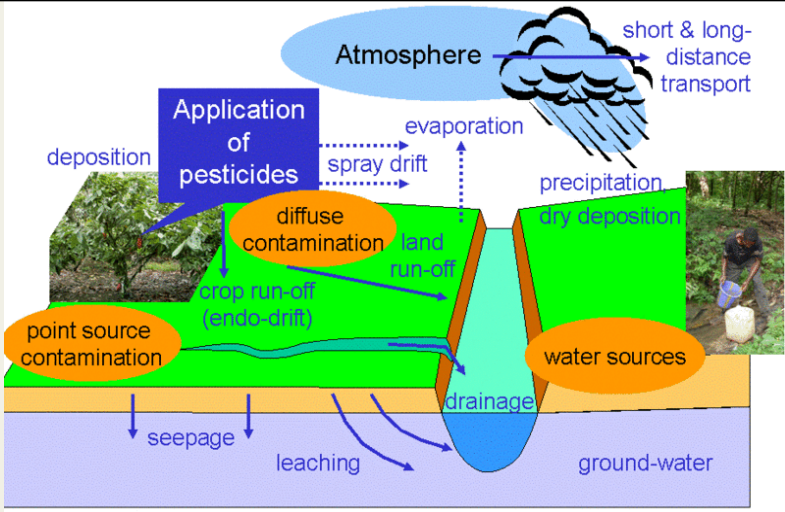
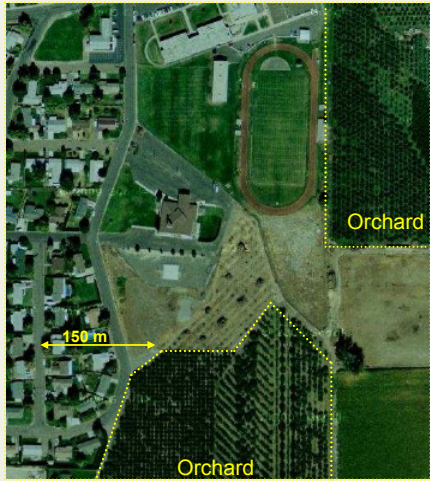
Average Annual Number of Organophosphate Exposure Incidents Before (1995–1999) and During (2000–2004) Their Phase-Out From Residential Use

Type of exposure	Mean number of exposures		p Value
	Years 1995–1999	Years 2000–2004	
Total	17,865 ± 2935 (SD)	9512 ± 2086 (SD)	.009
Unintentional	17,016 ± 2756 (SD)	8975 ± 2017 (SD)	.009
Intentional	426.8 ± 83.5 (SD)	268.6 ± 47.6 (SD)	.028
Treated in health care facility	4021 ± 467 (SD)	2397 ± 542 (SD)	.009

Note. Data sources: American Association of Poison Control Centers Toxic Exposure Surveillance System annual reports (Litovitz et al., 1996, 1997, 1998, 1999, 2000, 2001, 2002; Watson et al., 2003, 2004, 2005b).

Sudakin, Daniel L. and Power, Laura E. (2007) Journal of Toxicology and Environmental Health, Part A, 70: 2, 141 — 147

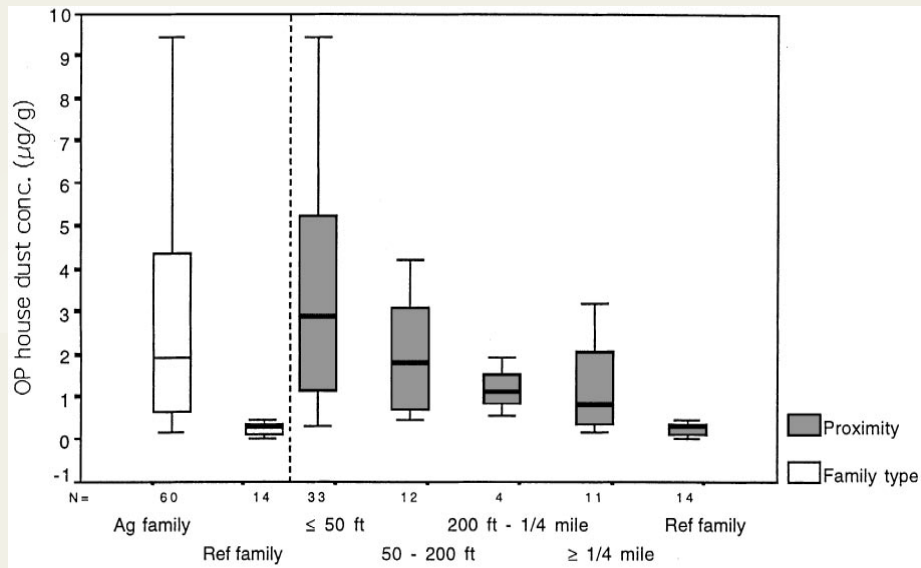
Spray Drift



Bateman, 2008, IPARC, Imperial College, London

- Injury to non-target plants and animals.
- Contamination of nearby water and soil.
 - Organic farms.
- Possible human exposures and resulting health outcomes.

Increased Pesticide Residues in Farmworker Homes



Increased Pesticide Exposures

- Residues in yard soil and house dust significantly higher (*Simcox et al., 1995*)
- Metabolites in urine higher in children (*Loewenherz et al., 1997*)
- House pesticide dust levels 7x higher (*Lu et al., 2000*)
- Residues in house dust and vehicle dust of agricultural workers were significantly correlated (*Curl et al. 2002*)
- Metabolites in urine for agricultural workers and their children were significantly correlated (*Curl et al., 2002*)



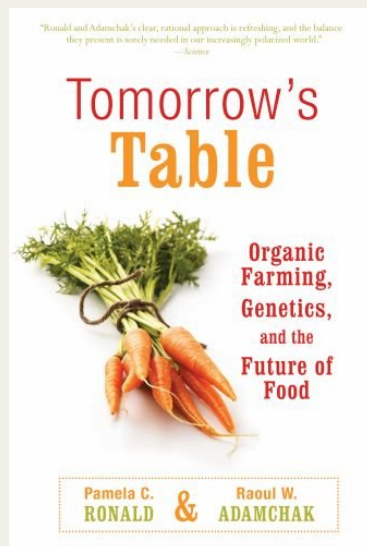
Integrated Pest Management (IPM)

- Use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.
 1. **Set Action Thresholds**
 2. **Monitor and Identify Pests**
 3. **Prevention**
 4. **Control**

Environmental Justice

- Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, educational level, or income with respect to the development, implementation, and enforcement of environmental laws.
- Environmental justice seeks to ensure that minority and low-income communities have access to public information relating to human health and environmental planning, regulations and enforcement.
- Environmental justice ensures that no population, especially the elderly and children, are forced to shoulder a disproportionate burden of the negative human health and environmental impacts of pollution or other environmental hazard

Genetically Modified Organisms



(Oxford University Press, 2008)



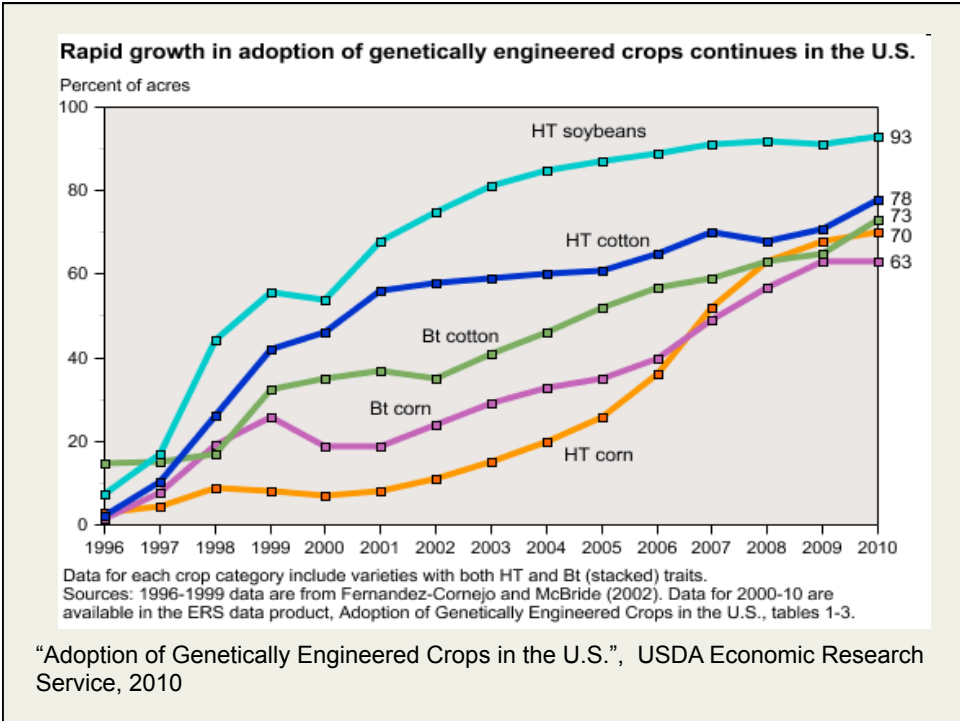
Harvard University Press, 2008

Genetically modified organisms



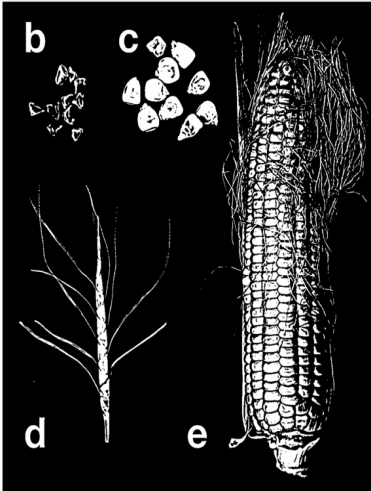
Genetically modified organisms

- Genetic engineering differs from conventional methods of genetic alteration in two major ways:
 - (1) introduces one or a few well-characterized genes into a plant species and
 - (2) can introduce genes from any species into a plant



Why GMOs?

- Tolerance of a pesticide or herbicide
- Grows in arid soils or hot/cold conditions
- Tastes better (e.g. sweeter)
- Aesthetics



Golden Rice

- Improvement of nutritional value.
 - β -carotene (provitamin A)
- Increased yields and stress tolerance.



Environmental Health Concerns

- Loss of natural biodiversity through mono-cropping
- Powerful new technology that is in general poorly understood and whose long term effects are unknown
- Increased corporate control of agriculture
- Gene “hopping” – transfer of genes and traits to other relative species



Identification of a Brazil-Nut Allergen in Transgenic Soybeans

- In 1995, The company Pioneer Hi-Bred placed genes from Brazil nuts into soybeans to increase levels of certain amino acids.
- Labeling did not require brazil nuts as an ingredient.
- After laboratory tests, the Brazil nut soybean was never released for consumption.
- Concern that an allergens (e.g. proteins) from a food known to be allergenic can be transferred into another food by genetic engineering.

Julie A. Nordlee, M.S., Steve L. Taylor, Ph.D., Jeffrey A. Townsend, B.S., Laurie A. Thomas, B.S., and Robert K. Bush, M.D. N Engl J Med 1996; 334:688-692

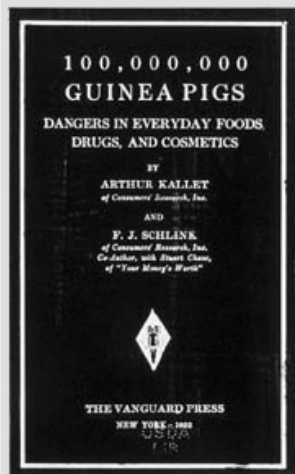
Precautionary Principle:

- "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically" .
 - *Wingspread Statement on the Precautionary Principle, Jan. 1998*

Precautionary Principle:

1. Taking preventive action in the face of uncertainty.
2. Shift the burden of proof to the proponents of an activity.
3. Exploring alternatives.
4. Involve public in decision making.

Precautionary Principle:



"If the poison is such that it acts slowly and insidiously, perhaps over a long period of years, then we poor consumers must be test animals all our lives; and when, in the end, the experiment kills us a year or ten years sooner than otherwise we would have died, no conclusions can be drawn and a hundred million others are available for further tests"

- *Kallet and Schlink, 1933*

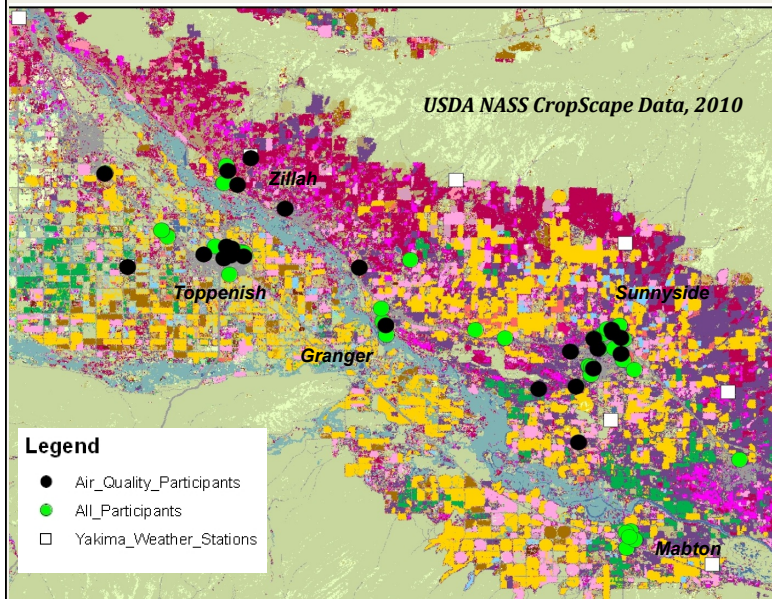
<http://www.usda.gov/open/Ideas.nsf/0/218F694C86E8DF8D862576C400220560?opendocument>

My Research: Rural Air Quality

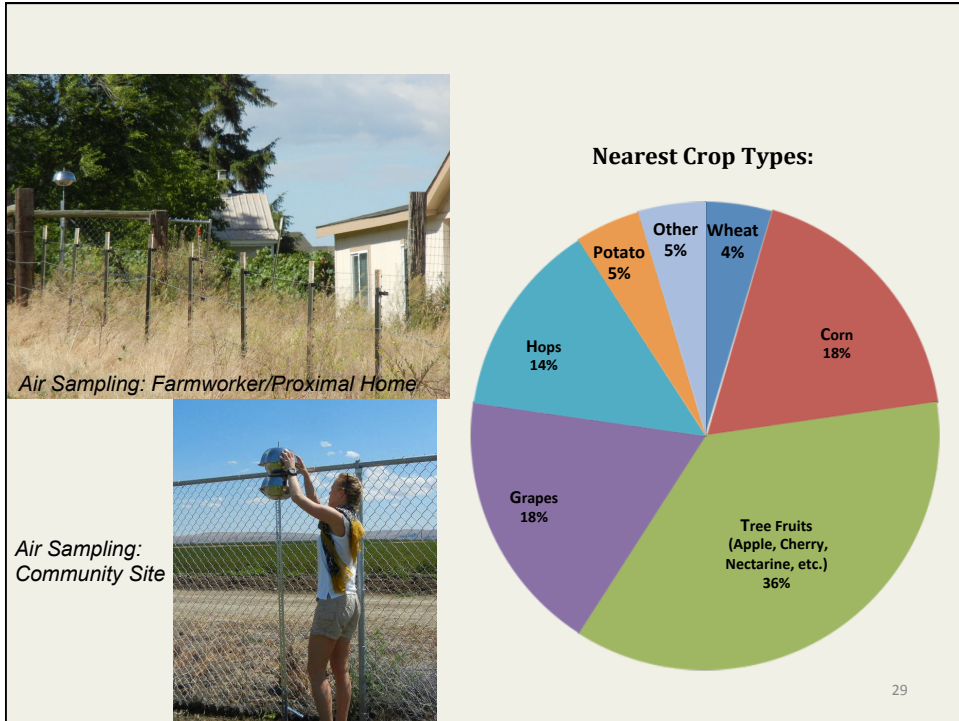


27

COMPLETE: 2011 GIS Data for All Participants and Air Monitoring Subset



28



misery for all seasons
allergies: a modern epidemic

the hygiene hypothesis

Feature Article, National Geographic, 2006

The collage features several images: a child sitting in a bathtub with a shower cap, a child in a blue raincoat looking to the side, a child standing next to a cow in a field, and a person operating a tractor in a field. The text 'the hygiene hypothesis' is overlaid on a background of pollen grains.

Occupational Asthma

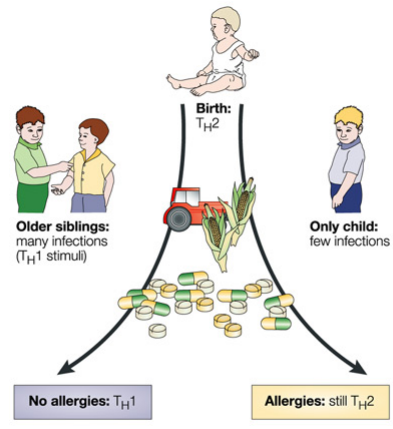
Bloomberg Businessweek, 2008

British Institute of Radiology, 2011

Figure 1. Chest radiographs of a 58-year-old man suffering recurrent episodes of acute farmer's lung (a) admitted to hospital with acute dyspnoea, fever, hypoxaemia, (b) recovery on cessation of contact with moldy hay and (c) re-admitted 4 months later with relapse after re-exposure.

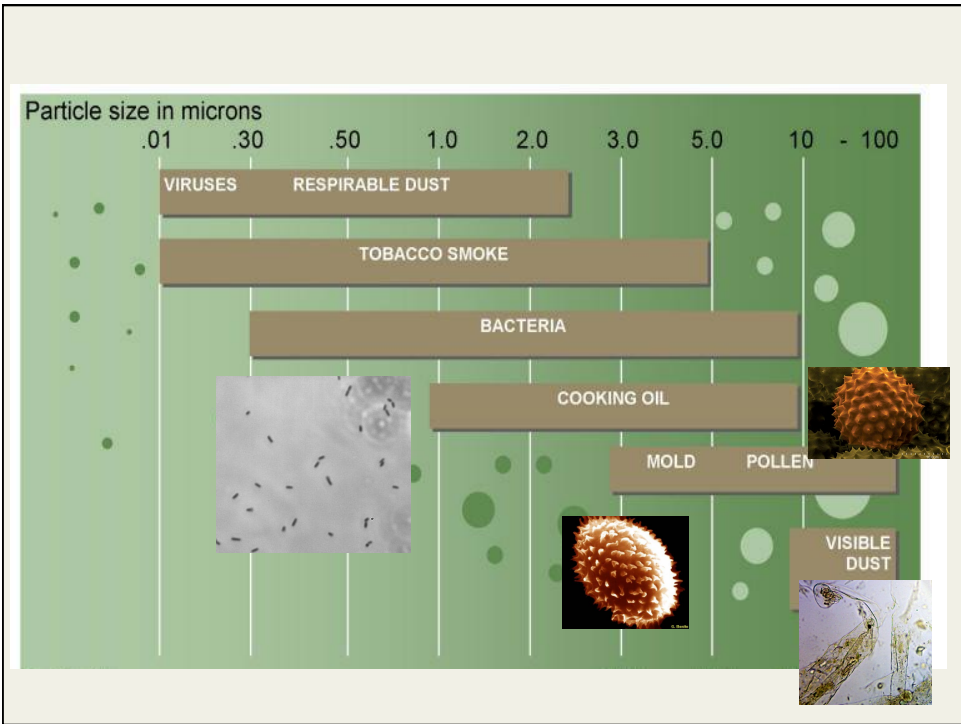
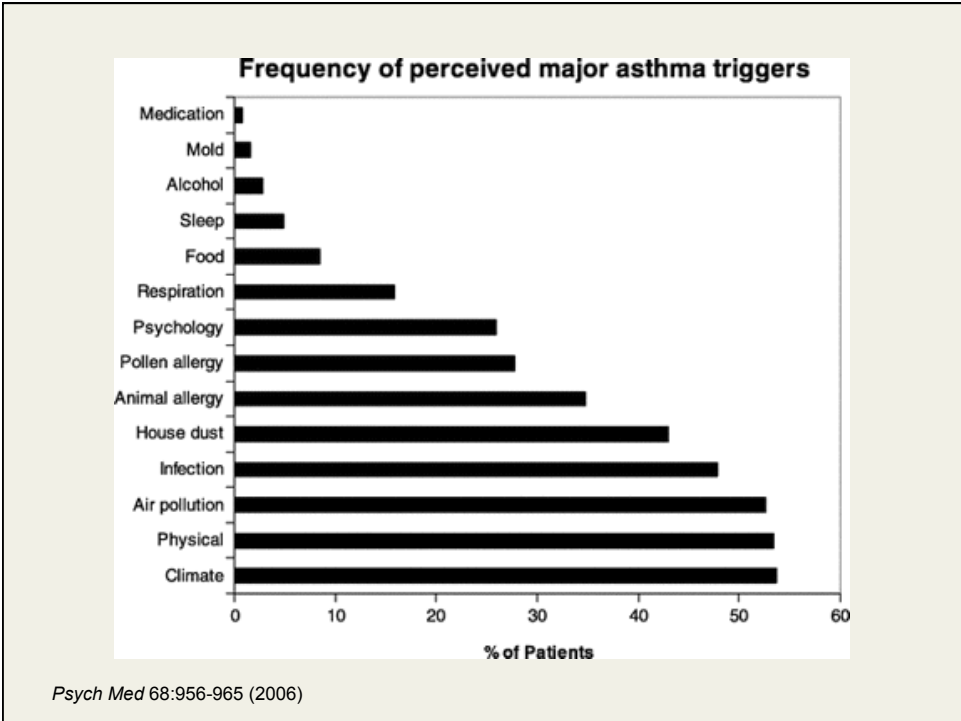
Childhood Asthma: "Hygiene Hypothesis"

Farm children whose household dust has the *greatest* variety of bacteria and fungi are much less likely to develop asthma and allergies than non-farmers, whose homes had fewer microscopic inhabitants, says the study of 933 European children in today's *New England Journal of Medicine*.

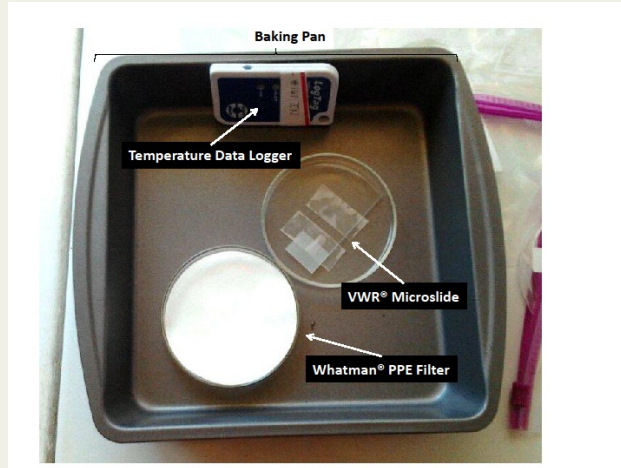


Nature Reviews | Drug Discovery

Nature Reviews, 903-915 (November 2003)

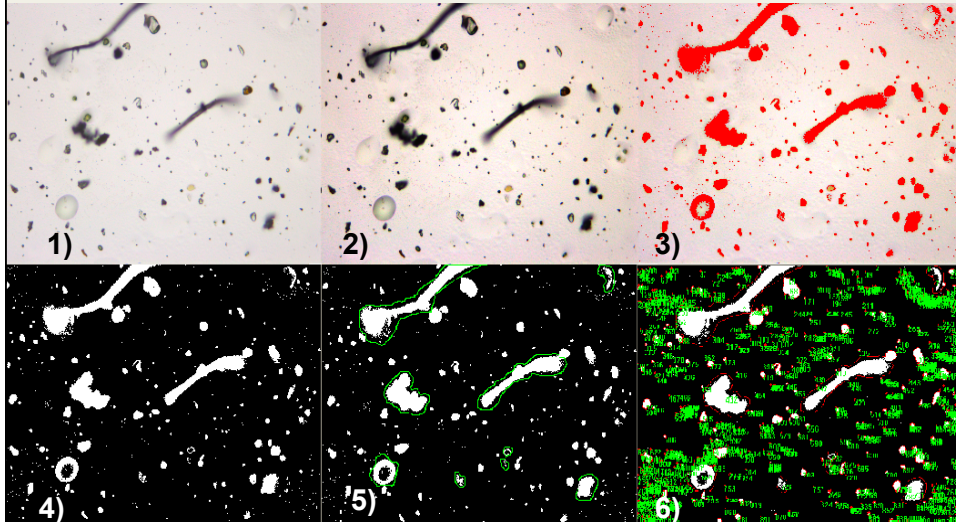


Polypropylene Filter Deposition Plate



35

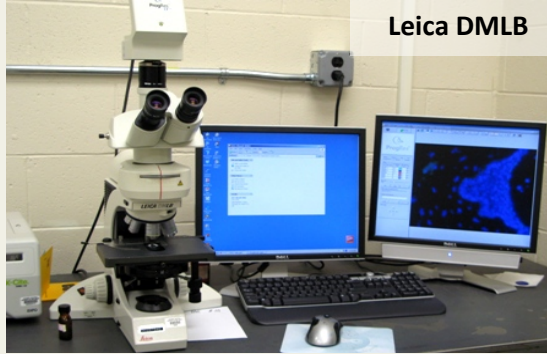
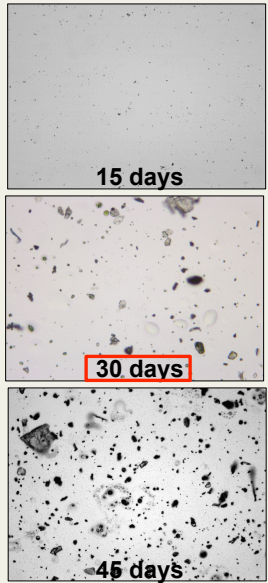
Microslide Imaging w/ *Image Pro Plus 6.3*



1)

36

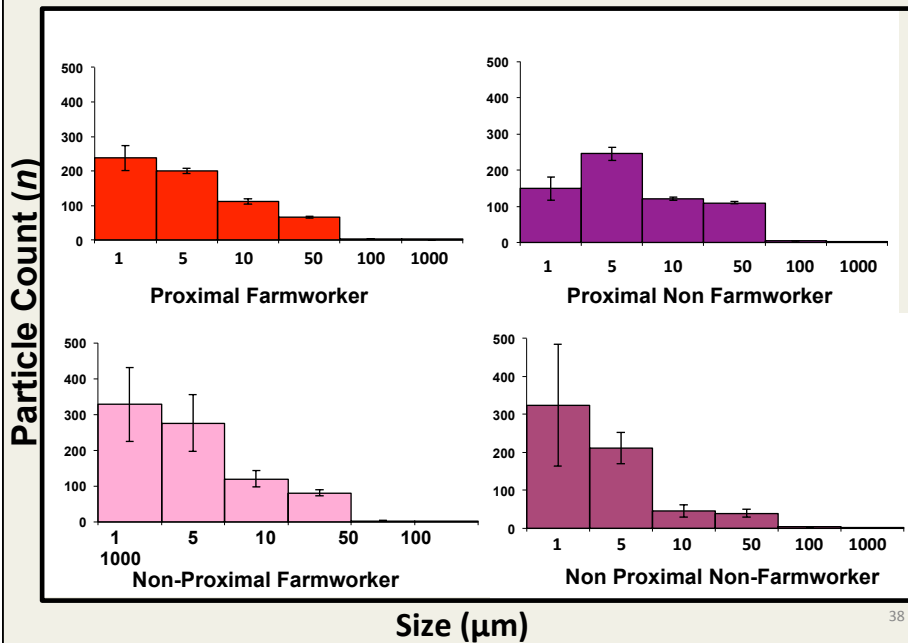
House Dust Microslide Imaging



- Particle deposition plate loading.
- Microslide analysis with Leica DMLB fluorescence and digital imaging for particles 1-1000 μm .
- Residents living near fields have \uparrow coarse particles, i.e. pollen, spores, plant material.

37

Rural Household Particulate



38

Agricultural Burning

- CO₂
- CO
- Other VOCs
- PM ≤ 2.5
- NO_x
- PAHs



CAFOs

- Animal
 - Cow dander
 - Cow urine
 - Egg yolk proteins
 - Fungi
 - Grain mite
 - Grain weevil
 - Meal worm
 - Pig urine
 - Pig dander (Alternaria, Aspergillus, Cladosporium)
 - Poultry mites
 - Poultry dander
- Chemicals (used in feed)
 - Antibiotics (spiramycin, amprolium)
 - Formaldehyde
 - Glutaraldehyde
- Plant
 - Grain dust (all types of grain)



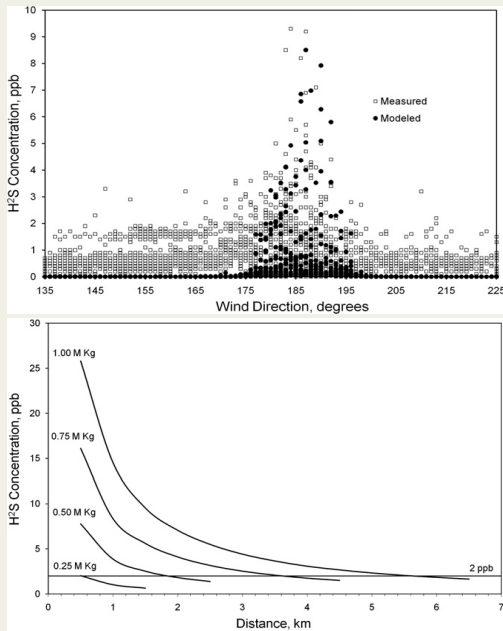
Pics: NCSU Department of Entomology

Animal Waste

- Dust
 - Endotoxin
 - Allergens
- Ammonia
- Hydrogen Sulfide (H₂S)



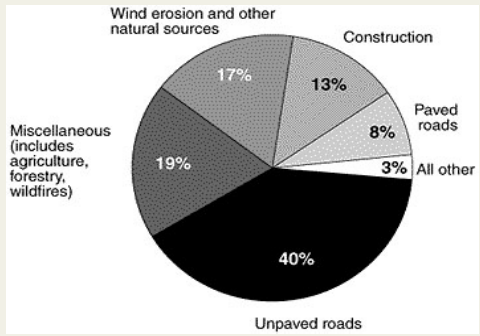
Animal Waste, cont.



- Homes downwind ↑ exposure to H₂S
- Proximal homes ↑ exposure

O'Shaughnessy, Altmair. *Atm Environment*, 2011

Dust



EPA, National Air Quality and Emissions Trends Report

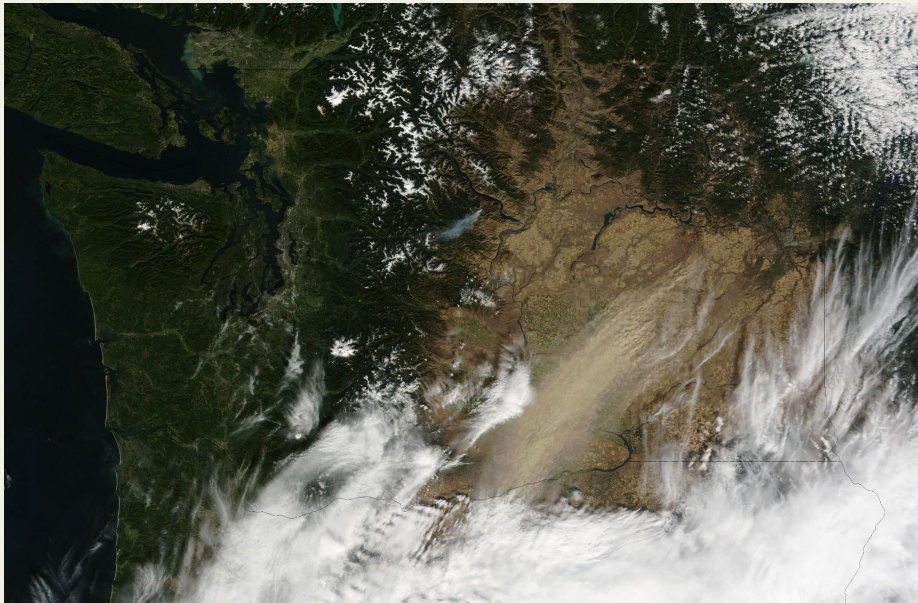
- **Organic**

- Spores
- Bacteria
- Endotoxin
- Fungal Antigens
- Pollen

- **Inorganic**

- Silica
- Persistent minerals, like Cadmium, Arsenic

Dust



Climate Change and Air Quality in the Yakima Basin

- Total water supply available to irrigated agriculture will decline.
- Agricultural practices will adapt to longer growing seasons, reduced summer precipitation, and increasingly competitive weeds.
- Diseases will generally become more problematic over the next century, as a result of warmer temperatures.
- Earlier emergence of insects and prolonged hatching cycles.



Climate Impacts Group
JOINT INSTITUTE FOR THE STUDY
OF THE ATMOSPHERE AND OCEAN
UNIVERSITY OF
WASHINGTON