Pesticides in Agriculture: Effects on the Environment and Human Health

November 10, 2005

Ecological Agriculture

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PESTICIDES!
meyer

Outline of Talk

I. Types of pesticides and their use in US, common pesticides used

II. Effects on human health and environment of acute toxics and endocrine disruptors

III. Pesticide effects on energy use and the balance sheet

IV. Alternatives to pesticides

V. Precautionary principle applied with respect to pesticides: The case of Sweden

Who uses them?

Table 1.1 Estimated annual pesticide use

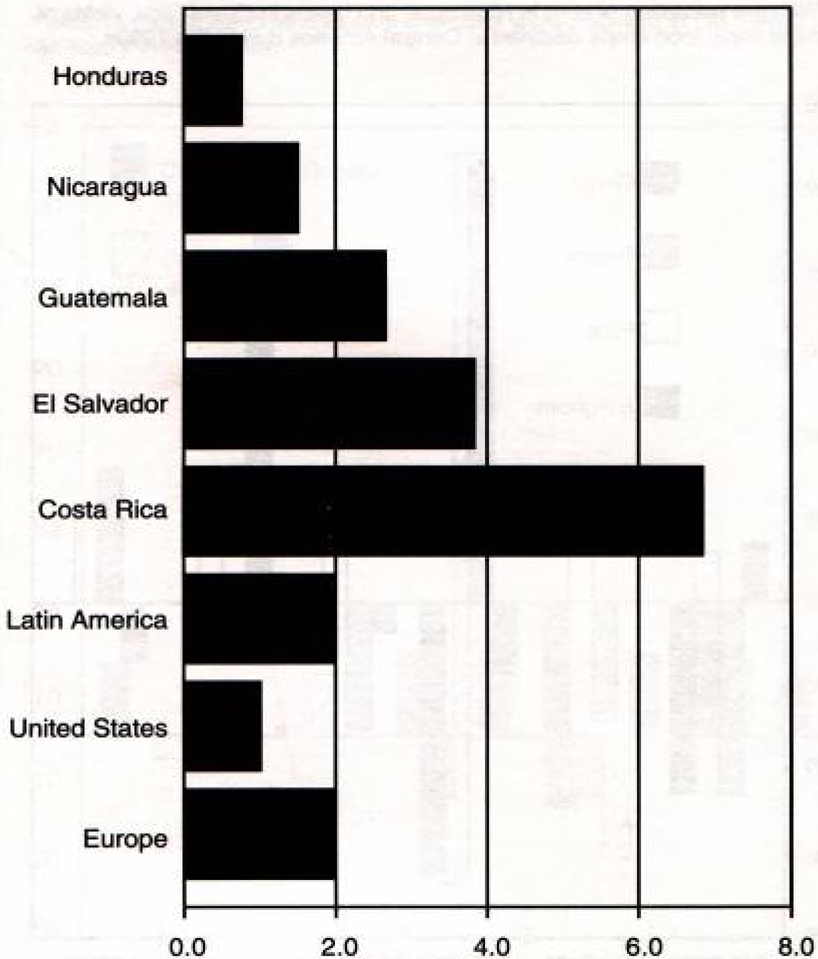
Country/region	Pesticide use (10^6 metric tons)
United States	0.5
Canada	0.1
Europe	0.8
Other, developed	0.5
Asia, developing	0.3
Latin America	0.2
Africa	0.1
Total	2.5

Source: Data from Pimentel, 1995b.

Pimental, Techniques for Reducing Pesticide Use 1997

- Developing countries may have higher rates than developed
- Comparisons of pesticide use by area
- Units are grams / ha

FIGURE 17. COMPARISON OF PESTICIDE USE[a] (grams per hectare)



[a]Data from early 1980s.

Source: World Resources Institute, *World Resources 1990-1991* (New York: Oxford University Press, 1990) Table 18.2; General Accounting Office, *Food Safety and Quality* (Washington, DC: GAO, 1989), Appendix 1.

Increasingly toxic pesticides used though total amount has decreased

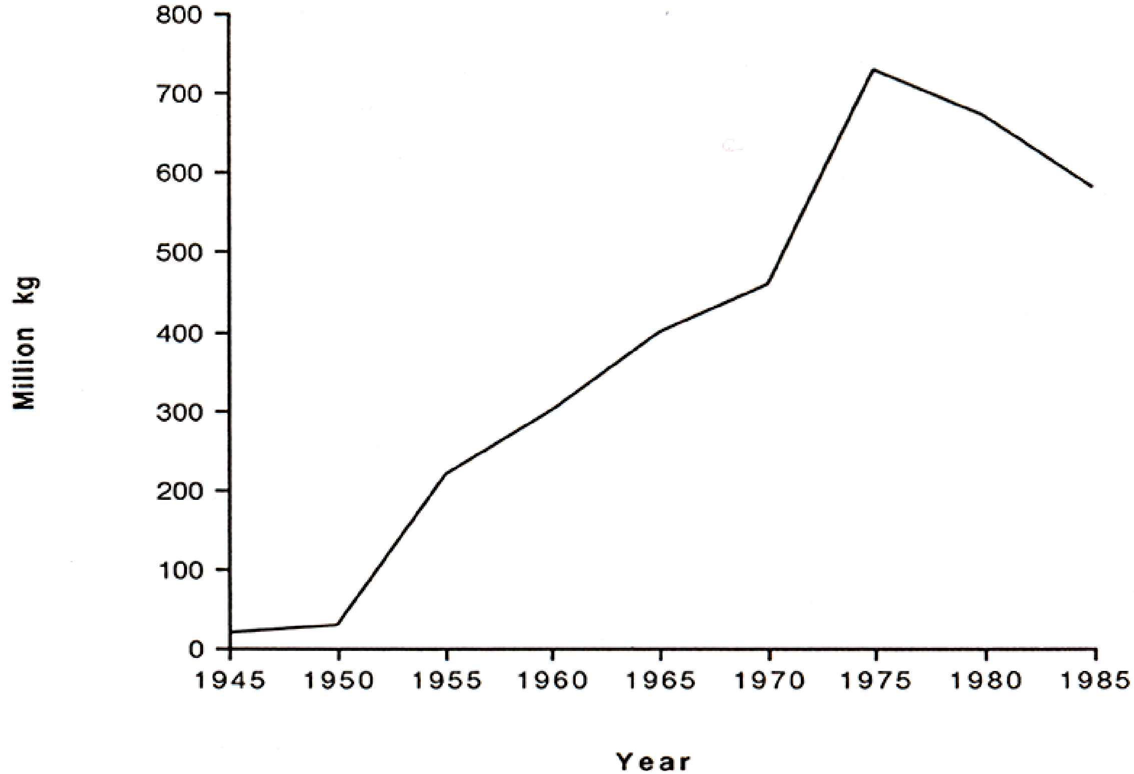


Figure 19.1 The amount of synthetic pesticides—insecticides, herbicides, and fungicides—produced in the United States. About 90% is sold in the United States. The decline in the total amount produced since 1975 is in large part due to the 10– to 100–fold increased toxicity and effectiveness of the newer pesticides (based on Pimentel et al. 1993)

(Pimentel, Techniques for Reducing Pesticide Use 1997)

Estimated losses from insects: ave 12%

Table 17.1 Vegetable crop losses from insects with current insecticide use and estimated costs if insecticides were reduced and several alternatives were substituted

		Total insecticide use (kg – 10^6)		Insecticide treatment					
Crop	Area (ha – 10^3)[a]	Current[b]	Reduced[c]	Hectares treated (%)[d]	Cost ($ ha^{-1})[e]	Total cost ($ – 10^6)	Current crop pest loss (%)[c]	Added alternative cost ($ ha^{-1})[c]	Total added alternative control cost ($ – 10^6)[c]
Lettuce	90	0.35	0.26	97	68	5.9	7	10	0.70
Cole	111	0.40	0.20	62	30	2.1	13	10	0.70
Carrots	39	0.02	0.01	37	10	0.1	7	5	0.08
Potatoes	570	1.60	1.12	88	46	23.1		10	5.40
Tomatoes	145	0.20	0.15	95	26	3.6		0	0.00
Sweetcorn	206	0.27	0.05	84	70	12.1	19	10	2.00
Onions	54	0.75	0.50	79	18	0.8	4	5	0.27
Cucumbers	42	0.02	0.01	34	12	0.2	21	5	0.10
Beans	132	0.11	0.07	72	9	0.9	12	5	0.33
Cantaloupe	50	0.08	0.05	78	40	1.6	8	0	0.00
Peas	135	0.02	0.01	49	5	0.3	4	5	0.61
Peppers	25	0.09	0.06	85	80	1.7	7	5	0.09
Sweet potatoes	31	0.26	0.02	100	0	1.3	16	5	0.22
Watermelons	72	0.06	0.04	53	14	0.5	4	5	0.30
Other vegetables	100	0.01	0.006	40	30	1.2	13	5	0.20
Total		4.24	2.556			54.40			11.00

[a] USDA, 1992.
[b] Converted from USDA, 1993.
[c] Pimentel et al., 1991.
[d] USDA, 1993.
[e] Calculated.

(Pimentel, Techniques for Reducing Pesticide Use 1997)

Insects developed resistance to pesticides

Earliest WA San Jose scale on apples resistant to lime-sulfur sprays 1908

In 1954 resistance to organochlorine in cotton boll weevil

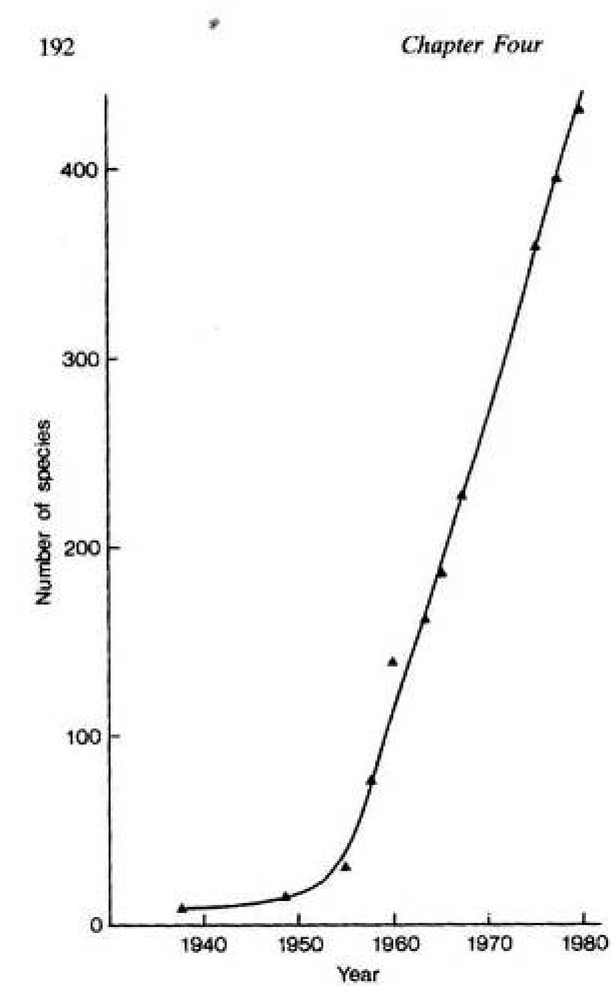


Fig. 4.13. The increase in the number of insect species known to be resistant to at least one insecticide (after Georghiou and Mellon, 1983).

Dent, D. 1991. *Insect Management*

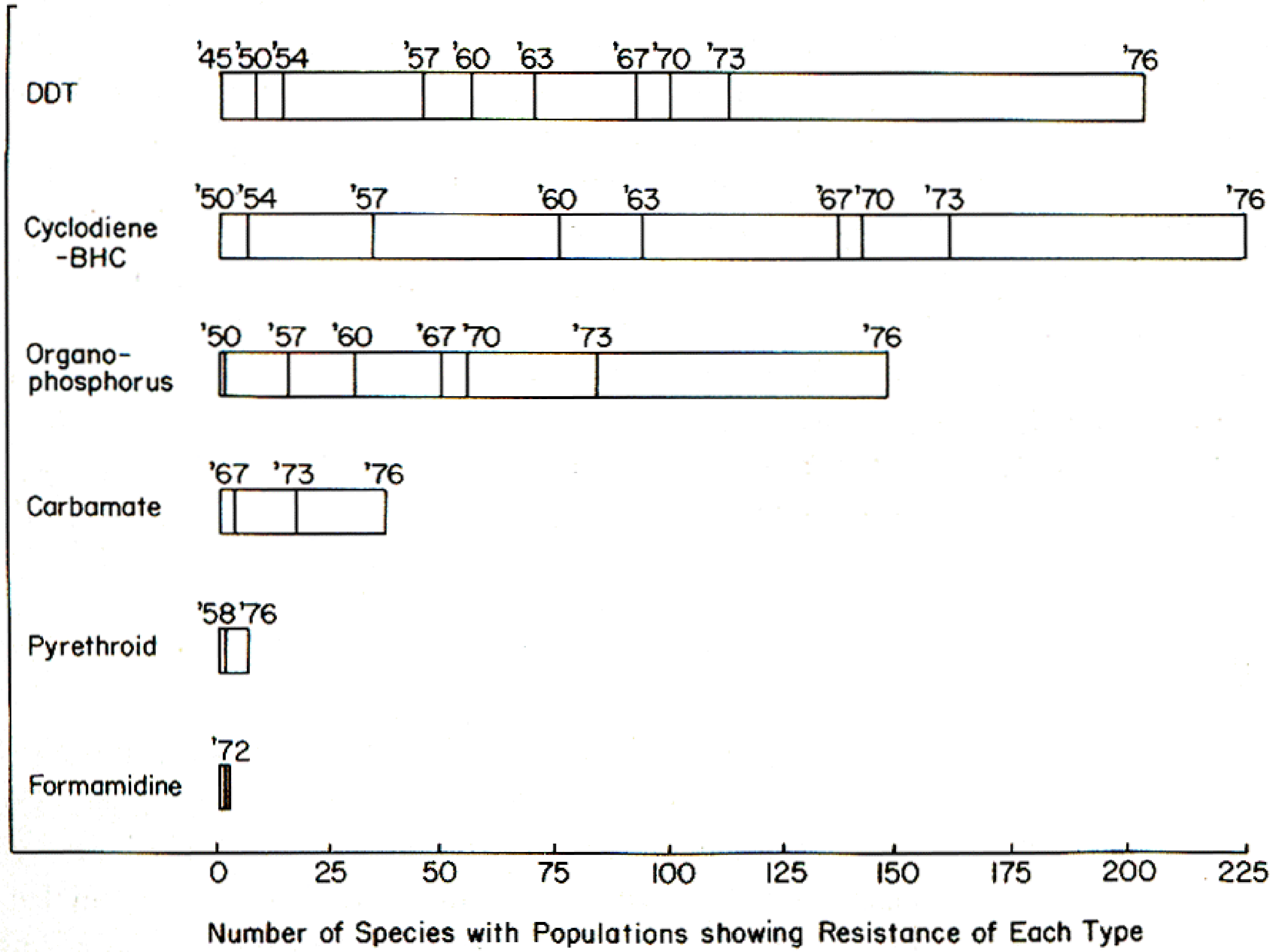


Fig. 1.7. Numbers of arthropod species in which populations have developed resistance to insecticides of the six principal types available.

(Brown, Ecology of Pesticides 1978)

Pesticide treadmill

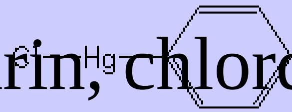
- Pest develops resistance
- Meanwhile have killed natural enemies of the pest
- Need to use pesticides more frequently
- Other insects that had been held in check now become pests called *secondary pest resurgence*

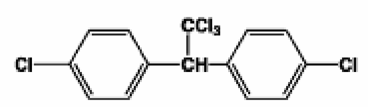
What makes a pesticide “bad?”

- Broad spectrum (many types of organisms killed)
- High environmental acute effect and chronic effect within ecosystem (bioaccumulation)
- High toxicity (acute) and chronic effects within mammals
  - carcinogen
  - developmental and reproductive toxins
  - endocrine disruptors

Chemical classification of pesticides

- Heavy metals and elementals (19th century): Lead, Arsenic, Mercury, Sulfur, Copper
  - insecticides, fungicides, microbiocides
  - PbAs: bioaccumulation, high acute mam. Tox. carcinogen, behavioral disorders, devel./reprod. toxin, As endocrine disruptor
- Organochlorines (1938): DDT, aldrin, chlordane, lindane, heptachlor
  - insecticides, persistent bioaccumulation, low acute mammalian toxicity, carcinogen, devel/reprod toxicity, sus. endocrine disruptor





DDT

DDT application in 1945

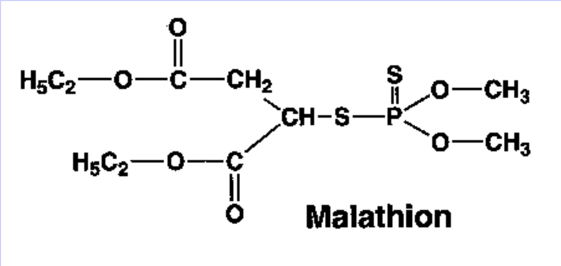
UPI/BETTMANN

■ FROM THE GEOGRAPHIC ARCHIVES

An ill wind

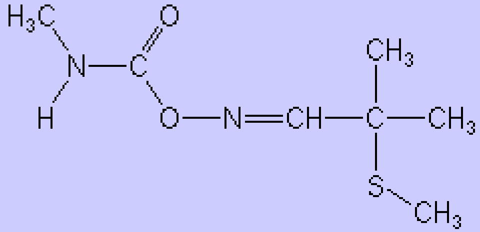
A cloud of the insecticide DDT billows over the beach—and beachgoers—in 1945 as part of a mosquito-control program at New York's Jones Beach State Park. Used in Europe to ward off bug-borne disease during World War II, DDT was once hailed as a miracle product. This photograph was published in the October 1945 GEOGRAPHIC article "Your New World of Tomorrow." But by the time "tomorrow" came, evidence showed that birds from sprayed areas accumulated high levels of DDT, damaging their ability to reproduce. Other research pointed to the chemical as a human carcinogen. Use of DDT was banned in the United States in 1972.

- Organophosphates (1940s): parathion, diazinon, malathion

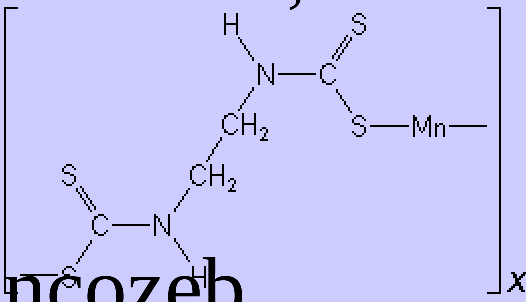


  - insecticide, low persistence, high acute mammalian toxicity, possible carcinogen, sus. endocrine disruptor

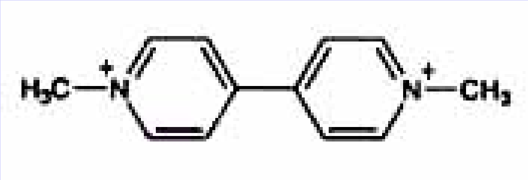
- Carbamates (insecticides, nematicides): aldicarb, benomyl



  - more persistent than OP, high acute mam. toxin, cholinesterase inhib, ground water, sus. endocrine disruptor

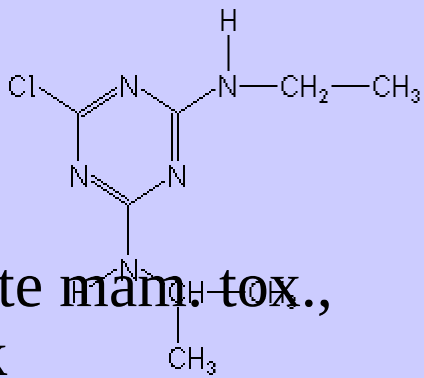


- Carbamate (fungicides): maneb, mancozeb
  - not acute mam. tox., carcinogen, dev/reprod toxin, sus. endocrine disruptor, low acute aquatic

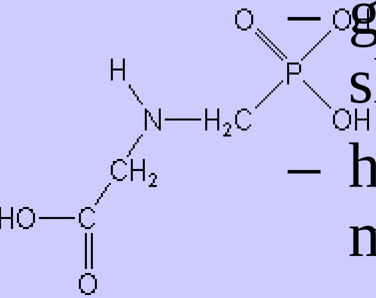


- Contact herbicides
  - Paraquat: persistent, high acute mam. Toxicity, slightly to high toxic aquatic
  - Triazine herbicides: Atrazine- persistent, low acute mam. toxicity, carcinogen,

    sus endo. dis., ground water



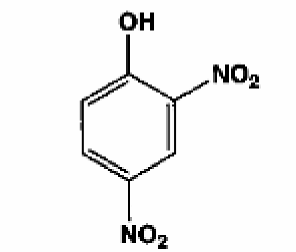
- Systemic herbicides



  - glyphosate (OP)- not persistant, low acute mam. tox., slightly toxic aquatic, Porter's new work
  - hormones (2,4-D (auxin); 2,4,5-T) - not persistent, moderate acute mam. tox.,

    poss. carcinogen; sus. endo. disruptor,

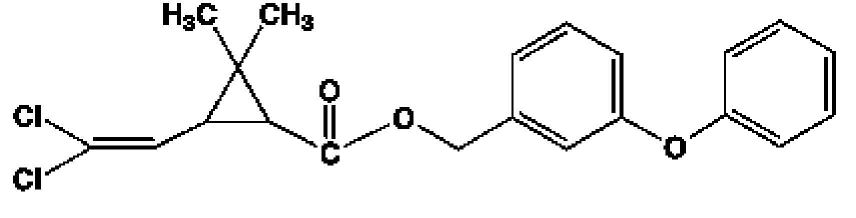
    potential ground water contaminant



2,4-Dinitrophenol

Pyrethroids (botanical)

- insecticide, low persistence, moderate acute mammalian toxicity, carcinogen, very highly acute toxicity to aquatic organisms
- Permethrin (add compound so doesn't degrade w/UV light), not organic
- used with salmon to eliminate



Permethrin


Associated Press

Maria Lopez for The New York Times

Banana Workers Get Day in Court

By DAVID GONZALEZ with SAMUEL LOEWENBERG

CHINANDEGA, Nicaragua — Manuel Guido Montoya never had the children he once hoped would ease his workload and bring home a few extra dollars. Years ago, he tried to start a family, he said, but the woman left him once she realized he was sterile.

Like scores of men and women in this banana-growing region — and thousands of field workers throughout Central America, the Caribbean, Africa and the Philippines — Mr. Guido blames dibromochloropropane, or DBCP, for his medical problems. The pesticide was banned in much of the United States in 1977 when it was found to cause sterility, but continued to be used for years in the banana plantations that supply American supermarkets.

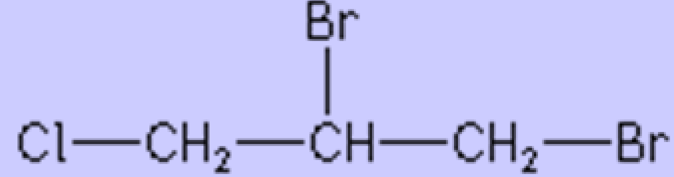
For two decades, the workers say, their efforts to win compensation for the damage done by DBCP — including sterility, cancer, and birth defects in children — have been frustrated by the legal tactics of American chemical and fruit companies. But now they are getting their day in court.

A ruling by a federal judge in New Orleans has opened the way for a lawsuit brought by 3,000 Central American banana workers seeking millions in damages, the first time one of these cases would be tried in the United States. The United States Supreme Court will hear arguments Wednesday on whether or not to allow other DBCP lawsuits to be tried in state courts.

And over the objections of the Bush administration, which has pressed the Nicaraguan government on behalf of the corporate

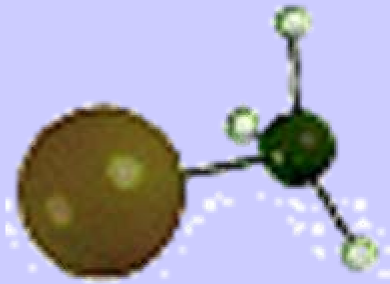
Continued on Page 3

Plantation workers in Nicaragua marched in November, demanding compensation for health problems they say were caused by a pesticide. Manuel Guido Montoya, above, said he and other workers who applied the pesticide were not told of the potential hazards.



DBCP

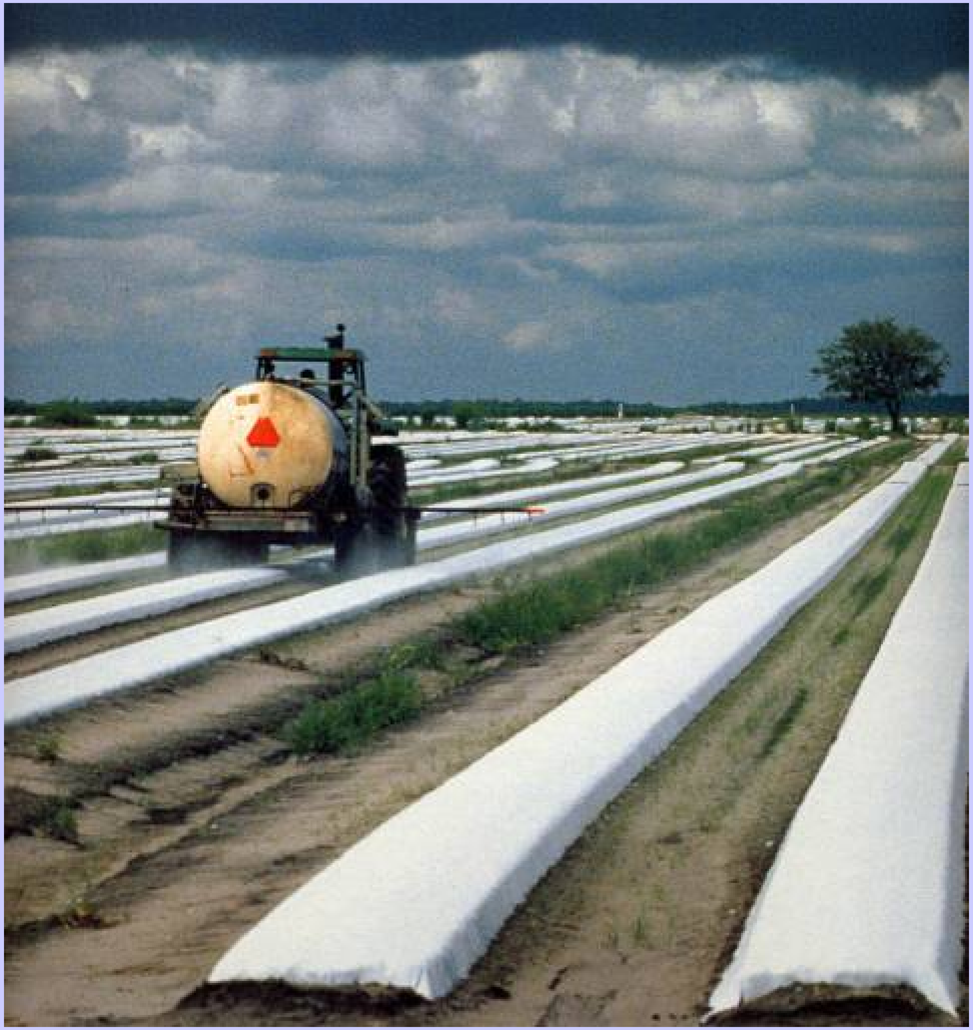
- nematicide
- Trade name Nemagon
- Moderate acute toxicity, causes male sterility, carcinogen, suspected endocrine disruptor, slight acute toxicity
- Used in Central America for 10 years after known US sterilization
- Still court cases
- Ave $6500/person in one settlement



Methyl Bromide

fumigant,sterilant

- High acute mam. toxicity, dev/reprod toxin, moderate acute aquatic toxicity
- Used on many crops before planting
- Phaseout in Jan 2005 Montreal convention, but Bush admin applied for an extension
- Now applying more than in 2003



Clopyralid (pyradine herbicide)
especially used in grasses for thistle control

Acute toxicity not available, not likely carcinogen, potential ground water contaminant, much not known
Problem: compost contamination

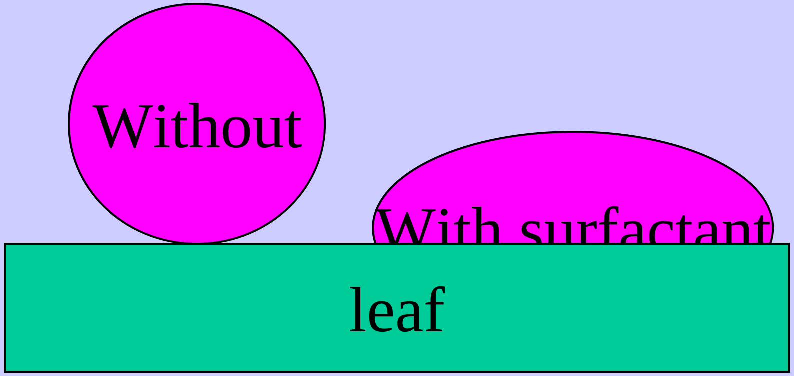
50-0 ppb symptoms on pinto bean

50 ppb

wsu.gov/compost

Adjuvants or additives

- Any substance added to a pesticide to enhance its performance
- Not under same regulations as pesticides
- "Considered to be non-pesticidal and non-toxic"
- Includes: surfactants, spreader-sticker, wetting agents, emulsifiers, reduced evaporation, foaming, buffering
- Many chemical types
- Under "inert" or now "other"



Surfactants reduce surface tension

“Inerts”

- In study from 1987-97 inerts doubled from 1200 to 2311
- Some 26% hazardous to human or environmental health
- EPA mandated public disclose and use decrease 97%
- 292 listed as unknown toxicity are registered by EPA as active ingred in other pesticides
- EPA supports rest of ingredients as secret
- Many no toxicity data
- Cox, Toxic Secrets “Inert Ingred. In Pesticides” NCAP

NCAP

Case of Roundup (glyphosate) surfactant POEA (polyethoxylated tallow amine), similar to spermicide

- Caroline Cox publishes paper 1988 that surfactant in Roundup was poisonous to people/animals based on Japanese data
- No action
- 2005- U of Pitt Biologist Relyea publishes that toxic to tadpoles
- In article in Science News EPA admits that it doesn't spent much time testing inerts

Science News Sept 7, 2005

Where to find info… www.pesticideinfo.org

- **Mike Beug's formulation used Atlox surfactant-** "Agramyl 135 is a modified starch derived from waxy maize that generates highly water-soluble films"
- If not pesticide but still has "inerts": Household products database http://householdproducts.nlm.nih.gov/cgi-bin/household/brands?tbl=chem&id=1754

Mode of action of certain insecticides on insects (acute)

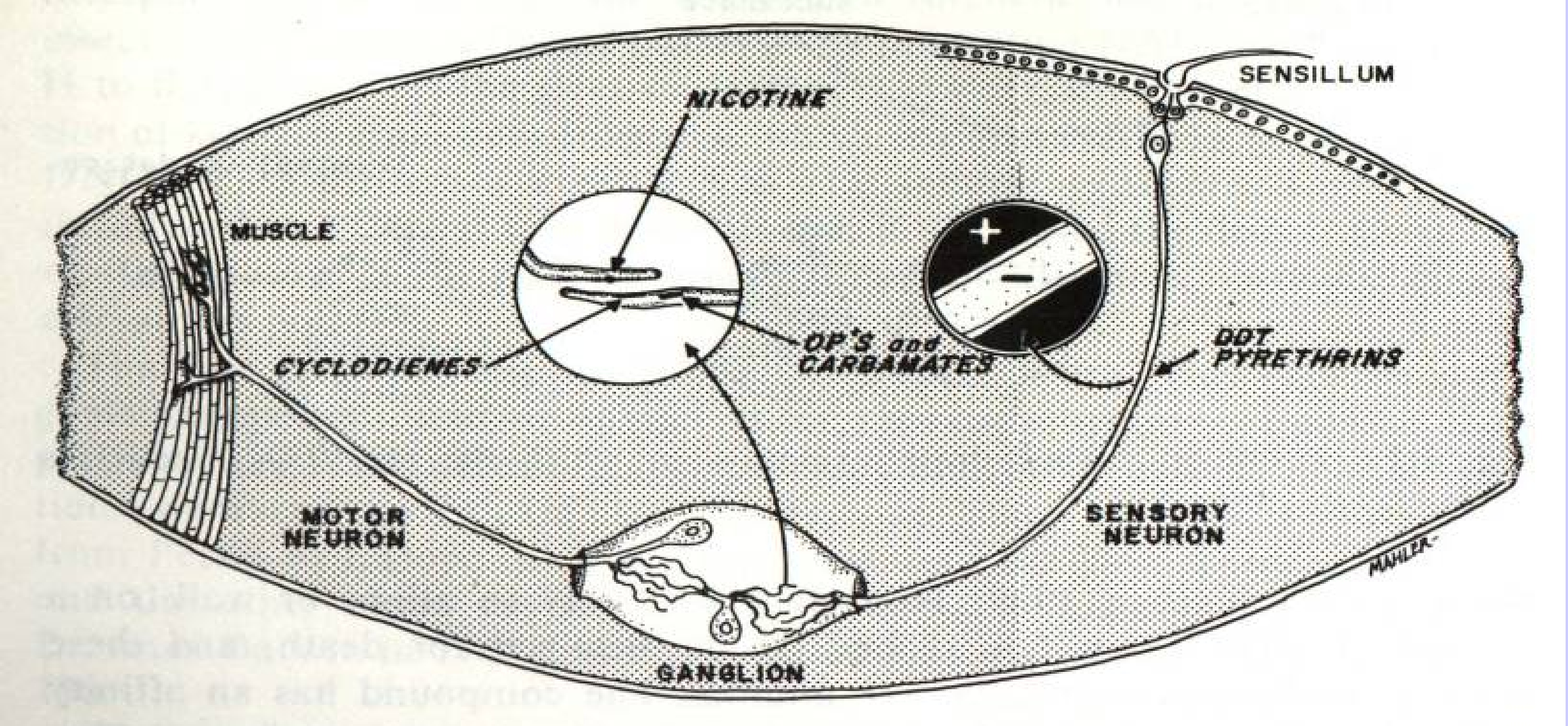
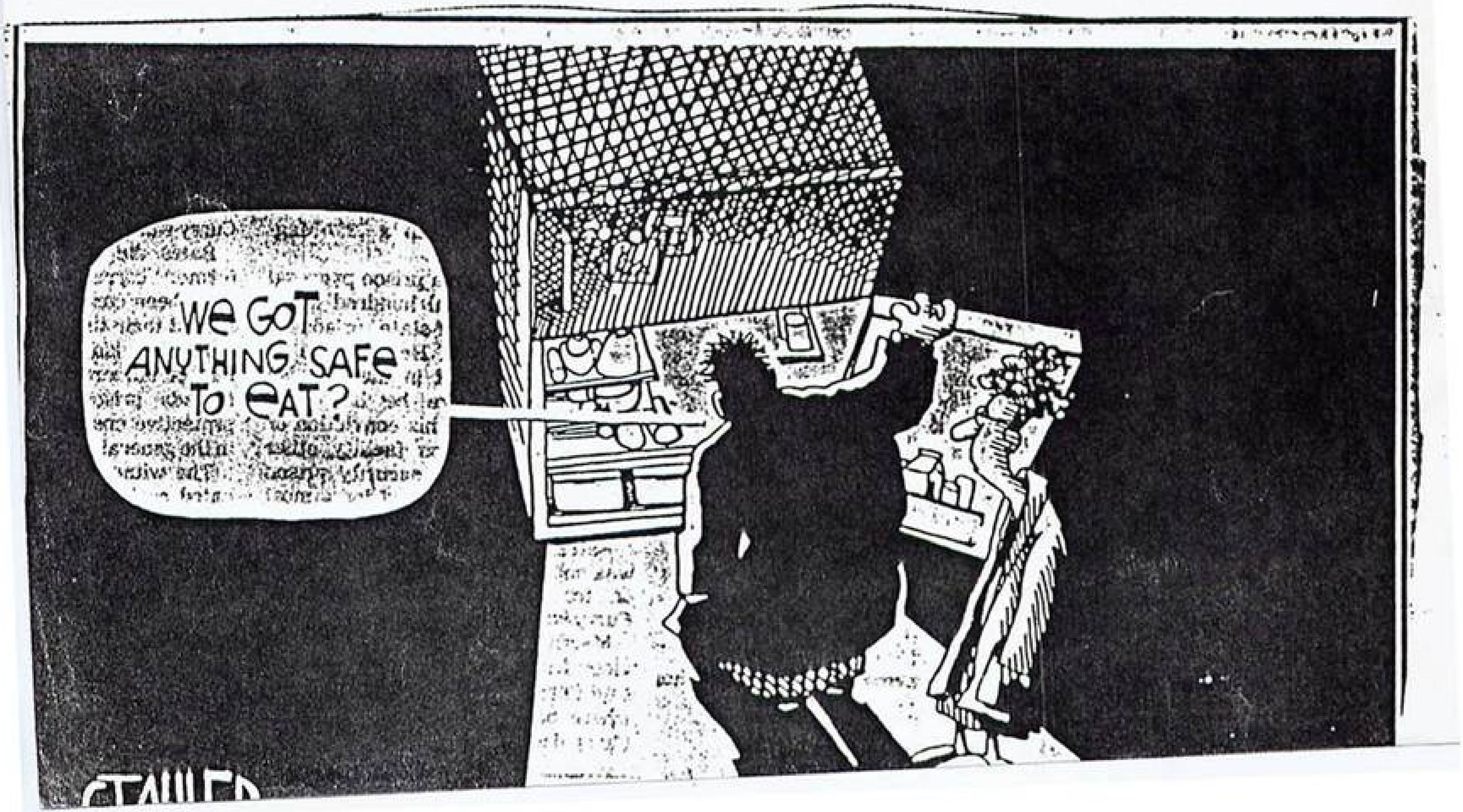


Fig. 1.2. Points in the insect nervous system at which the post-1945 insecticides derange or inhibit action-potential transmission.


WE GOT ANYTHING SAFE TO EAT?

II. Human and environmental health problems

- Consumers- acute and chronic effects of pesticide residues in food
  - Prev to 1938 tried to regulate Pb, As and Fl on fruits and vegetables
  - In mid 1990s still could buy PbAs in Costa Rica
- Farm workers- acute and chronic toxicity of pesticide applicators
- Wildlife- acute and toxic problems

Top 10 foods with pesticide residues

Impact on farmworker health

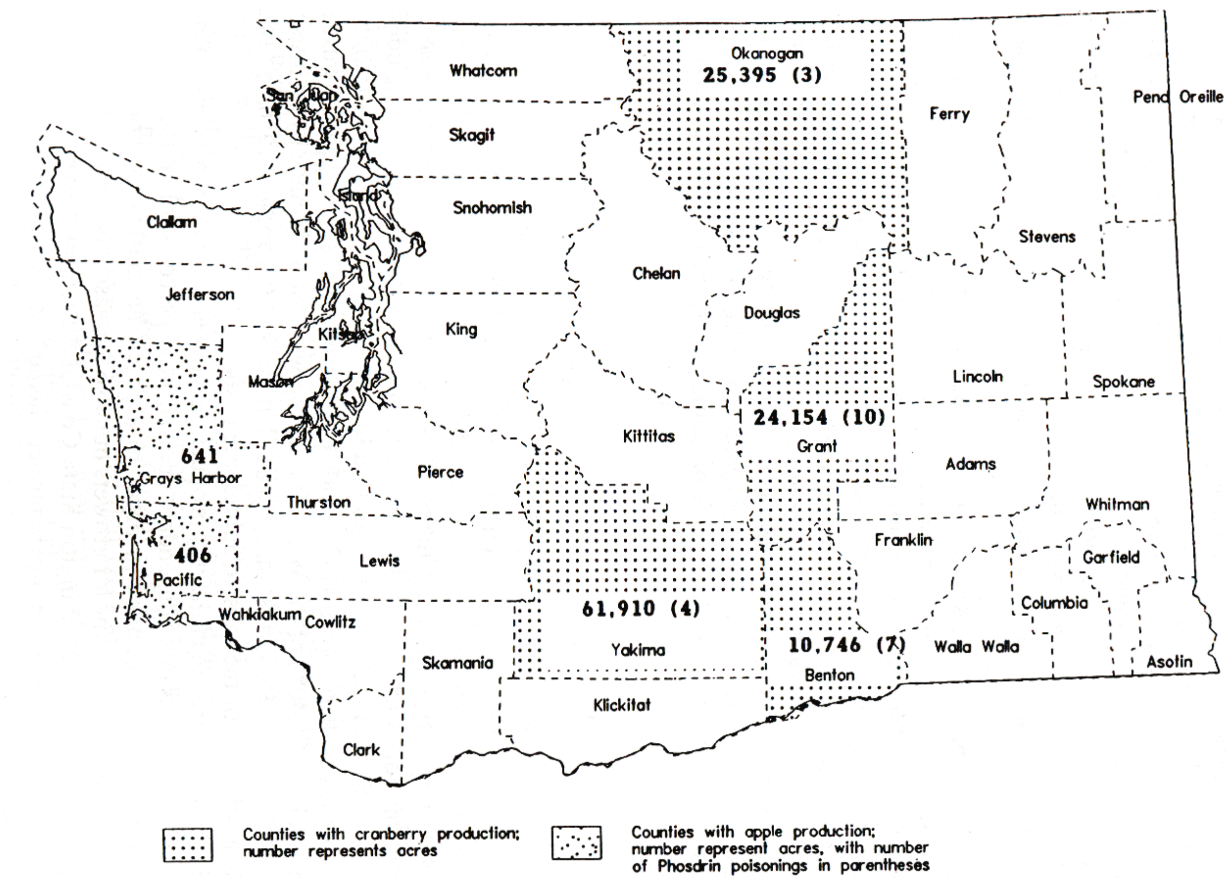


Figure 2.1 Geographic distribution of cranberry production and incidences of Phosdrin poisonings in apple orchards

(Pimentel, Techniques for Reducing Pesticide Use 1997)

1993

banned in '94

How acute toxicity determined

- Determination of safety: LD_{50}
  - Number of milligrams that kill 50% of rats or mice by method indicated (inhalation, cutaneous etc.)
  - Acute (immediate)

LD_{50}

Aldicarb 1 mg/kg

Atrazine 3080 mg/kg

Nitrate not tested for LD_{50} but causes blue babies

LD_{50} don’t take into account:

- Longterm effects
- Endocrine disruption
- Immune system effects
- Effects of low concentrations
- Mixtures of pesticides and fertilizers
- Multiple routes of exposure
- Additions (surfactants and other “inert” ingredients)
- Physiological stressors (malnutrition)

“New” story: Endocrine disruptors

Theo Colborne, 1987. *Our Stolen Future*.

- PhD UW, observations of birds of Great Lakes
- Led to endocrine disruptor hypothesis
- Data still emerging
- National EPA still not released list of suspected chemicals, though Illinois EPA, Keith, Colborn and Benbrook list and Canada and other countries have

Function of endocrine disruptors

- They can act like a natural hormone and bind to a receptor. This causes a similar response by the cell, known as an *agonist* response.
- They can bind to a receptor and prevent a normal response, known as an *antagonistic* response.
- A substance can interfere with the way natural hormones and receptors are synthesized or controlled.

Source of agricultural endocrine disruptors

- Agricultural runoff /Atmospheric transport
  - Organochlorine Pesticides (found in insecticides, many now phased out)
    - **DDT, dieldrin, lindane**
  - Carbamate insecticides
    - ****Aldicarb (PAN-pesticide database)**
- Agricultural runoff
  - Pesticides currently in use
    - ****Atrazine, trifluralin, permethrin**

Other sources of endocrine disruptors

- Incineration, landfill
  - PCB (Polychlorinated biphenyls), PCD (PC dioxins)
- Municipal effluent and agricultural runoff
  - Natural hormones produced naturally by (animals); synthetic steroids (contraceptives)
    - 17-b-estradiol, estrone, testosterone; ethynyl estradiol

- ECS Communications Last update: September 15 1999 http://www.ec.gc.ca/eds/fact/broch_e.htm

Dr. Warren Porter
UW Dept. Zoology

- Testing on wild mice
  - Mixtures of agrochemicals (including endocrine disruptors) at levels found in WI groundwater:
    - **Atrazine, Aldicarb, nitrate**
  - Concentrations at much below EPA testing
  - Different times of year
  - Different nutritional states
- EPA Response

Porter's article makes headline news in Madison WI

WI STATE JOURNAL

March 16 1999

50 CENTS

DISON, WISCONSIN

UW-Madison scientist Warren Porter is the lead author of a study which found that common combinations of pesticides and fertilizers altered thyroid hormones in young mice, changing their behavior and growth. His study complements other studies which show that pesticides affected the personalities and motor skills of children.

File photo/ PASKUS STUDIO INC.

Study sees dangers in the water

Research on mice hints chemicals could harm kids

By Rick Barrett
Agribusiness reporter

A mix of chemicals commonly found in ground water altered the development of young mice and indicates a threat may exist for children, a UW-Madison professor said Monday in releasing a five-year study.

sources, supports other studies that looked at children exposed to pesticides.

"It's not much of a leap to go from a mouse to a human when you are talking about the level of a chemical that might induce cancer or mutations," he said. Children have developing brains and immune systems and are "especially vulnerable" to changes in thyroid hormones.

To complement his study, Porter cited tests in the state of Sonora, Mexico, where scientists found striking differences in hand-eye coordination and other mental and physical skills when compar-

Co-authors of Porter's study include James Jaeger of the UW-Madison zoology department and Ian Carlson of the University Hospital Endocrinology Laboratory.

Porter said he believes this type of research is in its early stages and that more work needs to be done in assessing risks based on combinations of pesticides and fertilizers.

"But the single most important finding of the study is that common mixtures, not the standard one-chemical-at-a-time experiments, can show biological effects at current conditions in ground water," Porter said. "I think we have added something to a growing body of evidence."

Helpful definitions

Pesticide: A substance used to control insect, plant, or animal pests. Pesticides include fungicides, herbicides.
Fungicide: A chemical used to control fungi.
Herbicide: A chemical used to kill or inhibit plant growth
Insecticide: A chemical used to control insects.
Trade name: The brand name which is the specific, registered name given by a manufacturer to a pesticide product also known as the proprietary name.

SOURCE: Wisconsin Department of Agriculture, Trade and Consumer Protection

WSJ graphi

Endocrine, immune, and behavioral effects of aldicarb (carbamate), atrazine (triazine) and nitrate (fertilizer) mixtures at groundwater concentrations

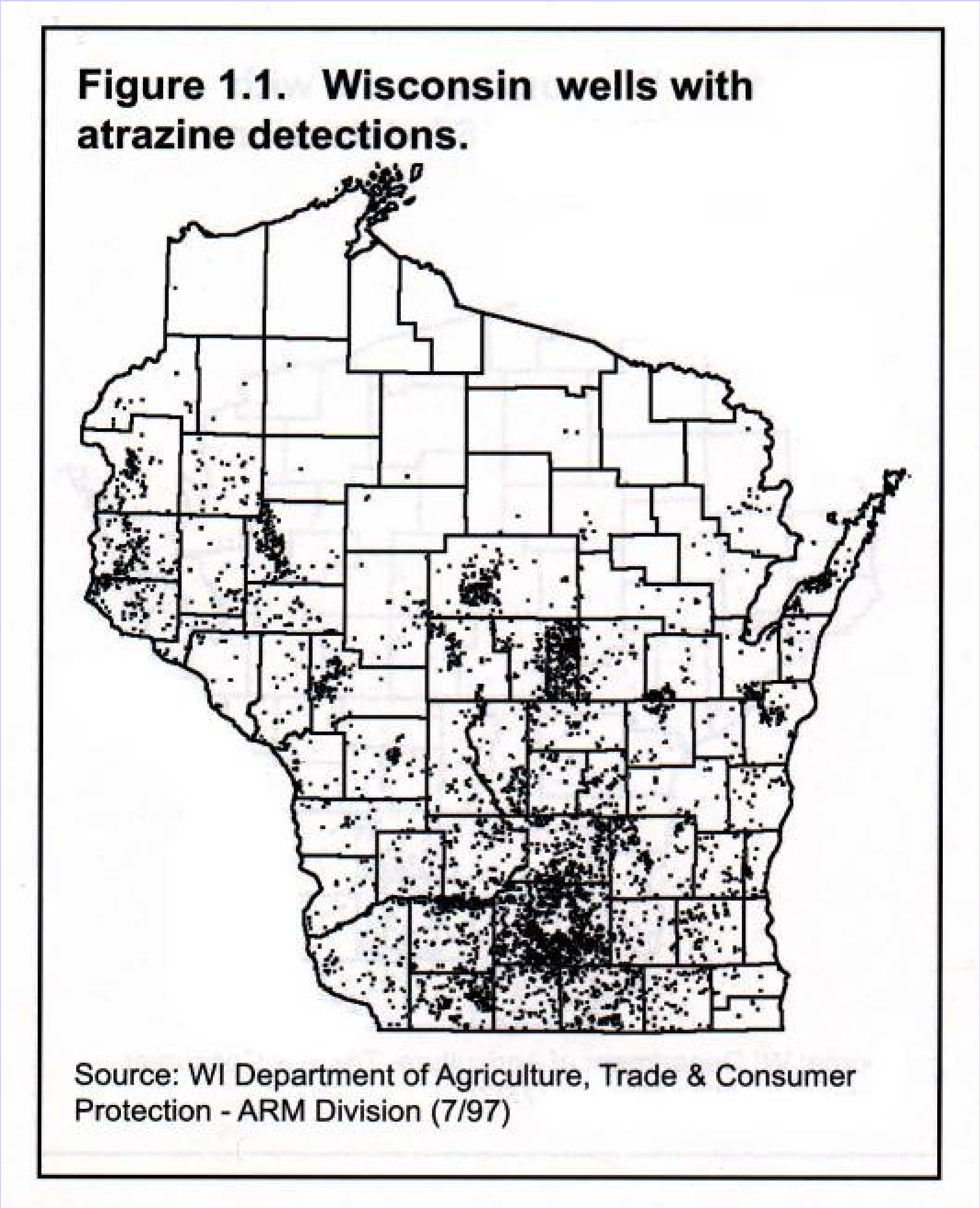
WARREN P. PORTER, [a,†] JAMES W. JAEGER [a] AND IAN H. CARLSON [b]

[a] *Department of Zoology, University of Wisconsin, Madison, Wisconsin*
[b] *Endocrinology Laboratory, University of Wisconsin Hospital, Madison, Wisconsin*

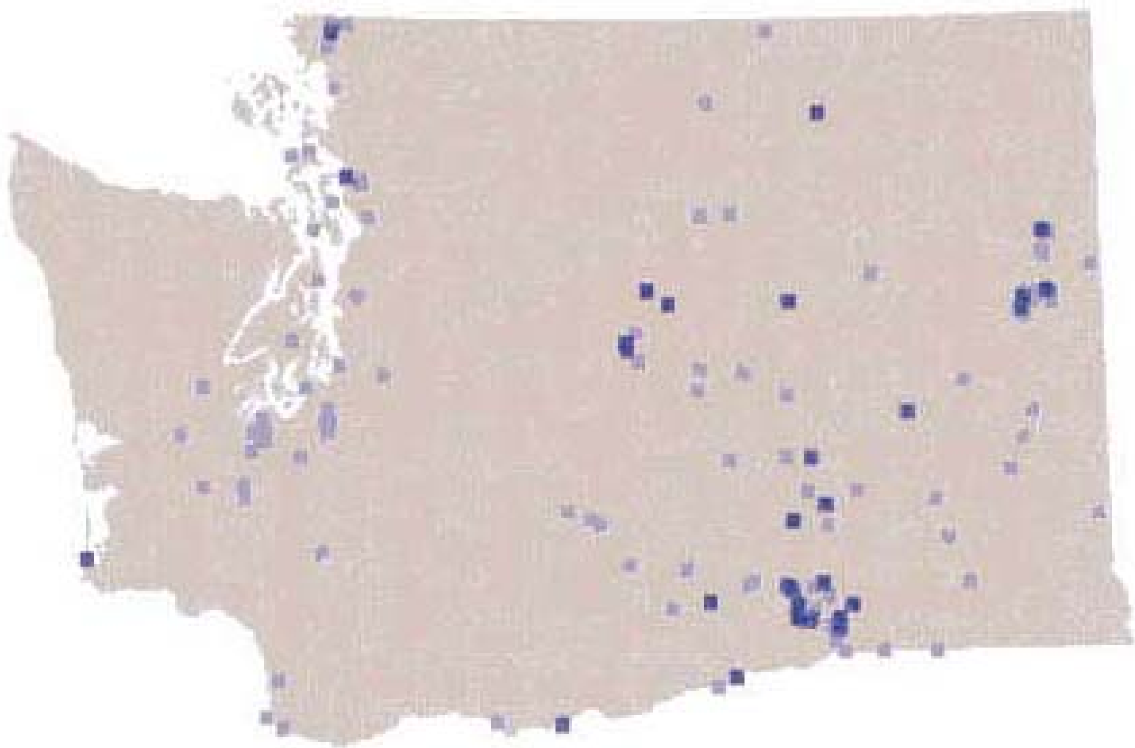
This paper describes the results of 5 years of research on interactive effects of mixtures of aldicarb, atrazine, and nitrate on endocrine, immune, and nervous system function. The concentrations of chemicals used were the same order of magnitude as current maximum contaminant levels (MCLs) for all three compounds. Such levels occur in groundwater across the United States. Dosing was through voluntary consumption of drinking water. We used fractional and full factorial designs with center replicates to determine multifactor effects. We used chronic doses in experiments that varied in duration from 22 to 103 days. We tested for changes in thyroid hormone levels, ability to make antibodies to foreign proteins, and aggression in wild deer mice, *Peromyscus maniculatus*, and white outbred Swiss Webster mice, *Mus musculus*, ND4 strain. Endocrine, immune, and behavior changes occurred due to doses of mixtures, but rarely due to single compounds at the same concentrations. Immune assay data suggest the possibility of seasonal effects at low doses. We present a multiple-level model to help interpret the data in the context of human health and biological conservation concerns. We discuss six testing deficiencies of currently registered pesticides, and suggest areas of human health concerns if present trends in pesticide use continue.

Keywords: *aldicarb, atrazine, behavior, endocrine, groundwater mixtures, immune, nitrate.*

Atrazine detected in groundwater in Wisconsin



Public water supply wells with Nitrate-Nitrogen levels above 5 milligrams/liter - 1995



Aggression after 14 days of exposure

Chemical(s)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 7*
Ald	-	-	-	-	-	-
Atz	-	-	-	-	-	-
Nit	0.1662	-	0.0579	0.008 **	-	-
Ad-Az	0.1948	-	-	-	0.0347 *	-
Ad-Ni	-	-	-	-	-	-
Az-Ni	-	0.0547	-	0.0247 *	-	0.1963
A-A-N	-	-	0.0077 **	-	0.1549	-
Degrees of Freedom Num, denom	1,33	1,40	1,40	1,40	1,40	1,40

* significant $p < 0.05$

** significant $p < 0.01$

Porter 2000

Ability to make antibodies to foreign proteins significantly reduced in mixtures

Plaque forming ability

Chemical(s)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 8	Exp 11
Ald	-	-	-	-	-	0.0827	.0179 *	0.1222
Atz	.0348 *	0.1937	-	0.1275	-	-	-	-
Nit	-	-	-	-	0.0541	-	-	-
Ad-Az	-	.0026 **	0.0775	-	0.0832	-	.0362 *	-
Ad-Ni	-	.0039 **	-	-	.0280 *	-	-	-
Az-Ni	-	.0044 **	0.0587	.0045 **	.0258 *	-	0.1158	-
A-A-N	-	-	-	0.1691	0.1858	-	-	-
Degrees of Freedom Num. denom	1,34	1,39	1,37	1,35	1,39	1,39	1,38	1,40

* significant p <0.05

** significant p <0.01

Porter 2000

Free thyroid index

Chemical(s)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 11
Ald	-	0.0053 **	-	-	0.0777	0.1779	-	0.194	-
Atz	-	-	-	-	-	-	-	-	0.1842
Nit	-	-	-	-	0.1942	-	-	-	-
Ad-Az	-	-	0.1611	-	-	0.1654	-	0.1582	-
Ad-Ni	-	0.1418	0.1289	-	-	-	-	-	-
Az-Ni	-	0.0432 *	-	-	-	-	-	-	-
A-A-N	-	-	-	-	0.0149 *	-	0.0614	-	-
Degrees of Freedom Num, denom	1,26	1,37	1,37	1,33	1,37	1,39	1,35	1,38	1,35

* significant $p < 0.05$

** significant $p < 0.01$

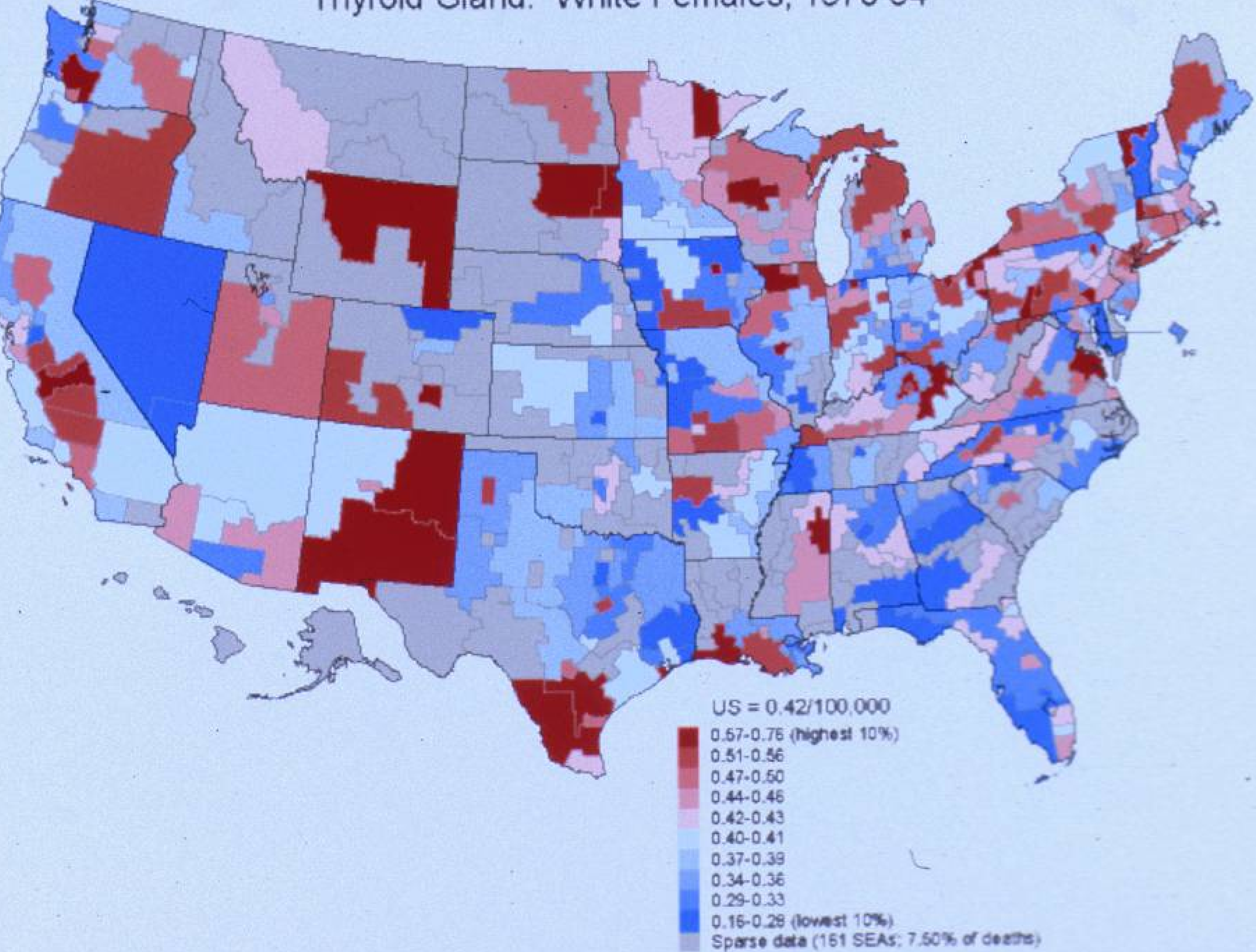
Porter 2000

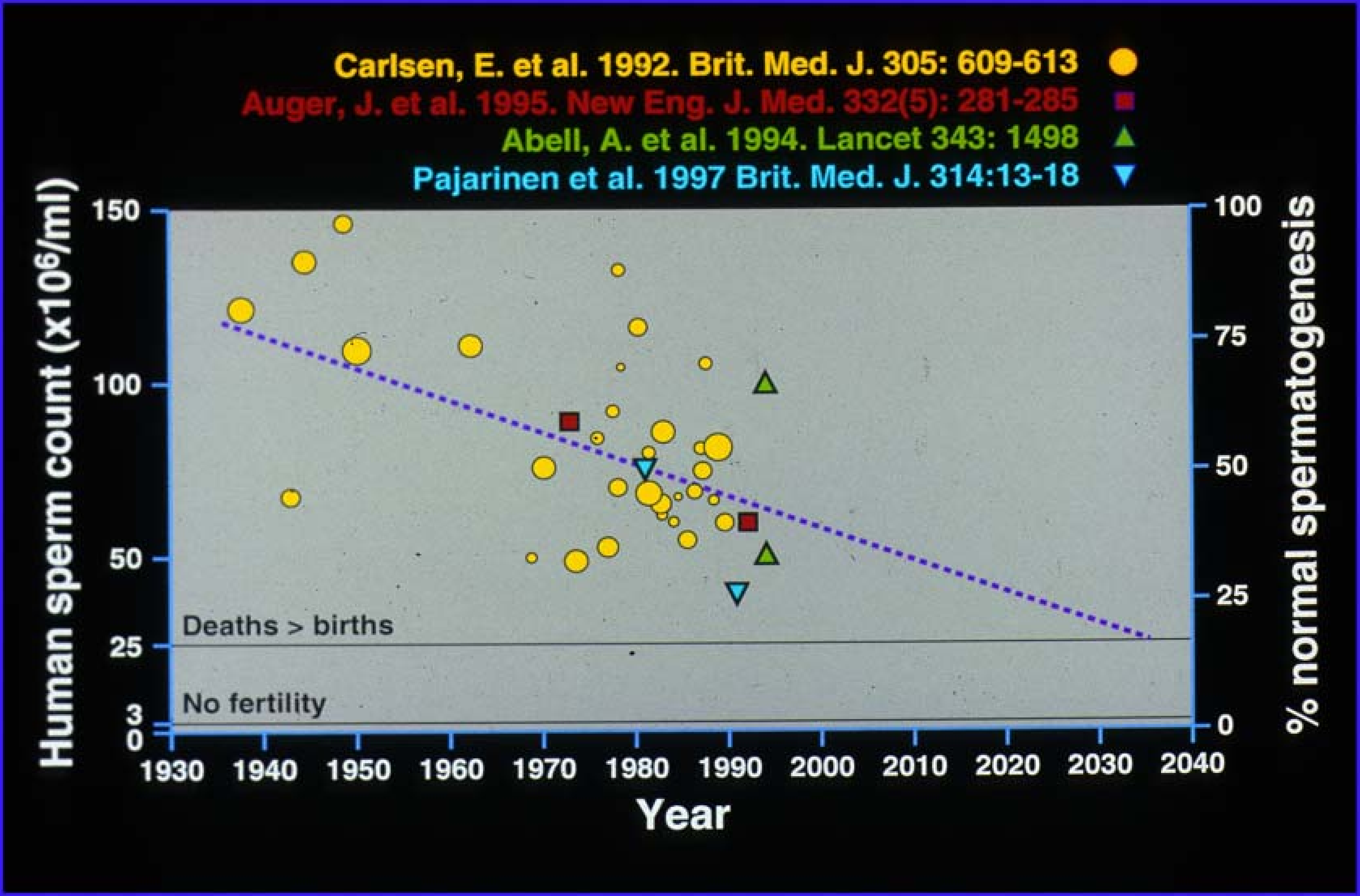
Human health effects from this mixture at environmental levels

- increases in thyroid cancer
- reduction in sperm count
- depressed immune response
- increased in emotional disturbance
- increased learning disabilities

Cancer Mortality Rates by State Economic Area (Age-adjusted 1970 US Population)

Thyroid Gland: White Females, 1970-94




Carlsen, E. et al. 1992. Brit. Med. J. 305: 609-613
Auger, J. et al. 1995. New Eng. J. Med. 332(5): 281-285
Abell, A. et al. 1994. Lancet 343: 1498
Pajarinen et al. 1997 Brit. Med. J. 314:13-18
Human sperm count (x10⁶/ml)
150
100
50
25
3
0
Deaths > births
No fertility
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
Year
% normal spermatogenesis
100
75
50
25
0

Porter 2000

Pesticide Appliers, Biocides, and Birth Defects in Rural Minnesota

Vincent F. Garry(1), Dina Schreinemachers(2), Mary E. Harkins(1), and Jack Griffith(2)

(1) University of Minnesota Laboratory of Environmental Medicine and Pathology, Minneapolis, MN 55414 USA; (2) U. S. Environmental Protection Agency, Research Triangle Park, NC 27711 USA

Earlier studies by our group suggested the possibility that offspring of pesticide appliers might have increased risks of birth anomalies. To evaluate this hypothesis, 4,935 births to 34,772 state-licensed, private pesticide appliers in Minnesota occurring between 1989 and 1992 were linked to the Minnesota state birth registry containing 210,723 live births in this time frame. The birth defect rate for all birth anomalies was significantly increased in children born to private appliers. Specific birth defect categories, circulatory/respiratory, urogenital, and musculoskeletal/integumental, showed significant increases. For the general population and for appliers, the birth anomaly rate differed by crop-growing region. Western Minnesota, a major wheat, sugar beet, and potato growing region, showed the highest rate of birth anomalies per/1000 live births: 30.0 for private appliers versus 26.9 for the general population of the same region. The lowest rates, 23.7/1000 for private appliers versus 18.3/1000 for the general population, occurred in noncrop regions. The highest frequency of use of chlorophenoxy herbicides and fungicides also occurred in western Minnesota. Births in the general population of western Minnesota showed a significant increase in birth anomalies in the same three birth anomaly categories as appliers and for central nervous system anomalies. This increase was most pronounced for infants conceived in the spring. The seasonal effect did not occur in other regions. The male/female sex ratio for the four birth anomaly categories of interest in areas of high phenoxy herbicide/fungicide use is 2.8 for appliers versus 1.5 for the general population of the same region ($p = 0.05$). In minimal use regions, this ratio is 2.1 for appliers versus 1.7 for the general population. The pattern of excess frequency of birth anomalies by pesticide use, season, and alteration of sex ratio suggests exposure-related effects in appliers and the general population of the crop-growing region of western Minnesota. **Key words**: agriculture, birth defects, data linking, fungicides, herbicides, pesticide appliers. --Environ Health Perspect 104:394-399 (1996) http://ehpnet1.niehs.nih.gov/docs/1996/104(4)/garry.html

WISCONSIN STATE JOURNAL

MONDAY, FEBRUARY 10, 1997 — MADISON, WISCONSIN

INSIDE

FOOD *Monday*

CELEBRITIES REVEAL FAVORITE RECIPES

See Daybreak/1C

Executive hopefuls offer range of skills

■ **The Dane County position requires leadership and management abilities.**

By Marv Balousek
County reporter

Six candidates with varied backgrounds in business and government want to be the next Dane County executive.

The position will pay $72,189 a year, nearly $12,000 more than the annual salary of incumbent County Executive Rick Phelps.

The job requires a combination of leadership and management skills. The executive must provide political leadership and determine the "big picture" direction for the county.

Whoever is elected also will serve as chief executive officer, managing a $284 million budget, supervising 1,969 employees and appointing members of 49 boards and commissions.

It's a relatively new position as far as government jobs go, having been established in 1972.

County functions include human services, the jail, the emergency dispatch center, Dane County Exposition Center, zoo, airport, landfill, parks, highways and zoning.

Phelps, who is not seeking reelection after nine years in office,

Please see COUNTY, Page 4A

SPECIAL REPORT

Elvehjem Elementary fifth-graders Bobby Buright, left, and Jim Dalton work on their spelling skills with special education teacher Marilyn Uselman outside of their regular classroom. The district combines such "pull-out" programs with one-on-one help in students' regular classes.

The cost of accommodating

As special education grows, so does the expense of staffing

By Phil Brinkman
Education reporter

To introduce an assignment on division, Elvehjem Elementary teacher Mary Brand asked her students to try to find the number of minutes in 200 seconds.

While not overly complicated, the exercise required her students' undivided attention. Twenty-one of the 23 students in this typical Madison classroom had their eyes on the teacher. Several of them raising their hands to answer the question.

The other two were in worlds of their own. One kept opening and closing her desk top, digging among the crayons and notebooks. The other seemed overwhelmed, not knowing quite what to do with the assignment sheet on his desk.

Brand never stopped teaching; she didn't have to. In both cases, an adult hovered nearby, as sort of a guardian angel, to calm down the children, explain the material and lead them through the task.

The adults, handicapped children's assistant Sandra Hebgen and special education teacher Marilynn Uselman, are among the hundreds of specialists employed by the Madison School District to help troubled or disabled children — and their teachers — make it through the school day.

"I would never be able to meet these children's needs without their help," Brand said of the two.

But is the cost of that help getting too high? Some are asking whether the district can continue paying for the extraordinary level of support special education offers to a relatively small number of students.

"I think parents in the system who expect every teacher to cater to their every need ... is well beyond what they can ask the district to deliver," said Nancy Mistele, a former School Board member and frequent critic of district spending. "It's giving short shrift to a lot of

Please see SPECIAL, Page 3A

Number of special education students rising

Change in the number of students between 1990–1995 in the Madison school district, by disability

Disabling condition	Total 1990	Total 1995	Percent change
Autism	—	6	—
Cognitive disability	412	466	13.1
Emotionally disturbed	272	509	87.1
Hearing handicapped	40	44	10.0
Learning disabilities	727	1,236	70.5
Other health impaired	34	17	-50.0
Orthopedically impaired	41	75	82.9
Speech and Language	876	871	-.6
Visual impairment	22	17	-22.7
Total	2,424	3,355	38.4

SOURCE: U.S. Department of Education Federal Childcounts — WSJ graphic

SCHOOLS *of* HOPE

This is the second in a three-part series examining how the Madison School District spends money on personnel.

Sunday: Where are staffing dollars going?

Today: The cost of special education.

Tuesday: Meeting students' social and emotional needs.

Governor criticized for silence on mining

Chvala, others view his environmental proposal as 'weak'

By Natasha Kassulke
Wisconsin State Journal

Legislative leaders had mixed reactions Sunday to Gov. Tommy Thompson's $200 million environmental protection plan.

Parts of the plan were made public Sunday in the Wisconsin State Journal, and Senate Majority Leader Chuck Chvala called what he read "weak."

Chvala criticized Thompson for not addressing mining-related proposals, especially Exxon's plan to dig a zinc and copper mine in Crandon in northeastern Wisconsin.

"The Crandon mine is the number one environmental issue right now and clearly the governor is shying away from the issue," Chvala said.

Thompson's mining proposals won't be released until Wednesday when he gives his budget address for the 1997-99 biennium to the Legislature.

Rep. DuWayne Johnsrud, R-Eastman, said he wasn't surprised by the plan, but he was disappointed Thompson didn't address mining.

"There are lots of proposals related to mining floating around out there and I have no idea what the governor's up to with that," said Johnsrud, chairman of the Assembly Natural Resources Committee.

Among the plans before the Legislature is one from Rep. Spencer Black, D-Madison, who proposed a ban on sulfide mines until a similar mine has been operating elsewhere for at least 10 years without damaging the environment.

Black, Democratic leader on the Assembly Natural Resources Committee, criticized Thompson's plan to use $20 million from the state's recycling fund, about half the annual recycling budget, to help clean up abandoned industrial sites.

"Our recycling program is the best in the nation and the governor's proposed raid on the recycling fund would undermine our recycling efforts," Black said. "While I support the (cleanup) effort, it's a shame the governor is proposing to pit one good environmental program, recycling, against another."

Chvala slammed Thompson for ignoring an agenda Democrats will

Number of special education students rising

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Autism	—	6	—
Cognitive disability	412	466	13.1
Emotionally disturbed	272	509	87.1
Hearing handicapped	40	44	10.0
Learning disabilities	727	1,238	70.3
Other health impaired	34	17	-50.0
Orthopedically impaired	41	75	82.9
Speech and Language	876	911	4.0
Visual Impairment	22	17	-22.7
Total	**2,424**	**3,283**	**35.4**

SOURCE: U.S. Department of Education Federal Childcounts

WSJ graphic/LAURA SPARKS

Environmental Health Perspectives Volume 106, Number 6, June 1998

[Citation in PubMed] [Related Articles]

An Anthropological Approach to the Evaluation of Preschool Children Exposed to Pesticides in Mexico

Elizabeth A. Guillette,[1] María Mercedes Meza,[2] Maria Guadalupe Aquilar,[2] Alma Delia Soto,[2] and Idalia Enedina Garcia[2]

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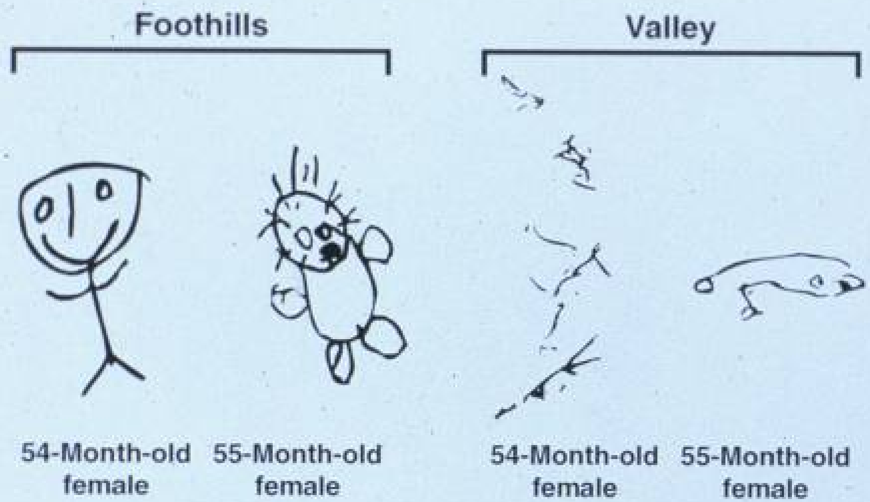


Figure 1. Representitive drawings of a person by 4-year-old Yaqui children from the valley and foothills of Sonora, Mexico.

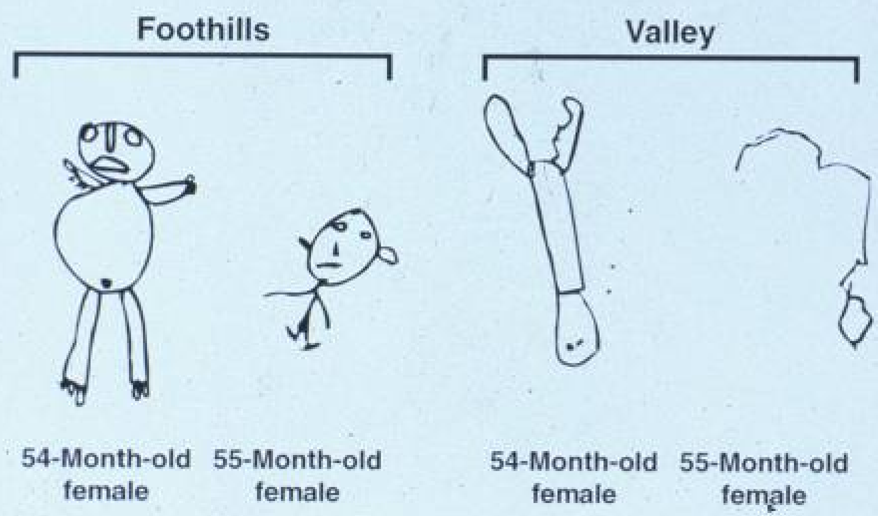


Figure 2. Representitive drawings of a person by 5-year-old Yaqui children from the valley and foothills of Sonora, Mexico.

Pesticide cost on human health (without the more subtle effects)

Table 4.1 Estimated economic costs of human pesticide poisonings and other pesticide-related illnesses in the United States each year

Human health effects from pesticides	Total costs ($)
Cost of hospitalized poisonings	
2380[a] × 2.84 days at $1000 day^{-1}	6 759 000
Cost of outpatient treated poisonings	
27 000[b] × $630[c]	17 010 000
Lost work due to poisonings	
4680[a] workers × 4.7 days × $80 day^{-1}	1 760 000
Pesticide cancers	
<12 000[d] cases × $70 700[c] $case^{-1}$	848 400 000
Cost of fatalities	
27 accidental fatalities[c] × $2.2 million	59 400 000
Total	933 329 000

[a]Keefe et al., 1990.
[b]J. Blondell, EPA, Washington, DC, personal communication, 1991.
[c]Includes hospitalization, foregone earnings, and transportation.
[d]See text for details.

From: Pimental and Greiner. 1994. Environmental and social costs of pesticide use. *Techniques for Reducing Pesticides.* Wiley

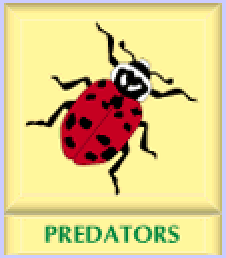
Examples of endocrine related effects in wild populations

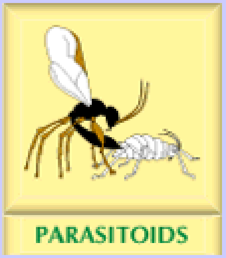
- **deformities and embryo mortality in birds and fish caused by exposure to industrial chemicals and organochlorine insecticides;**
- **impaired reproduction and development in fish exposed to effluents from pulp and paper mills;**
- **abnormal reproduction in snails exposed to antifouling substances applied to the exteriors of ships;**
- **depressed thyroid and immune functions in fish-eating birds;**
- **feminization of fish near municipal effluent outlets.**

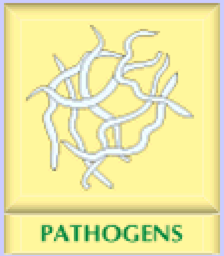
http://www.ec.gc.ca/eds/fact/broch_e.htm

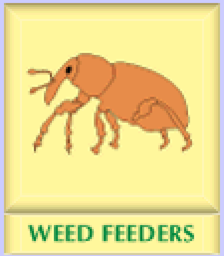
Destruction of natural enemies and honey bees

- Broad spectrum insecticides kill non-target organisms
- 1920-1950 much work on “natural enemies” and beneficial insects
- After about 1945 loss of pollinators and need to rent colonies of honey bees









Effects of pesticide use on energy

Table 1.2 Energy and economic inputs per hectare for conventional and modified corn production systems

	Conventional			Modified		
	Quantity	10^3 kcal	Economic ($)	Quantity	10^3 kcal	Economic ($)
Labour (h)	10	7	50	12	9	60
Machinery (kg)	55	1485	91	45	1215	75
Fuel (l)	115	1255	38	70	764	23
N (kg)	152	3192	81	27	5591	17
P (kg)	75	473	53	34	214	17
K (kg)	96	240	26	15	38	4
Limestone (kg)	426	134	64	426	134	64
Corn seed (kg)	21	520	45	21	520	45
Cover crop seed (kg)	–	–	–	10	120	10
Insecticides (kg)	1.5	150	15	0	0	0
Herbicides (kg)	2	200	20	0	0	0
Electricity (10^3 kcal)	100	100	8	100	100	8
Transport (kg)	322	89	32	140	39	14
Total		7845	523		3712	337
Yield (kg)	7000	24 746		8100	29160	
Output/input ratio		3.15			7.86	

Source: Data from Pimentel, 1993.

Pimental. 1994. Pest Management in Agriculture.*Techniques for Reducing Pesticides.* Wiley

III. Summary of environmental and social costs of pesticide use

Table 4.6 Total estimated environmental and social costs from pesticides in the United States

Costs	\$ million $year^{-1}$
Public health impacts	933
Domestic animal deaths and contamination	31
Loss of natural enemies	520
Cost of pesticide resistance	1400
Honey bee and pollination losses	320
Crop losses	959
Surface water monitoring	27
Groundwater contamination	1800
Fishery losses	56
Bird losses	2100
Government regulations to prevent damage	200
Total	8346

From: Pimental and Greiner. 1994 Environmental and social costs of pesticide use. *Techniques for Reducing Pesticides.* Wiley

The balance sheet

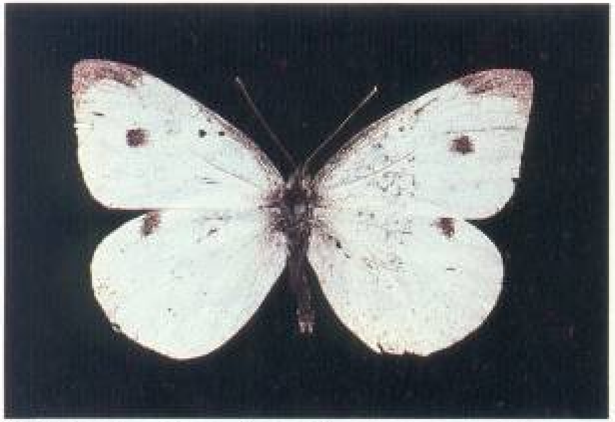
- $6.5B/yr in pesticides saves $26B/yr in US crops
- Environmental and social costs another $8.3B/yr (conservative figure)
  - difficult to estimate environmental and social costs
  - how to put into $ the cost of a human life

  From: Pimental and Greiner. 1994 Environmental and social costs of pesticide use. *Techniques for Reducing Pesticides.* Wiley

IV. Alternatives: Bio-pesticides

- Microbials- *Bacillus thuringensis (Bt)* stomach poison of a number of larvae of Lepidoptera (insect order which includes butterflies/moths)
  - Cabbage diamondback, looper, imported cabbageworm
  - Some resistance to *Bt* before genetically engineered into crops
  - Resistance is now increase due to incorporation in genetically engineered varieties
- Biochemical- plant growth regulators, or substances that repel or attract pests
  - pheromones, insect growth hormones

Imported Cabbageworm, *Pieris rapae*, Order Lepidoptera



Adult male cabbage butterfly.

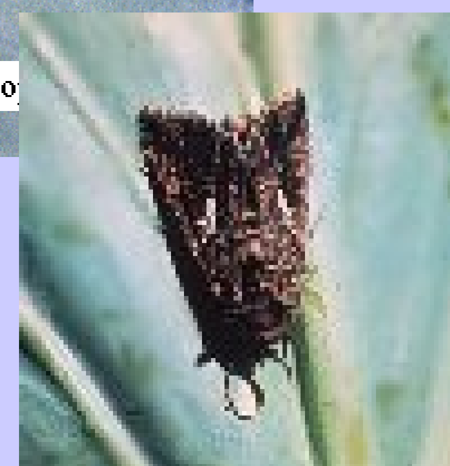
Imported cabbage worm larva and leaf damage. Note fecal pellets on leaf.

- Small yellow bullet-shaped eggs
- Similar larvae and damage to cabbage looper and diamond back moth
- Can be destructive
- Handpick in garden or spray *Bacillus thuringiensis*

Cabbage Looper, *Trichoplusia ni* Lepidoptera moth

Major problem of cabbage family

Can be controlled through *Bacillus thuringiensis*



Cabbage diamondback moth *Plutella xylostella*

Adult is moth
Smaller than other two
Causes holes in leaves
Manage using *Bacillus thuringiensis*

Alternatives, cont.

- botanical sprays and powders:
  - horsetail, pyrethrum (?)
  - rotenone, derris root
  - many now limited like tobacco, rotenone
- compost teas for fungal and bacterial diseases
- dormant oils
- some limited use of copper and sulfur
  - Bordeaux- hydrated lime plus copper

Fertility affects diseases: Take-all management with macro- and microelements

- **High NO_3-N favors disease**
- **High NH_4-N depresses disease**
- **In what form you apply nutrients can affect disease incidence**

Table 1. Mineral elements affecting take-all of cereals.

Increase Take-all	Reduce Take-all
Potassium nitrate	Potassium chloride
Phosphorus excess	Phosphorus sufficiency
Calcium carbonate (lime)	Sulfur
Magnesium carbonate	Magnesium chloride
Magnesium sulfate	Calcium chloride
Molybdenum	Manganese
	Iron
	Zinc
	Copper chloride

Huber 1989

Substitution not that costly

Table 17.1 Vegetable crop losses from insects with current insecticide use and estimated costs if insecticides were reduced and several alternatives were substituted

		Total insecticide use (kg – 10^6)		Insecticide treatment					
Crop	Area (ha – 10^3)[a]	Current[b]	Reduced[c]	Hectares treated (%)[d]	Cost ($ ha^{-1})[e]	Total cost ($ – 10^6)	Current crop pest loss (%)[c]	Added alternative cost ($ ha^{-1})[c]	Total added alternative control cost ($ – 10^6)[c]
Lettuce	90	0.35	0.26	97	68	5.9	7	10	0.70
Cole	111	0.40	0.20	62	30	2.1	13	10	0.70
Carrots	39	0.02	0.01	37	10	0.1	7	5	0.08
Potatoes	570	1.60	1.12	88	46	23.1		10	5.40
Tomatoes	145	0.20	0.15	95	26	3.6		0	0.00
Sweetcorn	206	0.27	0.05	84	70	12.1	19	10	2.00
Onions	54	0.75	0.50	79	18	0.8	4	5	0.27
Cucumbers	42	0.02	0.01	34	12	0.2	21	5	0.10
Beans	132	0.11	0.07	72	9	0.9	12	5	0.33
Cantaloupe	50	0.08	0.05	78	40	1.6	8	0	0.00
Peas	135	0.02	0.01	49	5	0.3	4	5	0.61
Peppers	25	0.09	0.06	85	80	1.7	7	5	0.09
Sweet potatoes	31	0.26	0.02	100	0	1.3	16	5	0.22
Watermelons	72	0.06	0.04	53	14	0.5	4	5	0.30
Other vegetables	100	0.01	0.006	40	30	1.2	13	5	0.20
Total		4.24	2.556			54.40			11.00

[a] USDA, 1992.
[b] Converted from USDA, 1993.
[c] Pimentel et al., 1991.
[d] USDA, 1993.
[e] Calculated.

(Pimentel, Techniques for Reducing Pesticide Use 1997)

IPM Programs

- Cotton, corn, alfalfa, soybeans, citrus, walnuts, apples, pears, vegetables and others
- In a study of 3500 growers in 15 states reduction of pesticide use has earned users $54 million/year than conventional (Rajotte et al. 1987 in BIRC)
- National Park Service reduced pesticide use 70% in first 3 years IPM implemented

V. Precautionary Principle for the adoption of new technologies

- determine if new technology is needed
- proof that it is <u>not</u> harmful

Currently

- a) no need to prove it is needed
- b) proof that it <u>is</u> harmful

The precautionary principle applied: the case of Sweden

- Public concern mid 1980s caused change
- Reduction of pesticides 50% 1985-1990
- Reduction of pesticides 50% of that 1990-1993
- As of 1993 reduction 65%
  - use of lower dose less detrimental herbicides- 25-30%
  - reduction in 10% due to less acreage planted
  - reduction 20-25%

The case of Sweden

Table 5.5 Pesticides in Swedish agriculture that have been suspended or restricted, 1986–1990

Removed from the market mainly because of:			Severely restricted for health or environmental reasons
Health reasons	Environmental reasons	Insufficient documentation	
Aldicarb	Aldicarb	Carbaryl	Benomyl
Bromacil	Atrazine	Chloroxuron	Captan
Carbaryl	Dicofol	Dienoclor	Carbendazim
Chlorothalonil	Lindane	Lenacil	Diquat dibromide
Cyhexatin	2-Methoxyethyl mercury acetate	Metoxuron sodium chlorate	Endosulfan
Diaminozide	Terbacil	TCA-sodium	Folpet
Dinocap	Thiram	Ziram	Simazine
1,3-Dichloro-propene	Trifluralin		Thiophanate-methyl
2-Methoxyethyl mercury acetate	Ziram		
Metoxuron			

Source: Swedish National Chemicals Inspectorate (1995).

Has the loss of pesticides hurt Swedish agriculture?

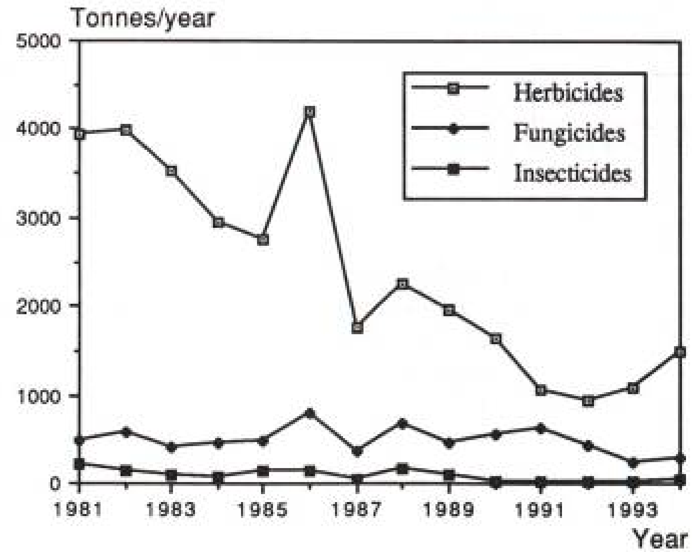


Figure 5.6 Use of pesticides in Swedish agriculture since 1980 by tonnes of active ingredient. *Source*: Swedish National Chemicals Inspectorate, 1995

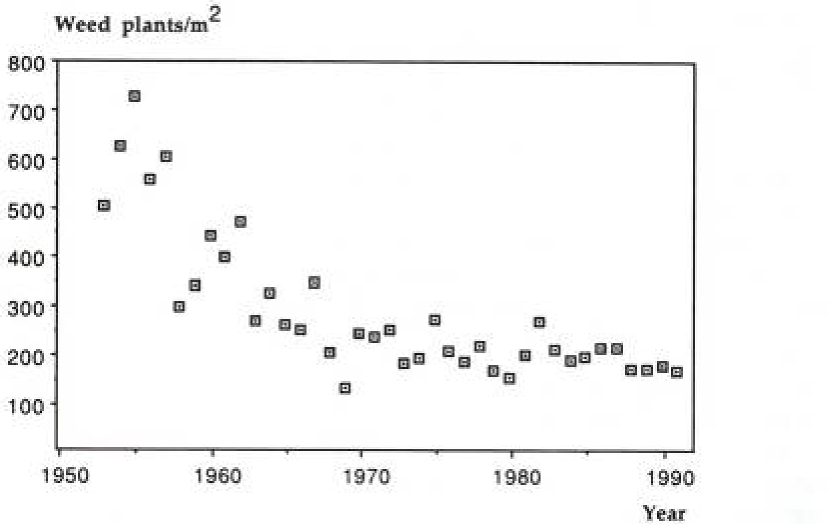


Figure 5.3 Number of weeds per square metre in Swedish field trials. *Source*: Pettersson (1994)

Summary

- Change to precautionary approach important (prove safety not damage)
- Test appropriately (mixtures etc.) and in addition to LD_{50},, developmental and reproductive effects, immune system, endocrine disruption, learning disabilities
- Public education about the problem
- Investment in green products, stocks (stakeholder power), research
  - (Assadourian, "The Role of Stakeholders" Sept/Oct 2005 WorldWatch)

Useful references and websites

- Pesticide Action Network http://www.pesticideinfo.org/index.html
- Washington Toxics Coalition
  www.watoxics.org 1-800-844-SAFE
- Farm Chemicals Handbook. Meisterpro Reference Guides. Annual update.
- Environment Canada Communications http://www.ec.gc.ca/eds/fact/broch_e.htm
- US EPA http://www.epa.gov/pesticides/
- Environmental Working Group
  www.ewg.org

Study questions

1) Look over information on your favorite pesticide on the PAN database (..www..pesticideinfo.org)

- Look up its LD_{50} and calculate the #g for acute, oral, dermal and inhalation for a 125lb person. What suspected endocrine disruptor by what list? What are the ecological effects?

2) The precautionary approach is adopted by the Int'l Biodiversity Convention for the protection of BD, but not any of the other international treaties the US has signed. How might this generate a conflict in a particular case?

3) How does a secondary pest resurgence contribute to the pesticide treadmill?