FOOD QUALITY, NUTRITION AND HEALTH

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Factors influencing human health

- **In 54% lifestyle, psychological status, people behaviour, in that nutrition pattern**
- **In 21 % environmental conditions, and food quality is connected with it**
- **In 15 % genetic background**
- **In 10 % medical service activity**

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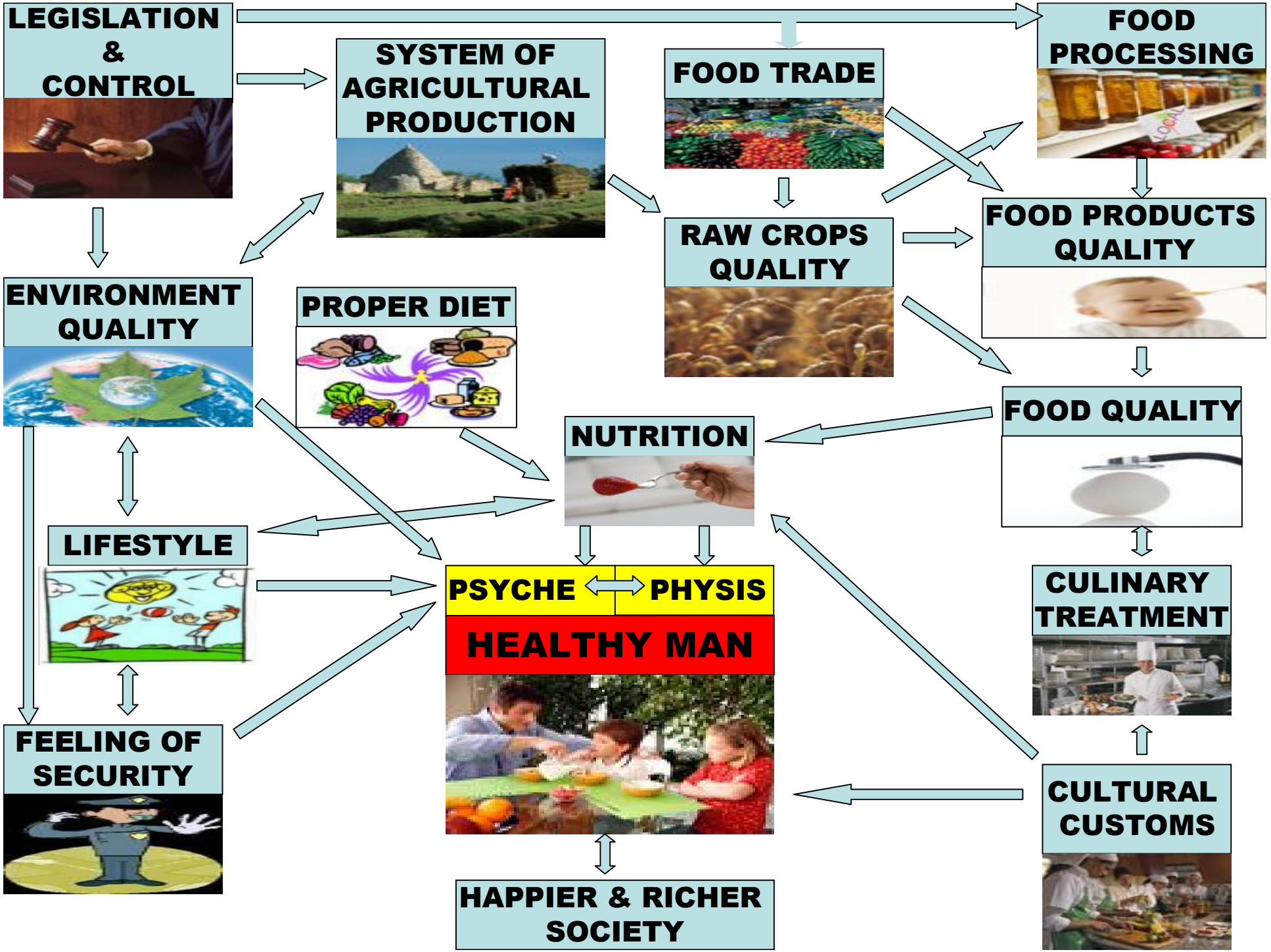
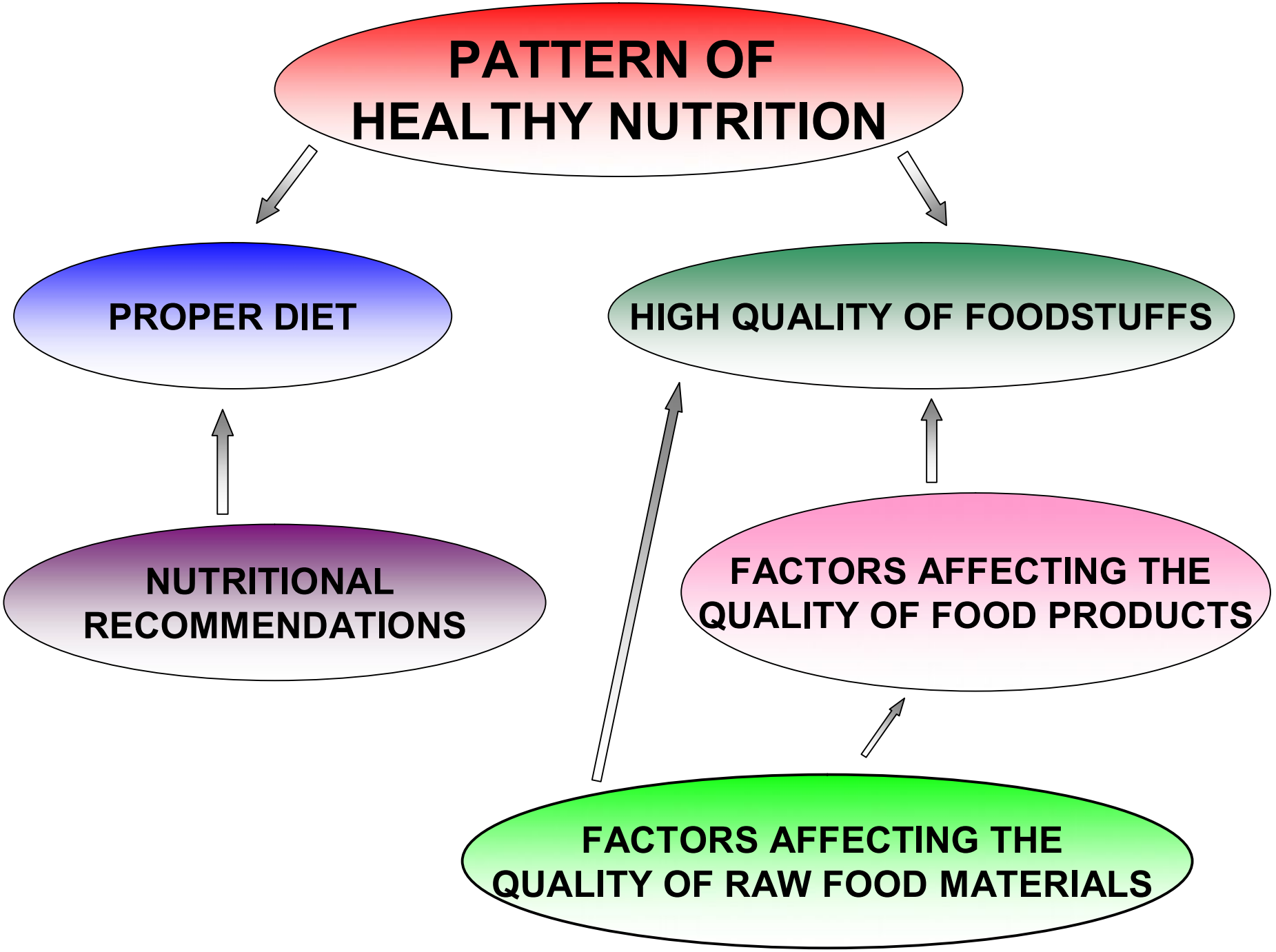
According to American Centre of Diseases Control (1996)


LEGISLATION & CONTROL
SYSTEM OF AGRICULTURAL PRODUCTION
FOOD TRADE
FOOD PROCESSING
RAW CROPS QUALITY
FOOD PRODUCTS QUALITY
ENVIRONMENT QUALITY
PROPER DIET
NUTRITION
FOOD QUALITY
LIFESTYLE
PSYCHE
PHYSIS
HEALTHY MAN
CULINARY TREATMENT
FEELING OF SECURITY
CULTURAL CUSTOMS
HAPPIER & RICHER SOCIETY


PATTERN OF HEALTHY NUTRITION
PROPER DIET
HIGH QUALITY OF FOODSTUFFS
NUTRITIONAL RECOMMENDATIONS
FACTORS AFFECTING THE QUALITY OF FOOD PRODUCTS
FACTORS AFFECTING THE QUALITY OF RAW FOOD MATERIALS

Nutritional recommendations elaborated by the specialists from FAO / WHO and Polish Nutritional Institute:

- health safety in a diversity of the consumed foodstuffs
- supporting of proper body mass protects from the metabolic diseases
- dark bread richer in vitamins, mineral compounds and fiber than white bread and rolls

- two glasses of skimmed milk daily secure sufficient quantity of calcium

- fish is better source of proteins than meat
- a lot of vegetables and fruits secure sufficient quantity of vitamin C, β-carotene, mineral compounds and fibre to our organism

- limited consumption of animal fats is a necessary condition of arteriosclerosis prevention
- avoidance of sweets protects our teeth from caries (decay) and facilitates to support the proper body mass
- less salt - smaller risk of hypertension and probably also cancer
- indulging too freely in alcohol ruins our health - moderation is recommended!

Definition of food safety

[Hansen et al. 2002]

FOOD SAFETY

Product safety *	Agri-food-system safety
• Safety, non-toxicity of the food • Safety, nutritious food • Safety of the declaration (all components of the food are shown on a declaration) • Safety of the label (the organic food is truly organic)	• Safety of supply • Safety of distribution • Safety of transparency and proximity • Safety of consumer influence on food production • Safety of information on the whole food production process (e.g. by using labels) • Safety, no negative impacts of production practices on humans and other living organisms, the environment, climate etc.

- The traditional definition (e.g. given by the Danish authorities)

FOOD CONTAMINATION, ITS SOURCES AND NEGATIVE HEALTH IMPACTS

FOOD CONTAMINATION	SOURCES	NEGATIVE HEALTH IMPACTS
HEAVY METALS		
Cadmium (Cd)	**Industry (non- ferrous metallurgy)** **Agriculture (phosphoric fertilisers)**	**Damage of kidneys, liver, osseous system** **Prostate cancer**
Lead (Pb)	**Industry** **Transport (lead petrol)** **Pots, canned food**	**Disturbances of protein synthesis** **Anaemia** **Neurological and cerebral changes**
Mercury (Hg)	**Chemical, electromechanical and dyeing industry** **Agriculture (seed dressing)**	**Paralysis of nervous system** **Mutagenic and teratogenic impact**
Arsenic (As)	**Metal - forming industry** **Petroleum refinery** **Agriculture (pesticides)**	**Carcinogenic impact** **Metabolic disturbances**
NITRATES, NITRITES	**Agriculture (nitric mineral fertilizers)** **Food processing**	**Methemoglobinaemia**
NITROSOAMINES	**Agriculture (nitric mineral fertilizers)** **Food processing**	**Carcinogenic**
PESTICIDES, SEED DRESSINGS	**Agriculture** **(insecticides, herbicides etc.)**	**Chronic intoxication** **Damage of nervous and digestive system** **Carcinogenic**
MYCOTOXINS	**Improper drying and storage of grain** **Chemicalization of agriculture → degradation of soils**	**Strongly toxic** **Carcinogenic**
CHLORINATED BIPHENYLS (PCB)	**Plastic packages** **Greases, paints, insulators** **Insecticides**	**Toxic impact on the whole organism**
AROMATIC HYDROCARBONS e.g. benzo (a) pyren	**Food processing** **(drying of cereals, smoking)** **Contamination from industry, transport and communal sources**	**Carcinogenic**
PLANT GROWTH STIMULATORS, e.g. choline chloride	**Agriculture**	**Toxic impact**
ANTIBIOTICS, HORMONES	**Animal breeding**	**Metabolic disturbances** **Reduction of resistance** **Asthma, anaemia, allergy**
RADIOACTIVE ISOTOPES	**Radiation accidents** **Trials with nuclear weapons** **Medicine**	**Leukaemia, cancer** **Radiation sickness**
PLASTIC SUBSTANCES (MONOMERS)	**Plastic packages** **(polypropylene, polystyrene)**	**Toxic impact**

Factors affecting the quality of raw food materials

- environmental conditions (clean or contaminated environment)
- method of farming (organic or conventional)
- conditions of plant production and animal breeding (proper or improper for the particular variety or breed)
- climatic- weather conditions
- storage and trade conditions of raw food materials

Factors affecting the quality of processed foods

- quality of raw food materials (from bad grain not possible to produce good flour)
- technology of processing and culinary treatment
- packing system
- storage and trade conditions of food products

What is „ORGANIC FOOD”?

- **Food produced according to certain, legally regulated production standards**

- **Production methods are friendly for environment, maintain biodiversity and soil fertility**

- **Social criteria are important (small farms, using local means of production, activation of the country areas)**

- **Organic agriculture excludes the use of synthetic fertilisers, pesticides, plant growth regulators**

- **Only natural organic fertilizers (compost, manure), green manures and biological crop protection methods are allowed**

- **Animal production excludes the use of antibiotics, hormones and GMOs**

- **Food processing protects nutritional quality, excludes synthetic food additives (preservatives, synthetic colour additives etc.)**

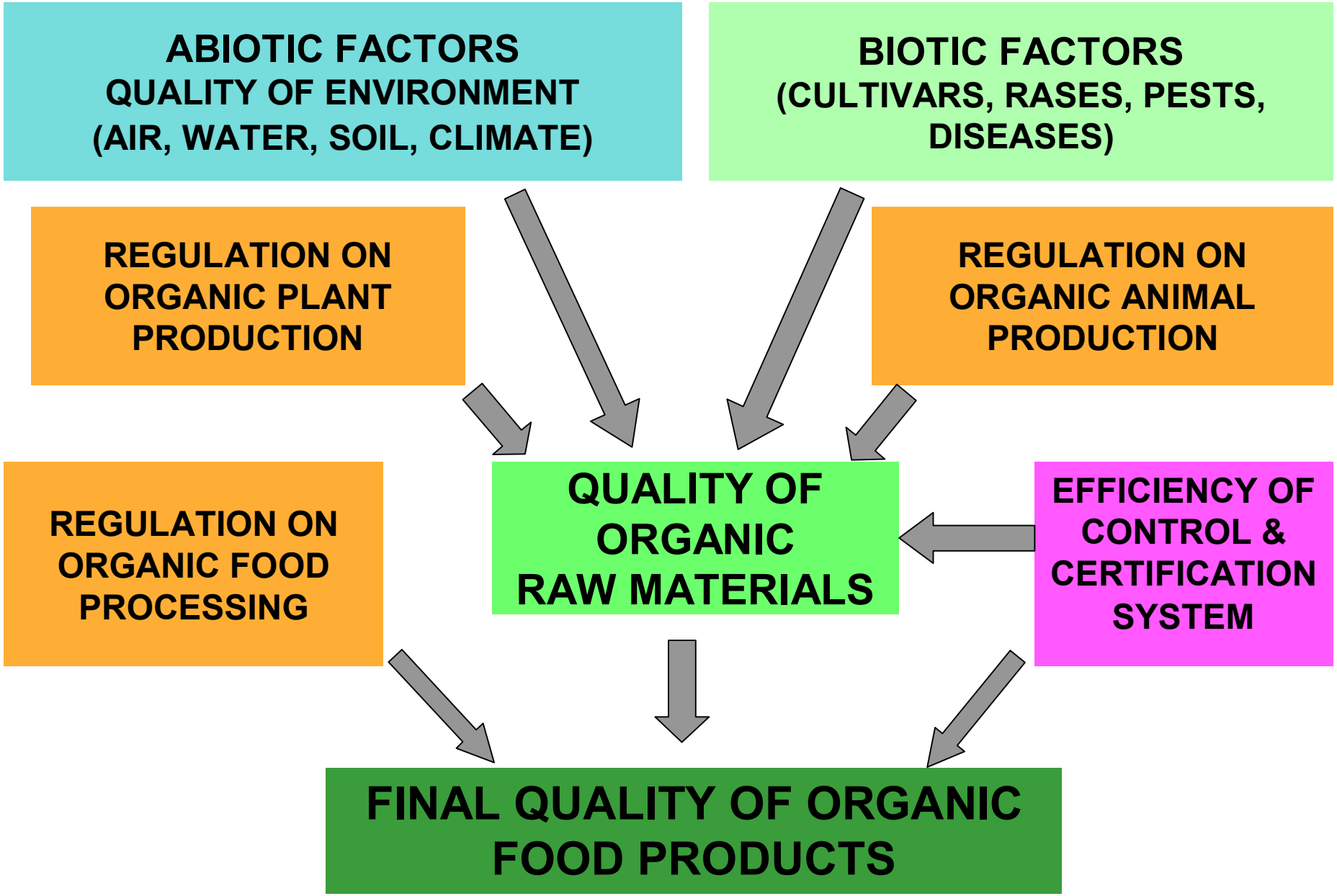
ORGANIC FARMING IN EU LEGISLATION

- The basic law on organic farming and processing, applying in the UE is **Regulation EEC No 2092/91** of 24 June 1991 **on organic production of agricultural products and idications referring thereto on agricultural products and foodstuffs.**

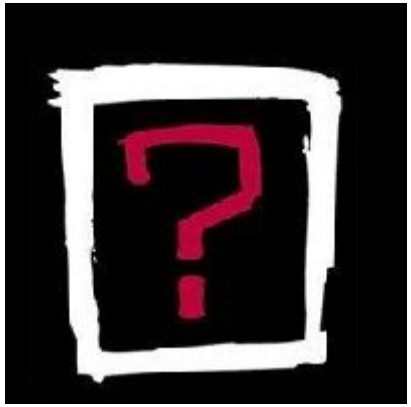
- In August 1999 rules on production, labelling and inspection of the most relevant animal species (cattle, sheep, goats, horses and poultry) were also agreed **- Regulation (EC) No 1804/1999** of 19 July 1999. This agreement covers such issues as foodstuffs, disease prevention and veterinary treatments, animal welfare, husbandry practices and the management of manure.

- From 1 January 2009 **Council Regulation (EC) No 834/2007** of 28 June 2007 **on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91** will be in force.

FACTORS INFLUENCING THE QUALITY OF ORGANIC FOOD PRODUCTS



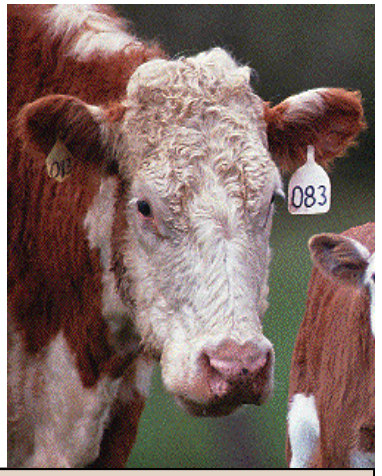
Why do consumers look for organic food…???



M O T I V A T I O N

The loss of trust to conventional food produced on a massive scale

Food Scandals in Europe since 1996



1996	**A probable link between BSE (bovine spongiform encephalopathy) and vCJD (Creutzfeldt-Jakob disease) has been established (Harris, 2000; Sy, 2003)**
1998	**Elevated levels of chlorinated dioxins in milk due to use of citrus pulp neutralized with waste of $Ca(OH)_2$ (Den Hartog, 2003)**
1999	**The Belgian PCB/dioxin incident. Polychlorobiphenyls (PCB) and dioxins were mixed into a tank of recycled frying oil, which was used for the production of animal feed (Bernard et al., 2002)**

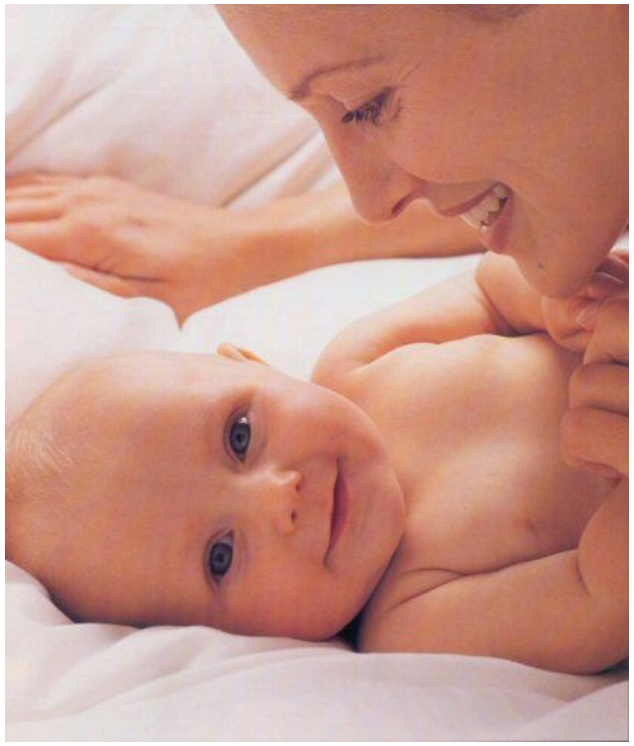
OTHER MOTIVATIONS

- **A strong conviction that organic food is safe for health**
- **The taste of organic food**
- **Care for natural environment**
- **Observance of animal welfare**

(Żakowska-Biemans, Gutkowska, 2003)

PROFILE OF ORGANIC CONSUMER

- **Well-educated, relatively young people**
- **Inhabitants of big cities**
- **Women with children**
- **Alergic patients**
- **Chronically ill people**
- **Vegetarians**



The main basis

Consumers' belief in higher health- and nutritional quality of organic products

Is the belief justified?

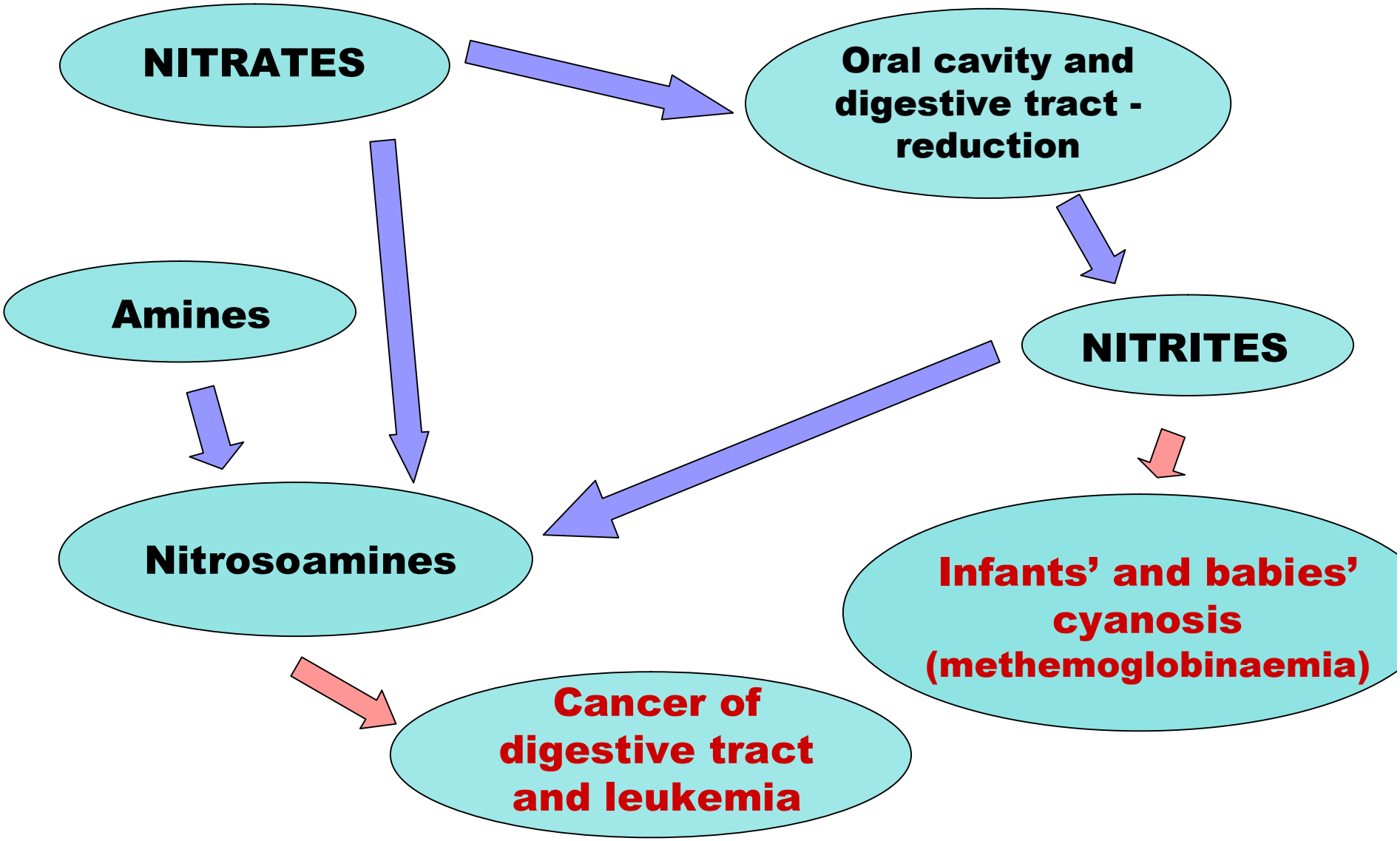
There are some empirical evidences

POSITIVES

- **Higher health quality/food safety**

Undiserable substances

NITRATES' EXCESS IS HARMFUL TO HUMAN HEALTH



Maximum levels for nitrates in foodstuffs

(Acc. COMMISSION REGULATION (EC) No 1881/2006

Foodstuffs	Maximum levels (mg NO_3/kg)	
Fresh spinach (*Spinacia oleracea*)	Harvested 1.10 to 31.03	3000
	Harvested 1.04 to 30.09	2500
Preserved, deep frozen or frozen spinach		2000
Fresh lettuce *(Lactuca sativa L.)* (protected and open-grown)	Harvested 1.10 to 31.03: Lettuce grown under cover Lettuce grown in the open air	 4500 4000
	Harvested 1.04 to 30.09: Lettuce grown under cover Lettuce grown in the open air	 3500 2500
Iceberg-type lettuce	Lettuce grown under cover Lettuce grown in the open air	2500 2000
Processed cereal-based foods and baby foods for infants and young children		200

Nitrates content in organic (ORG) and conventional (CONV) vegetables

Plants	Nitrate content (mg/kg)		Difference in the content of bioactive compound in favour of the conventional product*	Difference in the content of bioactive compound in favour of the conventional product**	Author
	ORG	CONV			
Beetroot	1871	2690	+43,77	+35,91	Kunachowicz et al. 1993
Leek	370	499	+34,86	+29,69	Kunachowicz et. al. 1993
Parsley	234	383	+63,68	+48,30	Leszczyńska 1996
Carrot	154	293	+90,26	+62,19	Leszczyńska 1996
Potatoes	145	203	+40,00	+33,33	Leszczyńska 1996
Beetroot	932	2255	+141,95	+83,02	Leszczyńska 1996
Cabbage	147	928	+531,29	+145,30	Leszczyńska 1996
Carrot	52,2	209,7	+301,72	+120,27	Rembiałkowska 1998
Head cabbage	344,3	907,8	+163,67	+90,01	Rembiałkowska 1998
Cabbage	99	512	+417,17	+135,19	Rutkowska 1999
Red cabbage	176	643	+265,34	+114,04	Rutkowska 1999
Carrot	102	461	+351,96	+127,53	Rutkowska 1999
Parsley	116	381	+228,45	+106,64	Rutkowska 1999

Nitrates content in organic (ORG) and conventional (CONV) vegetables

Plants	Nitrates content (mg/kg)		Difference in the content of bioactive compound in favour of the conventional product*	Difference in the content of bioactive compound in favour of the conventional product**	Author
	ORG	CONV			
Potatoes	99	229	+131,31	+79,27	Rembiałkowska 2000
Carrot	155	266	+71,61	+52,73	Rembiałkowska 2000
Cabbage	344	908	+163,95	+90,10	Rembiałkowska 2000
Beetroot	1343	2217	+65,08	+49,10	Rembiałkowska 2000
Potatoes	167,8	201,1	+19,85	+18,05	Wawrzyniak et al. 2004
Celery	488,8	656,9	+34,39	+29,34	Wawrzyniak et al.. 2004
Bok choy (Chinese leaves)	552,1	1045,7	+89,40	+61,78	Wawrzyniak et al. 2004

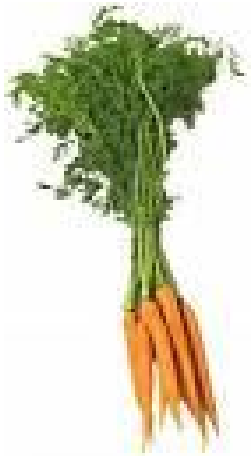
Nitrates content in organic (ORG) and conventional (CONV) vegetables

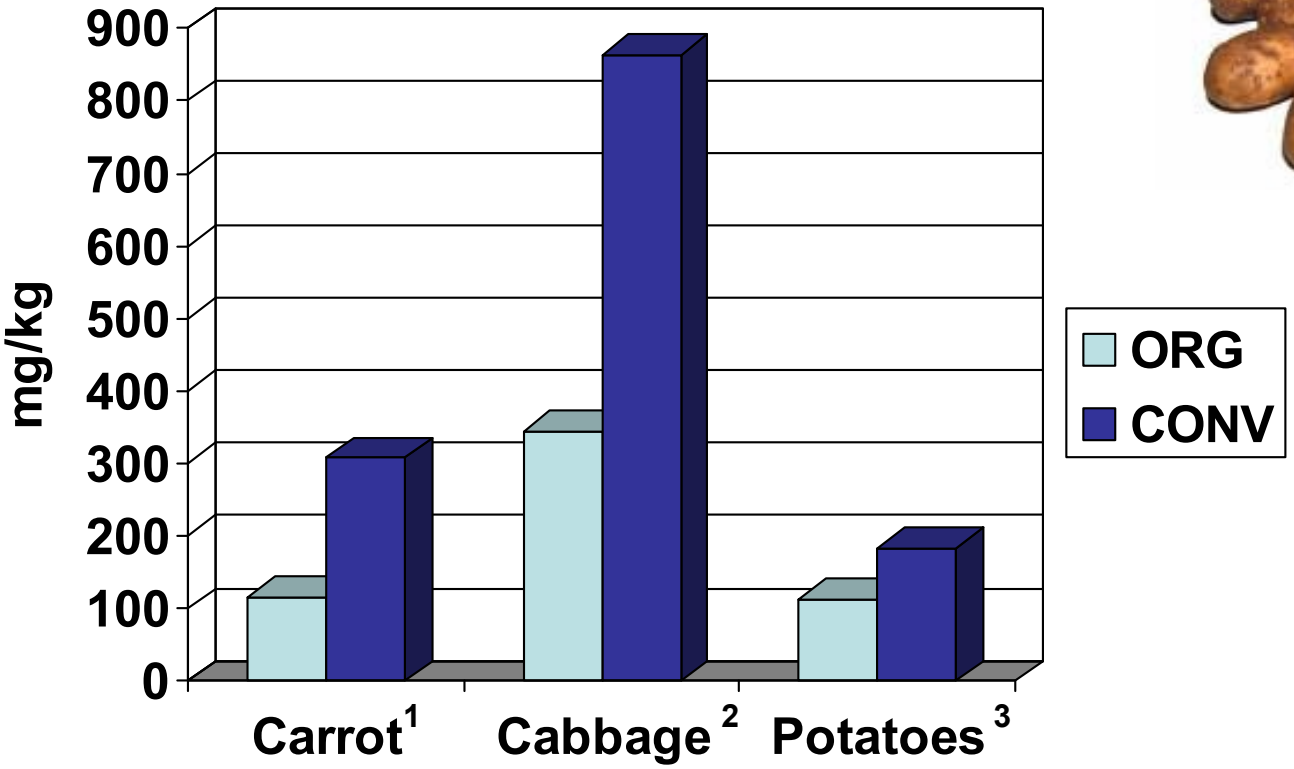
Plants	Nitrates content (mg/kg)		Difference in the content of bioactive compound in favour of the conventional product*	Difference in the content of bioactive compound in favour of the conventional product**	Author
	ORG	CONV			
Head cabbage	788,7	1061,6	+34,60	+29,50	Wawrzyniak et al. 2004
Potatoes	132	210,3	+59,32	+45,75	Hajslova et al. 2005
Spinach (frozen)	659	1011	+53,41	+42,16	CVUA Stuttgart 2005
Lettuce	818	1303	+59,29	+45,73	Guadagnin et al. 2005
Arugula	4073	5377	+32,02	+27,60	Guadagnin et al. 2005
Potatoes	15,5	72,8	+369,68	+129,78	Cachoeira Stertz et al. 2005
Mean:			**+ 148,39%**	**+70,47%**	

*Caltulated according to Worthington's system (2001): **(CONV-ORG)/ORG x 100%**

Calculated according to Lockeretz's system: **(CONV-ORG)/[(ORG+CONV)/2] x 100%

Nitrates content in organic (ORG) and conventional (CONV) vegetables





[1]Leszczynska 1996, Rembialkowska 1998, Rutkowska 1999, Rembialkowska 2000;
[2]Leszczynska 1996, Rembialkowska 1998, Rutkowska 1999, Rembialkowska 2000, Wawrzyniak et al. 2004
[3]Leszczynska 1996, Wawrzyniak et al. 2004, Hajslova et al. 2005, Cachoeira Stertz et al. 2005

Nitrates content *** in several cultivars of head lettuce in relation to the fertilizing system (Vogtmann 1985)

Fertilization		Cultivars *				
Method	Dose**	1	2	3	4	5
Control	0	1110	660	580	680	860
Compost	100	1370	1080	780	470	900
Compost	240	1430	2020	1330	800	1610
NPK	100	5820	5450	5860	4950	6240
NPK	240	16660	14350	12010	12140	12620

*1 - Benita 2 - Hilde 3 – Mona
4 - Neckarriese 5 – Viktoria

** kg N / ha
*** mg NO_3/1000 g fresh mass

Mineral fertilisation	Organic fertilisation
Directly provides easily soluble food substances to the plant roots (e.g. NO_3, NH_4, PO_4, and K ions). Root system draws the ion form the soil solution, however the regulation process is disturbed. Therefore a plant often draws and accumulates too high amount of nitrates in the tissues. Methods to confine the nitrates accumulation: ➢ Bisection of fertiliser dose into a part before sowing and after sowing ➢ Nitrogen fertilising in ammonium form, especially in a case of the short vegetation plants and as the after-sowing fertiliser shortly before the harvest time ➢ Using the complete organic-mineral fertilisers in a form of before-sowing deposit ➢ Using the fertilisers with slow operation on the organic carriers ➢ Leaf fertilising with carbamide and multicomponent fertilisers	**Provides the substrates to the soil organisms, which convert them into humus.** Food components are released from the compounds in the constant way and in the proper ratio. Organic fertilisers stimulate biological activity of the soil - micro-organisms and root system are well developed. The best form of organic fertiliser is compost because we introduce ready humus into the soil. Humus gets into balance with the soil very quickly, stabilising it biologically and providing food base for the soil organisms for several years There is no danger of over-fertilising while composting the soil; therefore a dose can be optional. Practically it's conditioned by the productive possibilities of the farm. A term of usage is also free, because compost is not a direct source of food components for the plants but it is a food base for the soil organisms providing soil fertility. Animal manure should be composted and properly stored, enriched and used.

Pesticides cause at least four serious problems:

- **Acute and heavy poisoning of people; there are every year 26 millions such accidents in the world, and about 200 000 people die**
- **Chronic poisoning of people leading to serious problems – various soft tissue cancers, physiological disturbances, malformations, prenatal damages of children, nervous and psychological changes**
- **Disturbances of biological balance in agro-ecosystems and surrounding ecosystems, lower plant resistance to diseases**
- **Decreased content of nutrients in crops, e.g. pesticide tetrachlorphenvinphos diminishes the content of carotene in carrots by 15 - 20% and content of vitamin C by 20 - 30%, carbaryle and parathion also decrease vitamin C content in cabbage, maize, spinach and beans**

Table 1. Conceptual Shifts in Toxicology: John Peterson Myers, Ph.D.

Old	New
High level contamination overwhelms detoxification and other defence mechanisms	Low level contamination hijacks control of development
"The dose makes the poison"	"Non-monotonic" dose response curves are common, in which low level exposures cause effects that disappear at higher levels
Only high levels of exposure matter	Impacts caused at what had been assumed to be "background" levels
Focus on adults	Periods of rapid growth and development (prenatal through puberty) are most sensitive to exposure
A small number of "bad actors"	Many chemicals thought safe are biological active and capable of interfering with signalling systems
Immediate cause and effect	Long latencies are common; fetal programming can lead to disease and disabilities decades later
Examine chemicals one compound at a time	In real life, mixtures are the rule. They can lead to effects at much lower levels than indicated by simple experiments with single chemicals.
Focus on traditional toxicological endpoints like mutagenesis carcinogenesis, cell death	Wide range of health endpoints, including immune system dysfunction (both hyper and hypo-active); neurological, cognitive and behavioral effects; reproductive dysfunctions; chronic diseases
One-to-one mapping of contaminant to disease or disability	Same contaminant can cause many different effects, depending upon when exposure occurs during development and what signals it disrupts. Multiple contaminants can cause same endpoint, if they disrupt the same developmental process.

ENVIRONMENTAL HEALTH PERSPECTIVES (1998) Vol 106: 347-353
GUILETTE et. al.

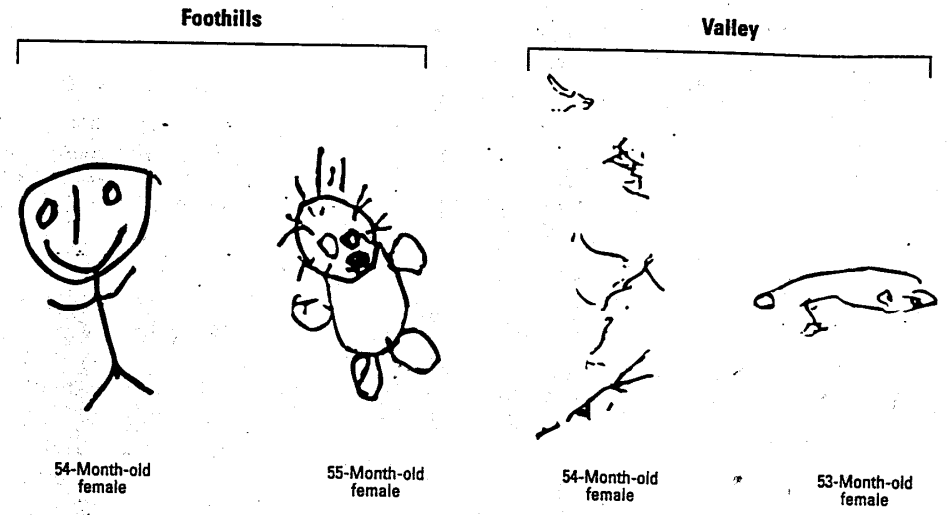


Figure 1. Representative drawings of a person by 4-year-old Yaqui children from the valley and foothills of Sonora, Mexico.

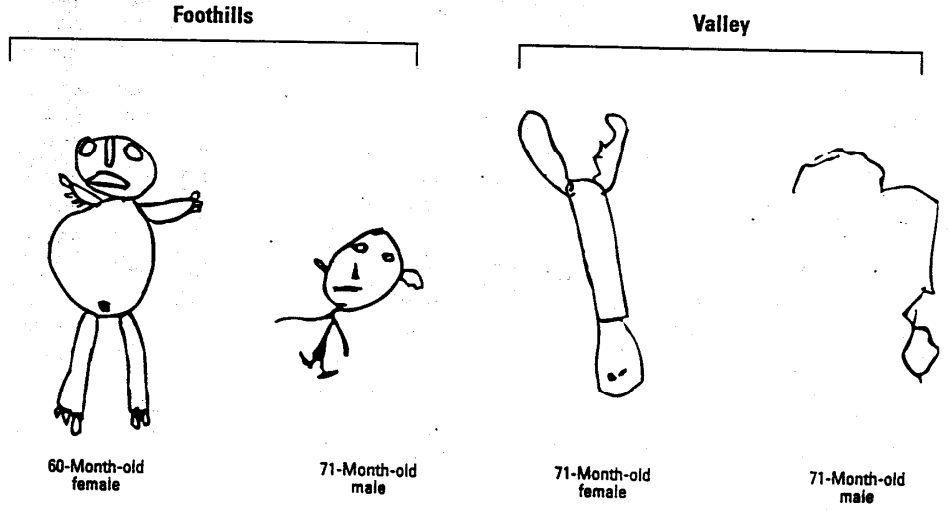


Figure 2. Representative drawings of a person by 5-year-old Yaqui children from the valley and foothills of Sonora, Mexico.

Complex Mixtures

- The average person's body carries a mixture of several hundred synthetic chemicals
- None of these could have been there before recent times - they are completely novel
- We have no way of characterising the toxicology of this mixture
- The highest dose is received early in life - the most vulnerable period for damage

We carry a mixture of hundreds of man made chemicals

Selected Percentiles and Geometric Means of Blood and Urine Levels of Environmental Chemicals (or Metabolites)

National Health and Nutrition Examination Survey, United States,1999

	Sample size	Units	Geometric mean (95% confidence interval)	Selected percentiles (95% confidence interval) 10th	25th	50th	75th	90th
Organophosphate Pesticide Metabolites[4]								
Dimethylphosphate	703	µg/L	1.84 (1.10-2.59)	<LOD	0.80 (0.36-1.11)	1.67 (1.04-2.86)	3.79 (2.38-7.46)	7.43 (5.43-17.3)
Diethylphosphate	703	µg/L	2.55 (1.33-3.78)	0.78 (0.70-0.90)	1.09 (0.93-1.31)	1.85 (1.19-4.11)	4.87 (2.58-14.0)	10.6[5] (6.29)
Dimethylthiophosphate	703	µg/L	2.61 (1.77-3.45)	<LOD	0.72 (0.13-1.73)	3.80 (2.93-4.53)	9.00 (7.35-12.3)	22.9 (18.7-30.7)
Diethylthiophosphate	703	µg/L	0.81 (0.69-0.94)	0.51 (0.41-0.53)	0.58 (0.55-0.59)	0.70 (0.64-0.78)	0.98 (0.78-1.45)	1.52 (1.16-2.91)
Dimethyldithiophosphate	703	µg/L	0.51 (0.39-0.62)	<LOD	<LOD	0.60 (0.39-0.78)	2.05 (1.65-2.42)	5.43 (3.16-10.3)
Diethyldithiophosphate	703	µg/L	0.19 (0.14-0.23)	0.08 (0.07-0.08)	0.09 (0.09-0.09)	0.14 (0.09-0.26)	0.30 (0.25-0.39)	0.54 (0.44-0.86)

They are tested one at a time

Maternal Plasma Concentrations of Pesticides: Circumpolar Study 1994-1996 (Geometric means ug/kg lipid (ppt))

Country/ Pesticides	Canada [1] (n = 67)	Green-land [2] (n = 117)	Sweden [3] (n = 40)	Norway [4] (n = 60)	Iceland [5] (n = 40)	Russia [6] (n = 51)
β-HCH	9.3	18.5	9.2	8.1	32.1	222.5
α-chlordane	1.0	1.1	1.0	1.3	1.3	1.6
γ-chlordane	1.1	1.3	1.0	1.3	1.3	1.4
Cis-nonachlor	6.6	20.9	1.2	1.8	2.7	5.3
p,p'-DDE	133	407	84.0	79.4	113.2	411.9
p,p'-DDT	7.9	15.0	2.4	3.0	4.0	48.3
HCB	55.1	97.6	15.6	23.1	41.2	62.8
Mirex	4.5	9.1	1.1	1.4	1.9	1.4
Oxychlordane	27.8	60.8	1.9	3.7	6.6	3.3
Transnonachlor	30.5	110	3.8	6.8	12.2	11.5

[1] Inuit women from west/central NWT,
[2] women from Disko Bay region,
[3] women from Kiruna,
[4] women from Hammerfest and Kirkenes,
[5] women from Nikel.
Source: Gilman *et al.* 1997).

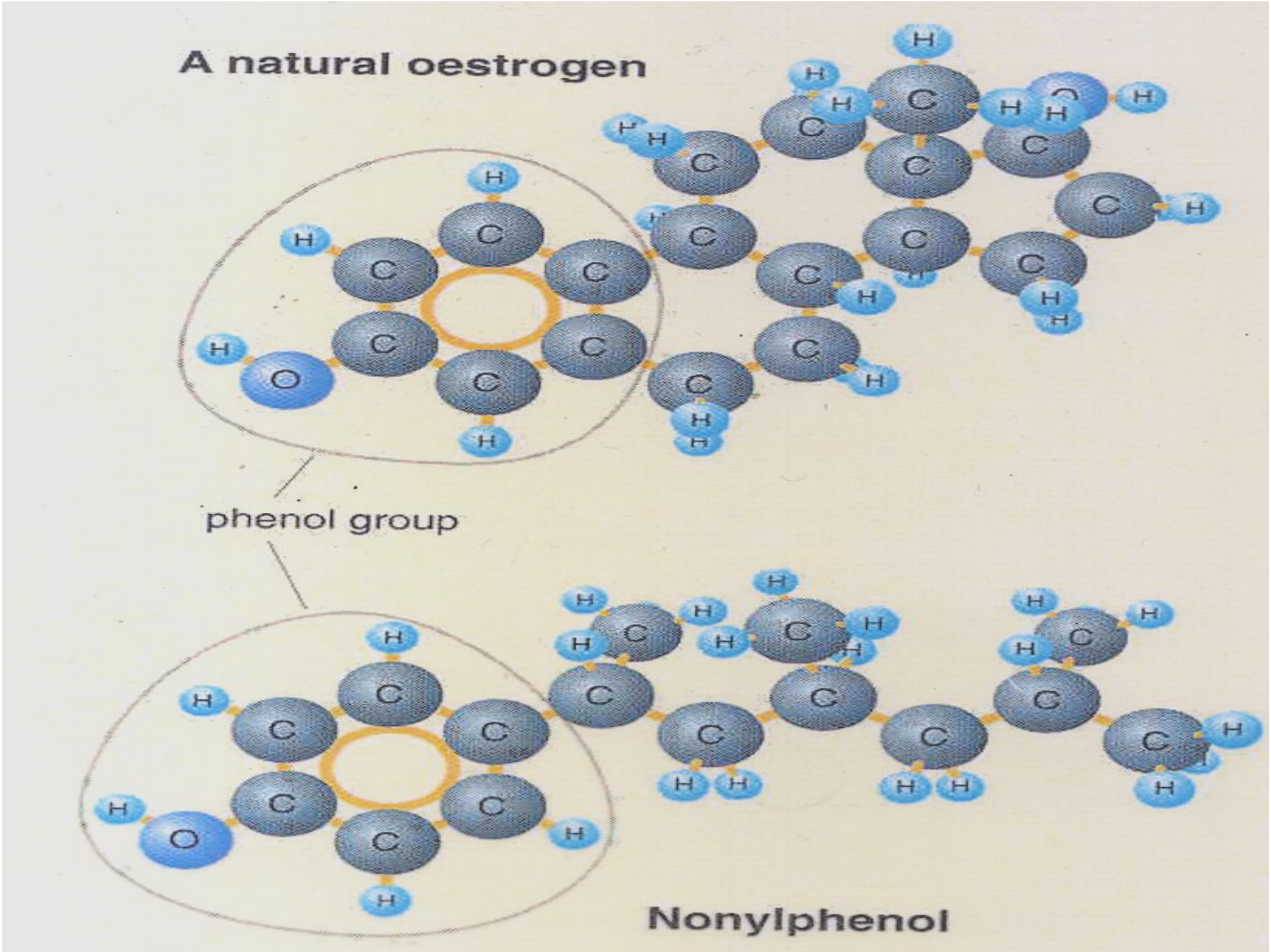
Lists of endocrine disrupting pesticides

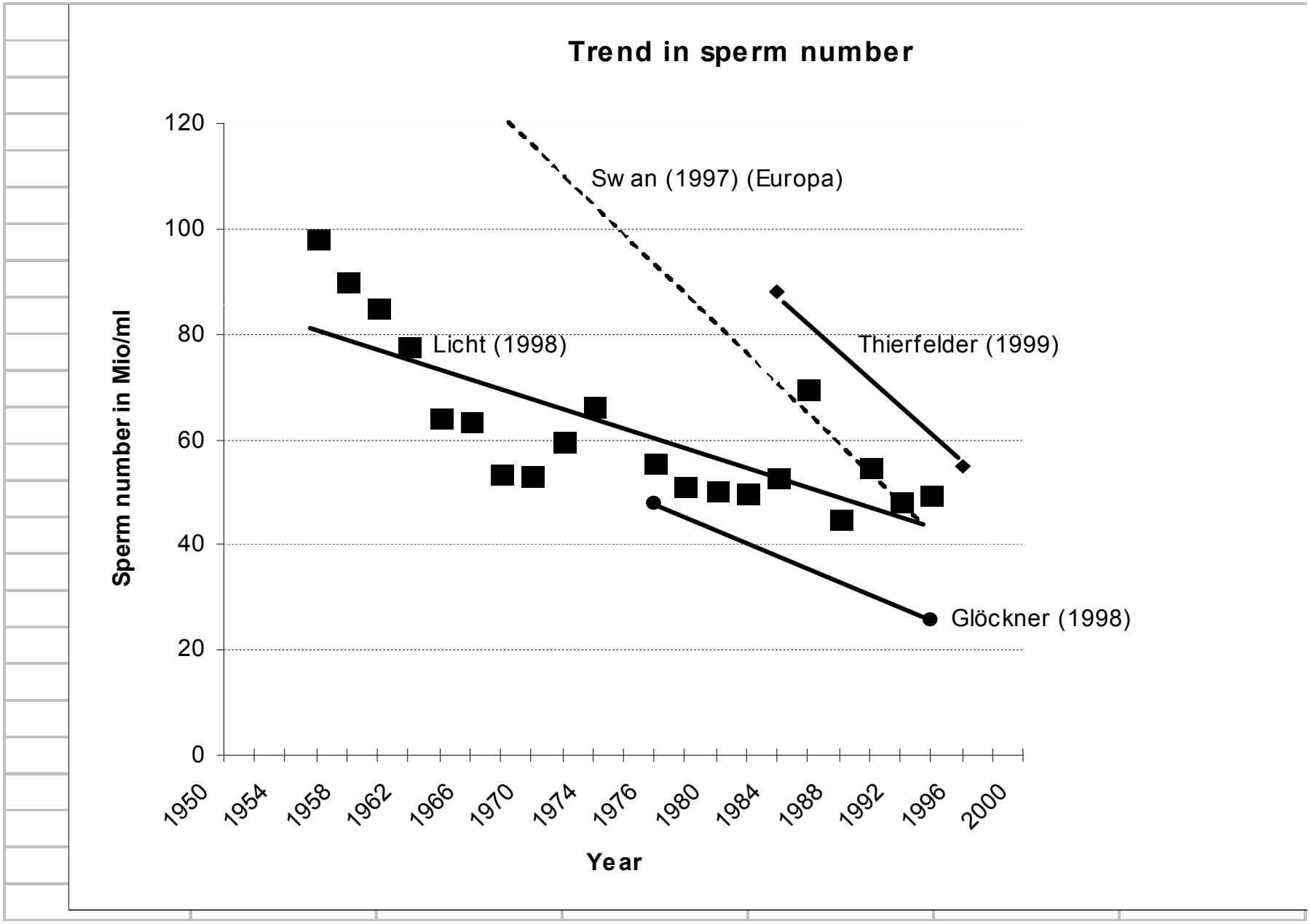
Active ingredient	EA	DETR	Ger.	EU	OSPAR	WWF
Acetochlor				✓		✓
Alachlor				✓		✓
Aldrin	✓					✓
Amitraz			✓?			
Atrazine	✓			✓	✓?	✓
Benomyl			✓?			✓
Beta-HCH					✓?	✓
Carbendazim			✓?			
Carbofuran			✓?			✓
Chlordane				✓	✓?	✓
Chlordecone				✓	✓?	✓
Chlorpyrifos			✓?			
DDT	✓	✓		✓	✓?	✓
Deltamethrin			✓?			✓
Demeton-s-methyl	✓					
Dichlorvos	✓					
Dicofol					✓?	✓
Dieldrin	✓				✓?	✓
Dimethoate	✓		✓?			✓
Endosulfan	✓				✓?	✓
Endrin	✓					✓
Epoxyconazole			✓✓			
Fentin acetate				✓		
Glyphosate			✓?			
HCB				✓	✓?	✓
Lindane	✓	✓		✓	✓?	✓
Linuron	✓			✓		✓
Maneb				✓		✓
Metam				✓		
Metiram			✓✓			✓
Methoxychlor		✓			✓?	✓
Mirex				✓		✓
Oxydemeton-methyl			✓?			
Penconazole			✓?			
Permethrin	✓					✓
Prochloraz			✓?			
Procymidone			✓✓			
Prometryn					✓?	
Propiconazole			✓?			
Simazine	✓					✓
Thiram				✓		
Toxaphene				✓	✓?	✓
Tributyltin	✓			✓	✓?	✓
Triphenyltin				✓		
Trichlorfon			✓?			
Tridemorph			✓?			
Trifluralin	✓					✓
Vinclozolin		✓	✓✓	✓	✓?	✓
Zineb				✓		✓

Pesticides that have proved to have endocrinal effects and that are still in use

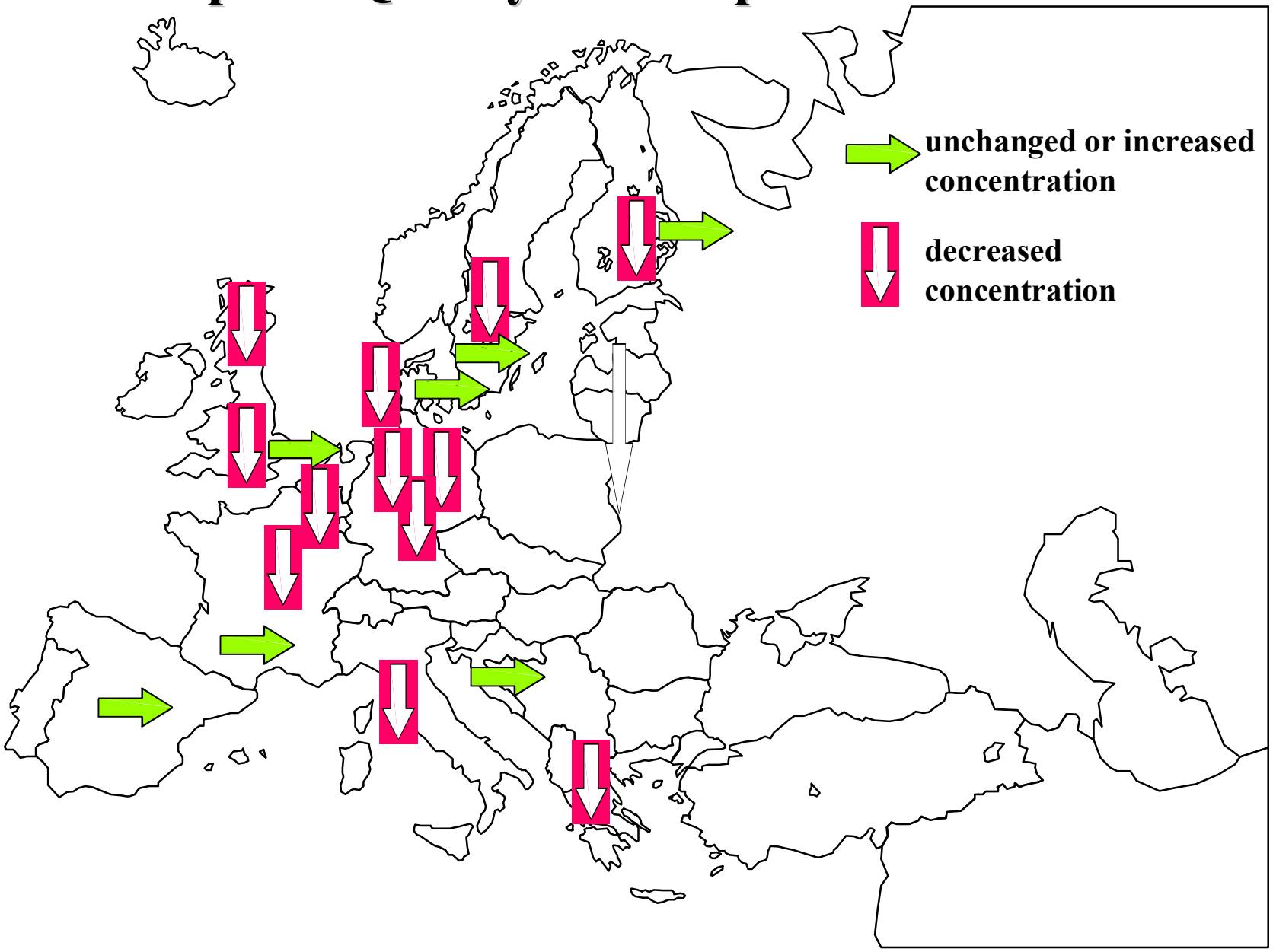
Fungicides	Insecticides	Herbicide
Benomyl	Cypermethrin	2,4 - D
Mancozeb	Endosulfan	Atrazine
Maneb	Esfenvalerate	Alachlor
Metiram	Fenvalerate	Simazine
Viclozolin	Kelthane	Trifluralin
Zineb	Lindane	
Ziram	Methomyl	
	Permetrin	

(Ansar Ahmed, 2000, Japan Offspring Found)


A natural oestrogen
phenol group
Nonylphenol

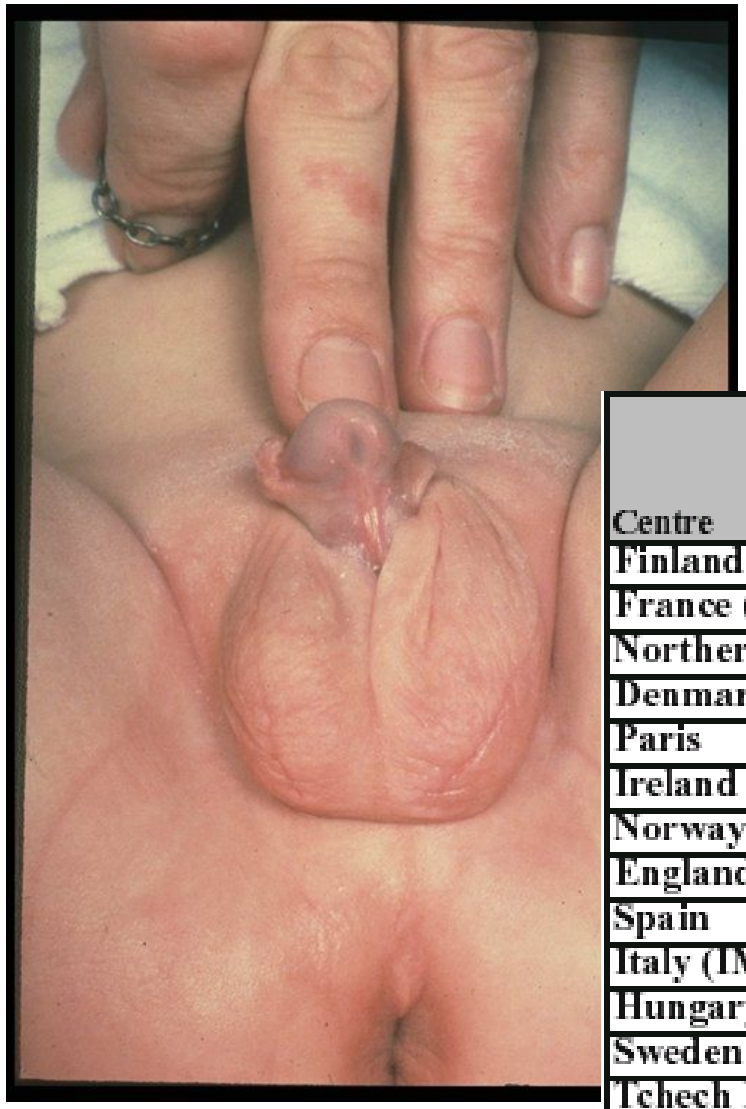

Trend in sperm number
Sperm number in Mio/ml
120
100
80
60
40
20
0
1950
1954
1958
1962
1966
1970
1974
1976
1980
1984
1988
1992
1996
2000
Year
Swan (1997) (Europa)
Licht (1998)
Thierfelder (1999)
Glöckner (1998)

Sperm Quality in Europe: Trends



Howard V. Pesticides and health. Newcastle: Soil Association, 2005

Hypospadias



Centre	Mean Prevalence Hypospadias per 10,000 birth	Observed years	Trend (only linear regression)
Finland	**4.7**	17	>
France (CE)	8.4	21	(>)
Northern-NL	10.7	12	<<
Denmark	11.5	19	>>
Paris	12.2	13	>
Ireland	12.4	17	(<)
Norway	12.9	29	>>
England	15.3	27	>>
Spain	17.6	21	(<)
Italy (IMER)	19.1	19	(<)
Hungary	19.4	27	>
Sweden	19.7	19	<
Tchech Republic	21.0	19	>
Italy (IPIMC)	**24.3**	13	>
Average prevalence of all	**14.0**		

Paulozzi 1999, Rösch et al. 2001

July 14th 2000

THE DAILY TELEGRAPH

Way of life 'is the main cause of cancers'

By David Derbyshire, Science Correspondent

ENVIRONMENT rather than genetic make-up is responsible for the majority of cancers, according to research published yesterday.

Although genes play a minor role in some types of the disease, factors such as smoking and diet were still far more important, the study found.

It followed an investigation into the medical histories of more than 89,000 twins, the largest study of its type carried out.

All cancers are genetic in that they are triggered by DNA defects that lead to uncontrolled cell proliferation. But the study is a reminder that while genes influence susceptibility to cancer, the primary cause of the disease is environmental.

Even identical twins, who share the same genetic make up, have only a 10 per cent chance of developing the same cancer.

Researchers from the Karolinksa Institute, Stockholm, compared 28 types of cancer in twins living in Sweden, Finland and Denmark. Dr Paul Lichtenstein's team found that 10,000 pairs of the twins developed cancer during their lifetime.

By contrasting identical twins, who share the same genes, with non-identical twins, who do not, the team was able to estimate the balance of genetic and environmental risk factors.

Prostate cancer had the highest genetic component, rectal at 35 per cent, and breast cancer at 27 per cent.

Dr Lichtenstein published the findings in the *New England Journal of Medicine*. He said: "Environmental factors are more important than gene factors, and that's important to remember, since everyone thinks everything is solved now we have the human genome in computers."

He believes that cigarettes, poor diet, lack of exercise, radiation and pollution are likely to be the main factors.

Dr Tim Key, of the Imperial Cancer Research Fund, Oxford, said behaviour and environment were probably even more important.

"Migrant studies have shown that you can get a four or fivefold increase in breast cancer, for example, when people move from Japan to the United States," he said.

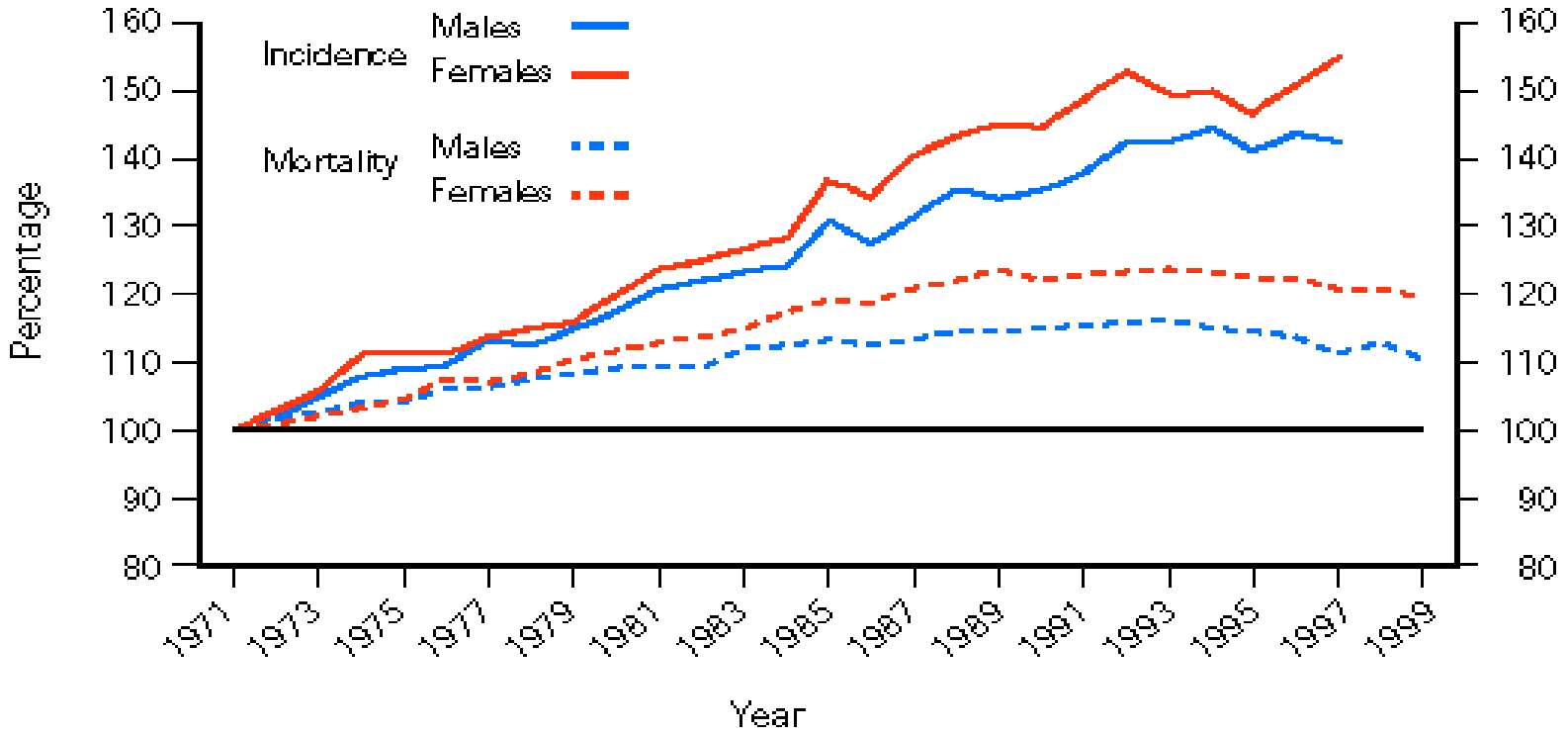
The biggest cause of cancer, with at least 35 per cent, was smoking.

"That's the number one factor, and it's completely preventable. Number two is thought to be diet, which accounts for 30 per cent."

As well as emphasising the role of environmental cancer risks, the study highlights how little is known about the genetic factors.

The few genes clearly linked to cancer so far accounted for only a small fraction of the genetic contribution seen in the research. This suggests that many cancer susceptibility genes have yet to be found.

Figure 2.11 **The numbers of new cases of, and deaths from, all cancers† by sex, England and Wales, 1971-1999* (1971=100)**



† All malignant neoplasms excluding non-melanoma skin cancer.
* Figures for incidence for 1995-1997 and mortality for 1999 are provisional.

Pennycook FR, Diamand EM, Watterson A & Howard CV (2004). Modelling the dietary pesticide exposures of young children. *IJOEH* 10: 304-309

- -Modelled variability of pesticide residues and exposure in children eating apples and pears, using government data.
- -Examined dithiocarbamates, phosmet and carbendazim.
- -**Estimates of between 10 and 227 children per day in the UK may be exceeding an acute reference dose.**
- -A major worry in the Dutch Health Council report was the variability of residues between single items of food.

Pesticides - conclusions

- **Diffuse exposure to a complex mixture through multiple sources**
- **Current regulation addresses most pesticides one at a time**
- **There are changes in the incidence of a number of human diseases, including cancer and malformations**
- **We do not and cannot know explicitly what is causing what → precaution is the main tool available to us!**

Residues of pesticides in fresh vegetables and fruits from organic and conventional farms in Germany (after Brugger 1987)

Years	Samples	Organic cultivation				Conventional cultivation			
		Total	Without residues	<permissible limit	>permissible limit	Total	Without residues	<permissible limit	>permissible limit
1983	Number	43	42	1	-	484	222	249	13
	%	100	97,6	2,4	-	100	45,9	51,4	2,7
1984	Number	108	100	7	1	383	180	191	12
	%	100	92,6	6,5	0,9	100	47	49,9	3,1
1985	Number	43	37	6	-	456	244	200	12
	%	100	86	14	-	100	53,5	43	2,6

Pesticide residues in fresh fruit and vegetables in USA*** 1994 – 1999 (Baker et al. 2002)

	Organic production**		Integrated production*		No market claim	
	Numer of samples	Per cent positive	Numer of samples	Per cent positive	Numer of samples	Per cent positive
Total fruit	30	23	71	49	12612	82
Total vegetables	97	23	124	45	13 959	65
All fresh foods	127	23	195	47	26 571	73

* IPM / NDR includes "No Detectable Residues" samples with the market claims „PDP No Pesticides detected", „PDP Pesticide Free", "Speciality No Pesticides Detected" and "Speciality Pecticide Free". These Market claims are typically accompanied by a requirement that integrated pest management systems also be used.

** "Organic" includes samples with the market claims "PDP Organic" and "Speciality Organic"

*** Pesticide Data Program Results

Comparison of the pesticide residues in crops from different production systems in several countries

	Organic farming	Integrated farming	Conventional farming
Country	% samples with residues	% samples with residues	% samples with residues
USA[1] 1993-2002	23	47	73
Belgium[2]	12	No data	49
Sweden 2002-2003[3]	3	11	44
Poland 2004[4]	0	50	44
Poland 2005[5]	7	47	28
Poland 2006[5]	5	48	21

[1] USDA (Baker et al. 2002)
[2] FSCA – FAVY 2001; big-scale studies 1995 – 2001
[3] National monitoring of plant origin food 2003
[4] Official control of national plant origin food 2005
[5] Gnusowski and Nowacka 2006

Pesticide residues in different food samples tested by California Department of Pesticide in 1989 – 1998

	Organic		Conventional	
Year	**Numer of samples**	**Per cent positive**	**Numer of samples**	**Per cent positive**
1989	196	3,6	9191	22,4
1990	194	2,6	8081	20,5
1991	82	6,1	7361	25,2
1992	40	10,0	7267	31,3
1993	22	0	6034	35,9
1994	45	4,4	5420	33,9
1995	41	7,3	5457	35,6
1996	144	13,9	5926	37,0
1997	155	9,7	5480	37,0
1998	178	12,8	5840	41,1
All years	**1097**	**6,5 %**	**66 057**	**30,9 %**

Pesticide residues in fresh apples, peach, sweet pepper and tomatoes by market claim: Consumer Union testing (Baker et al. 2002)

	Organic		Integrated		Conventional (no market claim)	
	Numer of samples	**Per cent positive**	**Numer of samples**	**Per cent positive**	**Numer of samples**	**Per cent positive**
Apples	20	35	20	95	20	100
Peach	12	33	5	60	13	85
Total fruit	32	34	25	88	33	94
Peppers	10	0	6	0	14	71
Tomatoes	25	28	14	7	21	62
Total vegetables	35	20	20	5	35	66
Total for the four foods	67	**27**	45	**51**	68	**79**

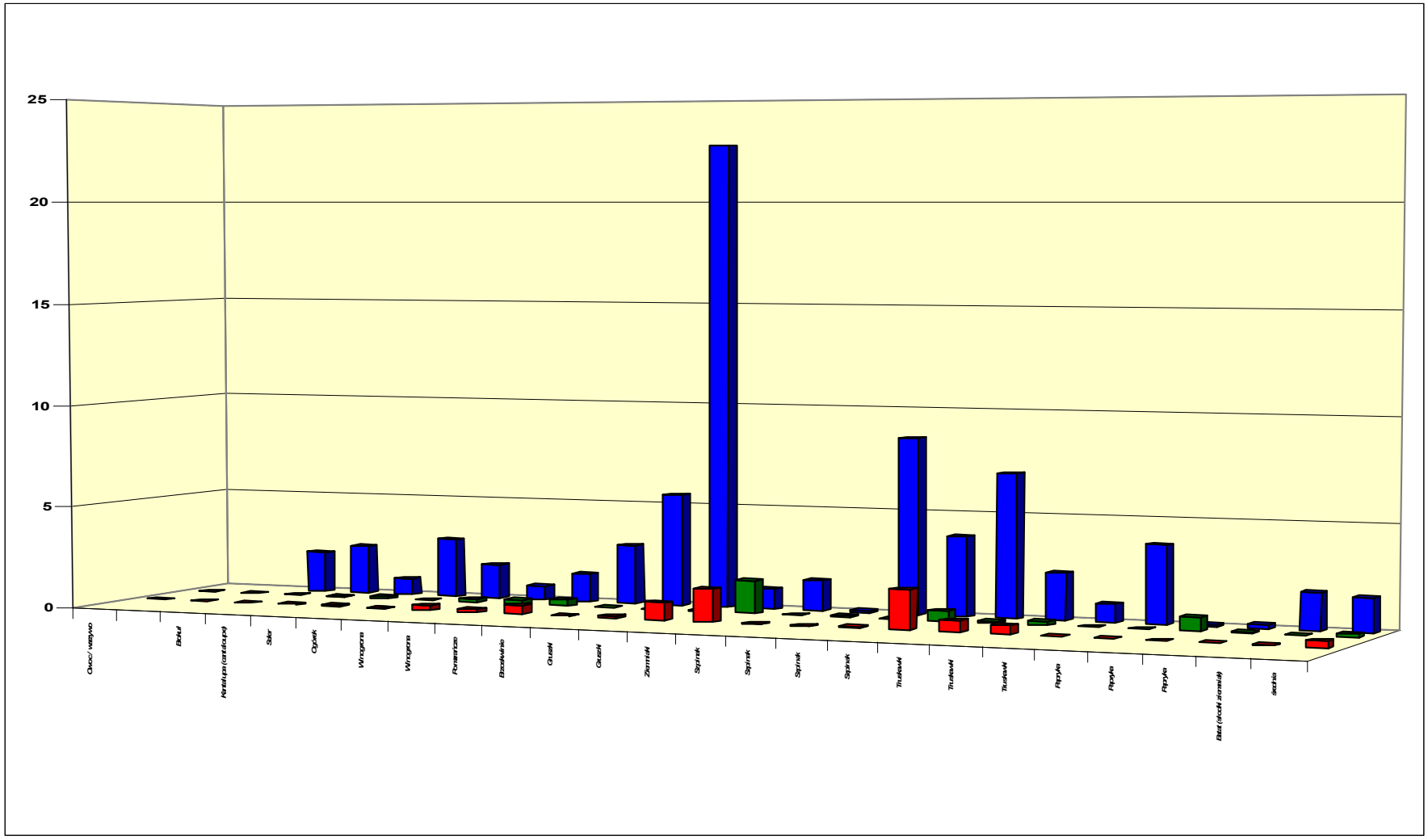
Samples containing multiple™ residues by market claim in three datasets (Baker et al. 2002)

	Organic		Integrated		Conventional (no market claim)	
Data set	**Numer of samples**	**Per cent positive**	**Numer of samples**	**Per cent positive**	**Numer of samples**	**Per cent positive**
PDP * (20 crops)	127	**7,1**	195	**23,6**	26 571	**45,5**
DPR ** (19 crops)	609	**1,3**	n.a. ****	**n.a.**	4 055	**11,9**
CU * (4 crops)**	67	**6,0**	45	**44,4**	68	**62**

* PDP = USDA's Pesticide Data Program
** DPR = California Department of Pesticide Regulation
*** CU = Consumer Union
**** n.a. = not applicable
™***multiple resiudes are commonly detected in several widely consumed fruits and vegetables, often the samples***
™***with 3 or 4 different residues are found (Bakeret al. 2002)***

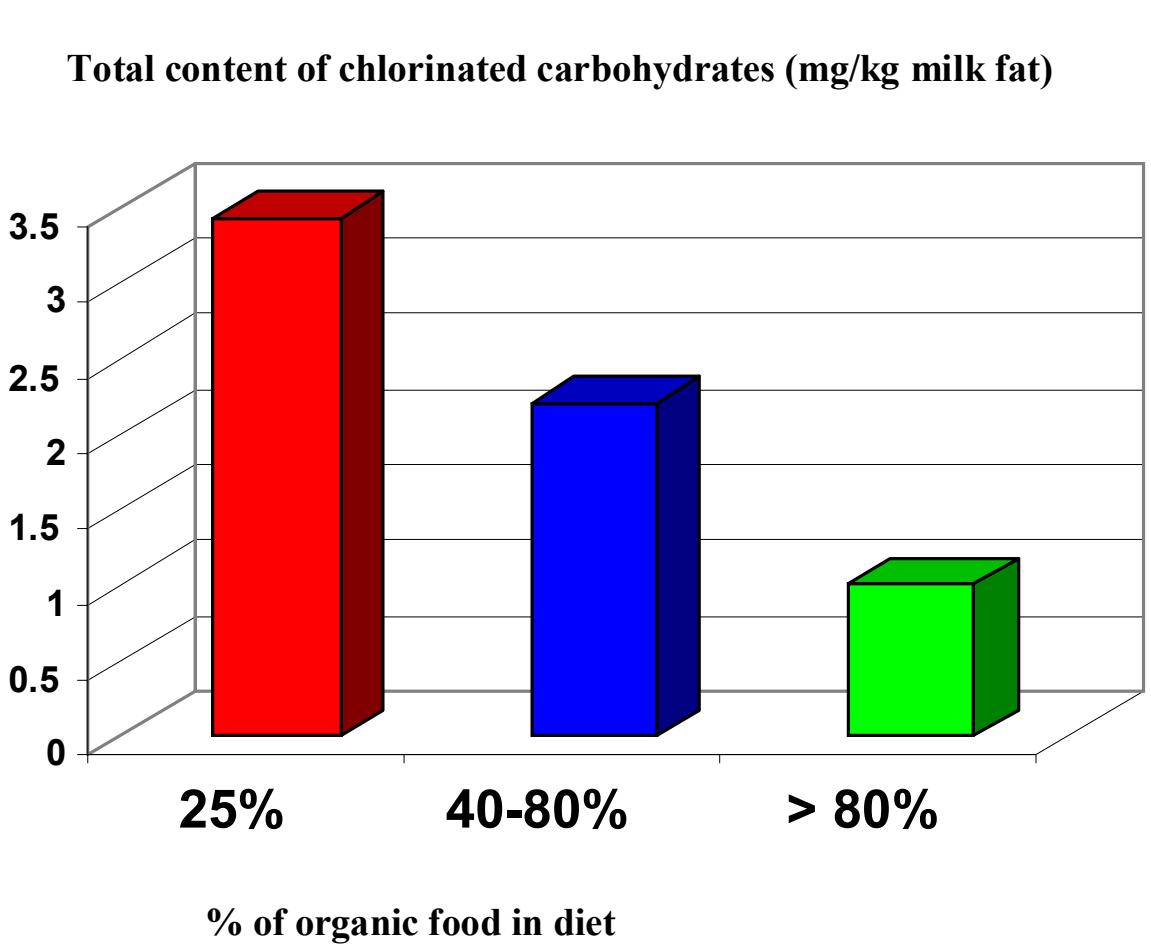
Comparison of organic and no market claim mean residues found in 22 crops, USDA data (Baker et al. 2002)

		Conventional samples (CONV)		Organic samples (ORG)		Ratio no market claim to organic mean
Food	**Active ingredient**	**Numer of positives**	**Mean residue (ppm)**	**Numer of positives**	**Mean residue (ppm)**	
Broccoli	DCPA	142	0,014	1	0,007	2,0
Cantaloupe	methamidophos	64	0,050	1	0,021	2,4
Celery	oxamyl	28	0,087	1	0,11	0,8
Cucumber	endosulphan I	319	0,023	1	0,008	2,9
Grapes	iprodione	746	0,233	1	0,14	1,7
Grapes	vinclozolin	197	0,147	1	0,2	0,7
Orange	formetanate HCL	86	0,422	1	0,3	1,4
Peach	endosulphans	49	0,029	1	0,01	2,9
Pear	diphenylamine	340	0,094	1	0,017	5,5
Pear	*o*- phenylphenyl	327	0,845	1	0,037	22,8
Potarto	chlorpropham	892	1,59	1	1,6	1,0
Spinach	DCPA	30	0,011	1	0,007	1,5
Spinach	methamidophos	43	0,009	1	0,072	0,1
Spinach	omethoat	225	0,069	1	0,008	8,6
Spinach	permethrin	946	1,920	1	0,49	3,9
Strawberries	iprodione	287	0,552	1	0,079	7,0
Strawberries	methomyl	162	0,440	1	0,19	2,3
Strawberries	chlorpryifos	5	0,006	1	0,007	0,9
Sweet bell pepper	edosulphan I	148	0,030	1	0,008	3,8
Sweet bell pepper	methamidophos	260	0.092	1	0,68	0,1
Sweet bell pepper	diazinon	6	0,012	1	0,061	0,2
Sweet potato	*o*- fenylofenyl	14	0,031	1	0,017	1,8
Mean			**0,305**		**0,185**	**1,65**



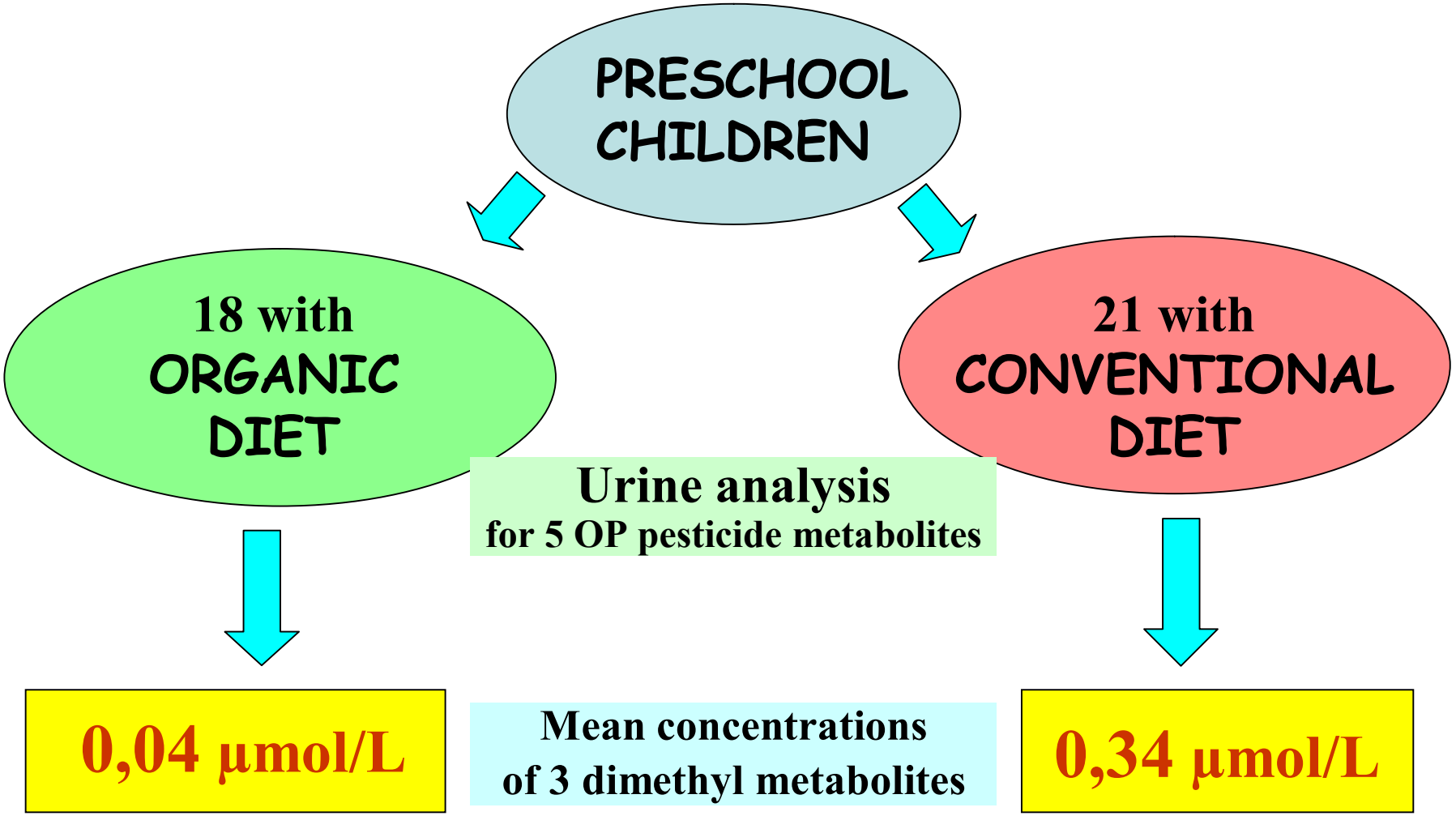
Comparison of the pesticide residues level in 22 crops from organic and conventional crops, USDA data (Baker et al. 2002)

Contamination of human milk with pesticides (chlorinated hydrocarbons) in relation to the share of organic food in diet (after Aubert 1987)



Organophosphorus Pesticide Exposure of Preschool Children with Organic and Conventional Diets

(Acc. to Curl et al. 2003)



Organophosphorus Pesticide Exposure of Preschool Children with Organic and Conventional Diets

(Acc. to Curl et al. 2003)

Dietary classification		Individual metabolites (µg/L)					Total molar concentrations (µg/L)	
		DMP	DMTP	DMDTP	DEP	DEPT	Dimethyl	Diethyl
ORG	Mean	1,1	4,3	0,8	1,0	2,7	0,04	0,02
	% detectable	22	78	11	17	83	-	-
CONV	Mean	1,9	41,0	4,8	0,8	4,0	0,34	0,03
	% detectable	43	95	62	14	86	-	-

*DMP, DMPT, DMDTP – dimethyl metabolites; DEP, DEPT – diethyl metabolites. The limits of detection (LOD) were 1,2 µg/L for DMP and 1,3 µg/L for the other metabolites. All samples containing concentrations < LOD were assumed to have concentrations equal to one-half the LOD.

CONCLUSION

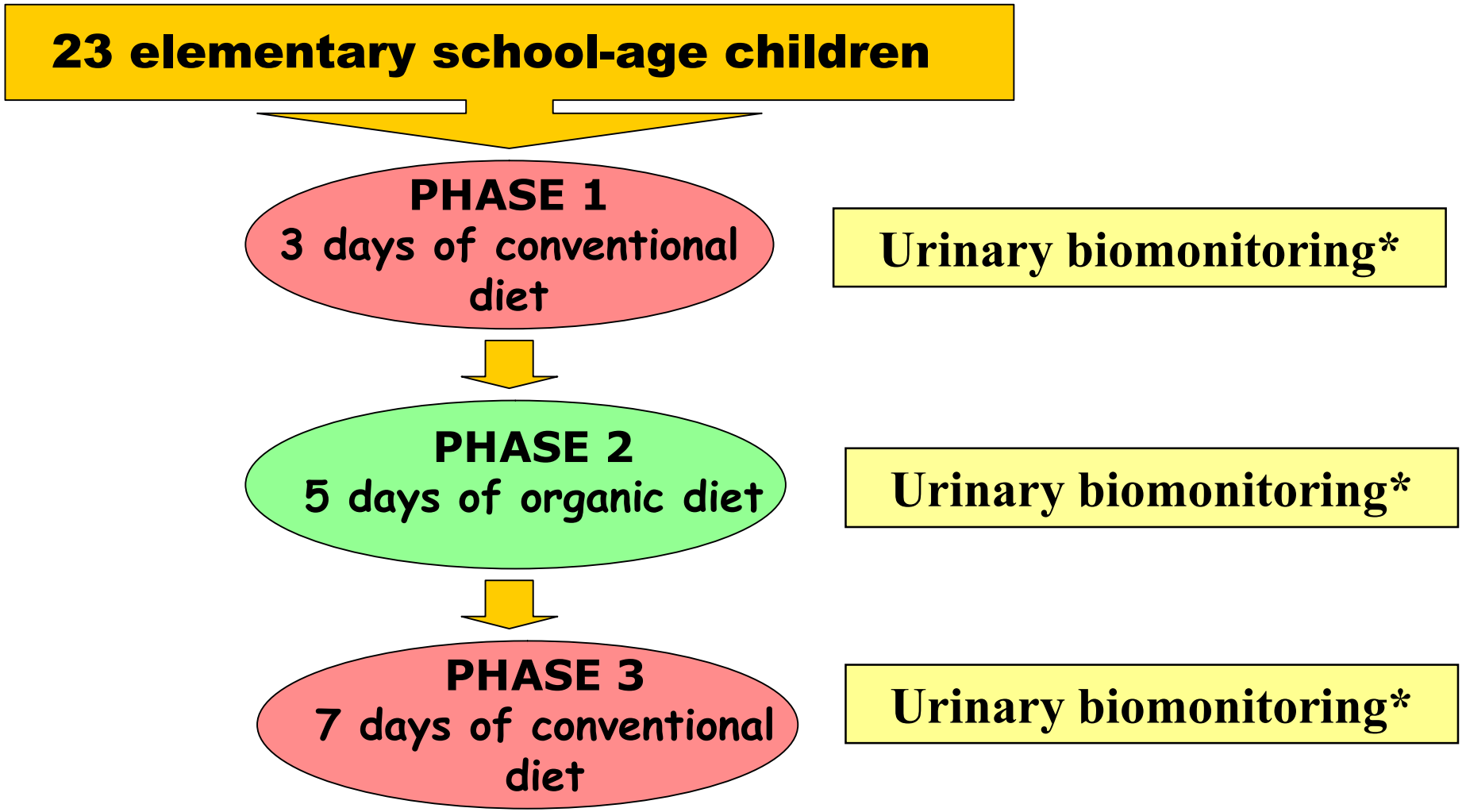
CONSUMPTION OF

ORGANIC PRODUCE

PROVIDE A SIMPLE WAY TO REDUCE CHILDREN'S EXPOSURE TO OP PESTICIDES

Acc. to Curl et al. 2003

Dietary organophosphorus pesticide exposure in a group of elementary school-age children (Lu et al. 2006)

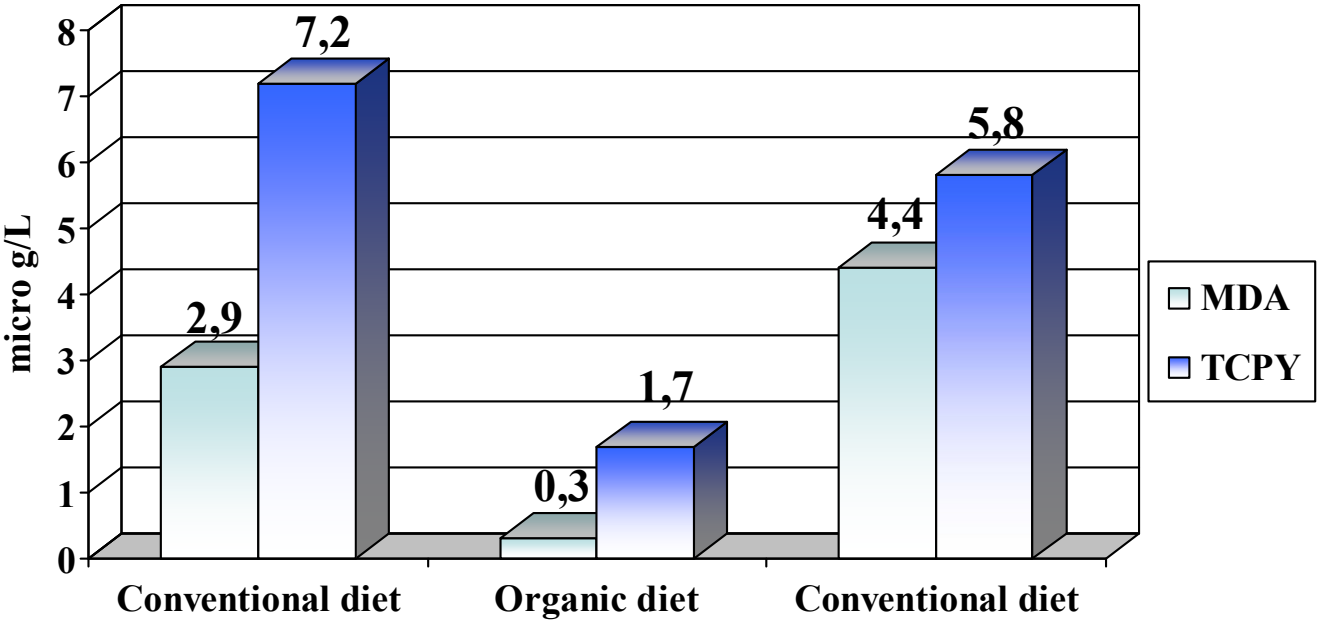


*Monitoring of 5 OP pesticide urinary metabolites (MDA, TCPY, IMPY, DEAMPY, CMHC). Two spot daily urine samples were collected every day (first-morning and before-bedtime voids)

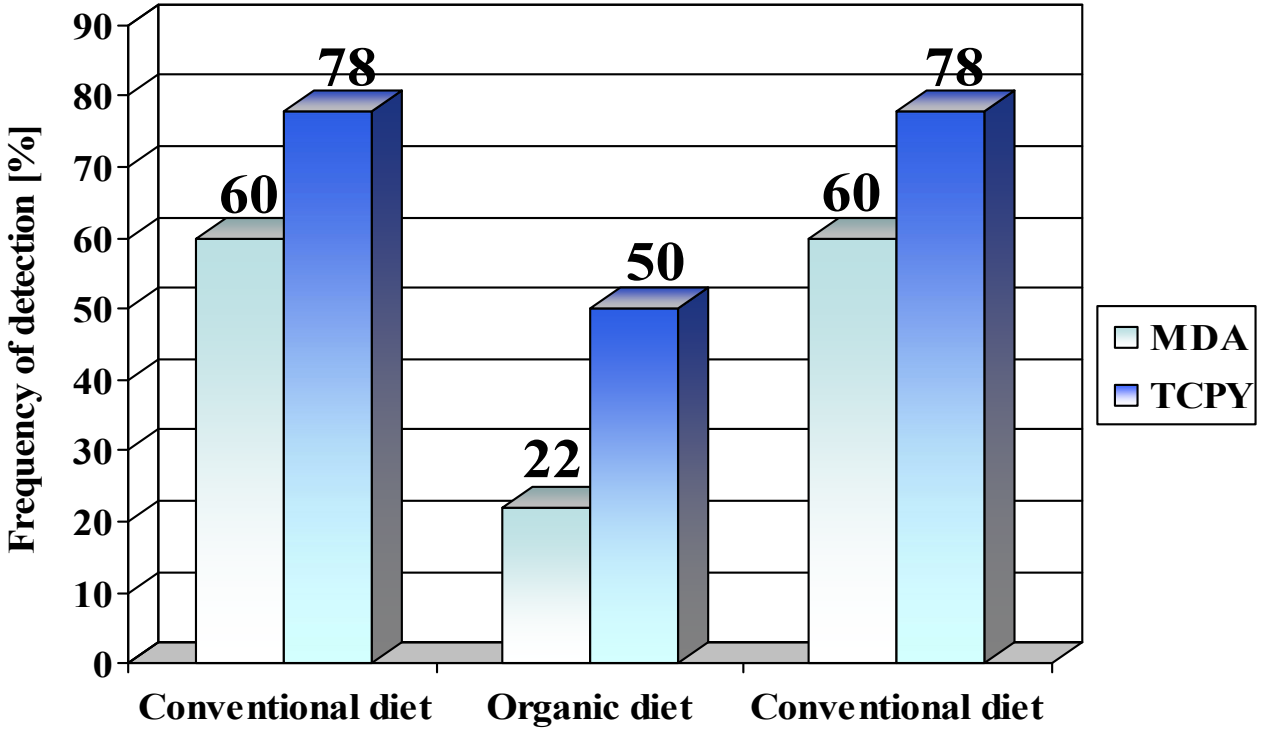
Organic Diets Significantly Lower Children's Dietary Exposure to Organophosphorus Pesticides
(Lu et al. 2006)

OP pesticides metabolite	Study phase	Frequency of detection (%)	Mean (µg/L)	Maximum (µg/L)
MDA*	1. (CONV)	60	2,9	96,5
	2. (ORG)	22	0,3	7,4
	3. (CONV)	60	4,4	263,1
TCPY**	1. (CONV)	78	7,2	31,1
	2. (ORG)	50	1,7	17,1
	3. (CONV)	78	5,8	25,3

*MDA – malathion dicarboxylic acid (LOD = 0,3 µg/L);
**TCPY – 3,5,6-trichloro-2-pyridinol (LOD = 0,2 µg/L)



Mean concentrations of MDA and TCPY in three study phases



Frequency of MDA and TCPY detection in three study phases [%]

According to Lu et al. 2006

Lower content of hormone residues, antibiotics, growth regulators, food additives…

in organic food

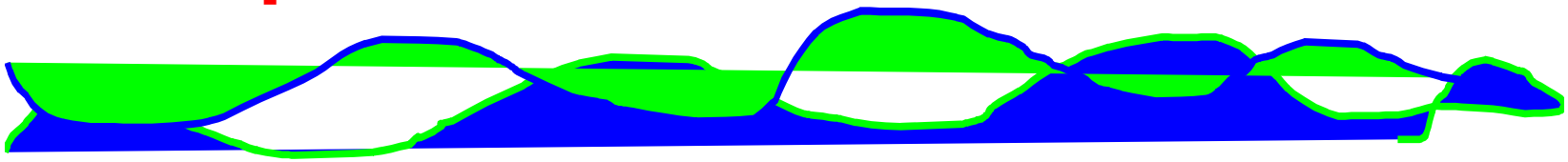
- **Higher nutritional value**

C/N Balance Theory (Bryant et al. 1883, Coley et al. 1985)

- When nitrogen is readily available, plants will primarily make compounds with high N content, e.g. Proteins for growth and N- containing secondary metabolites such as alkaloids

- When N-availability is limiting for growth, metabolism changes more towards carbon (C) containing compounds: starch, cellulose and non-N-containing secondary metabolites such as phenolics and terpenoids

GDBH theory (Growth / Differentiation Balance Hypothesis) [Lorio 1986, Herms and Mattson 1992]



- The plant in any given situation will assess the resources available to it and optimise its investment in processes directed toward growth or differentiation

- The term „differentiation" comprises increased formation of defence compounds as well as accelerated maturation and seed development

- The C/N balance theory is a special and typical case of the growth/differentiation balance theory, since low nitrogen availability is the most common growth-limiting condition in natural ecosystems (Brandt and Mølgaard 2001).

Polyphenols content in organic and conventional vegetables and fruit

Plants	Bioactive substance	Content		Difference in the content of bioactive compound in favour of the organic product*	Difference in the content of bioactive compound in favour of the organic product**	Author
		ORG	CONV			
Apples	Polyphenols (mg / 100g d.m.)	4,66	3,93	+18,58	+17,00	Weibel et al. 2000
Peach	Polyphenols (mg /100 g f. m.)	26,7	19,6	+36,22	+30,67	Carbonaro and Mattera 2001
Peach	Polyphenols (mg of tannic acid/100g f.m.)	29	21,3	+36,15	+30,62	Carbonaro et al. 2002
Pear	Polyphenols (mg /100 g f. m.)	49,5	48,2	+2,70	+2,66	Carbonaro and Mattera 2001
Pear	Polyphenols (mg of tannic acid/100g f.m.)	64,5	58,4	+10,45	+9,93	Carbonaro et. al. 2002
Marrionberries	Polyphenols (mg /100 g f.m.)	600	400	+50,00	+40,00	Asami et al. 2003
Corn (frozen)	Polyphenols (mg /100 g f.m.)	40	25	+60,00	+46,15	Asami et al. 2003
Strawberries (frozen)	Polyphenols (mg /100 g f.m.)	280	240	+16,67	+15,38	Asami et al. 2003

Polyphenols content in organic and conventional vegetables and fruit

Plants	Bioactive substance	Content		Difference in the content of bioactive compound in favour of the organic product*	Difference in the content of bioactive compound in favour of the organic product**	Author
		ORG	CONV			
Chinese cabbage Pac Choi	Polyphenols (mg of quercetin/g d.m.)	13,5	12,5	+8,00	+7,69	Young et al. 2005
Lettuce	Polyphenols (mg of quercetin/g d.m.)	15,2	11,5	+32,17	+27,72	Young et al. 2005
Apple juice	Polyphenols (mg/l)	397,3	304,6	+30,43	+26,41	Rembiałkowska et al. 2006
Apple mousse	Polyphenols (mg/100 g d.m.)	712,4	604,6	+17,83	+16,37	Rembiałkowska et al. 2006
Tomatoes	Flavonoids (mg of quercetin/100 g f.m.)	0,83	0,48	+72,92	+53,44	Rembiałkowska et al. 2003
Apples	Flavonoids (mg of quercetin/100g f.m.	1,34	0,73	+83,56	+58,94	Rembiałkowska et al. 2003
Apples	Flavonoids (mg/100g d.m.)	2,75	2,37	+16,03	+14,84	Weibel et al. 2004

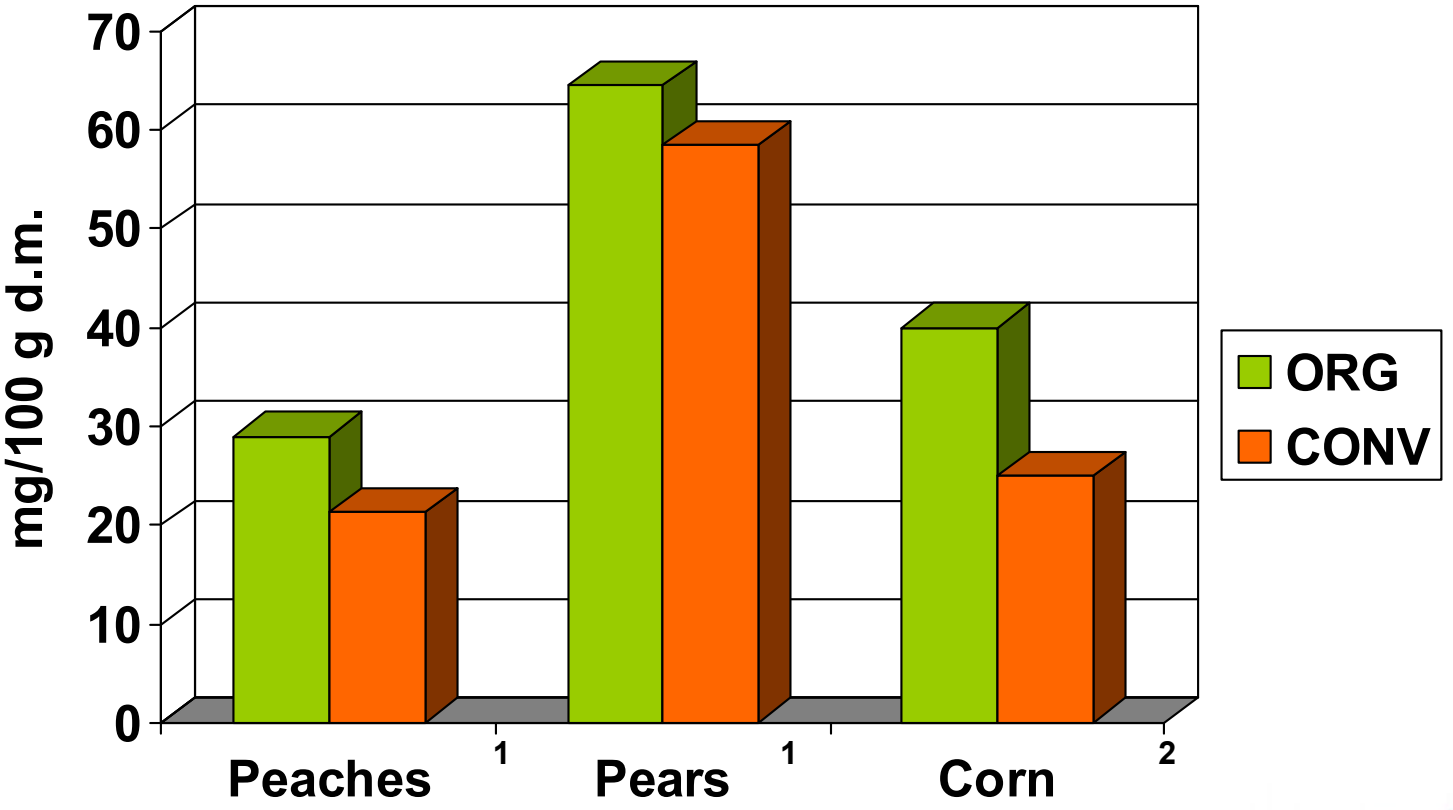
Polyphenols content in organic and conventional vegetables and fruit

Plants	Bioactive substance	Bioactive substance content		Difference in the content of bioactive compound in favour of the organic product*	Difference in the content of bioactive compound in favour of the organic product**	Author
		ORG	CONV			
Red pepper	Flavonoids (mg/100 g f.m.)	33,81	14	+141,46	+82,86	Hallmann et al. 2005
Onion	Flavonoids (mg quercetin/100 g f.m.)	95,27	84,61	+12,60	+11,85	Hallmann and Rembiałkowska 2006
Strawberries	Quercetin (mg/100g f.m.)	0,722	0,69	+4,64	+4,53	Anttonen et al. 2006
Strawberries	Kampherol (mg/100g f. m.)	0,692	0,784	-11,73	-12,47	Anttonen et al. 2006
Apples	Anthocyans (mg/100 g f. m.)	9,19	2,2	+317,73	+122,74	Rembiałkowska et al. 2003
Apples	Anthocyans (mg/100 g f.m.)	1,65	0,972	+69,75	+51,72	Rembiałkowska et al. 2004
Onion	Anthocyans (g/100 g f. m., mg% delphinidin)	14,61	8,37	+74,55	+54,31	Hallmann and Rembiałkowska 2006
Mean:				**+50%**	**+32,4%**	

*Caltulated according to Worthington's system (2001): **(ORG-CONV)/CONV x 100%**

Calculated according to Lockeretz's system: **(ORG-CONV)/[(ORG+CONV)/2] x 100%

Polyphenols content in organic and conventional vegetables and fruit



[1]Carbonaro et al. 2002
[2]Asami et al. 2003

Flavonoids

Flavonoids known also as bioflavonoids and flavones are antioxidants; they occur in the natural products and are responsible for the colour of leaves, flowers and stems (Sullivan, 1998). They belong to the polyphenolic compounds. They occur commonly in fruits and vegetables, often in a glycoside form. In dependence of the middle ring's structure several groups of flavonoids are distinguished: flavonols, flavones, flavanones, anthocyianes and other. Therefore it is difficult to determine unequivocally their functions, because in dependence on a group they can decide about the colour, taste, and aroma of the fruits (Coultate, 2002).

Importance of flavonoids for human health

- They show strong antioxidant and metal chelating activity
- They influence on the free radicals neutralization, hampering the cancer development
- They counteract arteriosclerosis
- They diminish the permeability of the blood vessels
- They weaken decomposition of vitamin C in human organism
- They help the immune system and counteract some bacterial and virus infections
- They diminish a risk of thrombus, unclenching the blood vessels, and slightly reduce blood pressure
- Some flavonoids show constricting properties, soothing the irritations of the mucous membrane

---

(acc. to Bidlack'a et al. 1998)

It is currently considered that the intake of flavonoids shouldn't be lower than 1-2 g per day (Ziegler 1997).

Carotenoids and chlorophyll content in organic and conventional vegetables and fruit

Plants	Substance	Bioactive substance content [mg/100g f.m.]		Difference in the content of bioactive compound in favour of the organic product *	Difference in the content of bioactive compound in favour of the organic product**	Author
		ORG	CONV			
Carrot	B-carotene	13,55	14,49	-6,49	-6,70	Rembialkowska 1998
Tomatoes	B-carotene	1,42	0,48	195,83	98,95	Rembialkowska et al. 2003
Red pepper	B-carotene	3,17	2,59	22,39	20,14	Hallmann et al. 2005
Red pepper	B-carotene	3,43	2,59	32,43	27,91	Hallmann et al. 2007
Tomatoes	Licopen	2,32	3,32	-30,12	-35,46	Rembialkowska et al. 2003
Red pepper	Licopen	4,25	4,68	-9,19	-9,63	Hallmann et al.2005
Red pepper	Licopen	4,15	4,68	-11,32	-12,00	Hallmann et al.2007
Red pepper	Lutein	5,945	4,49	32,41	27,89	Hallmann et al.2005
Red pepper	Lutein	5,45	4,49	21,38	19,32	Hallmann et al.2007
Beetroot leaves	Chlorophyll	321,3	298,6	7,60	7,32	Moreira et al. 2003
Mean:				**+25,5**	**+13,8**	

Vitamin C content in organic (ORG) and conventional (CONV) vegetables and fruit

Plants	vit. C content [mg/100g f.m.]		Difference in the content of bioactive compound in favour of the organic product*	Difference in the content of bioactive compound in favour of the organic product**	Author
	ORG	CONV			
Spinach	76,3	55,5	+37,48	+31,56	Vogtmann et al. 1984
Spinach	53,1	29,9	+77,59	+55,90	Schuphan 1974
Celery	8,1	7,3	+10,96	+10,39	Leclerc et al.1991
Celery	14	11,8	+18,64	+17,05	Schuphan 1974
Savoy cabbage	73,5	41,8	+75,84	+54,99	Schuphan 1974
Cabbage	47,02	40,87	+15,05	+13,99	Rembiałkowska 2000
Cabbage	44,58	34,26	+30,12	+26,18	Rembiałkowska 1998
Lettuce	15,4	9,7	+58,76	+45,42	Schuphan 1974
Leek	97,8	76,1	+28,52	+24,96	Lairon et al. 1986
Potatoes	18,1	15,5	+16,77	+15,48	Petterson 1978
Potatoes	33,1	28,3	+16,96	+15,64	Schuphan 1974
Potatoes	21,1	10,6	+99,06	+66,25	Fischer and Richter 1986
Potatoes	26,6	22	+20,91	+18,93	Rembiałkowska and Rutkowska 1996

Vitamin C content in organic (ORG) and conventional (CONV) vegetables and frui

Plants	Vit. C content [mg/100g f.m.]		Difference in the content of bioactive compound in favour of the organic product *	Difference in the content of bioactive compound in favour of the organic product**	Author
	ORG	CONV			
Potatoes	10,61	6,9	+53,77	+42,38	Rembiałkowska 2000
Potatoes	9,66	8,94	+8,05	+7,74	Hajslova et al. 2005
corn (frozen)	2,1	3,2	-34,38	-41,51	Asami et al. 2003
Swiss beetroot leaves	18,25	16,5	+10,61	+10,07	Moreira et al. 2003
Onion	28,14	12,24	+129,90	+78,75	Hallmann and Rembiałkowska 2006
Tomatoes	13,4	19,4	-30,93	-36,59	Rembiałkowska et al. 2003
Tomatoes	17,08	12,07	+41,51	+34,37	Hallmann, 2005
Tomatoes	16,84	12,47	+35,04	+29,82	Rembiałkowska, 2005
Red pepper	152,14	119,99	+26,79	+23,63	Hallmann, 2005
Red pepper	136,03	119,99	+13,37	+12,53	Hallmann et al. 2007
Apples	7,27	5,47	+32,91	+28,26	Rembiałkowska et al. 2003
Oranges	65,73	58,71	+11,96	+11,28	Rapisarda et al. 2005
Mean:			**+ 32,21**	**+23,9**	

Two calculation systems: according to Worthington* and Lockeretz**

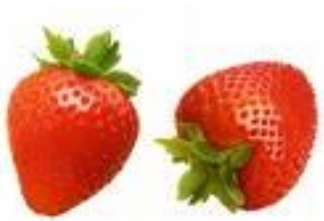
Vitamin C content in organic (ORG) and conventional (CONV) vegetables and fru

[1]Schuphan 1974
[2]Hallmann 2005, Hallmann et al. 2007
[3]Schuphan 1974, Vogtmann et al. 1984

Importance of vitamin C for human health







- creates the collagen
- participates in the hormones and transmitters synthesis
- increases the non-hem iron's bioavailability
- enhances a detoxication of the organism
- stimulates the immune system
- counteracts the heart ischemia disease
- prevents and hampers the initial stages of the carcinogenesis
- stimulates development and regeneration of the blood vessels
- helps to fight against allergy and diabetes

According to Ziemlański (1996) and Sullivan (1998)

The recommended intake of vitamin C for adults is 70 mg/day (Ziemlański 1995); the main sources are fruits and vegetables

Sugar content in sugar beets [% f.m.]

	Farm		
Year	Conventio-nal	Integrated	Organic
1980	16,4	16,2	16,4
1981	15,7	15,7	16,1
1982	16,2	16,7	17,3
1983	15,8	15,9	16,5
1984	13,6	15,8	16,3
Mean	15,5	16,1	16,5

Zadoks, 1989

Total sugars in organic (ORG) and conventional (CONV) vegetables and fruit

Plants	Sugars content (g/100g f.m.)		Difference in the content of bioactive compound in favour of the organic product*	Difference in the content of bioactive compound in favour of the organic product**	Author
	ORG	CONV			
Beetroot	8,44	8,38	+0,72	+0,71	Abele 1987
Potatoes	1,1	1,11	-0,90	-0,90	Abele 1987
Carrot	6,04	5,81	+3,96	+3,88	Abele 1987
Beetroot	16,5	15,5	+6,45	+6,25	Zadoks 1989
Carrot	7,53	6,57	+14,61	+13,62	Rembiałkowska 1998
Apples	10,91	10,39	+5,00	+4,88	Rembiałkowska et al. 2004
Potatoes	0,98	0,41	+139,02	+82,01	Cachoeira Stertz et al. 2005
Tomatoes	5,64	4,88	+15,57	+14,45	Rembiałkowska et al. 2005
Onion	3,26	1,7	+91,76	+62,90	Hallmann and Rembiałkowska 2006
Red pepper	5,08	3,6	+41,11	+34,10	Hallmann et al. 2007
Mean:			**+31,7%**	**+22,2%**	

Two calculation systems: according to Worthington* and Lockeretz**

Reducing sugars' content in organic (ORG) and conventional (CONV) vegetables and fruit

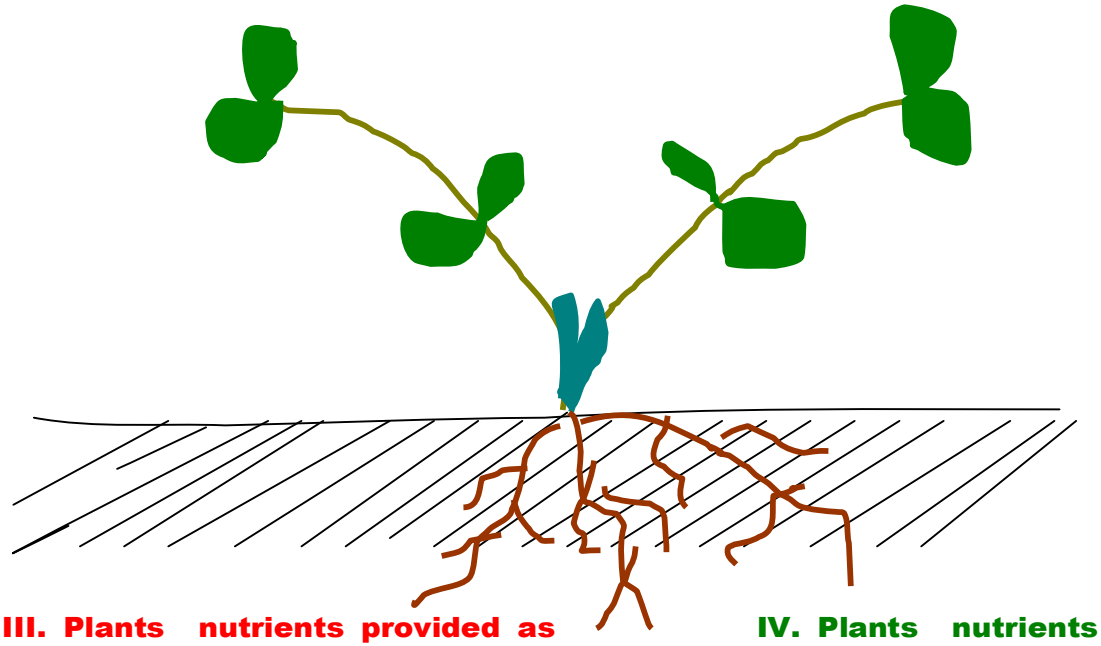
Plants	Reducing sugars (g/100g ś.m.)		Difference in the content of bioactive compound in favour of the organic product*	Difference in the content of bioactive compound in favour of the organic product**	Author
	ORG	CONV			
Beetroot	0,27	0,23	+17,39	+16,00	Abele 1987
Potatoes	0,32	0,33	-3,03	-3,08	Abele 1987
Carrot	2,71	2,7	+0,37	+0,37	Abele 1987
Apples	6,49	6,4	+1,41	+1,40	Rembiałkowska et al. 2004
Potatoes	0,25	0,1	+150,00	+85,71	Cachoeira Stertz et al. 2005
Tomatoes	3,68	4,41	-16,55	-18,05	Rembiałkowska et al. 2005
Onion	0,48	0,21	+128,57	+78,26	Hallmann and Rembiałkowska 2006
Red pepper	3,36	2,4	+40,00	+33,33	Hallmann et al. 2007
Mean:			**+93,3%**	**+55,1%**	

Two calculation systems: according to Worthington* and Lockeretz**

Conventional farming **Organic farming**

I. Plants defence by pesticides

II. Plants defence by immune mechanisms



III. Plants nutrients provided as salts

IV. Plants nutrients provided as organically combined substances

Chemical processes in soil **Biological processes in soil**

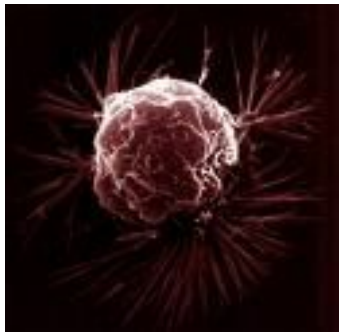
I. **Product can contain pesticides, decreased nutritive value documented**
II. **Product can contain more secondary metabolites, needs scientific verification**
III. **Product can contain unbalanced nutrient levels, needs scientific verification**
IV. **Product can contain substances connected with biological soil activity, needs scientific verification**

Lundegårdh i Mårtensson 2003

Similarities and differences between the protective functions and substances in plants and people

Plants	People
Detoxication system (e.g. cytochrome P450 and glutathione transferase)	Detoxication system inducible by plant compounds (e.g. cytochrome P450 and glutathione transferase)
Antioxidants	**Antioxidant functions (require antioxidants)**
Protein (type of immune defence) Phytoalexins	Immune defences inducible by plant compounds (against diseases and allergens) Tears, saliva and secretions contain antibacterial and anti-viral substances
Sensory agents Osmotic substances Structural substances • lignin • fibre • wax and cutin • cork	Anti-carcinogenic substances Osmotic substances Structural substances • skin • mucous membranes

Lundegårdh and Mårtensson 2003

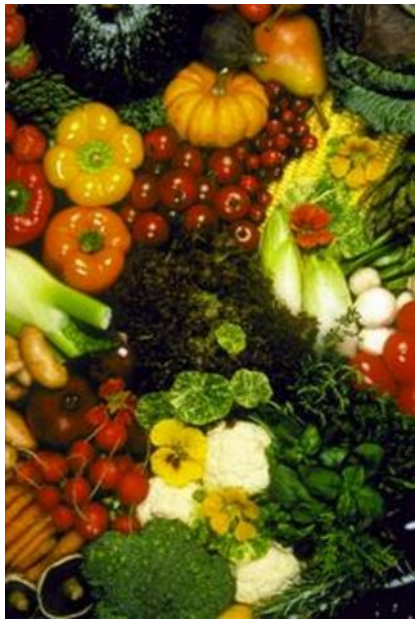


Factors affecting the incidence of cancer

Factor	Effect on cancer
Energy intake	Increased intake increases the risk of certain forms of cancer
Fat	Weak correlation fat intake and cancer
Fibre	Fruit and vegetable fibres reduce the risk of the large intestine cancer, whilst fibre from cereals increases it
Selenium	Protects against intestinal and breast cancer
Vitamin A / carotenoids	Often positive correlation with certain forms of cancer
Vitamin C	Seems to protect against a range of cancers. It is probably other factors in fruit that have the primary effect
Vitamin E	No significant effect

Willet 1996

Note. Vegetables have generally proved to protect against many forms of cancer



Classes of potentially anti-carcinogenic phytochemicals in fruit and vegetables

Phytochemical class	*Food source*
Allium compounds	Onion, garlic, leek
Carotenoids	Yellow / orange fruit and vegetables plus dark green-bladed vegetables
Cumarines	Vegetables and citrus fruits
Diothiolthionates	Brassicas
Flavanoids	Fruit and vegetables
Glucosinolates / indols	Brassicas
Inositol hexaphosphate	Plants, above all soya beans and cereals
Isoflavones	Soya beans
Limonene	Citru fruits
Isothiocyanates / thiocyanates	Brassicas
Phenols	Fruit and vegetables
Plant sterols	Vegetables
Protease inhibitors	Cereals and legumes, above all soya beans
Saponines	Plants, above all soya beans

Hasler 1996

Micronutrients that are currently known to be essential for plants and animals respectively

+ essential; - not essential; (+) probably essential

Substance	Essential for plants	Essential for animals
Arsenic	-	(+)
Boron	+	+
Cadmium	-	(+)
Chlorine	+	+
Chromium	-	+
Cobalt	(+)	+
Copper	+	+
Fluorine	-	+
Iodine	-	+
Iron	+	+
Manganese	+	+
Molybdenum	+	+
Nickel	(+)	+
Selenium	-	+
Silicon	(+)	+
Sodium	(+)	+
Tin	-	(+)
Vanadium	-	+
Zinc	+	+

Epidemiogical studies involving lycopene, lycopene-containing foods and chronic diseases

Disease	*Major conclusion*	*Reference*
Prostate cancer	Intake of tomato products inversely associated with prostate cancer	Giovannucci et al. 1995, Clinton et al. 1996
Digestive tract cancer	Reduced risk with high tomato intake	Franceschi et al. 1994
Bladder cancer	Serum lycopene associated with decreased risk	Helzlsour et al. 1989
Skin cancer	Decrease on skin lycopene on exposure to light	Ribago – Mercado et al. 1995
Breast cancer	Serum lycopene associated with decreased risk	Dorgan et al. 1998
Cervical cancer	Lycopene level showed inverse risk	Sengupta and Das 1999
Cardiovascular disease	Adipose tissue lycopene associated with lower risk, low serum lycopene with increased mortality	Kohlmeier et al. 1997, Kristensen et al. 1997

Bramley 2000

Mineral compounds in organic and conventional vegetables

(Worthington 2001)

Vegetable	Mineral compounds*			
	Vitamin C	Iron	Magnesium	Phosphorus
Lettuce	+17	+17	+29	+14
Spinach	+ 52	+25	- 13	+14
Carrot	- 6	+12	+69	+13
Potatoes	+22	+21	+5	0
Cabbage	+43	+41	+40	+22

*„+" and „-" determine % differences in the content of each compound in organic vegetable in comparison with conventional vegetable.

Dry matter content in organic and conventional vegetables

(Rembiałkowska 2000)

VEGETABLE	CULTIVAR	YEAR	ORGANIC	CONVENTIONAL
Potatoes	different cultivars, mixed	1991 - 1993	22.4 ± 2.09 a[1]	21.1 ± 2.25 b [1]
Potatoes	Bryza	1994	21.43 ± 1.50 a [1]	20.21 ± 1.96 a [1]
Potatoes	Sokół	1994	20.64 ± 1.86 a	20.79 ± 2.00 a
Potatoes	Sokół	1995	21.91 ± 1.61 a	20.21 ± 1.89 a
Potatoes	Ania	1995	24.12 ± 1.61 a	21.60 ± 2.79 b
Potatoes	Anielka	1996	24,3 ± 1,2 a	23,3 ± 1.5 b
Carrot	Regulska	1996	15.22 ± 2.26 a	14.11 ± 0.91 a
Carrot	Monanta	1997	11.55 ± 0.84 a	11.10 ± 0.80 a
Cabbage	Atria F_1	1997	8.37 ± 0.51 a	7.25 ± 0.48 b
Red beet	*	1997	16.76 ± 0.58 a	13.86 ± 1.39 b
Carrot	*	1997	11.78 ± 1.43 a	11.42 ± 1.42 a
Potatoes	*	1997	18.08 ± 0.91 a	16.85 ± 1.55 b

[1] (a – a) = difference statistically insignificant; (a – b) = difference statistically significant

* Vegetables from organic shops (cultivars not known)

Mass loss of several vegetables (in % of basic mass) after their storage in dependence on fertilisation type (after Samaras 1978)

Vegetable	Mass loss of rotten vegetables	
	Mineral fertilisation	Organic fertilisation
Carrot	45,6	34,6
Kohlrabi	50,5	34,8
Garden beet	59,9	30,4
Potatoes	29,6	15,6
Average	46,4	28,9

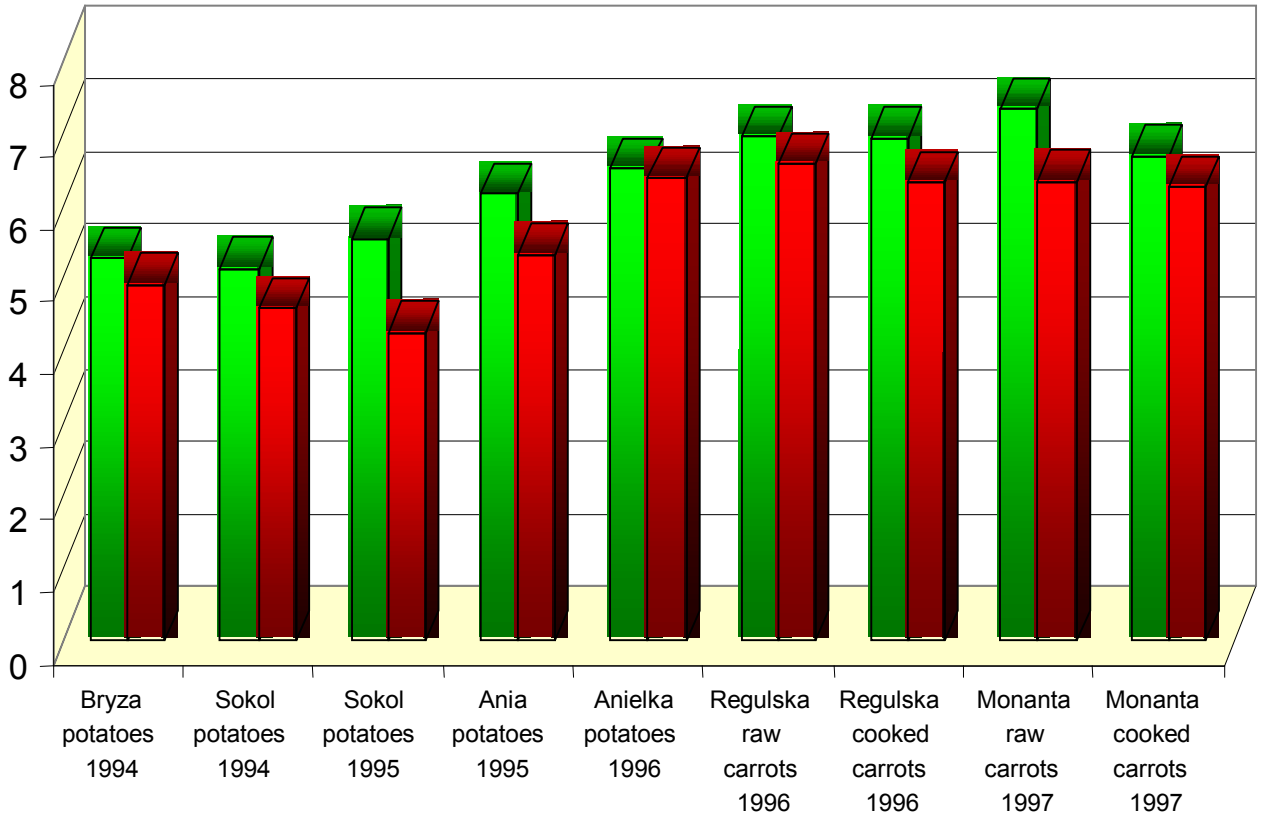
Better storage quality of organic vegetables (Higher content of dry matter, lower losses during storage period)

Storage losses of vegetables and potatoes from organic and conventional farms (Bulling 1987)

	Carrots		Potatoes		Various vegetables and fruit - average	
	ORG	CON	ORG	CON	ORG	CON
Number of studies	15	15	22	22	53	53
Storage losses in % of initial mass	33	40	22	30	28	38

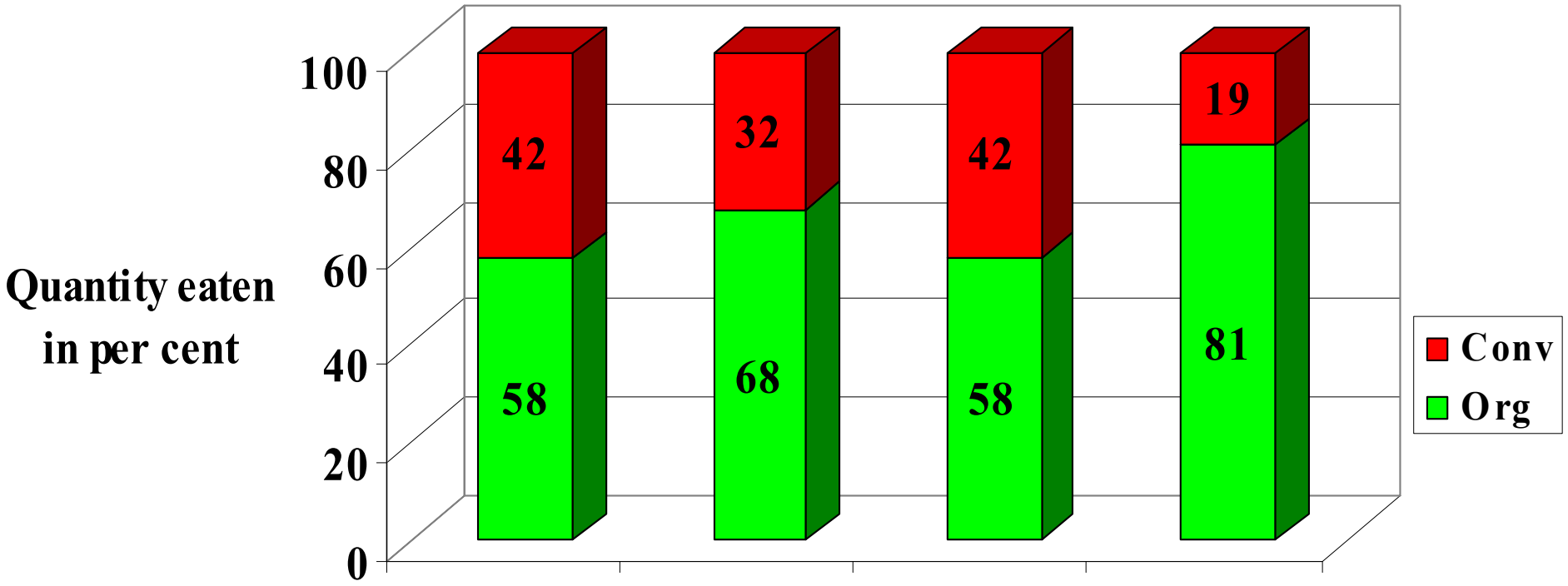
(Bulling 1987)

Sensory evaluation of potatoes and carrots from the organic and conventional farms in 1994 – 1996



in scale 1- 9 with hedonic method, all evaluations conducted in autumn

Rat studies on choice of organic vs. conventional feed



According to: Maeder 1993, Velimirov 2001, Velimirov 2002.

Conditions of animal breeding in organic agriculture according to EEC- Regulation No. 1804/1999 compared to general ordinances

Farm animals		EU-Ordinances on the keeping of farm animals	EEC-Regulation on Organic Livestock Farming
Dairy cows	Locomotion area* Floor characteristic Husbandry practices	No ordinance	6,0 m^2 indoors + 4,5 m^2 outdoors Lying space with litter(bedding) Keeping tethered is forbidden
Calves	Locomotion area * Floor characteristic Husbandry practices	1,3 m^2 Dry litter bedding*** Group penning after 8th week	1,5 m^2 indoors + 1,1 m^2 outdoors Dry litter bedding Generally group penning
Sow with piglets	Locomotion area * Floor characteristic	No ordinance Isolated, non-perforated floor	7,5 m^2 indoors + 5,0 m^2 outdoors Dry litter bedding
Fattening pigs	Locomotion area * Floor characteristic Husbandry practices	0,65 m^2 ** Safe floors Tools for occupation > 1 h	1,3 m^2 indoors ** + 1,0 m^2 outdoors Dry litter bedding No tail-docking and tooth-clipping
Laying hens	Locomotion area	450 cm^2	1660 cm^2 indoors + 4 m^2 outdoors

*** area per animal** **** up to 110 kg live-weight** ***** for calves up to 2 weeks of age**

The main factors affecting composition and properties of milk are (Fennema, 1996):

Genetic factors:

- **Species** – different mammals produce milk varying widely in composition.
- ***Breed*** – cow breeds are predominately the result of selection by man, obtained according to the intended use and local conditions. This has led to a wide variability in milk yield and composition. However, the strongly directed selection over the last 100 years has decreased the variation in milk composition between typical dairy breeds.
- ***Individual*** – variation in milk composition among individual cows of one breed may be greater than among breeds.

Physiological factors:

- ***Stage of lactation*** – this is the most important physiological variable. However it is difficult to separate this effect from that of other variables such as feeding regimen and grazing.
- ***Age of cow*** – most of the milk components decrease slightly in concentration with increasing age of the cow.
- ***Estrus and gestation*** – both of them do not have a great effect on milk composition, but they do have on milk yield.

Environmental factors:

- ***Feed*** **– the major factor affecting the fat content of milk and especially fat composition.**
- ***Climate*** – climate has little effect on milk composition unless it is extreme, causing heat stress. All other kinds of stress, exhaustion, and housing are associated mostly with a small effect.
- ***Method of milking*** – affects the milk composition strongly in several ways. The shorter the time elapsed after the previous milking, the lower the milk yield and the higher the fat content will be. Hence, evening milking usually results in a higher fat content than morning milking, the differences amounting to 25% fat. During milking the fat content of milk increases (from 1% to 10%), but the differences vary markedly among cows. Incomplete milking thus can decrease the fat content of milking. Short time intervals between milking increase the susceptibility of milk to lipolysis.

Illness of cow, mastitis in particular.

Features according to Polish Standards PN-A-86003 and PN-A-86002	Main factors influencing the particular feature	Potential impact of the organic husbandry [++ very positive; + positive; 0 neutral; - negative; -- very negative;? unknown]	Impact on milk quality
Organoleptic features:	Feeding regime	Probably high impact of organically produced fodder and management regime (grazing)	?
View			
Taste and smell			
Fraud / watering down	Honesty of the producer, control system	Organic breeders more controlled	+
Milk composition:	Feeding regime	Probably high impact of organically produced fodder and management regime (grazing)	?
Acidity (pH)			
Density (g/ml)			
Fat content (%)			
Bacteriological quality:	Hygienic production standard, health status of the cows	Organic breeders more controlled; several data show that cow health is better in ORG herds, and organic milk contains less total and pathogenic bacteria and less somatic cells	++
Total bacterial count in 1 ml			
Somatic cells count			
Salmonella			
Staphylococcus aureus			
Coli form bacteria		Probably higher in ORG system because of bedding system (not possible to clean a cow so exactly)	-
Chemical residues:			
Presence of antibiotics or other hampering substances	Production system (ORG vs. CONV)	Much better in ORG system (ban on pesticides and antibiotics)	++
Pesticides content			++
Heavy metals content	Environmental pollution	Probably low impact of the ORG system (mostly industry, communal sources and transport)	0
Aflatoxin M_1 content	Fungal growth, weather conditions during growing season, conditions during cow fodder storage	Possible positive impact of ORG system because of higher soil quality and better biological balance of different groups of bacteria and fungi in soil	?

Studies comparing the nutritional value of milk from organic (ORG) and conventional (CONV) farms [+! ORG much better; + ORG better; 0 no difference; ? ORG impact not clear]

Study	Study design	Features analyzed	Key results	Differences*
Zadoks 1989	Milk samples from Dutch organic and conventional experimental farms	Sensory quality, dry matter, fat, proteins, Ca, Na, vit. B2, aflatoxins, bacteriological quality	Sensory quality better for conv. milk, dry matter, fat, Ca, Na, vit. B2 higher for org. milk, no difference in proteins, org. lower aflatoxins, org. better bacteriological quality except coliform bacteria	+!
Guinot – Thomas et al. 1991	Milk from 3 farms compared – conv., transitional, org.; all from same location	Nitrate, dry matter, Ca, K, Na, Mg, P, Fe, Zn, Cu, N, protein	No difference in dry matter, fat, Ca, K, Fe, Cu, bet. 3 systems; org. lower Zn, N, protein cf transitional and conv.; org. higher nitrate cf conv., transitional	0
Lund 1991	Milk samples collected from 9 organic and 6 conv. farms over 12 months period	Total solids, fat, protein, non- casein N, non- protein N, lactose, vit. C, ash, P, Na, K, Ca, Mg, fatty acids	Better quality of organic milk: more dry matter, fat, protein, calcium and vitamin C than in conv. milk	+!
Jahreis G. et al. 1997	Milk samples from 3 big German dairy farms: 1. CONV indoor feeding 2. CONV grazing 3. ORG grazing	Fatty acid composition analyzed during 1 year	For the most studied trans fatty acids the lowest levels in CONV indoor milk, the highest in ORG milk, the intermediate in CONV pasture milk; the biggest difference for CLA	+!
Bergamo et al. 2003	Milk samples from Italian organic and conventional buffalo herds and cow herds, and several dairy products	Fatty acids (CLA, LA, TVA, LNA), α – tocopherol, ß – carotene, retinol	Regularly higher level of CLA,), α – tocopherol and ß – carotene in organic dairy products, higher ratio CLA / LA in org. samples, slightly lower level of retinol in org. samples	+!
Nielsen J. et al. 2004	Milk mixed samples from many Danish ORG and CONV farms	Vitamin E, synthetic stereo-isomers of vitamin E (α- tocopherol, carotenoids, β carotene, fatty acid composition, conjugated linoleic acids (CLA)	Significantly higher vit. E and lower synthetic vit. E, higher content of carotenoids, 2- to 3- fold higher content of β carotene, no diff. in fatty acids and CLA content	+!
Hermansen J. E. et al. 2005	Milk from 10 ORG and 10 CONV Danish farms	45 trace elements and 6 major elements	Ba, Eu, Mn and Zn were less abundant in ORG milk, Mo more in ORG milk	?
Santos J. S. et al. 2005	Milk from ORG and CONV farms in Brasil	Nitrates and nitrites	No diff. in levels of nitrates and Nitrites, generally low levels	0
Słoniewski K. et al. 2005	Milk samples from small dairy farms in Polish mountains Bieszczady; comparison of pasture and indoor periods	Fat, protein, fatty acids exact profile	During pasture season (grazing) less fat and protein in milk, less SFA (saturated fatty acids) and less MUFA(monounsaturated fatty acids), but more PUFA (polyunsaturated fatty acids), especially CLA	+
Ellis K. A. et al. 2005	Milk samples from 7 ORG and 5 CONV farms and 7 ORG and 5 CONV processed milk sources in UK (3-months study)	Total bacteria count, somatic cells count, fat, protein, CLA, ochratoxin A, POP (persistent organic pollutants): ortho PCBs, non-ortho PCBs, dioxins, PBDEs	Total bacteria count lower in ORG, somatic cells count higher in ORG, fat higher in ORG, protein the same. CLA growing during the season (April-June) but similar in ORG and CONV. Less MUFa but more PUFa in ORG mlk (the same as above). Other results are contradictory.	?

Comparison of bacteria count in milk and mastitis in ORG and CONV cows

Study	Study design	Features analyzed	Key results +! ORG milk much better + ORG milk better; - CONV milk better; 0 – means no difference	Difference between ORG and CONV milk*
Karwowska W. 1999	Milk from 10 ORG and 10 CONV Polish farms	Bacteria count in milk and immunological status of the cows	The most pathogenic groups of bacteria: Streptococcus agalactiae causing the lack of milk in cows and Streptococcus aureus causing coagulation of milk, were more frequent in CONV dairy herds. E. coli and Neisseria sp. more freguent in ORG herds; immunological status significantly better in ORG cows	+!
Toledo et al. 2002	Milk samples from 18 Swedish small org. herds and 13 large org. herds and 9 small conv. herds and 10 large conv. herds	Protein, fat, lactose, somatic cells, urea	Generally small differences; more somatic cells in milk from conv. small herds cf org. small herds; more urea in milk from conv. herds versus org. herds	+
Bennedsgaard T.W. et al. 2003	Milk samples from 82 ORG and 99 CONV farms in Denmark divided in dependence on time of conversion (before 1990, in 1995, in 1999 – 2000)	Somatic cell count, mastitis treatment, retained placenta, ketosis, persistency	All parameters significantly better for ORG herds; time of conversion has a great impact on cows' health: cows form herds converted before 1990 are the healthiest	+ !
Luukkonen J. et al. 2005	Milk samples from 126 ORG farms and 126 CONV in Finland	Total bacterial count, somatic cell count, fat, protein, lactose, urea	Significantly lower content of fat and protein in ORG milk, higher level of lactose in ORG milk, lower or similar level of urea in ORG milk, lower bacterial count and higher or similar somatic cells in ORG	+
Roesch M. et al. 2005	Milk from 60 pairs ORG vs. INT (integrated) in Switzerland	Fat, protein, urea, lactose, lactation persistency, somatic cells	Urea, fat and protein less in ORG milk, lactose and persistency the same, somatic cells more in ORG milk	0
Sato et al. 2005	Milk samples from 30 ORG and 30 CONV farms in USA/Wisconsin	Somatic cells, bacteria count, mastitis rate, body condition score in March, culling rate, mortality	Less somatic cells and bacteria count in ORG milk, and lower mastitis rate in ORG cows, lower culling rate and mortality in ORG herds, but higher body condition score in March for CONV cows	+

Selected results of milk analysis (Netherlands, Nagele 1982)

Evaluation criterion	Conventional farm	Organic farm
Sensory assessment		
Preference test	49	13
Smell	6,73	6,20
Composition		
Dry matter (g/kg)	129,7	131,5
Fat (g/kg)	41,8	44,0
Proteins (g/kg)	34,6	34,4
Ca (mg/100 ml)	113	123
Na (mg/100 ml)	38	43
Vitamin B2 (ppm)	1,88	2,16
Aflatoxins (ppb)	0,009	< 0,005
Bacteriological quality		
Heat-resistant bacteria (w ml)	1024	135
Butyric acid bacteria (in 100 ml)	222	14
Aerobic bacteria (in 1 ml)	490	79
Coliform bacteria (in ml)	4 - 33	6 – 150
Mastitis bacteria (Mastitis streptococci) (in ml)	4297	1299

Bacteriological quality of the milk samples from the organic and conventional farms

Type of the farm	The percentage part of the particular types of bacteria in the milk samples							
	Strepto-agalactiae	Strepto-faecalis	Staph. aureus	Esch. coli	Pseud. aeruginosa	Prot. vulgaris	Neisseria sp.	Coryneba-cterium sp.
ORG	7,1	74,1	1,1	2,2	4,1	-	8,1	3.5
CONV	12,4	78,1	3,1	1,1	4,0	1,1	0,5	-

Karwowska 1999

The most pathogenic groups of bacteria: Streptococcus agalactiae causing the lack of milk in cows and Streptococcus aureus causing coagulation of milk, were more frequent in the conventional dairy herds

Comparison of the health status of the dairy cows from the organic and conventional farms

Karwowska, 1999

Conclusions

1. **The clinic observations and analytical results indicate that the mastitis disease occurs in the studied herds of cows.**
   In the winter season 34 % of the conventional cows and only 7 % organic cows were ill with heavy mastitis.

2. **The cows from the conventional farms had smaller possibilities to fight against the infection development. Their leucocytes had lower phagocytosis capability, small possibility to decompose the phagocyted compounds and lower reactivity to mitogens.**

3. **Comparison of the clinic studies and hematological, biochemical and immune indexes showed better health status of the cows form the organic farms compared to the conventional farms.**

Norwegian study comparing the organic and conventional dairy herds 1994 –1997

Hardeng and Edge 2001

	Organic cow herds	Conventional cow herds
Number of studied herds	31	93
Feeding regime	50 % concentrates and silage; hay, pasture and root crops were important	75% concentrates and silage
Management regime	At least 30 min daily exercised outdoors during winter	Exercise outdoors - very rare practice
Mean lactation age	2.97	2.35
Spring calving	Larger proportion	Lower proportion
Milk yield [kg / cow / year]	4784	6129
Breed composition	More complex, more indigenous breeds	Less complex
Ketosis	Significantly less frequent	Significantly more frequent
Mastitis	Significantly less frequent	Significantly more frequent
Milk somatic cells	No significant difference	
Milk fever	Significantly less frequent	Significantly more frequent

COMPOSITION OF FARM-GATE MILK IN PILOT STUDY IN UK (Ellis et al. 2005)

Parameter	Average parameter value in each farming system for 3-month period	
	Organic n=7	Conventional = 5
	Mean (SD)	Mean (SD)
Somatic cells count ('000s)/ml)	293[a] *(202)*	109[b] *(17)*
Total bacteria count ('000s)/ml)	29*(16)*	64 *(45)*
% fat	4,32 *(0,60)*	3,98 *(0,12)*
% protein	3,32 *(0,15)*	3,28 *(0,08)*
Herd size (no. cows)	90 *(27)*	132 *(79)*
Av. yield / cow/ lactation	5526 *(989)*	6471 *(741)*

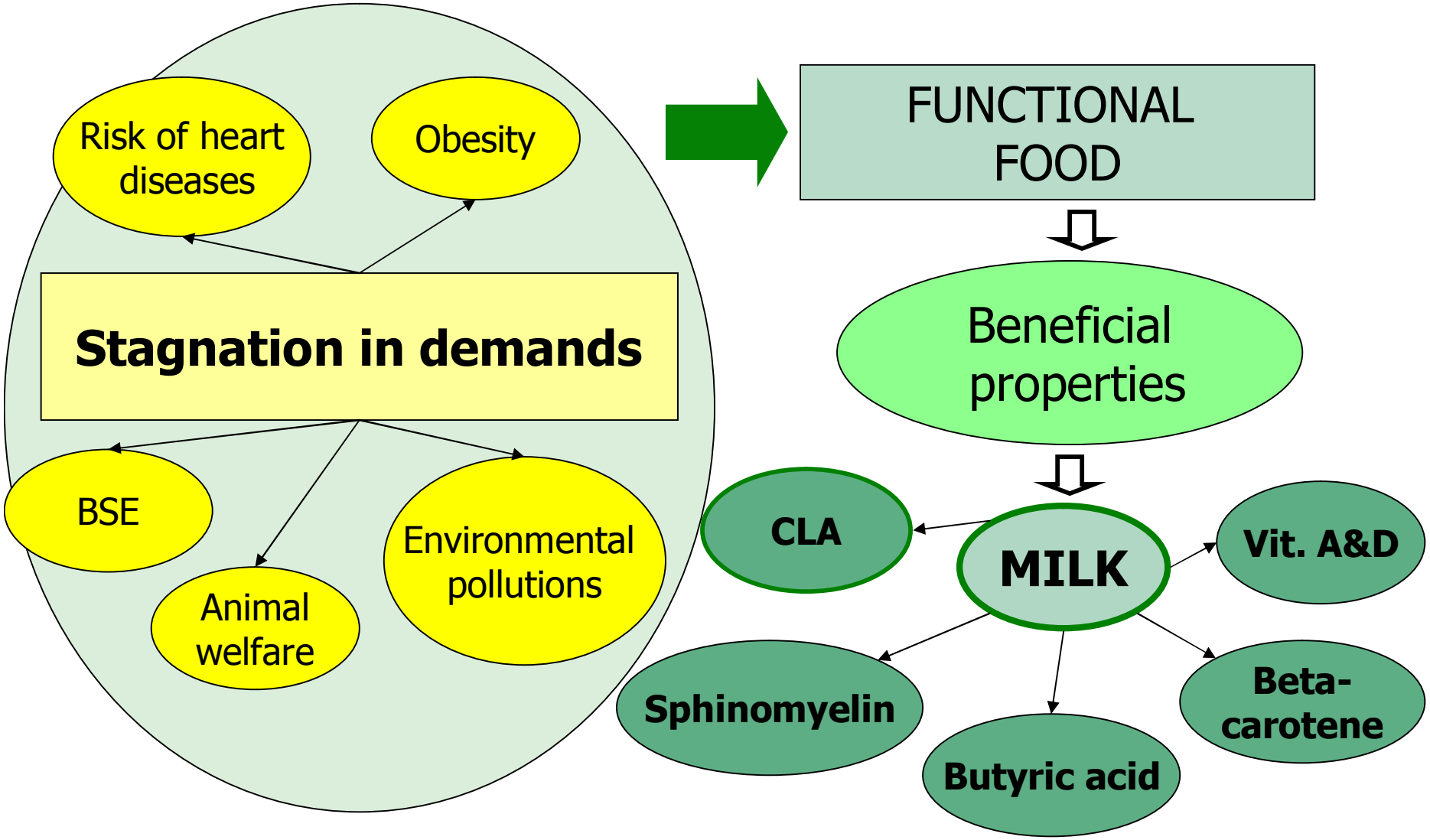
[ab] different superscript indicates significant difference where p <0,05

Pollutant content in organic (ORG) vs. Conventional (CONV) farm-gate milk in pilot study in UK (Ellis et al. 2005)

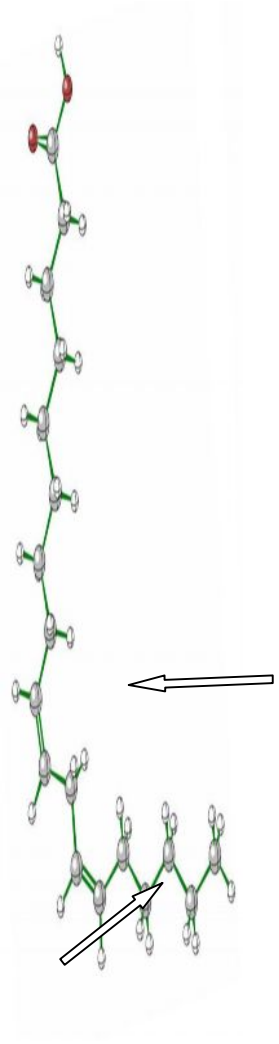
	Farm-gate		*Processed*	
Variable	**Mean (SD)**			
	ORG	CONV	ORG	**CONV**
Ortho PCBs (μg/kg fat)	8,22 (10,29)	5,06 (7,01)	4,04	**21,45**
Non-ortho PCBs (ng/kg fat)	6,45 (3,62)	8,06 (6,00)	8,69	**12,13**
Dioxins (ng/kg fat)	2,60 (0,91)	9,88 (12,57)	3,77	**2,32**
PBDEs (μg/kg fat)	1,09 (0,21)	0,91 (0,51)	1,83	**1,80**
TEQ (ng/kg fat)	**0,88 (0,21)**	**0,91 (0,52)**	**1,44**	**1,05**

Izabela Witkowska, Wageningen

Food of animal origin = the main component of most diets all over the world



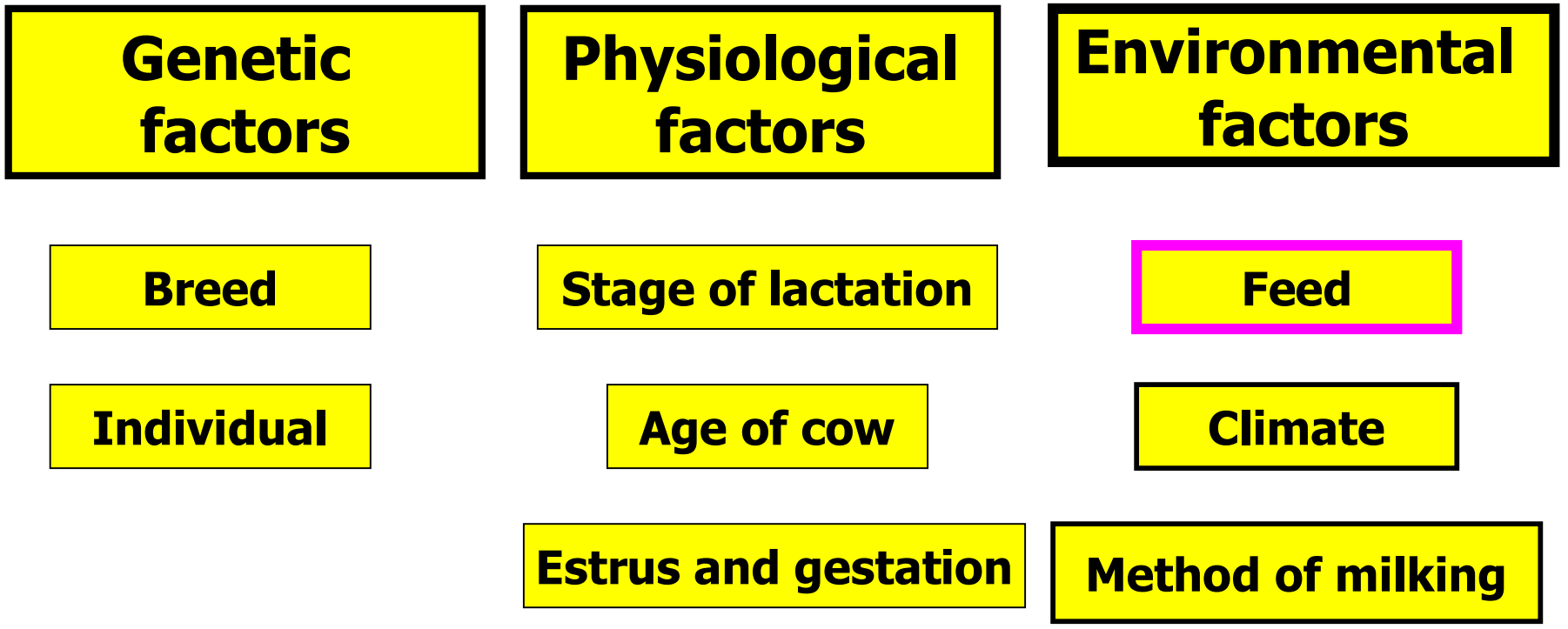
Rumenic acid
cis-9, *trans*-11 CLA



CLA

- Isomers of linoleic acid (C18:2) with conjugated double bonds in several position and confirmations
- 75-90% ***cis*-9, *trans*-11 CLA**
- **Supposed beneficial health effects of rumenic acid:**
  - **Prevention of cancer**
  - **Suppression of atherosclerosis**
  - **Anti-inflammatory properties**

Variability of rumenic acid in milk fat



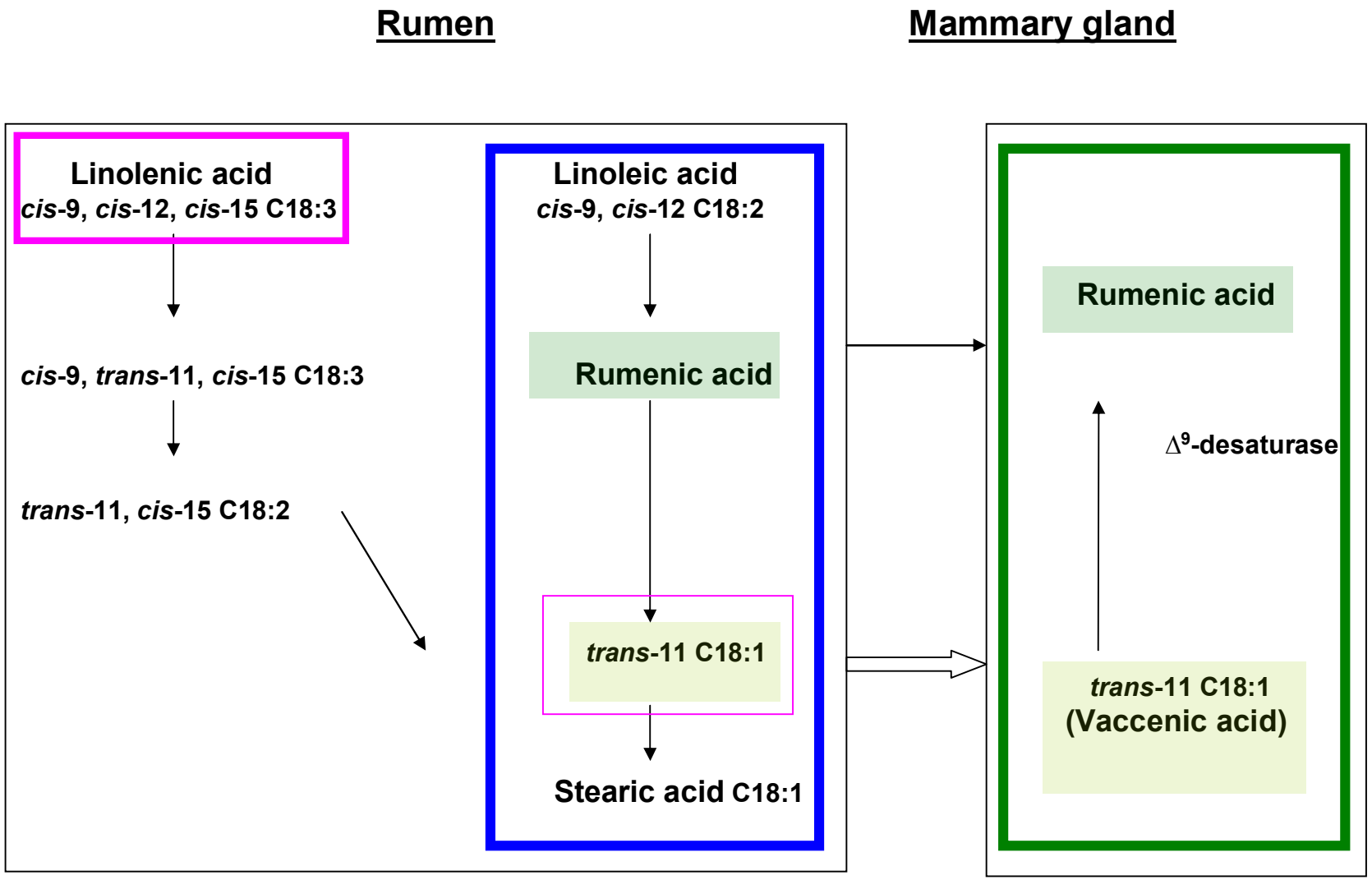
Lipid fraction of fresh forages

- Green leaves (chloroplast)
- 3-10% of DM
- Glycolipids and phospholipids
- FA chain (C14-24)
- 95% of total FA consists of:
  - α-Linolenic acid (C18:3) (**70-75%**)
  - Linoleic acid (C18:2) (10-15%)
  - Palmitic acid (C16:0) (10%)

Sources of variation of FA in fresh forages

- **Plant species** (*genetic differences*)
- **Growth stage** (*development rate*)
- **Management** (*cutting and grazing*)
- **Seasonal changes** (*temperature and light intensity*)

Pathways of rumen biohydrogenation and endogenous synthesis



Main factors influencing FA profile in milk:

- **Increased proportion of the fresh herbage in the diet results in increased proportion of rumenic acid in milk fat**

- **Nitrogen fertilization may have a positive influence on FA levels in the fresh herbage**
- **Plant composition of fresh herbage is significant**
- **Seasonal changes in FA profile of fresh herbage are typical**
- **Frequent cutting (grazing) – interruption of process from initiation of flowering to inflorescence emergence**
- **Weather is significant factor (temperature, light intensity and precipitation)**
- **Irrigation is a very important management tool**

Effect of pasture season on milk yield, milk composition and pools of fatty acids in milk fat (Słoniewski et al. 2005)

Item	Season (pasture versus indoor)	month (within season)	LSM	
			pasture season	indoor season
Milk (kg/day)	*	***	18.5	14.6
Fat (%)	***	***	3.96	4.22
Protein (%)	*	***	3.32	3.42
SFA (g/100 g fat)	n	***	50.38	51.5
MUFA	n	***	15.8	16.6
PUFA	*	ns	2.86	2.56
Short	ns	***	8.65	9.50
Medium	**	***	31.4	34.2
Long	ns	***	26.2	27.0

LSM – least square mean
ns, *, **, *** – effect not significant or significant at $p<0.05$, $p<0.01$, $p<0.001$ respectively
Short – sum of C4 to C10 fatty acids
Medium – sum of C11 to C15 fatty acids
Long – sum of C17 to C20 fatty acids
SFA – sum of saturated fatty acids; MUFA- sum of monounsaturated fatty acids
PUFA – sum of polyunsaturated fatty acids.

Effect of pasture season on pools of fatty acids in milk fat (Sloniewski et al. 2005)

Fatty acid	Season (pasture versus indoor)	Month (within season)	LSM (g/100g fat)	
			pasture season	indoor season
C4	ns	***	3.54	3.15
C6	***	ns	1.76	2.78
C8	ns	***	1.64	1.58
C10	***	***	1.61	1.89
C10:1	**	***	0.084	0.093
C12	***	***	1.17	1.48
C12:1	**	***	0.28	0.35
C14	**	ns	7.61	5.32
C14:1	***	***	0.57	0.69
C15	***	*	1.06	1.68
C16	***	**	18.4	21.4
C16:1	***	***	2.27	3.21
C17	*	***	0.42	0.38
C18	**	**	13.2	11.8
C18:1c9	***	**	0.48	0.25
C18:1t9	ns	***	12.1	12.0
C18:2c9,12	***	ns	0.65	1.37
C18 : 2(C)= CLA	***	***	**1.00**	**0.49**
C18:3c9,12,15	***	ns	1.01	0.47
C20:3c5,8,11	ns	***	0.070	0.062
C20:3c8,11,14	***	ns	0.021	0.015
C20:4c5,8,11,14	***	**	0.083	0.115
C20:5c5,8,11,14,17	*	ns	0.040	0.027

Conclusions

- Management regime in ORG vs. CONV cow rearing systems is completely different (daily activity, bedding, social interactions, space, freedom, feeding management)
- Management regime in ORG dairy production creates better conditions for good health and immune system in cows
- Organic husbandry rules can therefore improve several features of the produced milk [lack of fraud, lower total bacteria count and somatic cells, lower level of some contaminants (pesticides residues, antibiotics), higher vitamins level (B, E, carotenoids)]
- Increased proportion of the fresh herbage in the diet results in increased proportion of rumenic acid ((*cis*-9,*trans*-11 18:2) which is the main conjugated linoleic acid (CLA) isomer in milk
- Rumenic acid probably helps to prevent several civilization diseases as cancer, atherosclerosis and inflammations
- Prevalence of grazing in feeding management in ORG dairy production system probably contributes to better human health
- The impact of ORG rearing system on sensory and nutritional value of the produced milk has to be still investigated

Comparison of carcass quality from the organically and conventionally reared animals

Hansson et al. 2000

Conclusions

1. There was a significant difference at the postmortem inspection of growing-fattening pigs: 28% of the conventional and 17% of the organic pigs had one or more registered lesions
2. In cattle, 28 % of the organic and 27% of the conventional animals had registered abnormalities
3. Parasitic afflictions were more prevalent in organic herds
4. Eosinophyllic myositis was more frequent in organically reared cattle
5. Cows and heifers from organic herds showed significantly lower incidencies of abscesses, arthritis, mastitis, and liver diseases such as lipidosis
6. Pathological finding in sheep were low both for conventional (10%) and organic (9%) animals.

The study involved 3484 organically reared pigs, 4949 cattle and 4997 sheep, and 3.9 million conventionally reared pigs, 570 000 cattle and 190 000 sheep.

Beneficial impact of

ORGANIC FOOD

on animals' fertility

Comparison of weight gain and reproductive performance in animals fed organic and conventional feed

(Williams 2002)

Species	Study	Animals fed organic feeds showed:	Effect
Rats and mice 	McCarrison (1926)	Greater weight gain	+
	Rowlands & Wilkinson (1930)	Superior weight gain	+
	Scheunert et al. (1934)	Shorter lifespan, worse health	-
	Miller & Dema (1958)	No difference in weight gain or reproduction	0
	Scott et al. (1960)	Better reproduction with organic feeds; worst performance with mixed organic and conventional feed	+
	Mc Sheehy (1977)	No difference in weaning weight	0
	Neudecker (1987), Velimirov et al. (1992)	No difference in gestation rate litter weight or weaning weight. Lower stillborn and perinatal mortality	0 / +
Rabbits 	Hahn et al. (1971), Aehnelt & Hahn (1973, 1978)	Greater no. of eggs, higher fertilisation rate, beneficial histological changes in female genital organs	+
	Bram (1974), Alter (1978), Meinecke (1982)	No differences in reproductive performance, ovaries, uterus	0
	Gottschewski (1975)	Lower mortality of newborn	+
	Staiger (1986)	Long-term fertility rate (three generations) higher	+
	Edelmuller (1984)	More young born alive	+

Organic food

Positives:

- Contain less unwholesome substances (nitrates, pesticide residues, synthetic antibiotics, growth regulators, food additives)
- Contain more nutritious components indispensable for human and animal health (some vitamins, phenolic compounds, sugars, unsaturated fatty acids, essential amino acids, mineral components)
- Show better sensory quality and culinary usefulness
- Show better storage quality (higher dry matter content, lower losses during storage period)
- Exert beneficial impact on animals' fertility

Negatives:

- Lower yields in plant and animal production
- More frequent parasitic afflictions in organically reared animals

Uncertainties:

- Environmental contamination (heavy metals, dioxins)
- Bacterial contamination
- Mycotoxins

THANK YOU