The Metropolitan

Water Reclamation District

of Greater Chicago

WELCOME TO THE JANUARY EDITION OF THE 2011 M&R SEMINAR SERIES

BEFORE WE BEGIN

- SILENCE CELL PHONES & PAGERS
- QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION
- SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE AT (www. MWRD.org)
- Home Page ⇒ (Public Interest) ⇒ more public inter
  ⇒ M&R Seminar Series ⇒ 2010 Seminar Series

Dr. Kuldip Kumar

Ph.D. (Soil Science)	Lincoln University, New Zealand
M.S. (Soil Sci.-Soil Physics)	Punjab Ag University, India
Bachelor of Agric. Sci.	Punjab Ag University, India
B.Sc Ag. (Hons. in Soil Sci.)	

Associate Environmental Soil Scientist, MWRDGC

Research Professor, University of Minnesota: $ 1 million competitive grants from USDA, USGS, and Producer Groups as PI or Co-PI

Research Focus: fate/transport of pharmaceuticals, particularly antibiotics in land-applied manure and biosolids.

Associate Editor J of Environmental Quality
Senior Associate Editor for Agronomy Journal

Numerous Peer-Reviewed Journal Articles & National Presentations!

Awarded "*Commonwealth Scholarship*" for Ph.D - 1994 to 1998
Awarded "*Fund for Excellence Award*" by Lincoln University - 1997
Awarded "*Best Quality Research Award*" Lincoln University - 1996

Improving Soil Quality for Sustained Productivity and Human Health

From Soil to Snake Oil: Functional Foods, Sustainability, and Human Health

Dr. Kuldip Kumar

OBAMA'S SNAKE OIL!
I can sell this dumb people ……..Anything

- DIRT THE MOVIE!

OUTLINE

- Human health depends on a healthy fertile soil
- Food systems, diet, and disease
  - The Old Production Paradigm
  - Current Sustainability Paradigm
  - Need for New Paradigm
- Concept of Functional Foods, Nutraceuticals, Phytonutrients
- Gold in value added – but for whom?
  - Consumers ?
  - Producers ?
- Its about time we extol the benefits of biosolids with novel research rather than addressing –ive media hype
- Conclusions

Why Does Agriculture Exist?

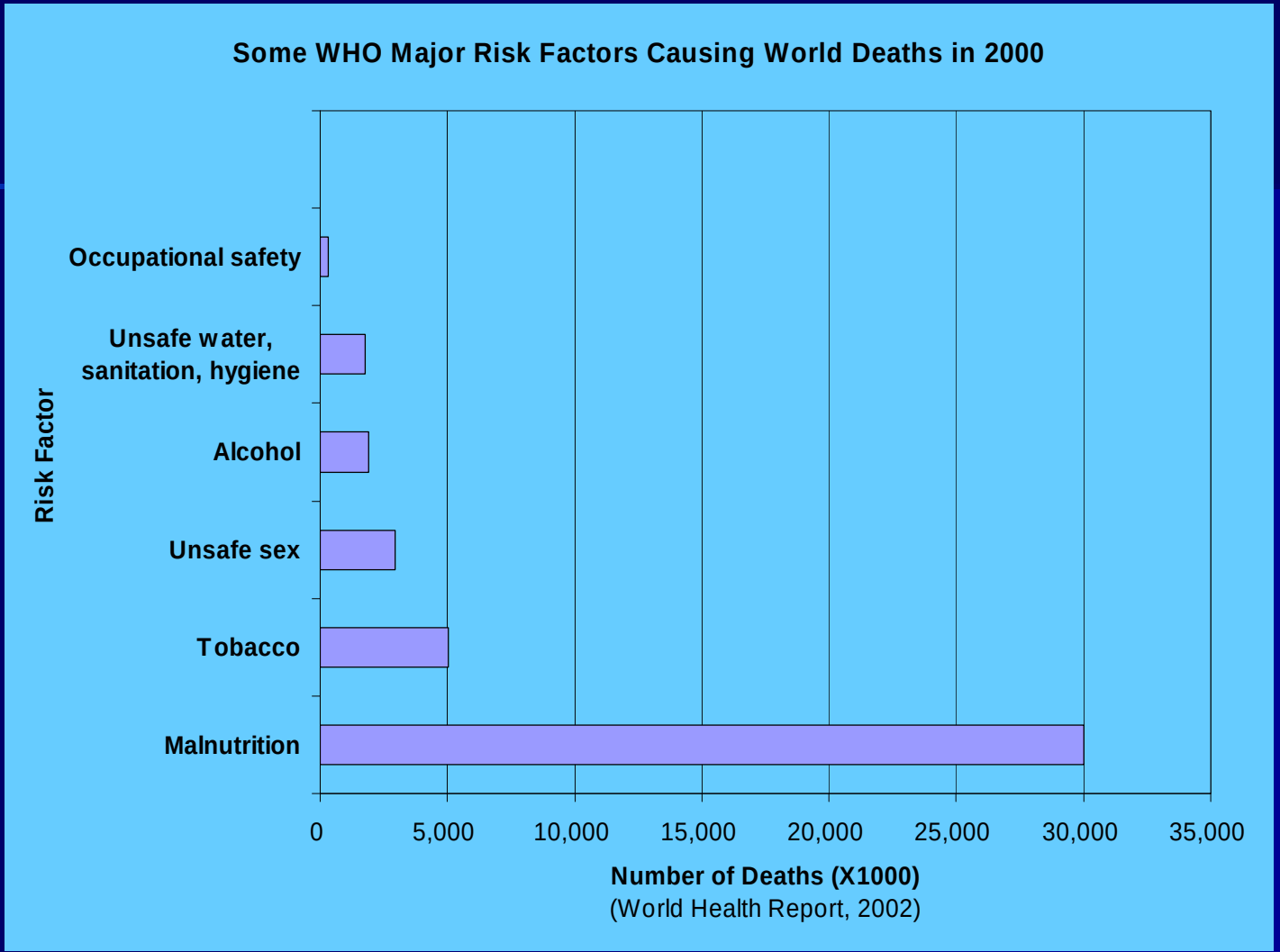
- **To produce food and fiber and provide livelihoods to farmers and profits to the agricultural and food industries alone?**
- **Why do we need "food"? – Nutrients!**
- **Soil is the primary source of all essential nutrients required for human life!**
- **Farmers are nutrient providers!**
- **If food systems, based in agriculture, cannot provide all the essential nutrients in adequate quantities to sustain human life during all seasons, diseases ensue, societies suffer and development efforts stagnate.**

The Known 51 Essential Nutrients for Sustaining Human Health*

Air, Water & Energy (3)	Protein (amino acids) (9)	Lipids-Fat (fatty acids) (2)	Macro-Minerals (7)	Trace Elements (17)	Vitamins (13)
Oxygen	Histidine	Linoleic acid	Na	Fe	A
Water	Isoleucine	Linolenic acid	K	Zn	D
Carbohydrates	Leucine		Ca	Cu	E
	Lysine		Mg	Mn	K
	Methionine		S	I	C (Ascorbic acid)
	Phenylalanine		P	F	B_1 (Thiamin)
	Threonine		Cl	Se	B_2 (Riboflavin)
	Tryptophan			Mo	B_3 (Niacin)
	Valine			Co (in B_{12})	B_5 (Pantothenic acid)
				B	B_6 (Pyroxidine)
				Ni	B_7/H (Biotin)
				Cr	B_9 (Folic acid, folacin)
				V	B_{12} (Cobalamin)
				Si	
				As	
				Li	
				Sn	

*Numerous other beneficial substances in foods are also known to contribute to good health.

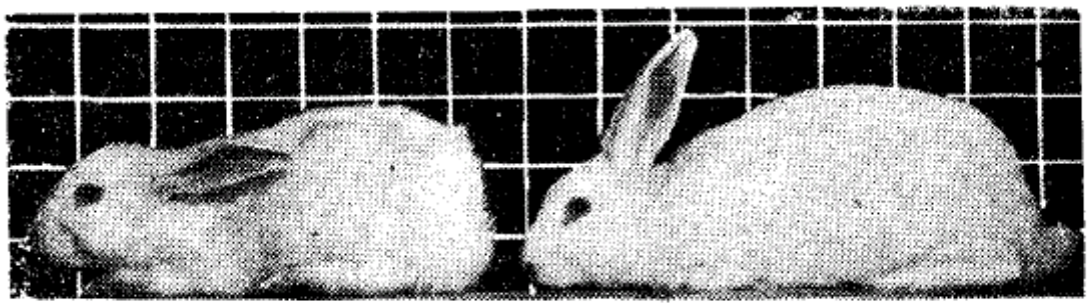
Major Risk Factors Causing Deaths



Malnutrition accounts for over 30 million deaths per year (about 1 death per second)

'We Are What We Eat"

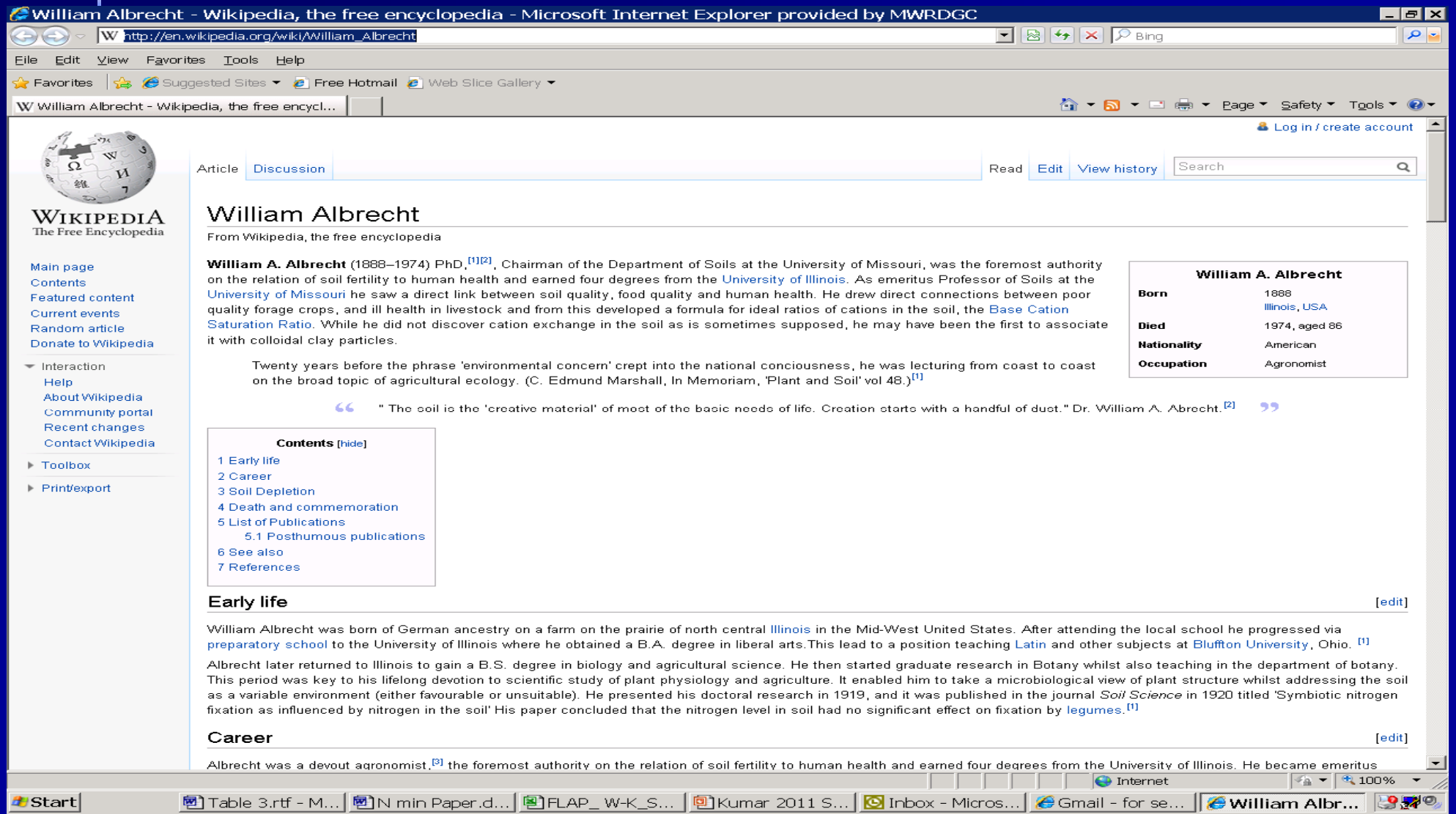
PICTURED ABOVE ARE FOUR STACKS OF HAY, THE ONE AT LEFT GROWN ON SOIL-TREATED LAND, THE OTHERS ON LAND THAT WAS NOT TREATED. COWS, WITH ACCESS TO ALL FOUR STACKS, ATE FROM THE SOIL-TREATED HAY, IGNORED THE OTHER STACKS.



THE RABBIT AT RIGHT, HEAVIER AND HEALTHIER THAN THE ONE AT LEFT, WAS FED FOOD FROM SOIL-TREATED LAND. THE ONE AT LEFT RECEIVED THE SAME AMOUNT OF FOOD FROM SOIL THAT HAD NOT BEEN TREATED.

Out of the Soil Comes the Weal or Woe of Living Things, Believes Dr. W. A. Albrecht, Scientist

Dr. William A. Albrecht 'The Father of Soil Fertility Research' saw a direct link between soil quality, food quality and human health in 1940s



Sir Albert Howard

• • • “related subjects as agriculture, food, nutrition and health have become split up into innumerable rigid and self-contained little units, each in the hands of some group of specialists. The experts, as their studies become concentrated on smaller and smaller fragments, soon find themselves wasting their lives in learning more and more about less and less. The result is the confusion and chaos now such a feature of the work of experiment stations and teaching centers devoted to agriculture and gardening. Everywhere knowledge increases at the expense of understanding. The remedy is to look at the whole field covered by crop production, animal husbandry, food, nutrition, and health as one related subject, and then to realize the great principle that the birthright of every crop, every animal, and every human being is health.” – March, 1945

In: Rodale, J.I. 1945. Pay Dirt, Farming & Gardening with Composts. Rodale Books, Inc., Emmaus, Penn. p. vii.

“Western civilization is suffering from a subtle form of famine – a famine of quality.”– November, 1947

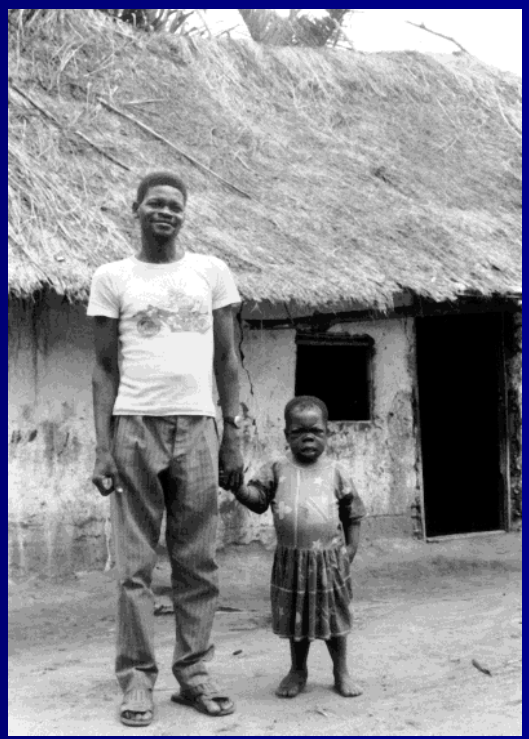
The Old Production Paradigm

- Scientific and technological advances in agriculture in the last 100 years has resulted in increased productivity
- It culminated in Green Revolution
  - Achieved adequacy in food production and averted mass starvation
  - Dr. N.E. Borlaug received Nobel Peace Prize, 1971
  - Focus was only on quantity, not quality

The Ugly Face of "Hidden Hunger"

Zinc Deficiency

Iron Deficiency

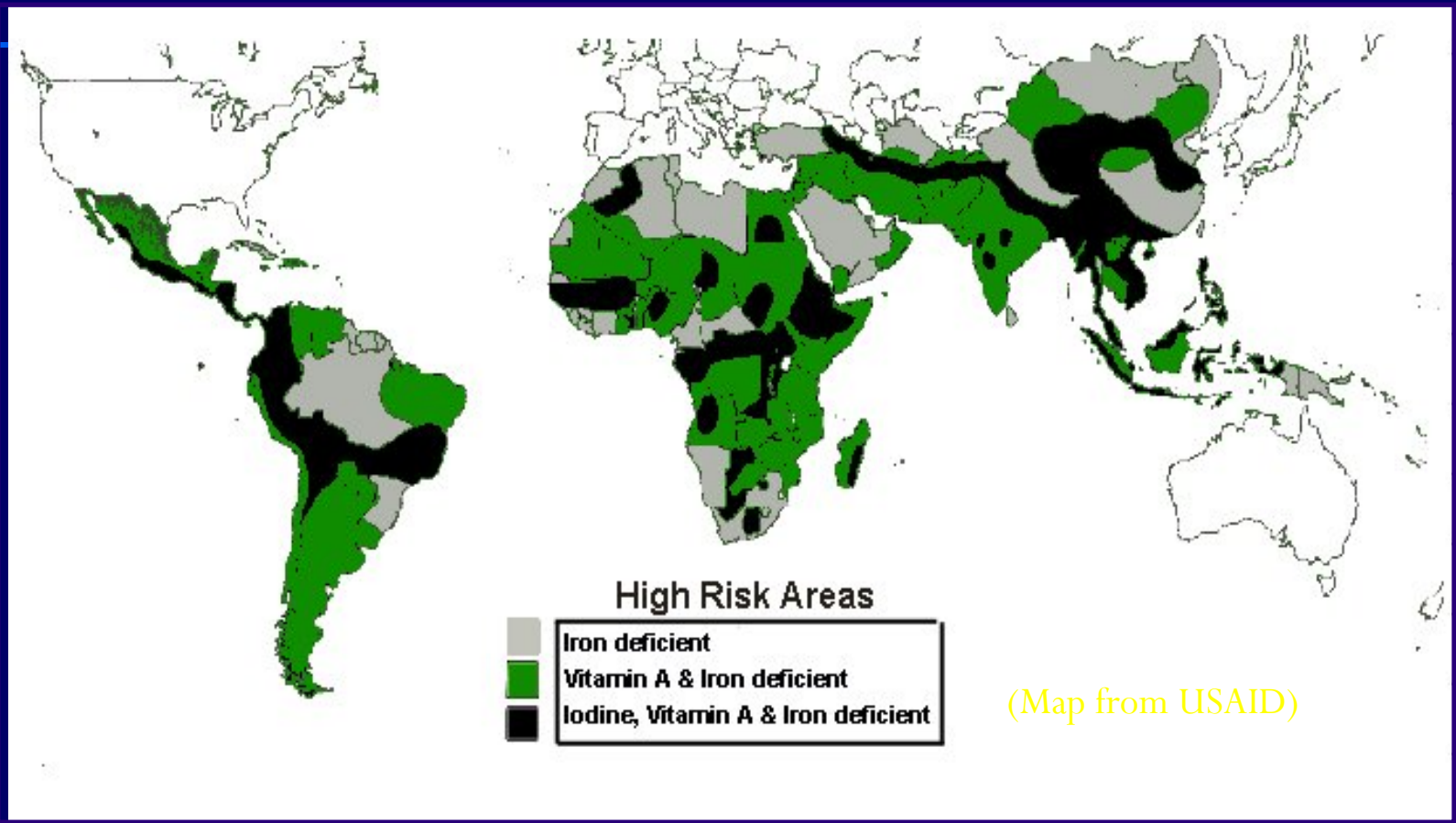


Iodine Deficiency

Vitamin A Deficiency

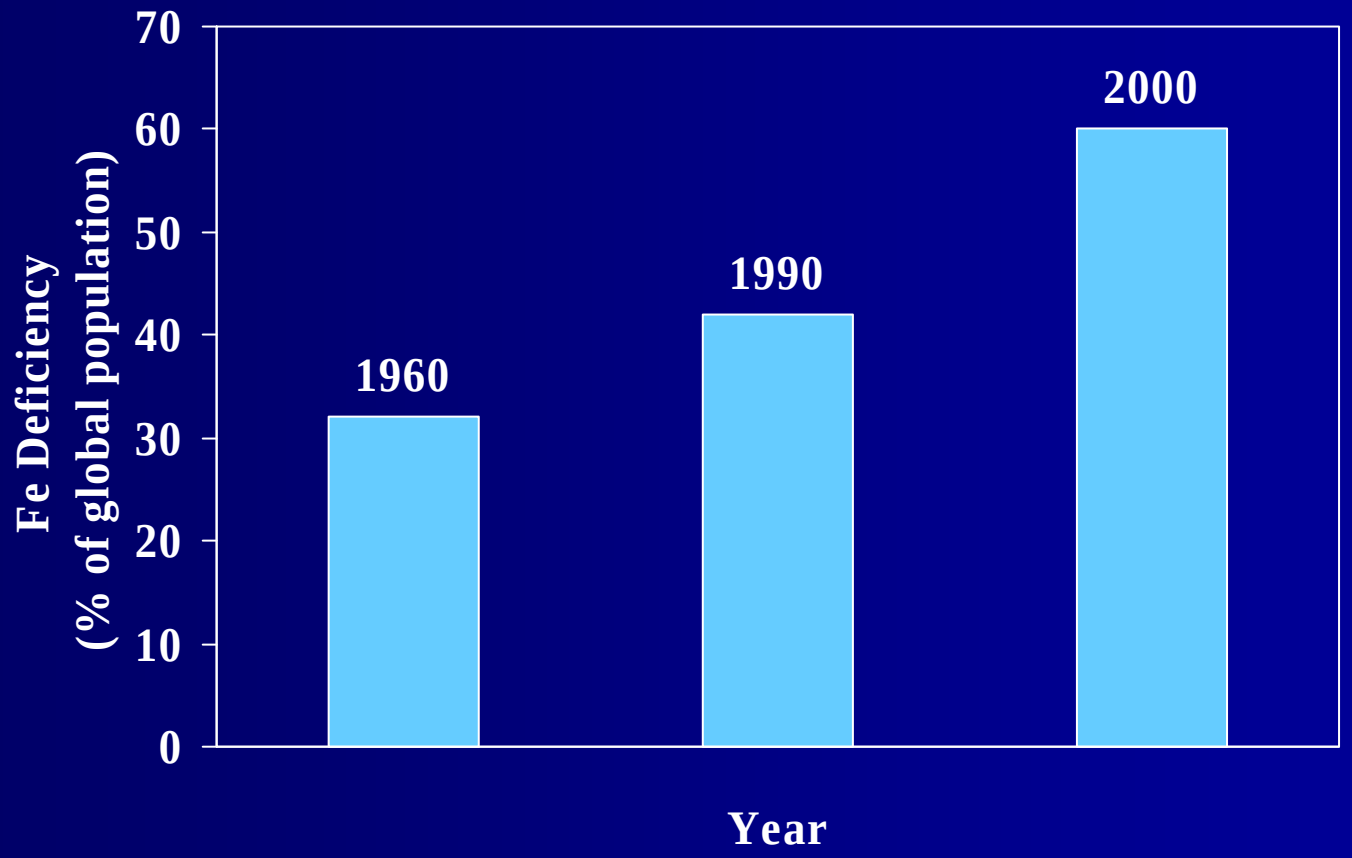
Ca Deficiency
Rickets

Global Micronutrient Deficiencies



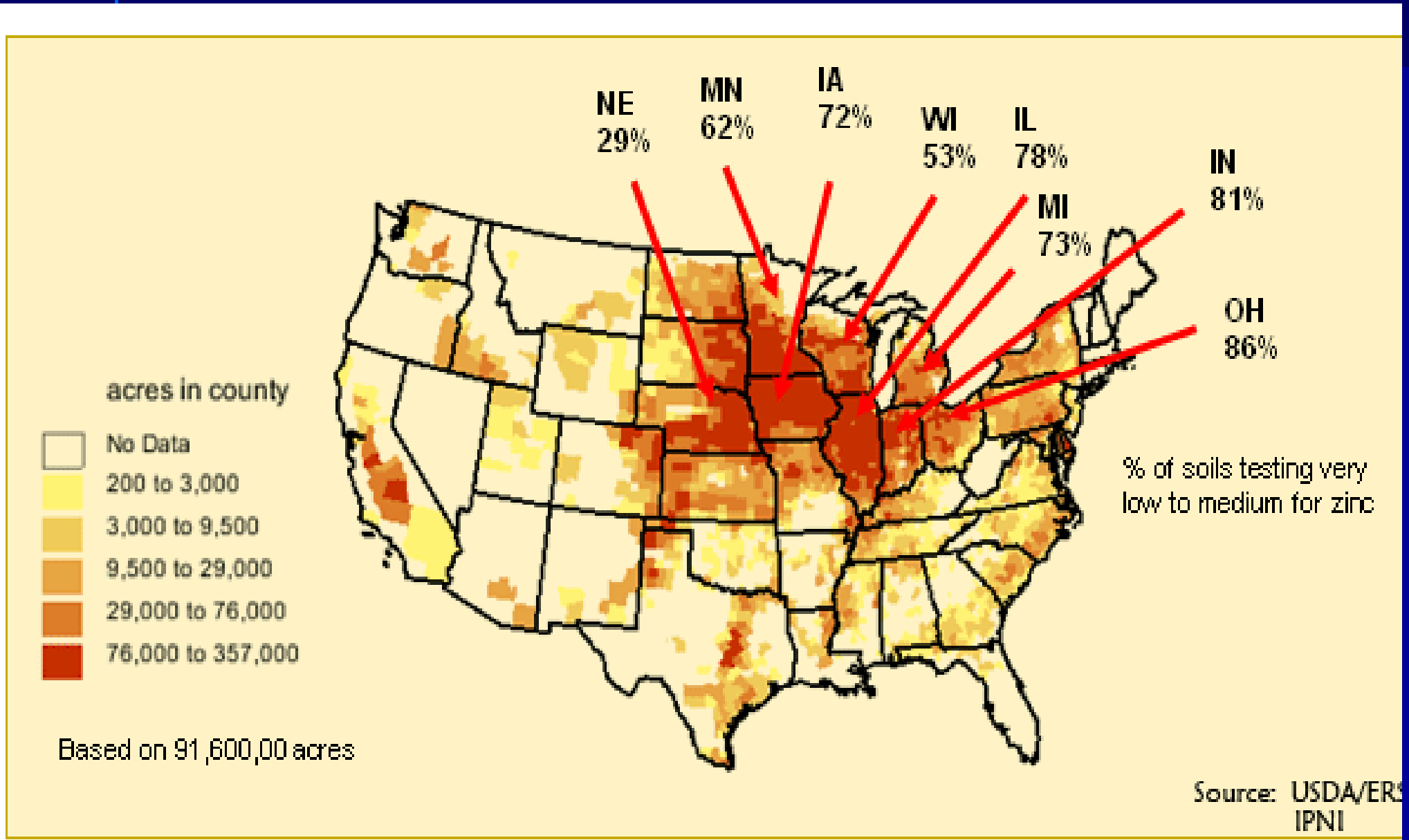
- **3 billion people afflicted worldwide**

Change in Prevalence of Iron Deficiency Globally

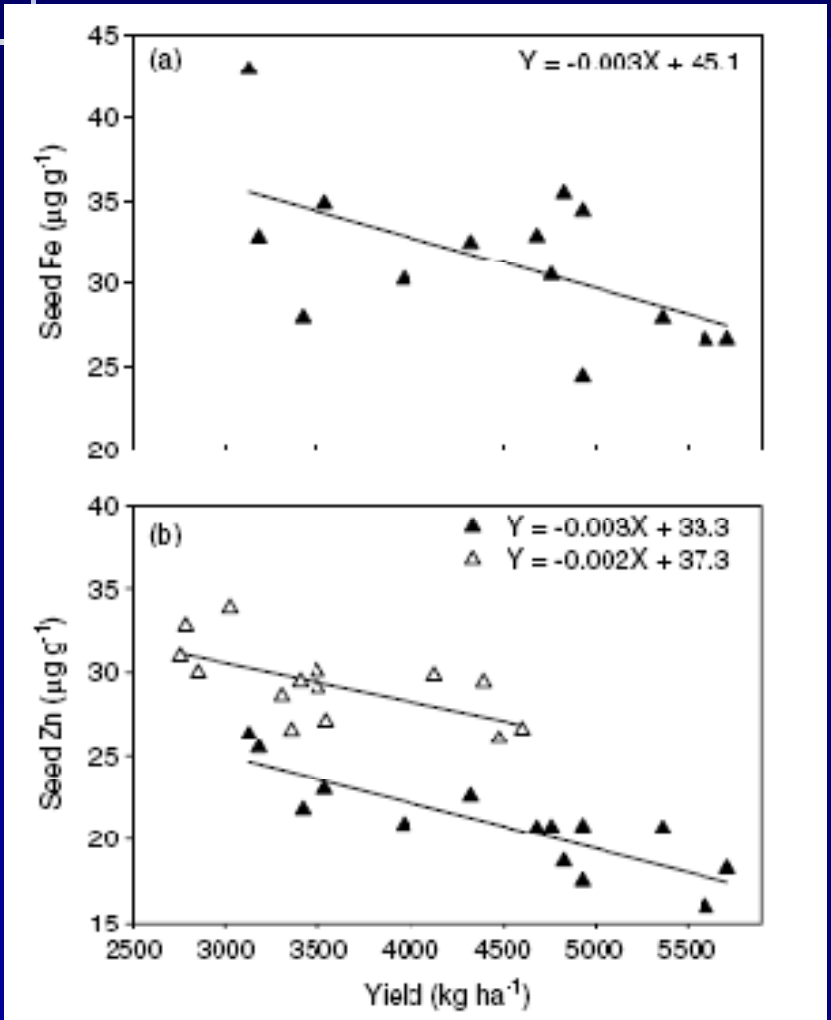


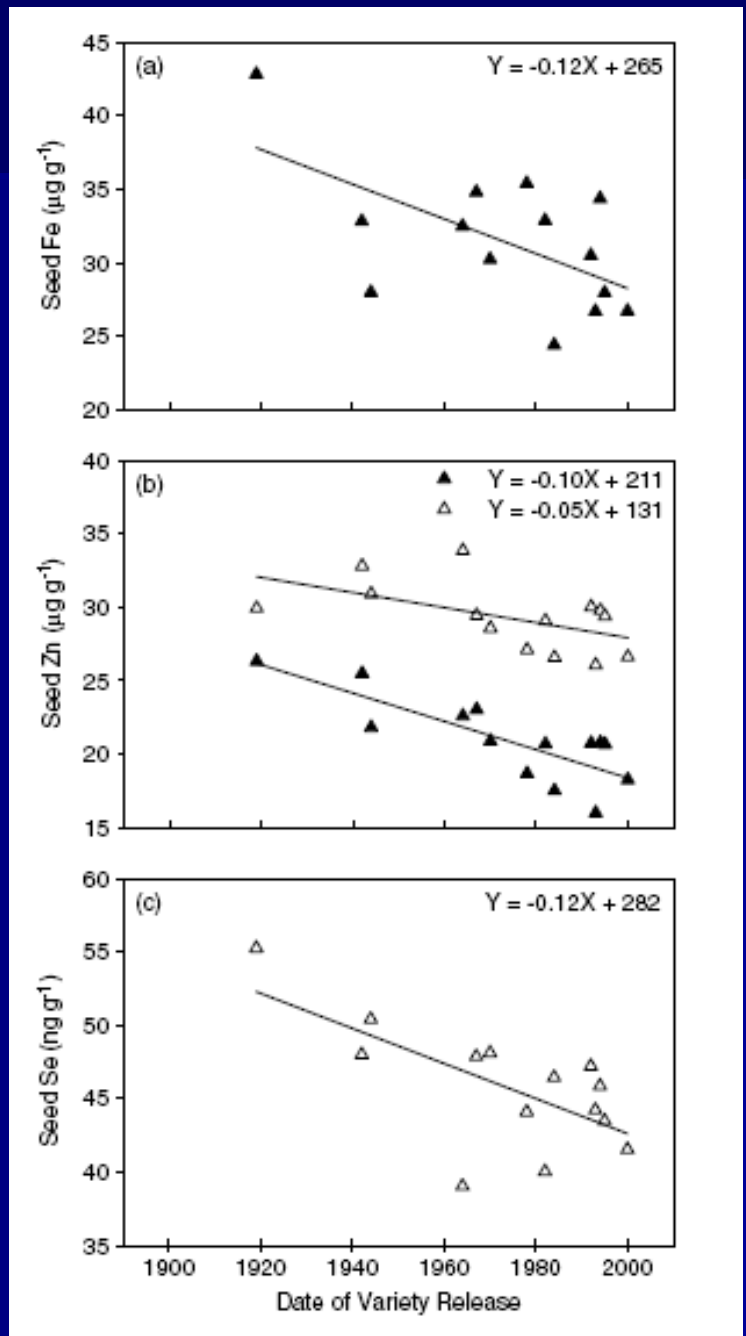
Data from WHO, 2002

Zinc Deficiency in US Soils



Historical Trends in Iron, Zinc & Selenium in Grain of Hard Red Winter Wheat Varieties in USA (1873 to 2000)



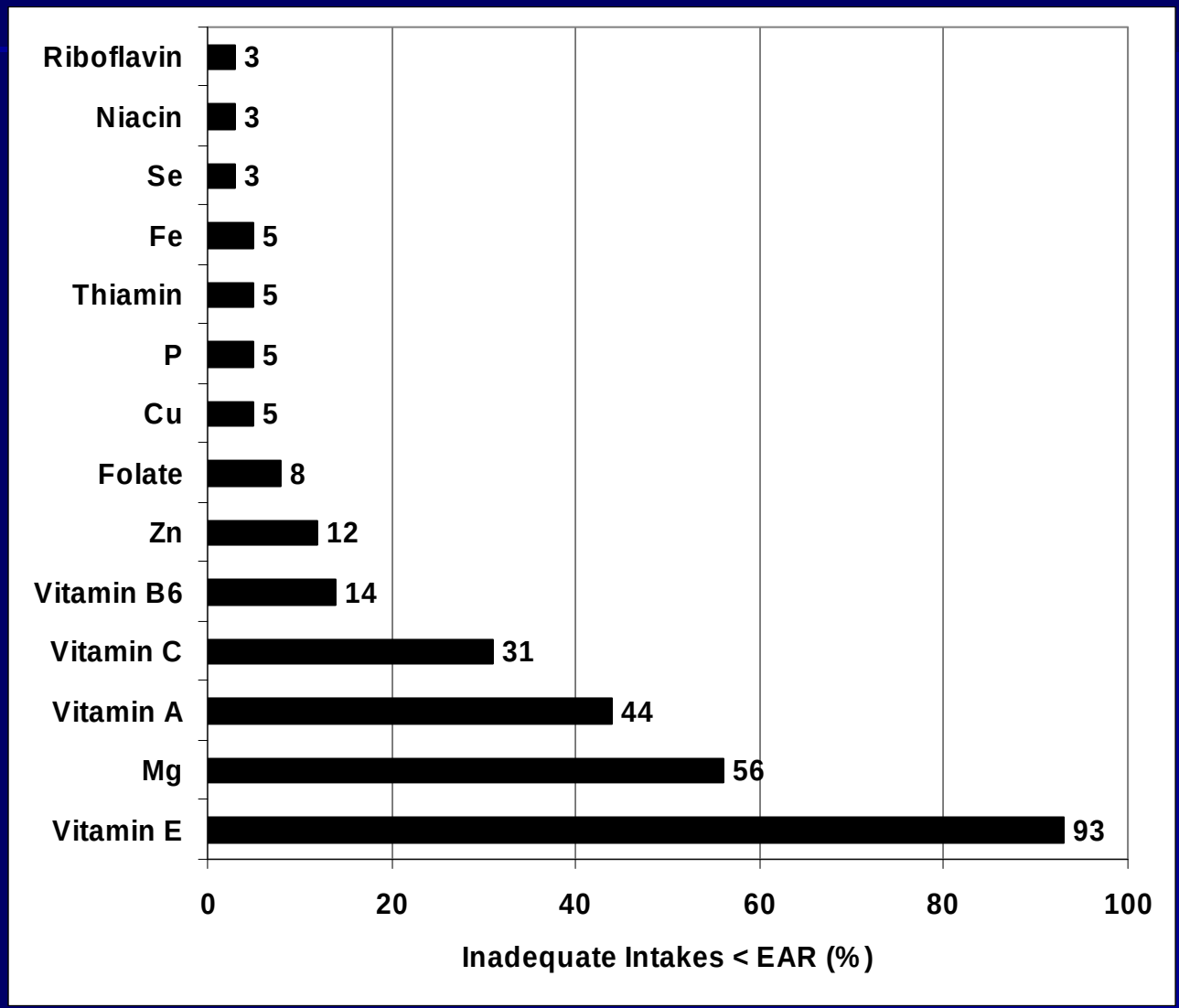


(From Garvin et al., J. Sci. Food Agr. 2006)

Influence of milling on iron and zinc concentration (mg/kg dry weight) in seed/grain

Crop	Milling fraction	Fe	Zn
Corn	Whole grain	23	21
	Degermed	11	4
Sorghum	Whole grain	179	36
	64% extraction	54	10
Rice	Brown rice	16	28
	90% extraction	5	17
Wheat	Whole grain	38	37
	70% extraction	22	12

Percent of People in USA Not Eating Adequate Intakes of Various Nutrients



Moshfegh et al., NHANES 2001-2002.

The Current Paradigm

- There is concern that the emphasis on agricultural production is threatening the resource base of land, soil, air and water.
- High productivity while preserving or improving the resource base of agriculture and the environment – the so-called Sustainability Paradigm

A New Paradigm is Needed!

- While the World's food supply has been sufficient (wars, food distribution problems and the like excepted), it is simply not providing adequate, balanced nutrition.
- Micronutrient malnutrition, often called "Hidden Hunger", is more conspicuous in many countries since the introduction of green revolution cropping systems.
- Today, micronutrient malnutrition diminishes the health, productivity, and well being of over half of the global community.

The Food System for Better Health Paradigm

- An Agriculture which aim not only at productivity and sustainability, but also at better nutrition and better health for all human race.

- Sir Albert Howard …….. the birthright of every crop, every animal, and every human being is health.” – March, 1945

Greek Physician Hippocrates,

Known as father of Medicine.

(said several centuries ago)

"Let Food be Your Medicine"

The Philosophy behind is:

"Focus on Prevention"

An Apple a Day Keeps the Doctor Away

The term “Nutraceutical” was coined from “Nutrition” & “Pharmaceutical” in 1989 by Stephen DeFelice,

“ A food or part of food or nutrient, that provides health benefits, including the prevention and treatment of a disease.”

Phytochemicals:

Phytochemicals could provide health benefits as:

1. Substrate for biochemical reactions
2. Co-factors of enzymatic reactions
3. Inhibitors of enzymatic reactions
4. Absorbents that bind to & eliminate undesirable constituent in the intestine
5. Scavengers of reactive or toxic chemicals
6. Enhance the absorption and/or stability of essential nutrients
7. Affect intestinal microbial activity and function

A Few Examples of Phytochemicals

Phytochemical	Source	Role
Resveratrol	Nuts & red wine	Antioxidant, antithrombotic, anti-inflammatory, anti-carcinogenesis activities
Lycopene	Tomatoes	Antioxidant carotenoid protective against prostrate and other cancers
Organosufur compounds	Onion & garlic	Antioxidant and anti-cancer specially against liver and colon cancer
Isothiocyanates	Crucifer vegetables	Cardioprotective and anti-cancer effects
Naringenin	Grapefruit	Lower cholesterol, slow hepatic detoxification of drugs like cyclosporine

Golden Rice (Rich in vitamin A)

- Golden Rice – A transgenic rice with a high level of pro-vitamin A b-carotenoid in grains
- Developed by Doctors Potrykus and Beyer within the European Union. They inserted two genes from a daffodil and one gene from a bacterium into a particular variety of rice (Taipei 309).
- The vision of these scientists was to help populations living in poverty, dependent on rice, to have a ready source of beta-carotene, a component lacking in many diets.

Flax Seeds (alpha-linolenic acid)

- Flaxseed is most commonly used as a laxative (due to soluble fiber they have).
- Flaxseed is also used for hot flashes and breast pain.
- Flaxseed oil is used for different conditions including arthritis.
- Both flaxseed and flaxseed oil have been used for high cholesterol levels and in an effort to prevent cancer.
- Prevention of coronary heart disease

Zinc

- Metabolism (functions in over 200 enzymatic reactions) in plants including synthesis of alpha-Linolenic acid
- Correlation between Zn uptake by crop with alpha-Linolenic acid in seeds
- District biosolids contain plenty of Zn (~900 ppm)

Table 1-8 Relative and Average Plant Nutrient Concentrations

Nutrient		Concentration in Plants*		
Name	*Symbol*	*Relative*	*Average*	*Classification*
Hydrogen	H	60,000,000	6 %	
Oxygen	O	30,000,000	45 %	
Carbon	C	30,000,000	45 %	
Nitrogen	N	1,000,000	1.5 %	
Potassium	K	400,000	1.0 %	Macronutrients
Phosphorus	P	30,000	0.2 %	
Calcium	Ca	200,000	0.5 %	
Magnesium	Mg	100,000	0.2 %	
Sulfur	S	30,000	0.2 %	
Chloride	Cl	3,000	100 ppm (0.01 %)	
Iron	Fe	2,000	100 ppm	
Boron	B	2,000	20 ppm	
Manganese	Mn	1,000	50 ppm	Micronutrients
Zinc	Zn	300	20 ppm	
Copper	Cu	100	6 ppm	
Molybdenum	Mo	1	0.1 ppm	
Nickel	Ni	0.1	0.01 ppm	

*Concentration expressed on a dry matter weight basis.

Havlin et al.,2005, p. 12

Table 1. Micronutrient sufficiency ranges in diagnostic tissue of selected crops.**

Element	Corn	Wheat	Alfalfa	Soybeans	Potatoes	Sugar Beet
			ppm			
Boron	4-25	6-40	31-80	21-55	15-40	26-80
Copper	6-20	6-50	11-30	10-30	7-30	11-40
Iron	21-250	11-300	31-250	51-350	30-300	51-200
Manganese	20-150	16-200	31-100	21-100	30-200	21-150
Molybdenum	0.1-2.0	0.03-5.0	1.0-5.0	1.0-5.0	0.5-4.0	0.15-5.0
Zinc	20-70	21-70	21-70	21-50	30-100	19-60
Chloride	2,000-20,000 (0.2-2.0%)					
Nickel	0.1-1.0					

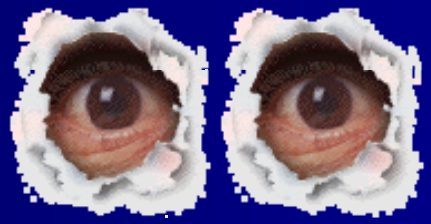
** Ranges taken from MSU Bulletin E-486, page 2, except general range for Cl and Ni taken from Havlin et al, 2005.

Onion (Phenols and Flavonoids)

- More phenols and flavonoids they contain, the more reputed antioxidant and anticancer activity they provide.
- Shallots have the most phenols and antioxidants, six times the amount found in Vidalia onion,
- Western yellow onions have the most flavonoids, eleven times the amount found in Western White
- When tested against liver and colon cancer cells, 'Western Yellow' pungent yellow (New York Bold) and shallots were most effective in inhibiting their growth. The milder-tasting cultivars (i.e., 'Western White,' 'Peruvian Sweet,' 'Empire Sweet,' 'Mexico,' 'Texas 1015,' 'Imperial Valley Sweet,' and 'Vidalia') showed little cancer-fighting ability.
- In general, the most pungent onions delivered many times the benefits of their milder cousins.

Shallots
Western Yellow
Pungent yellow
New York Bold
Northern Red
Mexico
Empire Sweet
Western White
Peruvian Sweet
Texas 1015
Imperial Valley Sweet
Vidalia

WIKILEAKS



It's 10:51 A.M.
Friday, January 28, 2011.

Since sulfur contributes to the pungency of onions, gardeners should avoid the application of sulfur or sulfur containing materials to the soil or plants. Note that certain fertilizers may contain sulfur

Benefits of the Sulfur Compounds in Cruciferous Vegetables (Broccoli, Brussels sprout, Cabbage, Cauliflower, Kale)

- These foods contain substantial quantities of the phytonutrients called isothiocyanates, specifically two isothiocyanates called sulforaphane and indole-3-carbinol.

- Research indicates that sulforaphane has the ability to increase the capacity of the liver to detoxify harmful, cancer-causing compounds. Specifically, sulforaphane increases the activity of the liver's Phase 2 detoxification enzymes. These enzymes (which include glutathione transferases, NAD(P)H: quinone reductase, and glucuronosyltransferases) are well known for their ability to clear a wide variety of toxic compounds from the body including not only many carcinogens, but also many reactive oxygen species, a particularly nasty type of free radical.

- These important detoxification enzymes, compounds in crucifers provide protection against cell mutations, cancer and numerous other harmful effects that would otherwise be caused by these toxins.

Sulfur

- Very important element not only for amino acids and vitamins but also for most crucifer vegetables that need it in high quantities to produce health beneficial phytonutrients
- After passage of Clean Air Act, sulfur deposition has been reduced by as much as 75% and most soils are deficient, especially sandy soils
- District biosolids contain ~1-2% S

Grapefruit – Naringenin & Limnoids

- **Naringenin** is a flavonoid that is considered to have a bioactive effect on human health as antioxidant, free radical scavenger, anti-inflammatory, carbohydrate metabolism promoter, and immune system modulator.
- This substance has also been shown to reduce oxidative damage to DNA *in vitro*. Scientists exposed cells to 80 micromoles of naringenin per liter, for 24 hours, and found that the amount of hydroxyl damage to the DNA was reduced by 24% in that very short period of time.
- Naringenin has also been shown to reduce hepatitis C virus production by infected hepatocytes (liver cells) in cell culture. This seem to be secondary to Naringenin ability to inhibit the secretion of very-low-density lipoprotein by the cells. The antiviral effects of naringenin are currently under clinical investigation.
- Naringenin lowers the plasma and hepatic cholesterol concentrations by suppressing HMG-CoA reductase and ACAT in rats fed a high-cholesterol diet.

WIKILEAKS

It's 10:51 A.M.
Friday, January 28, 2011.

Efforts to Reduce Bitterness of Grapefruits and Grapefruit Juice

United States Patent [19]

Mitchell et al.

[11] **Patent Number: 4,514,427**

[45] **Date of Patent: Apr. 30, 1985**

[54] **REMOVAL OF BITTER NARINGIN AND LIMONIN FROM CITRUS JUICES CONTAINING THE SAME**

[75] Inventors: **Donald H. Mitchell; Richard M. Pearce,** both of Winter Haven; **C. Byron Smith,** Lake County; **Sand T. Brown,** Lakeland, all of Fla.

[73] Assignee: **Mitco Water Laboratories Inc.,** Winter Haven, Fla.

[21] Appl. No.: **496,340**

[22] Filed: **May 19, 1983**

[51] **Int. Cl.**[3] **C12H 1/04;** A23L 2/00

[52] **U.S. Cl.** **426/271;** 426/330.5; 426/422

[58] **Field of Search** 426/271, 330.5, 422, 426/333, 590

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,439,458 3/1984 Puri 426/330.5

FOREIGN PATENT DOCUMENTS

58-56663 4/1983 Japan 426/271

Primary Examiner—George Yeung

Attorney, Agent, or Firm—Mason, Fenwick & Lawrence

[57] **ABSTRACT**

The principle bitter flavor components of natural grapefruit juice, naringin and limonin are substantially reduced by treatment of the grapefruit juice with a weak base anion exchange resin having a styrene polymer matrix carrying functional groups derived from a mono or poly amine. The ion exchange treatment also reduces the acid content of the grapefruit juice and does not impair the nutrient content or the desirable flavors in the treated juice.

3 Claims, No Drawings

Biosolids – A Missing Piece of The Sustainability Pie

- Biosolids is a unique resource to improve micro-nutrient content of soils
- Need for novel research to link the better availability of micro-nutrients in biosolids with enhanced phytonutrients in all crops including fruits and vegetables
- Now, we need a paradigm shift in how we view biosolids? Think of biosolids as a resource, not a waste!
- Research is needed to show that biosolids fertilized crops are rich in phytonutrients

Linking Agriculture to Human Health - Conclusions

- **All scientists, physicians, and nutritionists should go back to school and learn about new concepts of 'Nutrients for Plant, Animal, and Human Health'**
- **Necessary policy reorientation is needed to increase available micronutrient-rich and phytonutrients-rich foods within local food systems**
- **Food, nutrition, and health programs should not exist as vertical programs within the health department, nor should agricultural programs be solely production oriented, ignoring consumption issues, food security, and nutritional needs.**