Zinc...essential for life

Greg Brouwer

Director, Zinc Nutrient Initiative

Seminário de Micronutrientes

Sao Paulo, Brasil

November 2010

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International Zinc Association

- Founded in 1990
- > 40 Full Members
- > 100 Affiliate Members

- 80% of WW zinc production
- 55% of world zinc production

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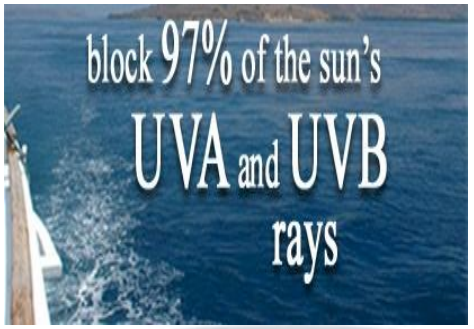
Zinc is Essential for Life

- Humans, animals, plants need zinc to function
- Affects over 300 enzymes in the body
- Helps generate cells
- Important for growth and brain development
- Key for immune system
- People need up to 15 mg of zinc per day



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Zinc is Essential for Life

Few extra milligrams of zinc

||

Difference between illness and good health

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Zinc Deficiency

- Reduced appetite, taste acuity
- Reduced growth velocity
- Skin lesions
- Diarrhea & infections vulnerability
- Delayed sexual maturation & reduced fertility

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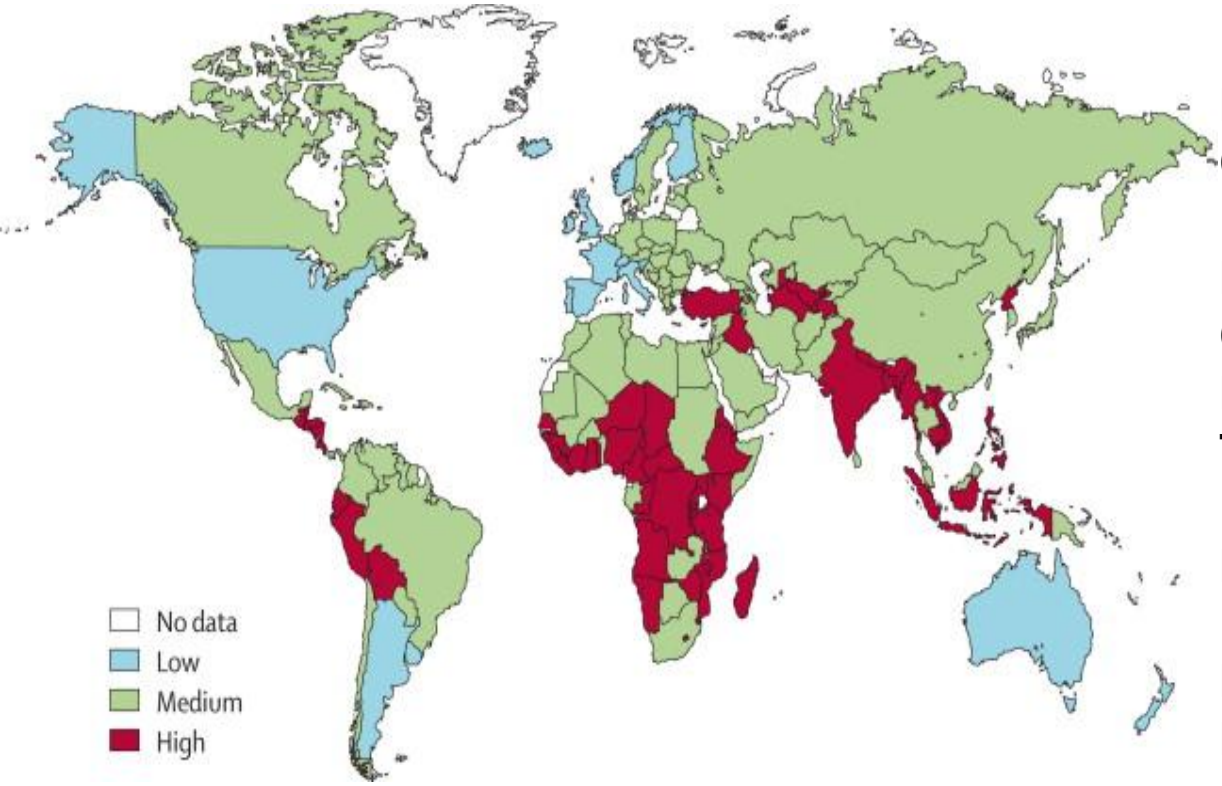
Zinc Deficiency: Global Issue

- Well-documented public health issue
- 1/3 of global population deficient
- Developing countries most affected

Zinc deficiency affects 2 billion people globally



The Top 20:

Bolivia	**Ecuador**
Guatemala	***Peru***
DR Congo	**Ethiopia**
Ghana	**Mozambique**
Nigeria	**Senegal**
Tanzania	**Uganda**
Kazakhstan	**Kyrgyzstan**
Bangladesh	**Cambodia**
India	**Indonesia**
Nepal	

Source The Lancet Maternal and Child Under nutrition Series January 2008

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Zinc Deficiency

- > 450,000 deaths annually in children under the age of 5 due to zinc deficiency – Black et al, 2008 Lancet

- 800,000 deaths estimated globally - WHO

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Zinc Deficiency is 5th Leading Cause of Death and Disease in the Developing World

Risk Factor	DALY (in %) *
Underweight	14.9
Unsafe sex	10.2
Unsafe water	5.5
Indoor smoke	3.7
Zinc deficiency	**3.2**
Iron deficiency	3.1
Vitamin A deficiency	3.0
Blood pressure	2.5
Tobacco	2.0
Cholesterol	1.9

* Disability Adjusted Life Years

Source: The World Health Report 2002

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Copenhagen Conference 2008

- 8 leading economists, 5 Nobel Laureates
- Prioritized efforts to address world's biggest challenges
- Zinc & vitamin A #1 issue

COPENHAGEN CONSENSUS2008

Copenhagen Business School
1917 – 2007

Press Release

Copenhagen Consensus 2008 - RESULTS

COPENHAGEN CONSENSUS CENTER

The world's best investment: Vitamins for undernourished children, according to top economists, including 5 Nobel Laureates

Copenhagen, Denmark (May 30, 2008) – Over two years, more than 50 economists have worked to find the best solutions to ten of the world's biggest challenges. During the last week, an expert panel of 8 top-economists, including 5 Nobel Laureates, sat down to assess the research.

Newsweek

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Top Story: McCain vs. Obama: Their Foreign Policy Views

Latest News: Judge refuses to block Alaska Troopergate

GIVING GLOBALLY

Feeding the 900 Milli
Micronutrients

By Sharon Begley | NEWSWEEK
Published Sep 20, 2008
From the magazine issue dated Sep 29, 2008

There is a good but sobering reason why "ending world hunger" has been a perennial hope of beauty-pageant contestants at least since Miss America contestants began naming that as their greatest wish: we haven't come close to doing it. This year some 900 million people—including 178 million children under 5—are suffering from malnutrition, estimates the United Nations; every day 50,000 starve to

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Copenhagen Conference 2008

	SOLUTION	CHALLENGE
1	Micronutrient supplements for children (vitamin A and zinc)	Malnutrition
2	The Doha development agenda	Trade
3	Micronutrient fortification (iron and salt iodization)	Malnutrition
4	Expanded immunization coverage for children	Diseases
5	Biofortification	Malnutrition
6	Deworming and other nutrition programs at school	Malnutrition & Education

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Can One Pill Tame the Illness No One Wants to Talk About?

By VIVIENNE WALT / SOGOLA Monday, Aug. 17, 2009

Anna Kari / Documentography for Time

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Think Zinc: A Healthy Option

www.zinc-crops.org

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"ZINC SAVES KIDS" Campaign

unicef

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UNICEF–IZA
Zinc Program: Objectives

- Reduce infant and child mortality
- Provide zinc treatment for children with diarrhea
- Prevent zinc deficiency through supplementation program
- Target audience: global zinc industry & customers, general public
- Target amount: $3 million + over 3-yrs

unicef

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THE PROBLEM

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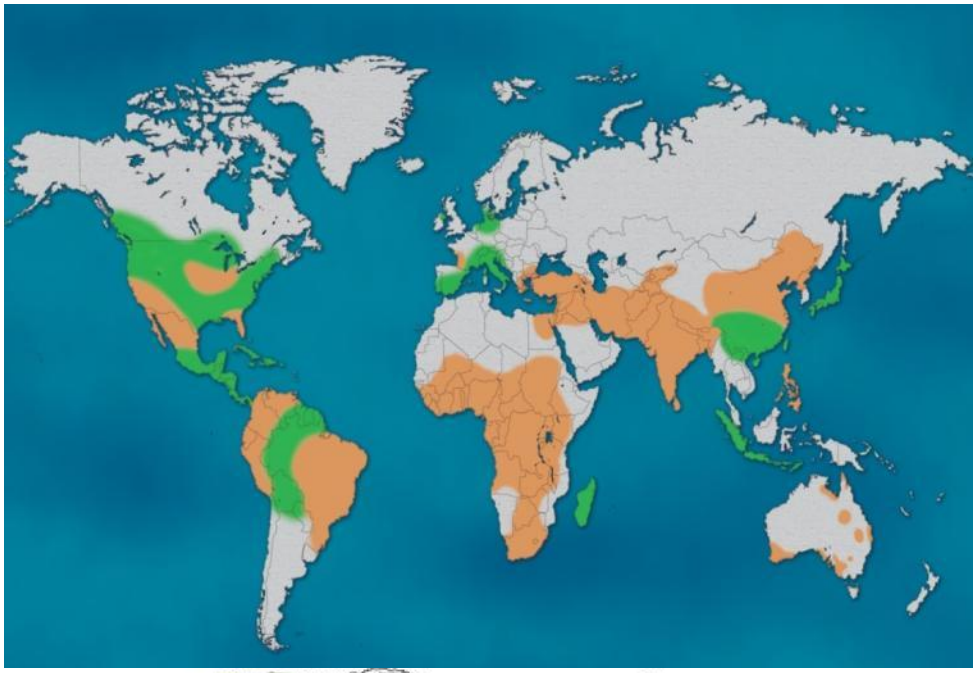
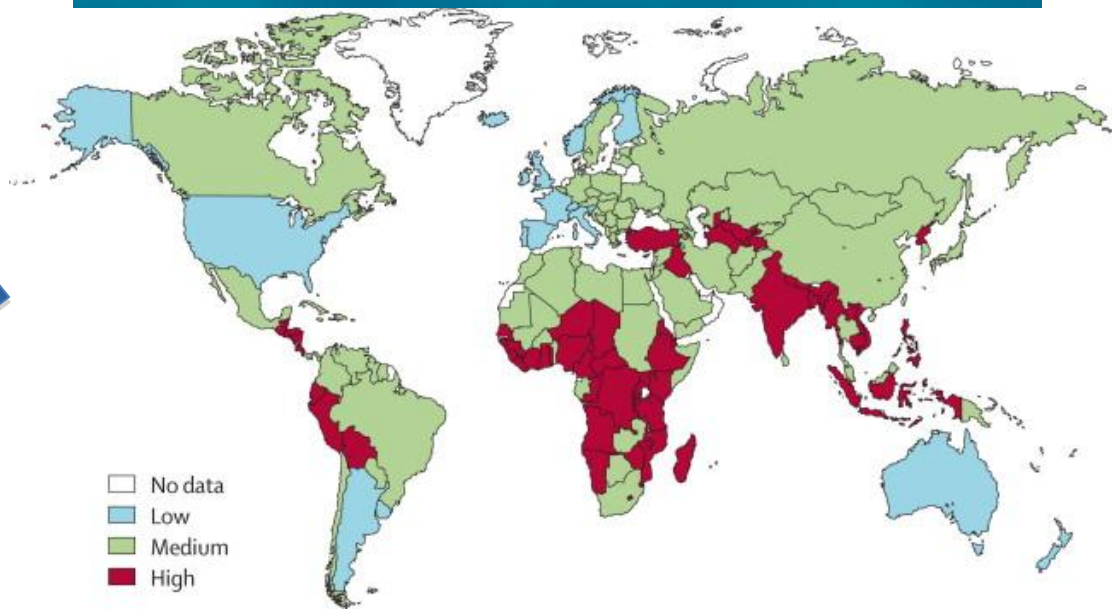
World Map – Zinc Deficiency

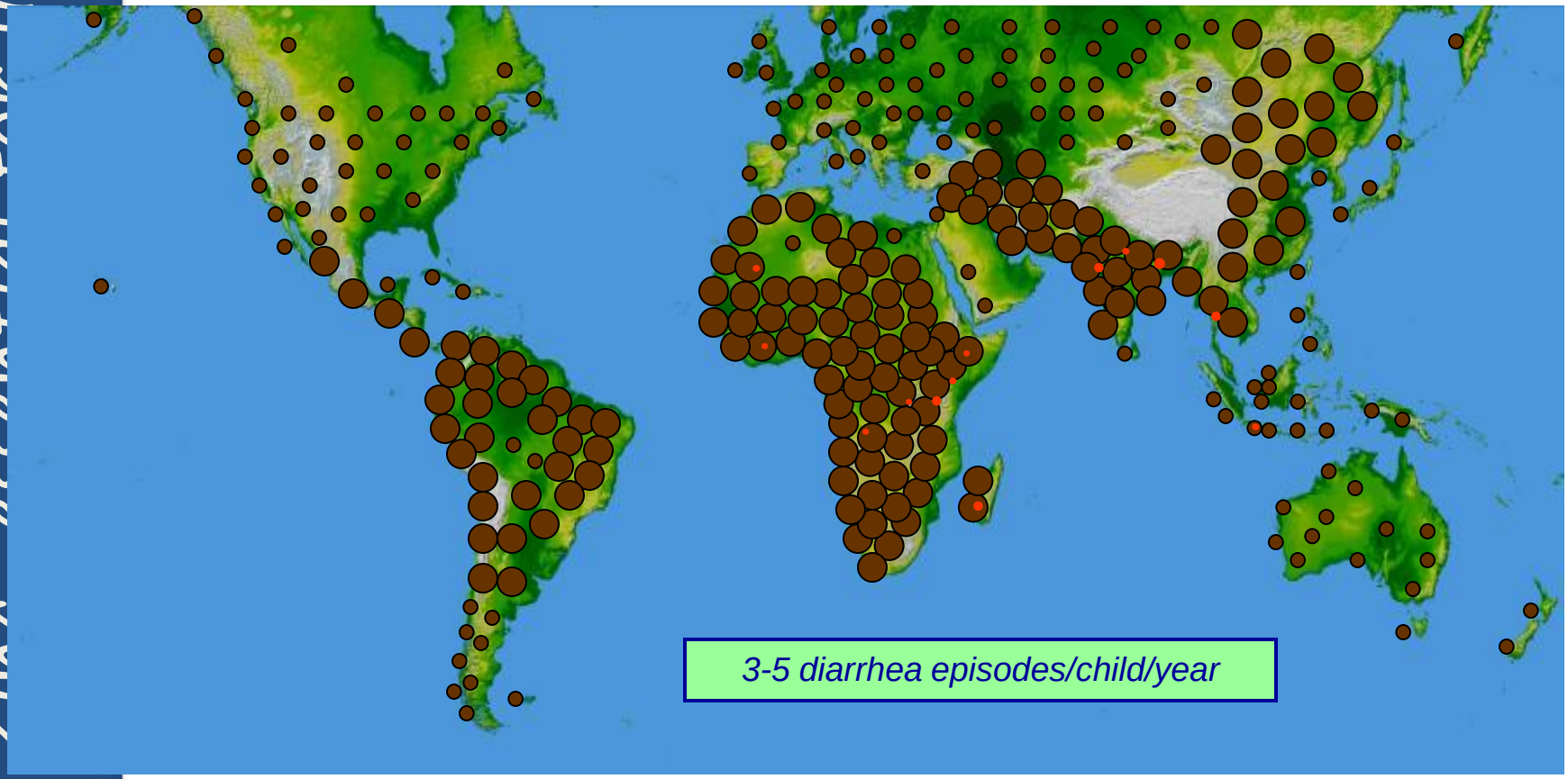


Soils



Humans

Diarrhea Incidence



●= Child diarrhea cases
• = Zinc treatment

Courtesy of NASA

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Kids aren't getting enough Zinc

Cereal grains should contain around 40-60 mg Zn/kg

Current Situation:
10-30 mg kg^{-1}

Courtesy of Dr. I. Cakmak

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Examples of Zinc Deficiency

Wheat

Severe Zn deficiency

Zn treated plot

Pictures: Potash & Phosphate Institute; Int'l Rice Research Institute

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Recognizing Zinc Deficiency

- Chlorosis
- Necrotic Spots on leaves
- Bronzing of Leaves
- Rosetting of Leaves
- Stunting of Plants
- Dwarf leaves
- Malformed leaves

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THE SOLUTION

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Applying Zinc to Crops: A Sustainable Solution to Zinc Deficiency

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After 14 Days of Zinc Treatment to Barley Crops on Zinc-Deficient Soil!

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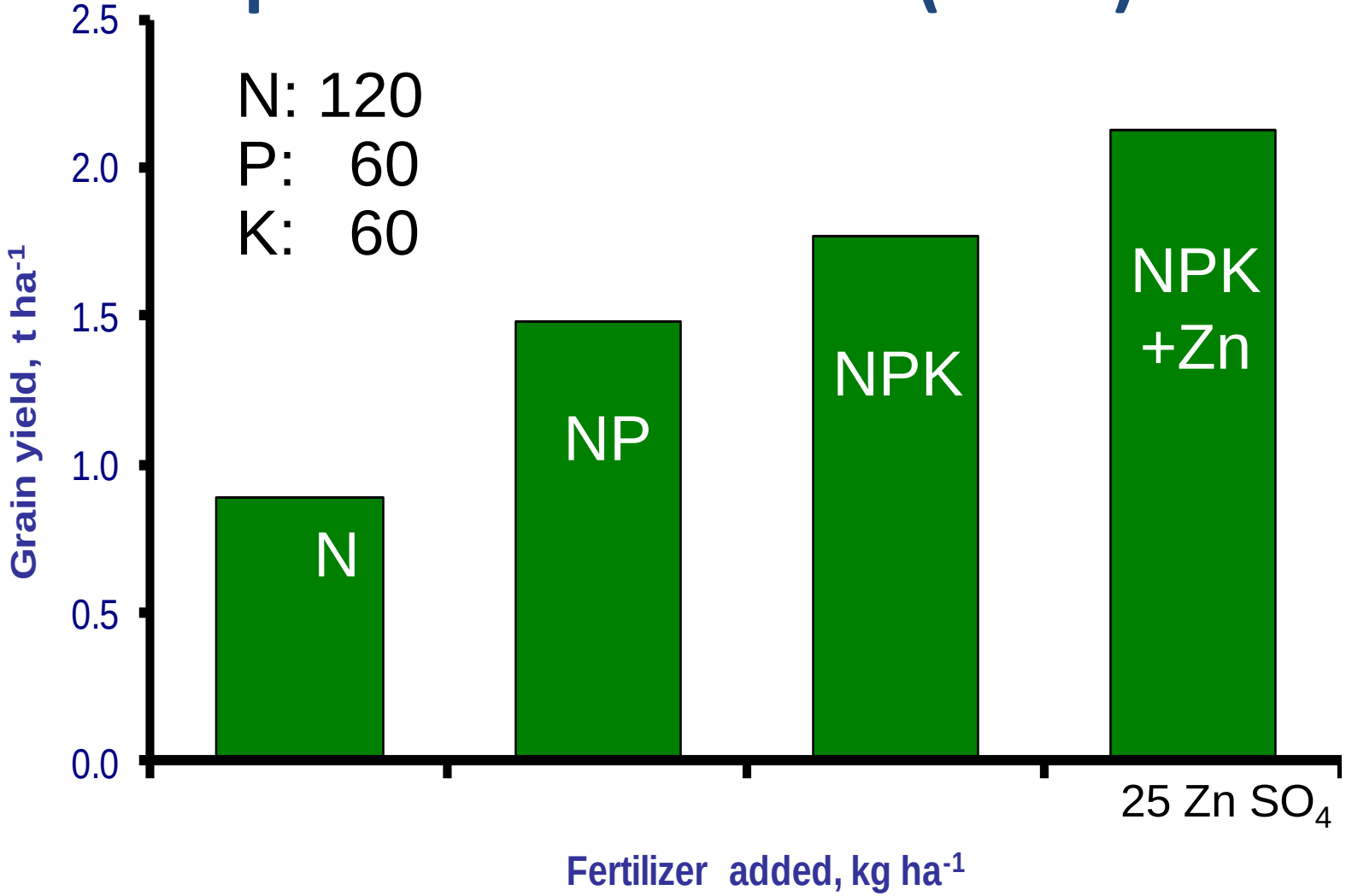
Impact of Zinc: 20-50% Increase

Experiments – Wheat (India)



Source: Tandon, 1995; I. Cakmak, 2006

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Zinc, a protective agent

- **Not only:**
  - **Increasing crop yield**
  - **Increasing zinc content**
- **But also acts as a protective agent against:**
  - **Iron toxicity in rice cultivated areas**
  - **Cadmium accumulation in wheat and rice grain**

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Cd Concern in Rice Grain in Asia

- In Asian countries rice contributes a high percentage of the Cd daily intake (Watanabe et al., 2000: Int. Arch. Occup. Environ. Health). Dietary uptake is an almost exclusive route of Cd exposure in Asia.

- Rice-originated Cd intake is responsible for approx. 45 % of the total Cd-intake (pollution) of Japanese (Cfr. Itai-Itai disease) and Korean populations.

- The Cd concentrations in rice samples collected from South China ranged from 0.01 to 4.43 mg/kg. Mean dietary Cd intake from rice for an adult is 191 µg/d (J. Environ. Sci. 2008, 20: 696–703)

Exposure levels of 30–50 µg Cd/d for an adult could increase the risk of bone fracture, cancer, kidney dysfunction, and hypertension (Satarug *et al*. 2003)

Slide courtesy of I. Cakmak

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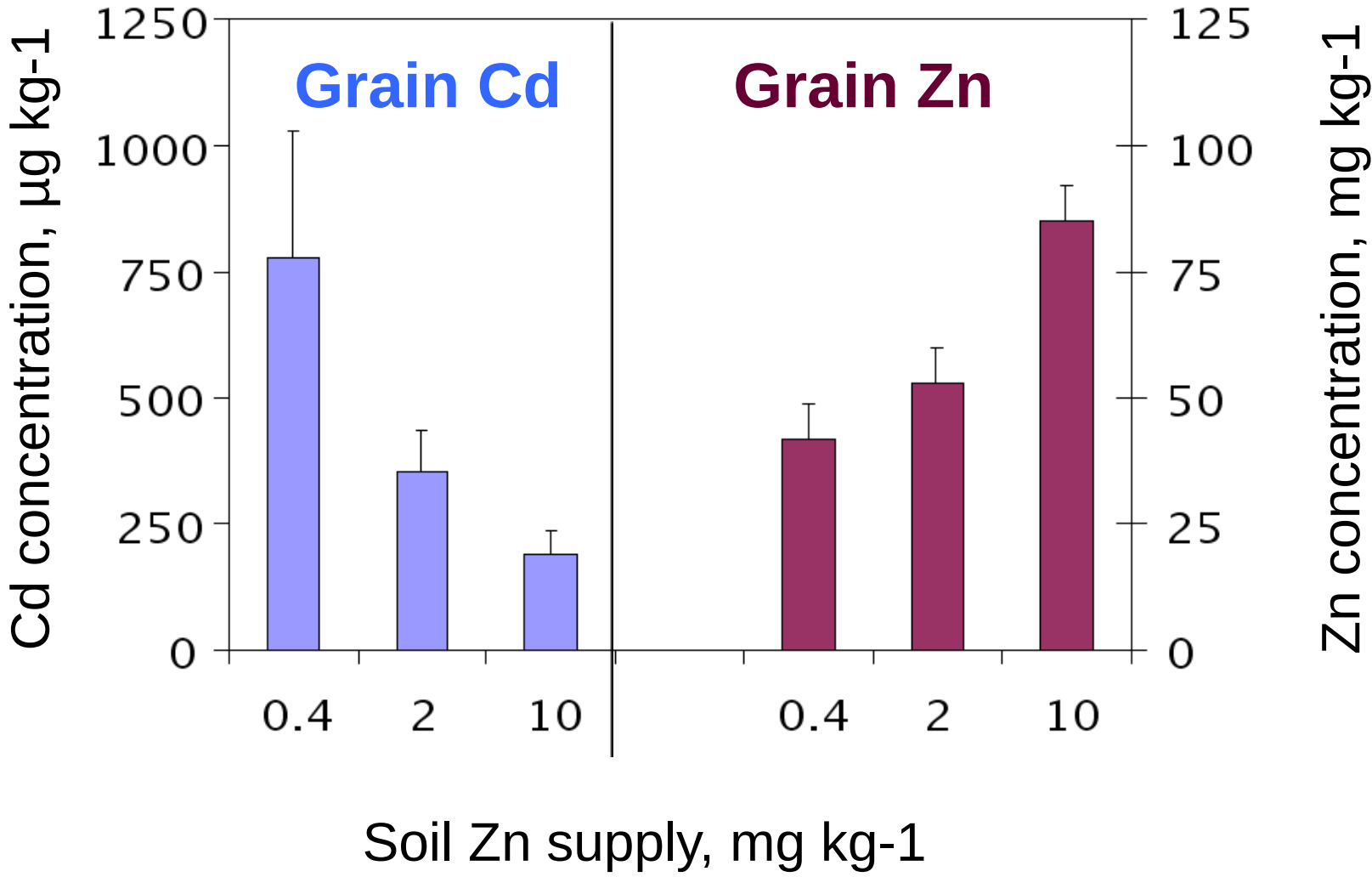
Effect of Increasing Zn Supply on Grain Concentration of Cd in Cd-Treated Plants



Source: Ozkutlu et al 2008

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Zinc nutrient initiative

- **4-yr program**
- **Global effort with focus in China, India, Brasil and Thailand**

- **Goal:**
  - **raise awareness about deficiency problem & benefits of using zinc**
  - **Increase use of zinc in fertilizers**

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Zinc nutrient initiative

Approach

- Demonstration crop trials
- Communication activities
- Workshops/seminars
- Country-based marketing

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Demonstration Field Trials

- ❑ study the effects of Zn fertilization on yield and nutritional status

- ❑ increase local awareness of the importance of zinc fertilization

Harvest Zinc Fertilizer Project (www.harvestzinc.org)

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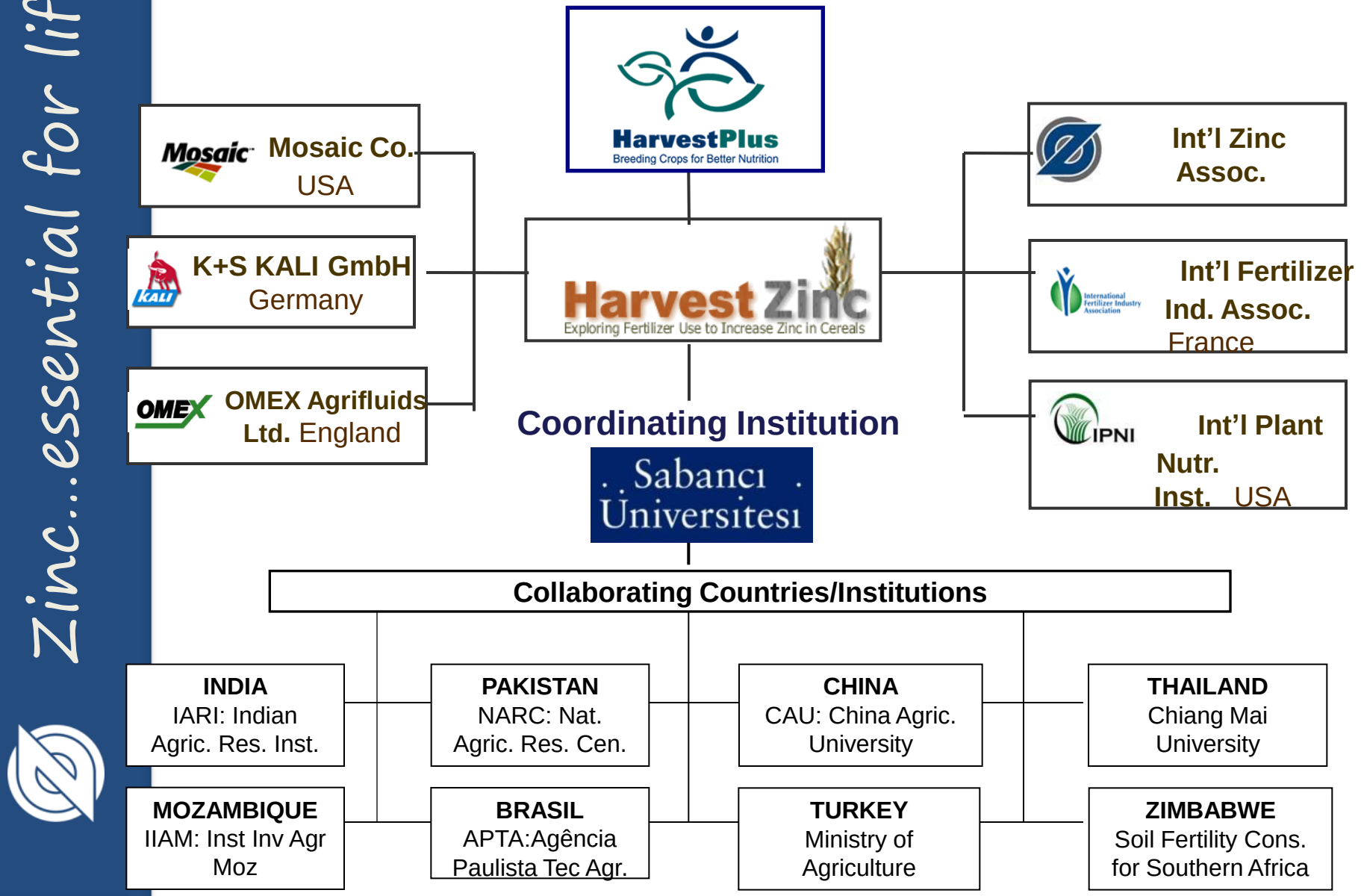

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IZA Crop Zinc Trials

- **India** – 17 wheat and rice trials
- **China** – 24 trials in 6 provinces with rice, wheat & maize
- **Thailand** - 2 rice trials
- **South Africa** - 2 maize trials
- **Brasil** – 2 soybean trials

Total of 47 crop trials globally

HarvestPlus
Breeding Crops for Better Nutrition

Global Zinc Fertilizer Project

International Zinc Assoc.

Coordinating Institution: Sabanci University

There was an increase in grain yield up to 20 % by Zn application in the experimental sites of the Nakorn Nayok and Chiang Mai Provinces

Zinc Applications improved rice grain yield up to 30 % in some locations of the Orissa State

INDIA

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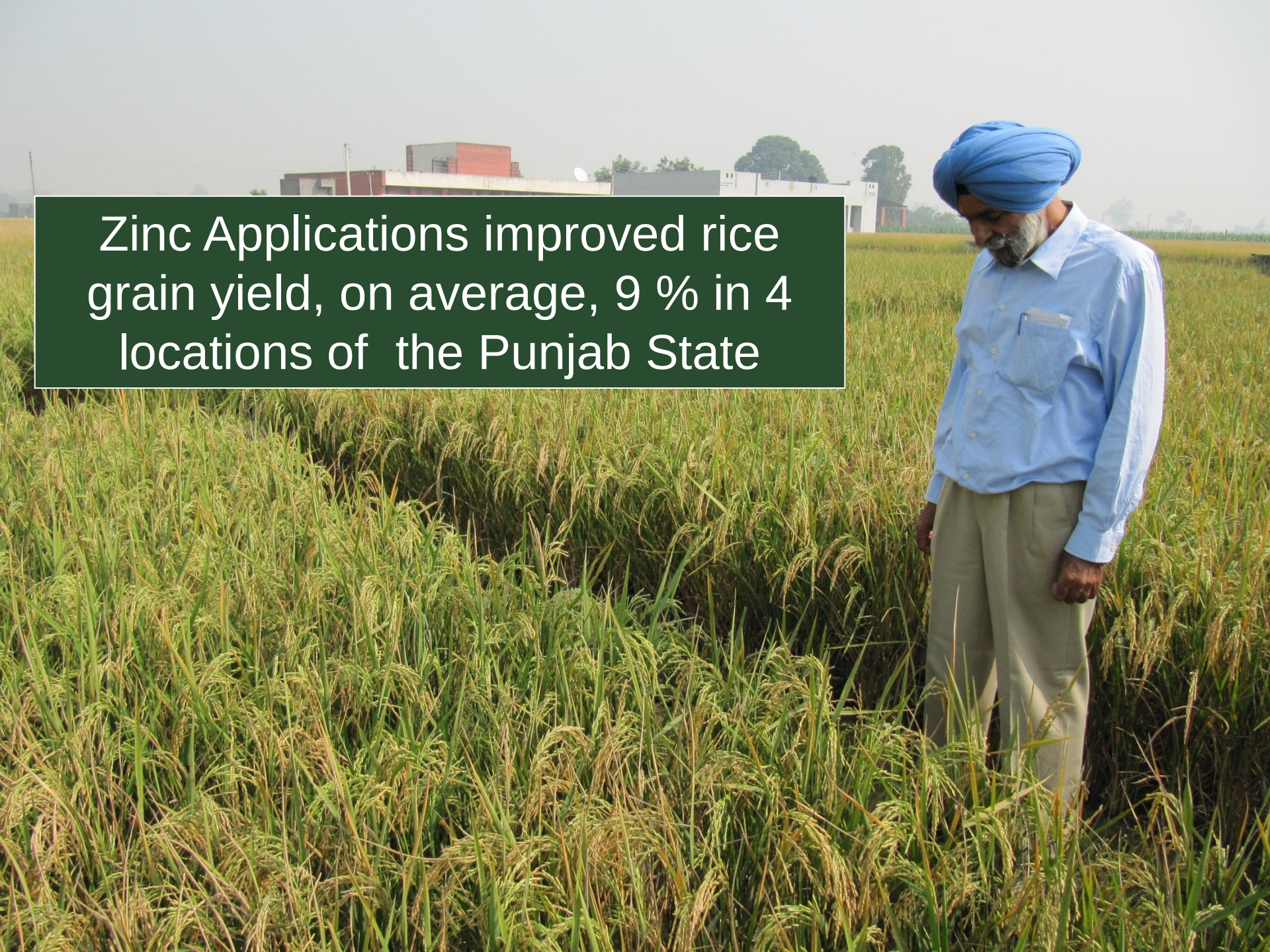
Zinc Applications improved wheat grain yield, on average, 9 % in 6 locations of the Uttar Pradesh and Haryana States

Zinc Applications improved wheat grain yield, on average, 7 % in 3 locations of Punjab State


Zinc Applications improved rice grain yield, on average, 9 % in 4 locations of the Punjab State

Zinc Applications improved rice grain yield 20 % in 2 locations of Sichaun, China

Grain Zn concentration in different countries with and without zinc fertilization

Country/Location	-Zn	+Zn
	mg kg^{-1}	
India		
•Varana		
•PAU-I		
•PAU-II		
•PAU-III		
•PAU-IV		
•IARI		
Kazakhstan		
•Loc-I		
•Loc-II		
Pakistan		
•Loc-I	27	48
•Loc-II	28	44
•Loc-III	30	40
•Loc-IV	29	60

Country/Location	-Zn	+Zn
	mg kg^{-1}	
Mexico		
•Year-I	21	45
	36	60
	12	29
	32	57
	23	49
	22	43
	28	54
	19	26
	18	39
	20	32
Iran		
•Average	17	28
Brazil		
•Average	30	52

Average Grain Zn Concentrations

(10 Countries with 32 locations)

-Zn: 26 ppm

+Zn: 50 ppm

Average of all countries -Zn: 26 +Zn:50

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Zinc is essential for crops

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But...

- Quality of zinc products a critical issue
- As, Pb and Cd reported in micronutrient fertilizers in range of 100's – 1000's of mg/kg
- Shipment of contaminated zinc fertilizer from China to S. Africa recently made the international news
- $MgSO_4$ sold as $ZnSO_4$ in Thailand & India

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Code of Practice needed

- ensure the safe and sustainable use of zinc-fertilizer products
- ensure quality of products for farmers
- help develop and grow zinc fertilizer market

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Two key goals of CoP

1) **<u>safe & sustainable product</u>**

2) Limits achievable by industry

- Working with Dr. Mike McLaughlin, Commonwealth Scientific and Industrial Research Organisation & University of Adelaide

- Review by Dr. Rufus Chaney, USDA

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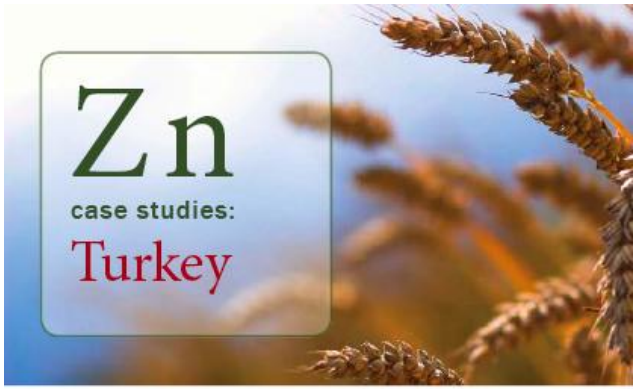
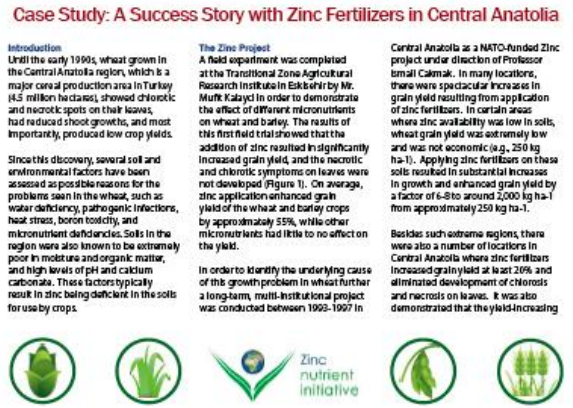
Zinc nutrient initiative

Communication Activities:

- Case-study on success story in Turkey
- Technical brochure
- Publication of articles/book
- Fact sheets
- Newsletter
- website: zinc-crops.org
- Videos
- Seminars/workshops





Case Study: A Success Story with Zinc Fertilizers in Central Anatolia

Introduction

Until the early 1990s, wheat grown in the Central Anatolia region, which is a major cereal production area in Turkey (4.5 million hectares), showed chlorotic and necrotic spots on their leaves, had reduced shoot growths, and most importantly, produced low crop yields.

Since this discovery, several soil and environmental factors have been assessed as possible reasons for the problems seen in the wheat, such as water deficiency, pathogenic infections, heat stress, boron toxicity, and micronutrient deficiencies. Soils in the region were also known to be extremely poor in moisture and organic matter, and high levels of pH and calcium carbonate. These factors typically result in zinc being deficient in the soils for use by crops.

The Zinc Project

A field experiment was completed at the Transitional Zone Agricultural Research Institute in Eskisehir by Mr. Mufit Kalayci in order to demonstrate the effect of different micronutrients on wheat and barley. The results of this first field trial showed that the addition of zinc resulted in significantly increased grain yield, and the necrotic and chlorotic symptoms on leaves were not developed (Figure 1). On average, zinc application enhanced grain yield of the wheat and barley crops by approximately 55%, while other micronutrients had little to no effect on the yield.

In order to identify the underlying cause of this growth problem in wheat further a long-term, multi-institutional project was conducted between 1993-1997 in Central Anatolia as a NATO-funded Zinc project under direction of Professor Ismail Cakmak. In many locations, there were spectacular increases in grain yield resulting from application of zinc fertilizers. In certain areas where zinc availability was low in soils, wheat grain yield was extremely low and was not economic (e.g., 250 kg ha-1). Applying zinc fertilizers on these soils resulted in substantial increases in growth and enhanced grain yield by a factor of 6-8 to around 2,000 kg ha-1 from approximately 250 kg ha-1.

Besides such extreme regions, there were also a number of locations in Central Anatolia where zinc fertilizers increased grain yield at least 20% and eliminated development of chlorosis and necrosis on leaves. It was also demonstrated that the yield-increasing

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Communication Activities:

Zinc nutrient initiative

Issue No. 1
July 2009

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zinc in fertilizers

Press Release: Zinc and Fertilizer Industries Form Task Force to Reduce High Mortality Rates in Developing World 2-3

Harvest Zinc

HarvestPlus Project: Making progress in the past year 3

National Soil and Fertilizer Conference in Thailand: A presentation of research and publications 3-4

Zinc Nutrient Initiative

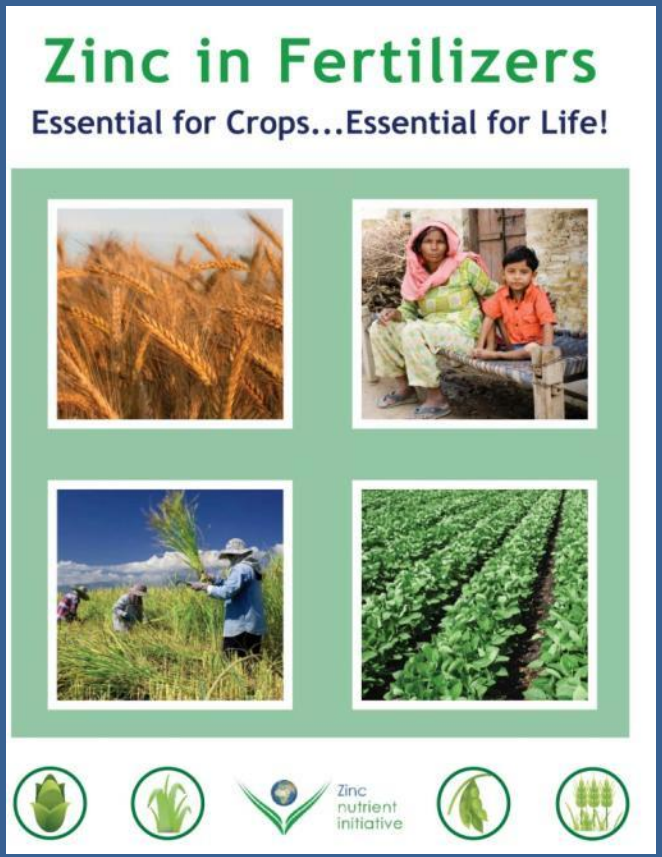
The Zinc Nutrient Initiative represents a new program with the overall goal of increasing the use of zinc in fertilizers. The Food and Agricultural Organization (FAO) has estimated that 50% of the world's agricultural lands are deficient in zinc. Further, the World Health Organization (WHO) attributes 800,000 deaths worldwide each year to zinc deficiency and highlights that zinc deficiency in humans is largely related to inadequate intake or absorption of zinc in the diet. Numerous other studies and findings have come out recently reconfirming the global and critical nature of the zinc deficiency problem, in crops and humans. The use of zinc fertilizers in zinc-deficient soils can increase crop productivity as well as the zinc nutritional status of the crops. To achieve these goals, the program will incorporate the use of demonstration crop trials (including the generation of time-elapsed video showing the benefits of adding zinc), plus communications and marketing, initiatives to government organizations, fertilizer companies, dealers and farmers.

A number of activities have occurred:

Meetings

- Latin American Fertilizer Conference held in Panama (January 2009) including presentation by Dr. Ray Hoyum (IZA Consultant) on Zinc and Fertilizers
- Zinc crop session and booth organized with Padaeng Industry (IZA Member) at Thailand's National Soil & Fertilizer conference (April 2009), including presentation by Dr. Andrew Green and Dr. Ismail Cakmak on IZA's Zinc Nutrient Initiative
- Zinc Symposium - New Delhi (April 2009) organized with Fertilizer Association of India and, including presentation by Dr. Andrew Green and Dr. Ismail Cakmak on IZA's Zinc Nutrient Initiative.

- Meeting held with the Food and Agricultural Organization (FAO) by Stephen Wilkinson and Johan Van Wesemael to discuss support of zinc fertilizer program and funding efforts.



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Communication Activities:

Zinc nutrient initiative

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Zinc Fact Sheets: Rice

Zinc nutrient initiative

Introduction

Rice production systems differ widely in cropping intensity and yield, ranging from single-crop rain-fed lowland and upland rice with low yields (1-3 tons/ha), to triple-crop irrigated systems with annual grain production of up to 15-18 tons/ha. Irrigated and lowland rice systems account for about 80% of the worldwide harvested rice area and 92% of total rice production. To keep pace with population growth, overall rice production must increase by 25% over the next 20 years. Rice provides up to 80% of the calories consumed by 3.3 billion people in Asia.

High yielding, nutrient rich rice requires improved, yet balanced, crop nutrition of all major, secondary and micronutrients. Unfortunately, it is estimated that over 50% of agricultural soils devoted to cereal cultivation are potentially zinc deficient. Also, over two thirds of the rice grown worldwide is produced on flooded paddy rice soils which are typically low in plant available zinc.

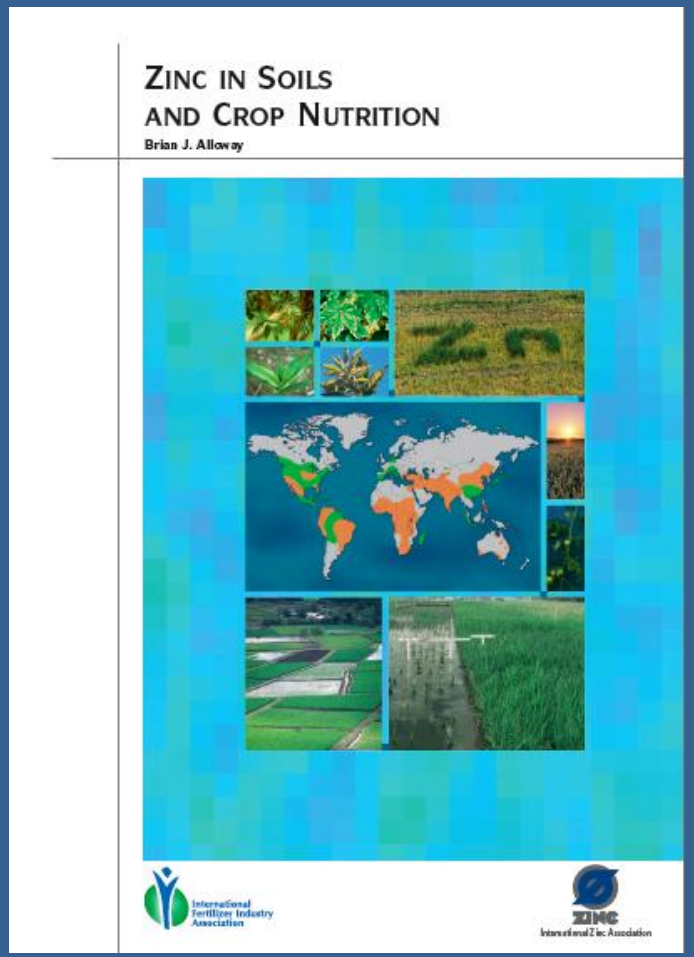
Balanced Crop Nutrition

For high yielding rice, crop nutrition must be adequate and carefully balanced. Where available, soil testing and plant analysis should be utilized to guide any fertilizer program. Any deficient or unbalanced use of nutrients potentially reduces yield. Recent research has shown significant reductions in yield when zinc is less than adequate (Table 1).

Table 1: Rice Yields With and Without Adequate Zinc

Country	+Zn (t/ha)	-Zn (t/ha)	% Change
Columbia	9.3	7.5	-19%
	11.3	10.3	-8%
	12.0	9.8	-18%
China	8.2	7.3	-10%
India	9.95	8.7	-12%

Results from 140 greenhouse trials based on soils from 17 provinces of China showed that 49% of the soils were deficient in zinc. When a variety of crops were grown, the average relative yields were only 75% of the optimum, again demonstrating the serious decline in yield when zinc is deficient.



ZINC IN SOILS AND CROP NUTRITION

Brian J. Alloway

International Fertilizer Industry Association

ZINC International Zinc Association

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Communication Activities:

Zinc nutrient initiative

Numerous key publications in trade and academic journals

Rice is very susceptible to Zn deficiency. The symptoms can be recognised from chlorosis, necrotic spots on leaves, bronzing and/or rusetting of leaves, dwarf or malformed leaves, and stunting of plants.

ZINC

A key micronutrient

As a vital micronutrient, zinc (Zn) is a natural element that is essential for normal healthy growth and reproduction of plants, animals and humans. It appears in the soil at a typical ratio of 25-200 mg Zn/kg DW, in the air at between 40-100 ng Zn/m³, in water at between 340 µg Zn/l and biomass (25-200 µg Zn/g DW).

In plants, Zn is critical for many physiological functions, including the maintenance of structural and functional integrity of biological membranes and the facilitation of protein synthesis. Of all micronutrients, Zn is required by the largest number of enzymes and proteins. The zinc pathways have important roles in:

- Photosynthesis and sugar formation
- Protein synthesis
- Fertility and seed production
- Growth regulation
- Defence against disease.

If the supply of plant-available Zn is insufficient, plant growth may be impaired and yields and crop quality will be reduced. Zn deficiency in a plant manifests itself in visible symptoms of stress, including:

- Stunting/reduced height
- Interveinal chlorosis, as shown by the yellowing of the leaves between the veins
- Bronzing of chlorotic leaves
- Abnormally-shaped leaves and leaf stunting.

These different types of symptoms vary with plant species and are usually only clearly displayed in severely deficient plants. In cases of marginal deficiency, plant yields can fall by as much as 20% or more without any obvious visible symptoms. (*Zinc in Soils and Crop Nutrition*, Brian J. Alloway, International Fertiliser Industry Association/International Zinc Association [July 2008].)

Zinc also plays a critical role in human and livestock diets, influencing metabolism, the perpetuation of genetic material and the transcription of DNA. Zn deficiency can lead to reduced appetite, reduced growth, vulnerability to illnesses and infections, reduced fertility and lower longevity.

Zinc is a key ingredient in human nutrition, soil and crop management and is being identified as an increasingly frequent limiting factor. This review evaluates the range of products that can counter this threat to crop yields.

Zn deficiency in animals and humans can be rectified through enhanced zinc content in cereals and other crops.

The International Zinc Association (IZA) identifies Zn as the third most important nutritional factor affecting grain yield after nitrogen and phosphorus. Many plant species are affected by Zn deficiency on a wide range of soil types in most agricultural regions in the world. The major staple crops, such as rice, wheat, maize and sorghum, are all affected by Zn deficiency, along with many different fruit, vegetable and other types of crops, including cotton and flax. Rice is particularly susceptible to Zn deficiency, as it grows in waterlogged soils which are conducive to zinc deficiency. Flooding the soil reduces Zn avail-

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Videos

Zinc nutrient initiative

- 4-5 minutes videos being developed for India & China

- 2-3 minute international video planned

- Time-elapsed videos developed from greenhouse and field-trials in Turkey

-Zn +Zn

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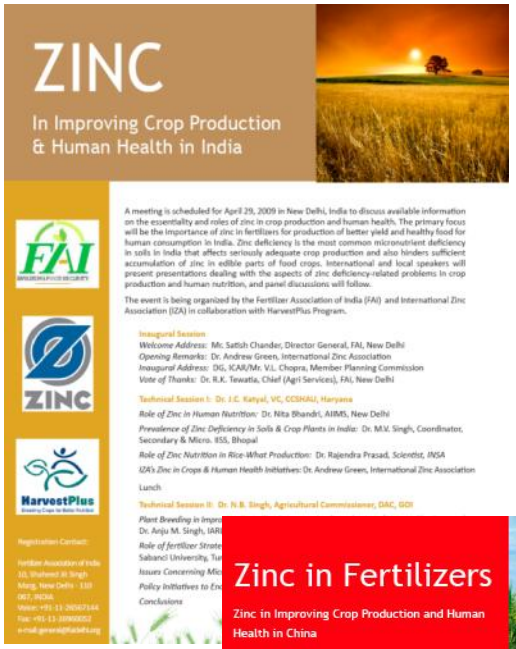
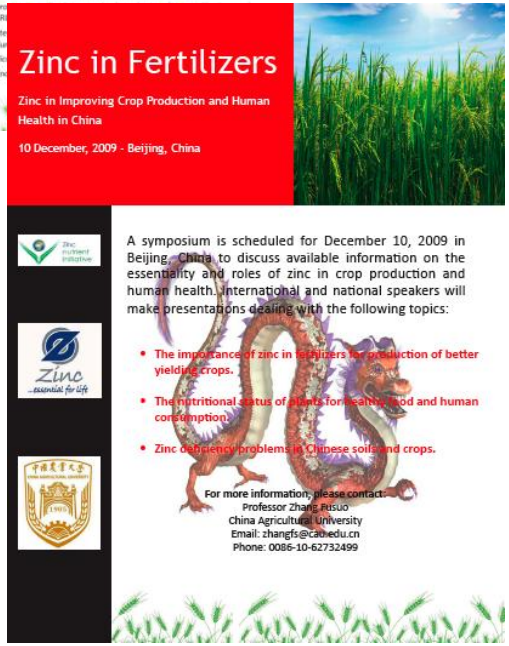
www.zinc-crops.org

Zinc Fertilizer Seminar/Sessions

- India
- Thailand
- Canada
- Mexico
- China
- Brasil
- S. Africa





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Zinc Crops 2007 Conference

- International conference held in Turkey with International Fertilizer Association
- Focus: Science on zinc deficiency and its impact on global crop production and human health
- 180 people attended from 36 different countries

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2011 International Zinc Conference

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Country Based Marketing

Zinc nutrient initiative

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IZA India Actions

- Hired Director, Dr. Soumitra Das
- Policy Intervention
- Agricultural Extension

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India -NBSS

- Total Indian subsidy for fertilizers is ~ 22-23 billion USD
- In old system, maximum retail price (MRP) of fertilizers set by government
- In NBSS, subsidy given on individual nutrients based on nutrient need. NBSS promotes balanced fertilization.

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India- NBSS

- Subsidy for zinc has now been included in NBSS
- First time zinc has been included in central government subsidization scheme
- 500 INR subsidy paid to fertilizer companies that fortify with Zn.

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India - Customized Fertilizers

- Only government approved fertilizers can be manufactured and sold in India
- Government promoting "Customized Fertilizers" that are crop specific , soil specific and location specific
- Must meet all of the nutritional requirements of the crops

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IZA India Actions

- **Policy Intervention**
  - Zinc Oxide Registration
  - Increase zinc subsidy

FAI
ENSURING FOOD SECURITY
The Fertiliser Association of India

भाकृअनुप
ICAR
Indian Council of Agricultural Research

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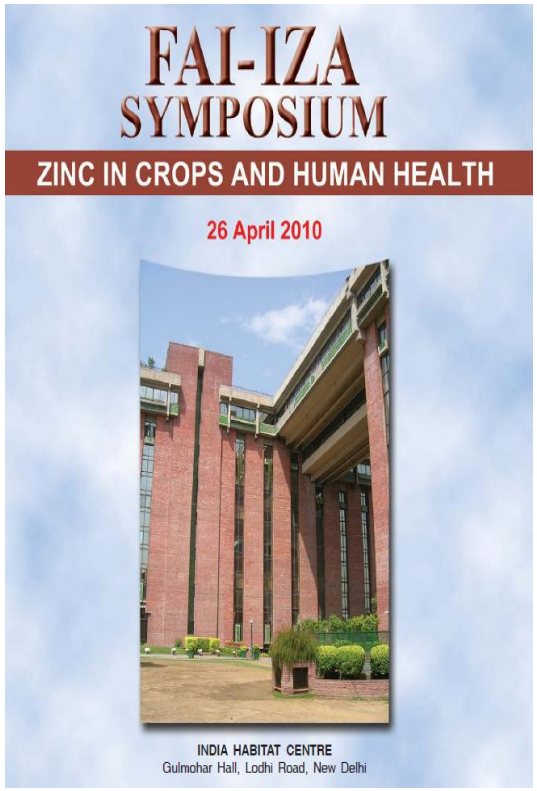
IZA India Actions

- **Agricultural Extension**
  - Zinc Training Program
  - Regional Workshops
  - International Zinc Conference
  - Institutional Award
  - Fertilizer Companies



DEEPAK FERTILISERS
AND PETROCHEMICALS CORPORATION LIMITED

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India Results

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nagarjuna group

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Govt. of India approved CF grades for Andhra Pradesh

S.No	Crop	Region	CF Grade (N-P_2O_5-K_2O-S-Zn)	Stage
1	Rice	Godavari disricts &Viskhapatnam	15-32-8-0-0.5	Basal
2	Rice	Krishna, Guntur & Khammam	18-33-7-0-0.5	Basal
3	Maize	Godavari disricts & Viskhapatnam	18-27-14-0-0.5	Basal
4	Maize	Krishna, Guntur & Khammam	18-24-11-0-0.5	Basal
5	Rice	Telangana districts	11-24-6-3-0.5	Basal
6	Maize	Telangana districts	14-27-10-4-0.5	Basal

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New Zinc Fortified Product

- Tata Chemicals Ltd.
  - N:P:K:S:Zn (4 grades)
  - N:P:K:S:Zn:B (1 grade)
- Deepak Fertilizers & Petrochemicals Corporation
  - N:P:K:S:Mg:Zn:B:Fe (4 grades)
- Coromandel International Ltd.
  - N:P:K:S:Zn:B (2 grades)

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China

- Hired Director, Dr. Ming Fan
- Crop Trials
- Policy Intervention
- Agricultural Extension

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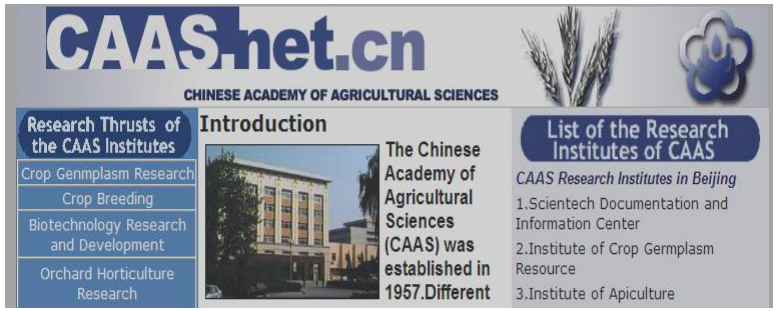
IZA China Actions

- **Policy Intervention**
  - Develop IZA/CAU/CAAS Report on Zinc
  - Zinc Labeling Standard
  - Add zinc to provincial/state level recommendations



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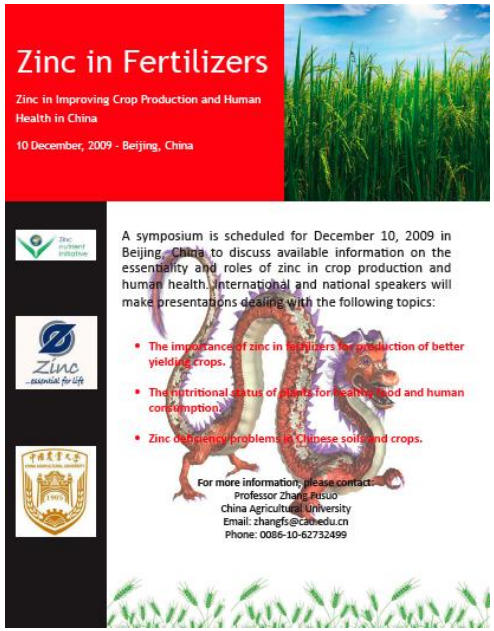
IZA China Actions

- **Agricultural Extension**
  - Zinc Training Program
  - Regional Workshops
  - IZA/IFA Task Force Roundtable
  - Fertilizer Companies
  - Partnerships with NPK groups



SINOCHEM 中化化肥 SINOFERT

北京新禾丰农化资料有限公司 BEIJING XINHEFENG AGROCHEMICAL CO.,LTD

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Thailand

- Working with Padaeng Industry
- Crop Trials
- Policy Intervention
- Communications

[Workshop planned in 1st quarter]

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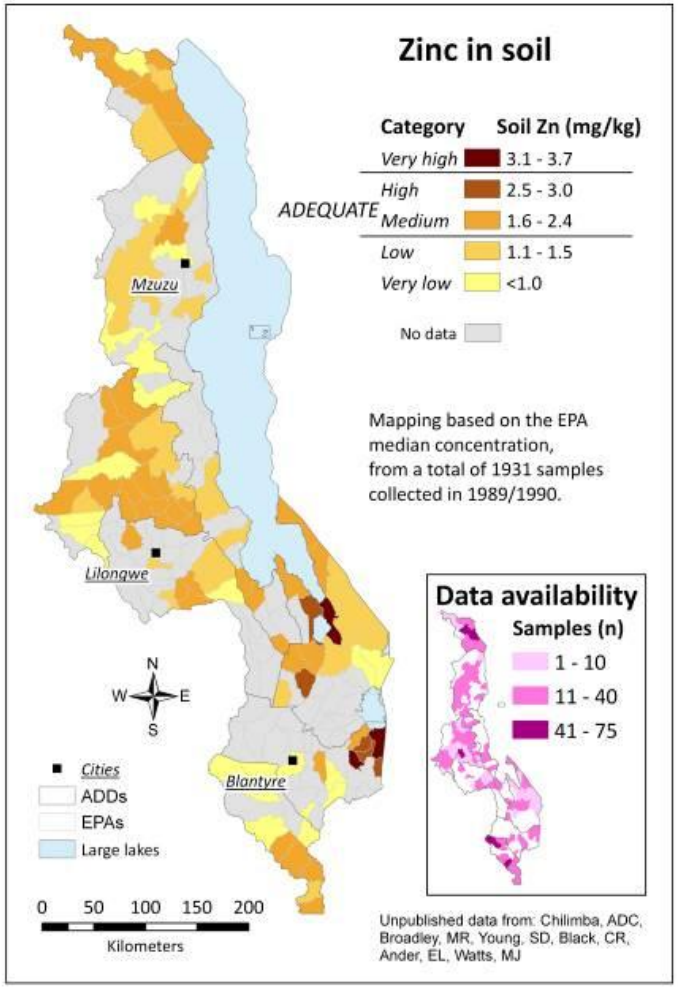
Malawi

- Proposal to CFC in partnership with ILZSG for $120,000
- Crop Trials
- Policy Intervention
- Communications



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Partnerships Needed for Success

- IFA
- IPNI
- The Sulfur Institute
- CFC/ILZSG
- Governments
- U.S. AID
- Gates Foundation
- FAI
- Fertilizer Companies

FAI
ENSURING FOOD SECURITY

TSI THE SULPHUR INSTITUTE

USAID
FROM THE AMERICAN PEOPLE

IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE

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Fertilizer Affiliate Members

- Mosaic
- IRM
- Deepak Fertilizers
- **Beijing Xinhefeng Agrochemical**
- Omex Agricultural
- Tetra Micronutrients
- International Raw Materials
- Sinofert

Mosaic

TETRA MICRONUTRIENTS

IRM

DEEPAK FERTILISERS AND PETROCHEMICALS CORPORATION LIMITED

XHF

SINOCHEM 中化化肥 SINOFERT

OMEX

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CLINTON GLOBAL INITIATIVE

- CGI highlighted the Zinc & Nutrition Initiative at annual event in September
- Effort focuses on addressing zinc deficiency in humans and crops through supplementation & fertilizer use.

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- **Zinc deficiency – in humans and crops is a critical, global, and linked issue**
- **Problem is solvable – Zinc Fertilizer**
- **Benefits include increased food security, nutrition, health and economics**

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Zinc is an essential nutrient for human health. Ensuring adequate levels of zinc intake should be a key component in efforts to reduce child illness, enhance physical growth and decrease mortality in developing countries. In spite of the proven benefits of adequate zinc nutrition, zinc deficiency is the fifth leading risk factor for disease in the developing world (WHO, 2002).

To learn more about zinc and health, visit us at booth #317 or www.zinc-health.org.

ZINC

International Zinc Association

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www.zincworld.org

iZiNCG

International Zinc Nutrition Consultative Group

Improving health of people in need by enhancing zinc nutrition

www.izincg.org

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Questions?

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unicef

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