



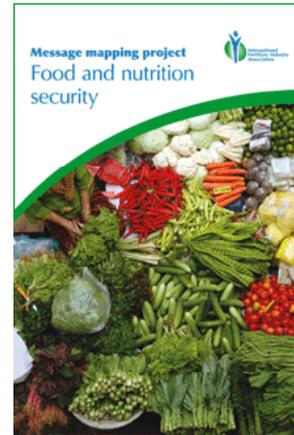
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' fertilizer se and uman ealth'*





ABOUT IFA

Print Share

Representing the global fertilizer industry. Serving farmers by providing the nutrients needed by soils and crops.



IFA has some 525 members in about 85 countries. About half of the membership is based in developing countries. IFA member companies represent all activities related to the production, trade, transport and distribution of every type of fertilizer, their raw materials and intermediates. IFA's membership also includes organizations involved in construction, engineering, consulting, agronomic research and training.

The global fertilizer industry produces some 170 million tonnes of fertilizer nutrients annually. These are used in every corner of the globe to support agricultural production. There is no substitute for the nutrients absorbed by crops. As a major source of these, fertilizers therefore represent an essential ingredient in the drive towards world food security.

www.fertilizer.org





IPNI Mission and Membership

“to develop and promote scientific information about the responsible management of plant nutrition for the benefit of the human family.”



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Biofortified and Functional Food: A Healthy Future? - 19th May 2011

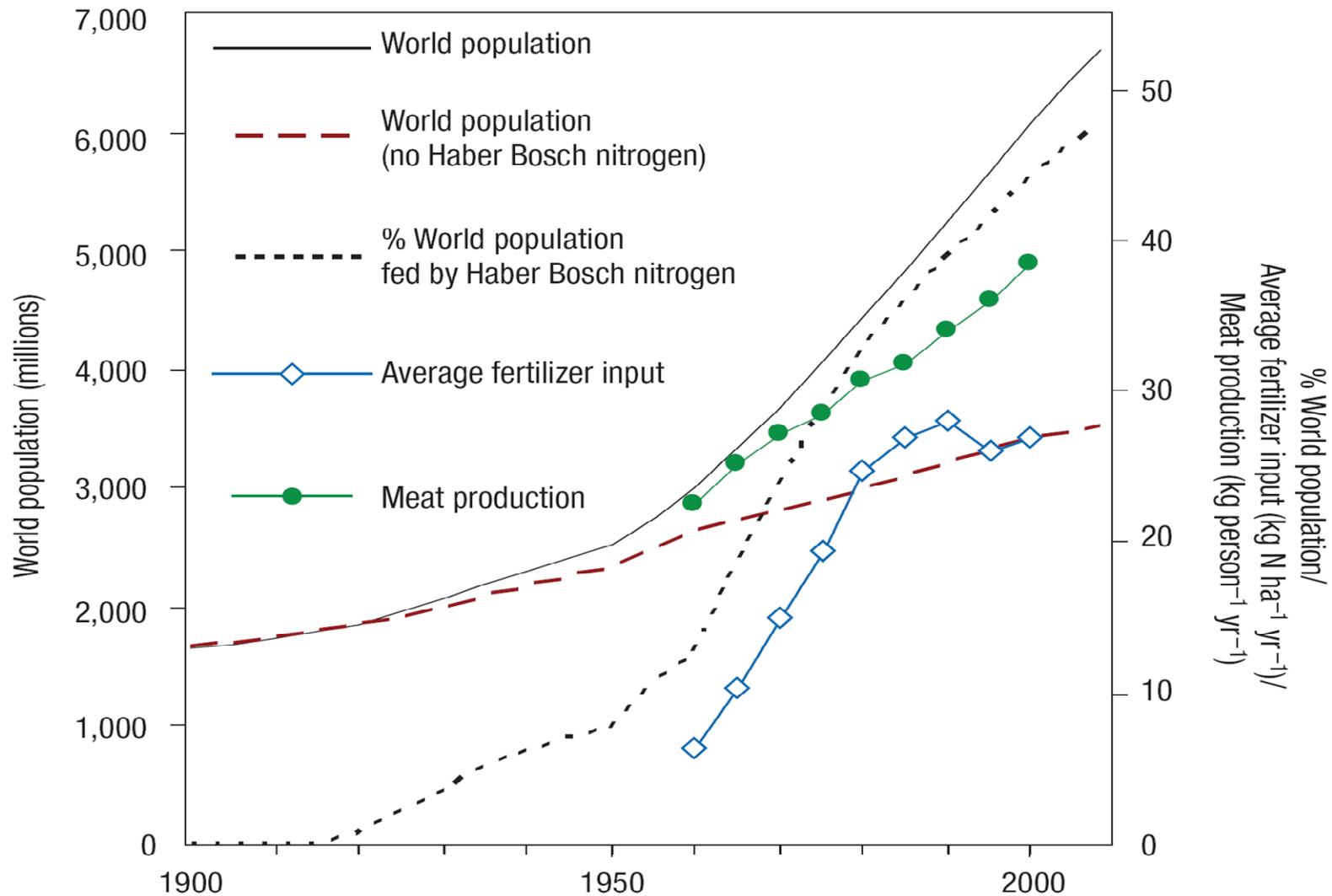


Preview of Presentation

- Outcomes of the Green Revolution 1.0
- Recognizing the need for the next Green Revolution 2.0
- Necessity for the 'Fertilizer Use and Human Health' initiative
- Development and progress to date
- Topics covered and relevant insights
- Conclusion: Establishing a 'New Agricultural Paradigm'
- SUMMARY



Outcomes of the (last) Green Revolution 1.0



Bruulsema 2010 (adapted from Erisman et al, 2008)



Recognizing the need for Green Revolution 2.0

The nine billion people question

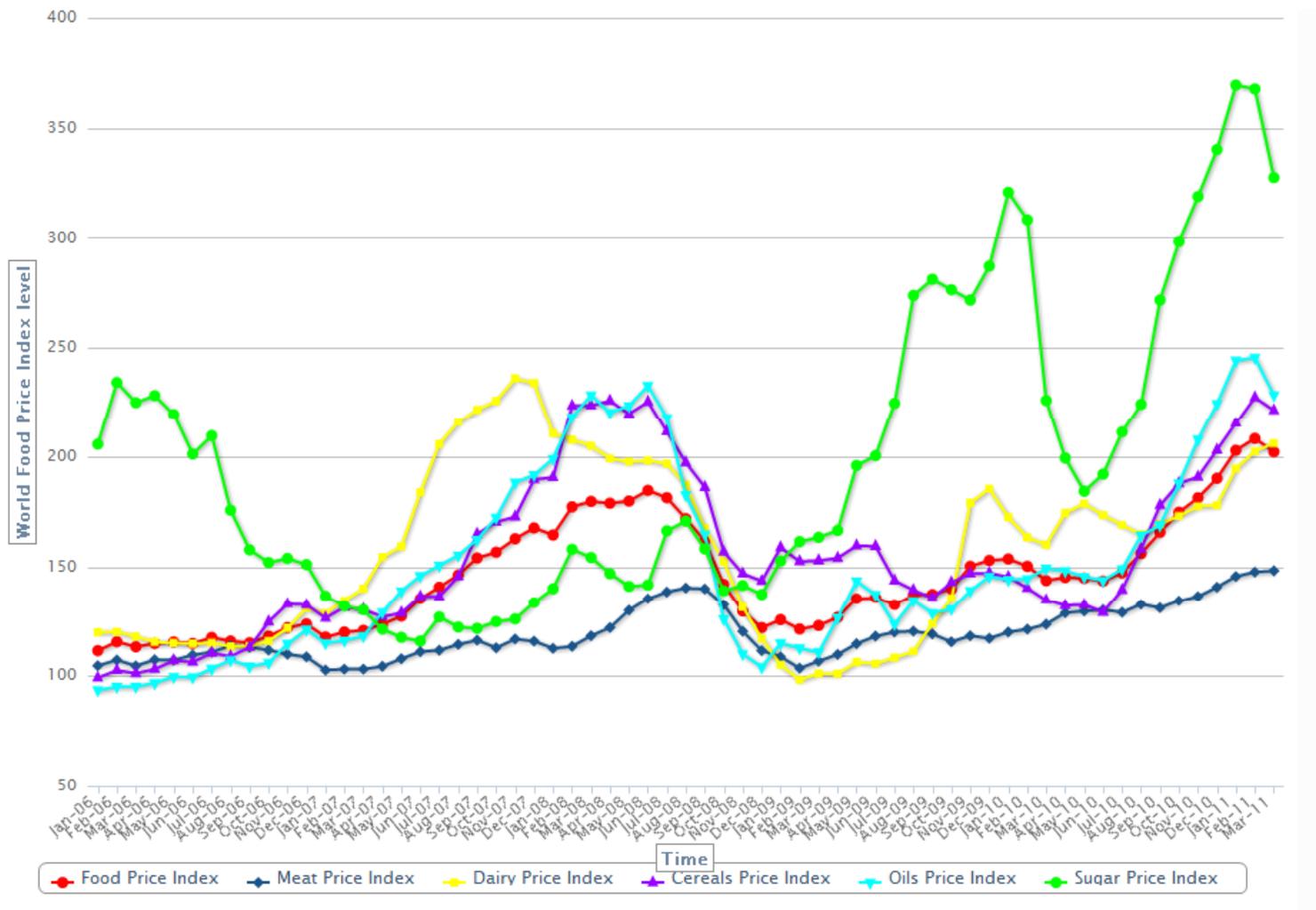
A special 16-page report on feeding the world. *The Economist*, Feb 26th 2011



Biofortified and Functional Food: A Healthy Future? - 19th May 2011



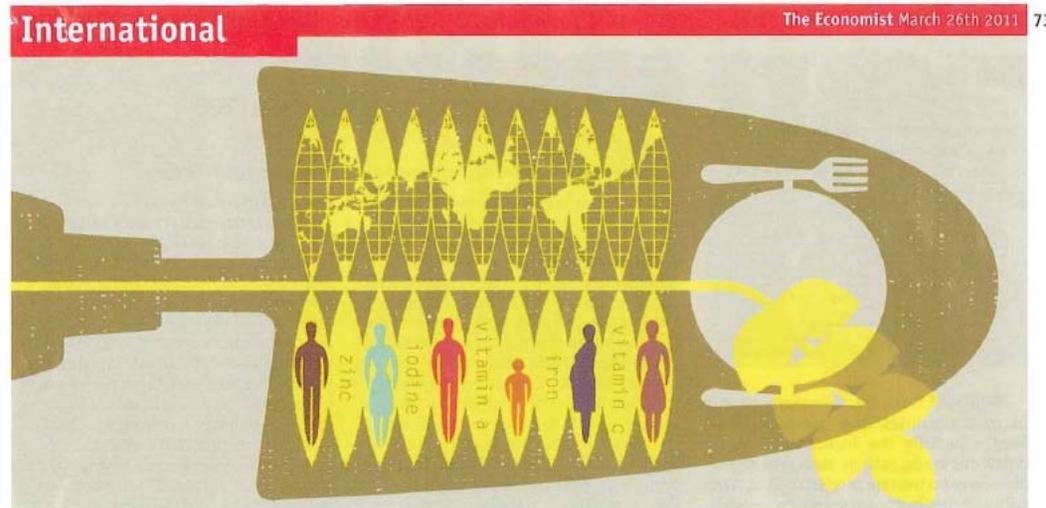
Once again food prices have risen to new heights



FAO Statistics (March 2011)



Micronutrient mal-nutrition becoming established on global agendas



Agriculture and nutrition
Hidden hunger

Also in this section
 74 Tackling FIFA's boss

The Economist
26th March 2011

DELHI
How much can farming really improve people's health?

IN A market in southern Uganda two traders squat behind little piles of sweet potatoes and a sign that says "with extra vitamin A". A passing shopper complains about the price: 10% more than ordinary sweet potatoes. Yes, say the traders, but they're better, bred with extra vitamin A. The bargaining goes back and forth, but the struggle to improve the crop has already been won. Since 2007, when an outfit called HarvestPlus began distributing the "biofortified" rootcrop in Uganda and Mozambique, 50,000 farmers have started to plant it or crops like it. Vitamin A intake has soared and the produce commands a premium. The shopper eventually buys some.

Nutrition has long been the Cinderella of development. Lack of calories-hunger-is a headline-grabber, particularly as rising food prices push more people towards starvation. But the hidden hunger of

potatoes). Others included girls' schools and trade liberalisation.

Of the 40 nutrients people need, four are in chronically short supply: iron, zinc, iodine and vitamin A. Vitamin A is essential for the mucous membranes that protect the body's organs, such as the eyes. Lack of it causes half a million children to go blind every year; half of them die within a year as their other organs fail. Vitamin A supplements were the Copenhagen experts' top choice. Zinc deficiency impairs brain and motor functions and causes roughly 400,000 deaths a year. Shortage of iron (anaemia) weakens the immune system and affects, in some poor countries, half of all women of child-bearing age.

Too hungry to think properly
 The missing nutrients bite wide and deep. Education levels drop (malnourished chil-

Farming ought to be especially good for nutrition. If farmers provide a varied diet to local markets, people seem more likely to eat well. Agricultural growth is one of the best ways to generate income for the poorest, who need the most help buying nutritious food. And in many countries women do most of the farm work. They also have most influence on children's health. Profitable farming, women's income and child nutrition should therefore go together. In theory a rise in farm output should boost nutrition by more than a comparable rise in general economic well-being, measured by GDP.

In practice it is another story. A paper* written for the Delhi meeting shows that an increase in agricultural value-added per worker from \$200 to \$500 a year is associated with a fall in the share of the undernourished population from about 35% to



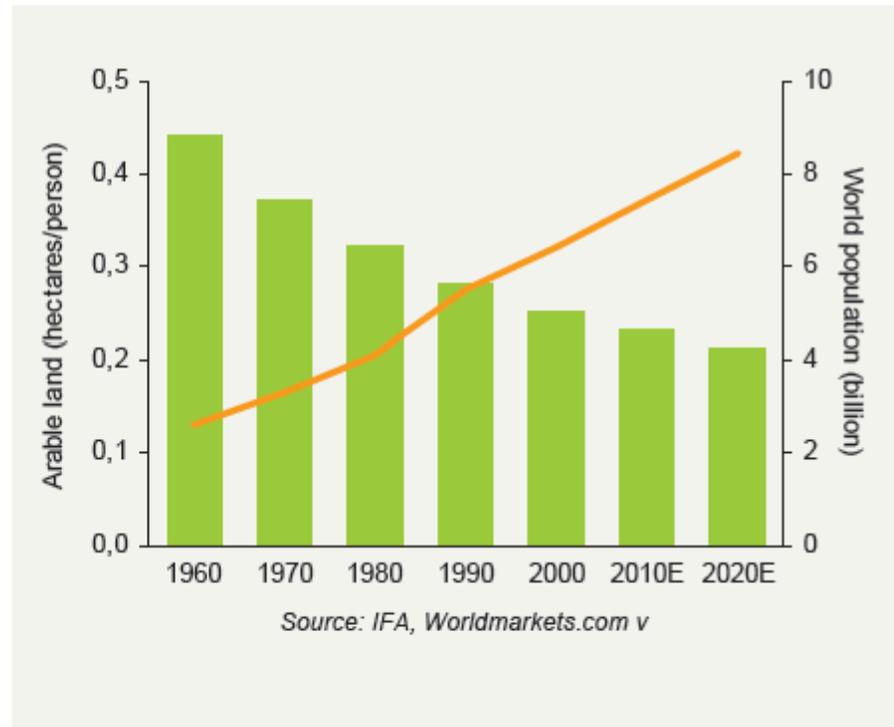
Consequent challenges to future agricultural production...

Very limited potential to increase arable land

Improved living standards increase protein consumption per person requiring more grain for animal feed



The only solution is to increase agricultural productivity



Source: Norman Borlaug statement on the basis of 2005 food production level.



...whilst reducing carbon foot-print and global warming...



Events Diary | royalsociety.tv | Scientific Meetings | Maps | Summer Science Exhibition | more

Reducing greenhouse gas emissions from agriculture

Starts: 9.00am on 28 February 2011
Finishes: 5.00pm on 01 March 2011
Venue: The Royal Society, London



Meeting the challenges of food security and climate change

Audio recordings of the presentations are now available

Organised by Professor Sir David Read FRS and Professor Sam Evans with Professor Richard Bardgett, Professor Sir David Baulcombe FRS, Professor Gareth Edwards-Jones, Professor Graham Farquhar FRS, Professor Maggie Gill, Dr Murray Lark, Dr Sinclair Mayne, Professor Pete Smith and Dr Jeremy Woods.

Supported by Department for Environment, Food and Rural Affairs; Agriculture and Horticulture Development Board; Biotechnology and Biological Sciences Research Council; Biosciences Knowledge Transfer Network; Environmental Sustainability Knowledge Transfer Network; Living With Environmental Change; National Farmers Union; Natural Environment Research Council; Technology Strategy Board

Monday 28 February 2011

9.00 Welcome by Dr Peter Cotgreave, Director, Public Affairs, Royal Society and Professor Sir David Read FRS

Session 1

9.05 Chair Dr Miles Parker, Department for Environment, Food and Rural Affairs (Defra), UK

9.10 Introduction

Professor Sir John Beddington CMG FRS, Chief Scientific Advisor to HM Government, UK

9.20 Food security and agricultural development: the challenges ahead

Professor Sir Gordon Conway KCMG FRS, Imperial College London, UK

We face three interconnected challenges: First, recurrent food price spikes that have a devastating effect on developing countries. Second, the existence today of about 1 billion chronically hungry people. Third, the need to increase food production by some 70-100% by 2050 to cope with rising populations, increasing per capita incomes and changing food preferences, the rising demand of biofuels, increasing costs of fertilisers and fuel, the declining availability and quality of water and land, and the threat of climate change. All these challenges are within the broader context of growing global energy, water and environmental crises.

“The need to tackle climate change while producing more food to feed the world’s growing population means that ‘climate-smart’ agriculture is the only way forward.”

Professor Sir John Beddington quoted in *Nature* following the Conference



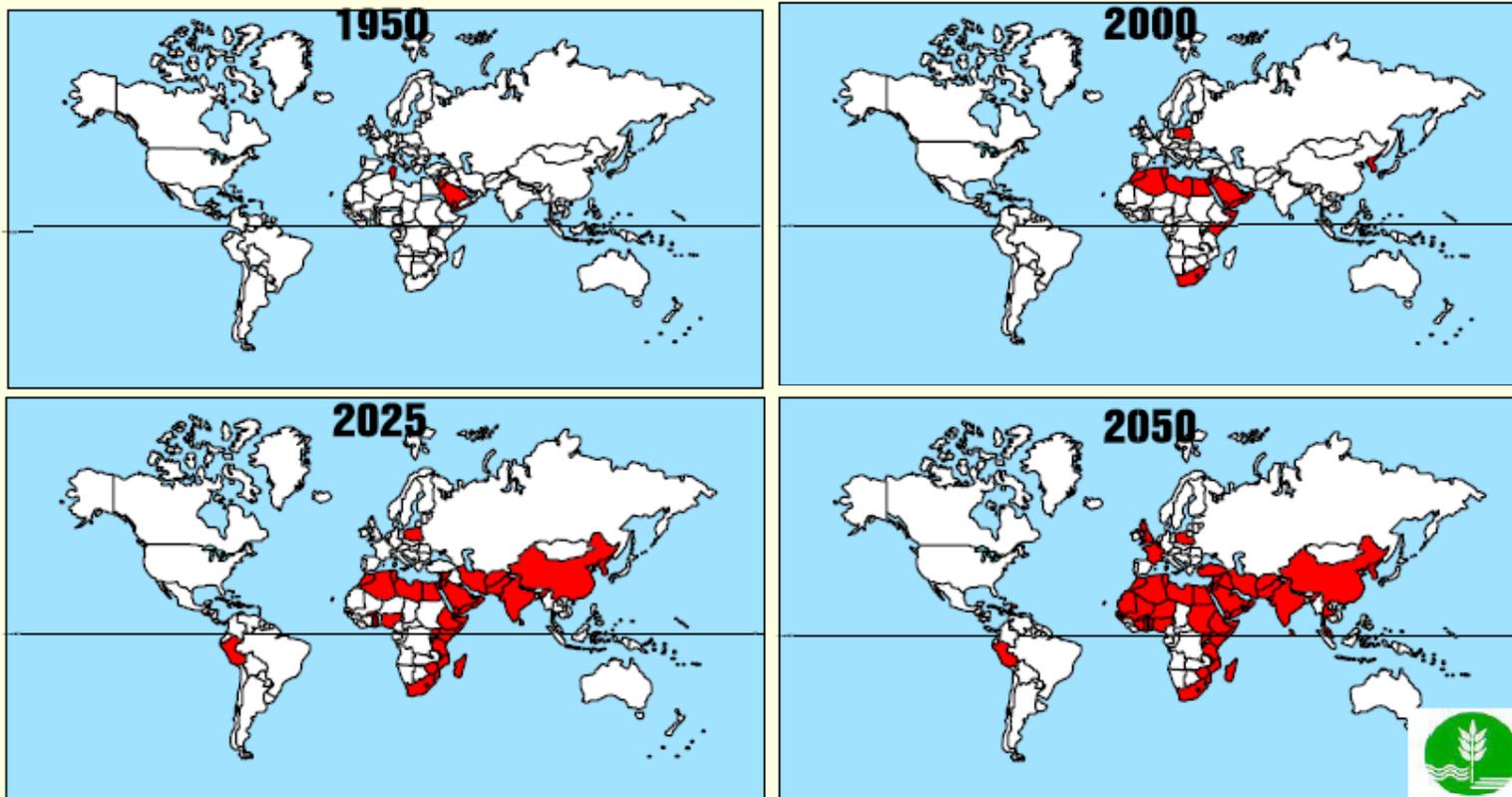
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...and using increasingly scarce resources more efficiently...

Water Scarcity Pressure

Evolution of Water Shortages in 100 Years



ICID-CIF



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...for sure fertiliser use will be key to Green Revolution 2.0

Agriculture Production and Resource Use

	1960	2000	2030-2040
Food production (Mt x10 ⁹)	1.8	3.5	5.5
Population (billions)	3	6	8 (/10)
Irrigated land (% of arable)	10	18	20
Cultivated land (hectares x10 ⁹)	1.3	1.5	1.8
Water-stressed countries	20	28	52
N fertilizer use (Tg/10 ¹² g)	10	88	120
P fertilizer use (Tg/10 ¹² g)	9	40	55-60

Pereira, 2003



So where to from here for Green Revolution 2.0 ?

- There has never been a more important time for the industry to review responsible stewardship of fertiliser inputs...
- ...to support sustainable increases in agricultural production towards future food and nutrition security goals...
- ...whilst minimizing environmental impact...
- ...maximising land, soil and water use efficiency...
- ...protecting bio-diversity...
- ...for the benefit of the health and well-being of all humans current and future



And why should the international fertiliser industry undertake a scientific review of human health impacts of fertiliser use at this time?

- **Informing industry:** to raise awareness of the positive impacts of fertilizer use, communicators must also be able to balance the associated risks with sound science and factual information.
- **Correcting misperceptions** among the critics of the industry – with a credible evidence-based approach.
- **Inviting constructive contributions** toward resolving issues of contention.
- **Who's going to be the target?**
 - Scientists, educators and policymakers involved with fertilizer, agriculture, food-chain, government, civil society organizations, university faculty and students.
 - Create a positive impression of an industry intent on responsible nutrient stewardship and fertiliser Best Management Practices (BMP's).



IFA-IPNI

'Fertiliser Use and Human Health'

Task Force Purpose and Progress

To undertake this review a Task Force was created in early 2008 with the goal to establish within the industry, academia and existing scientific literature:

What we know?

What we guess?

What we don't know?

The first step to identify the positive as well as associated risks, direct and indirect, of fertiliser use upon human health and well-being.

The second step to use the findings to improve fertiliser practices; raise awareness of policy makers; and identify areas for future R&D.



Main Task Force Members / Editors

- Tom Bruulsema, IPNI, Canada;
- Ismail Cakmak, Sabanci University, Turkey;
- Patrick Heffer, IFA, France;
- Kevin Moran, Yara UK, and Convenor of the Task Force;
- Ross Welch, Cornell University, USA.



Relevant Meeting Topics in the Review

- Food sufficiency, 'Food Security' and 'Nutrition Security';
- Micronutrient malnutrition; prevalence and interventions;
- Calcium, magnesium and potassium in food;
- Effects of fertilisers on protein, oil and carbohydrate content;
- Agronomic bio-fortification of food crops with micronutrients;
- Fertiliser affects on nutraceutical content of functional food crops;
- Human health issues associated with different cropping systems;
- Role of selenium and related nutrients in human health;
- Role of plant nutrition in harvest quality and food spoilage.



Relevant Insights

linking



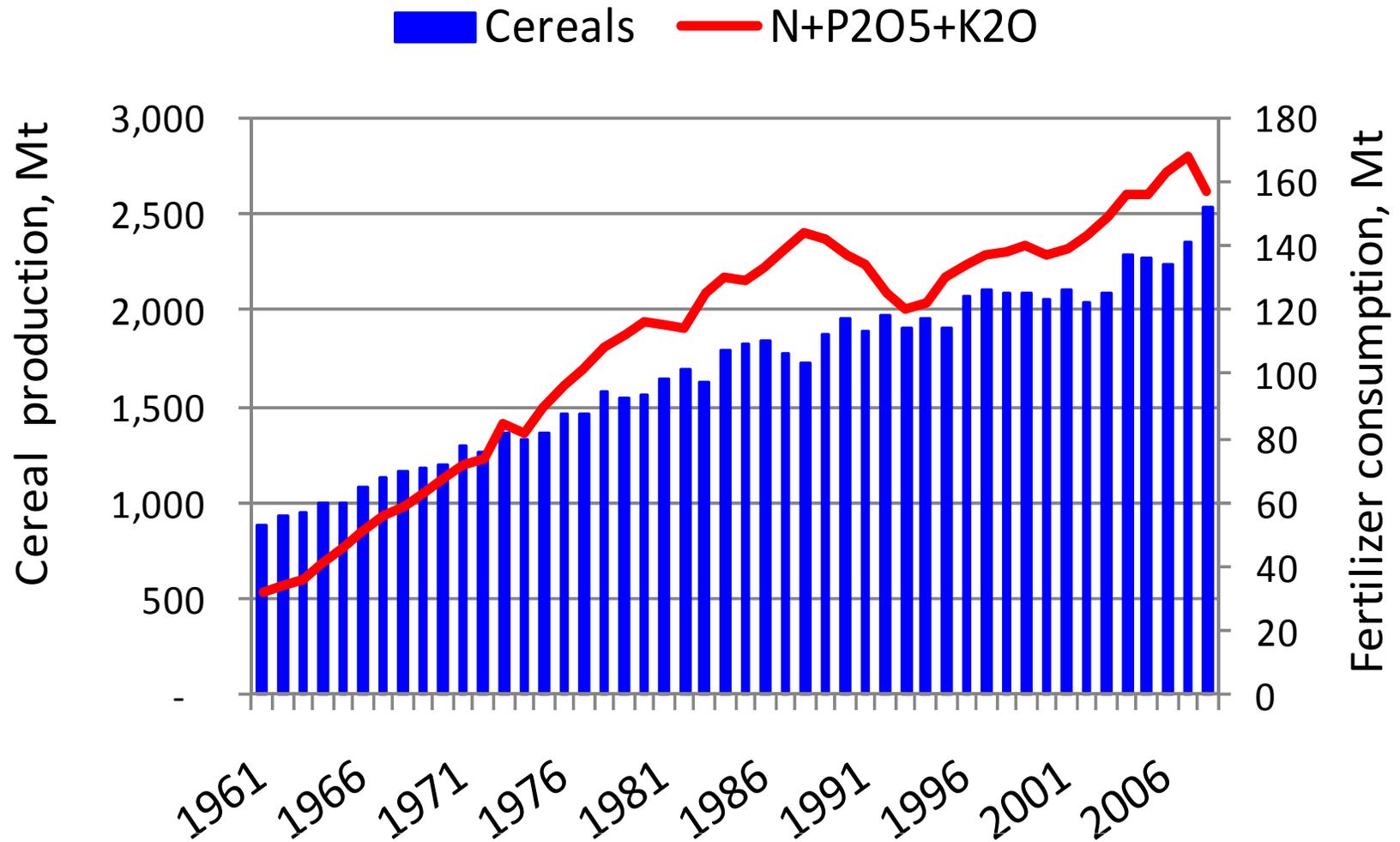
Fertiliser Use and Human Health



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Global cereal production and total fertilizer consumption (FAO 2010b; IFA 2010)



Micronutrient Malnutrition - % Prevalence (Bouis, Boy-Gallego & Meenakshi)

Region	Zn	Fe	I	Vitamin A
North America	8-11	18-29	11	2-16
Latin America	13-37	18-29	11	2-16
Europe	6-16	19-25	52	12-20
Sub-Saharan Africa	13-43	48-66	44	14-44
Southeast Asia	27-39	46-66	30	17-50
South Asia	18-36			
Global	10-32	30-47	32	15-33



Enhancing Nutritional Quality of Food Crops with Trace Elements (Welch and Graham)

Percentage of nutrient-deficient soils among 190 soils in 15 countries, based on a field experiment at each site and soil and test crop analyses (Sillanpaa, 1990)

<i>Nutrient</i>	<i>acute</i>	<i>latent</i>	<i>total</i>
<i>N</i>	71	14	85
<i>P</i>	55	18	73
<i>K</i>	36	19	55
<i>Zn</i>	25	24	49
<i>B</i>	10	21	31
<i>Mo</i>	3	12	15
<i>Cu</i>	4	10	14
<i>Mn</i>	1	9	10
<i>Fe</i>	0	3	3

“This review concludes that it is imperative ... that fertiliser technology be used to improve the nutritional quality of staple food crops that feed the world’s malnourished poor.”



Agronomic biofortification of food crops with micronutrients (Shivay et al, 2008)

Zinc level:	Rice		Wheat	
	Yield, t/ha	Grain Zn, ppm	Yield, t/ha	Grain Zn, ppm
Urea	4.0	30	3.7	40
Urea+1%Zn	4.7	39	4.3	49
% increase	17%	30%	14%	23%

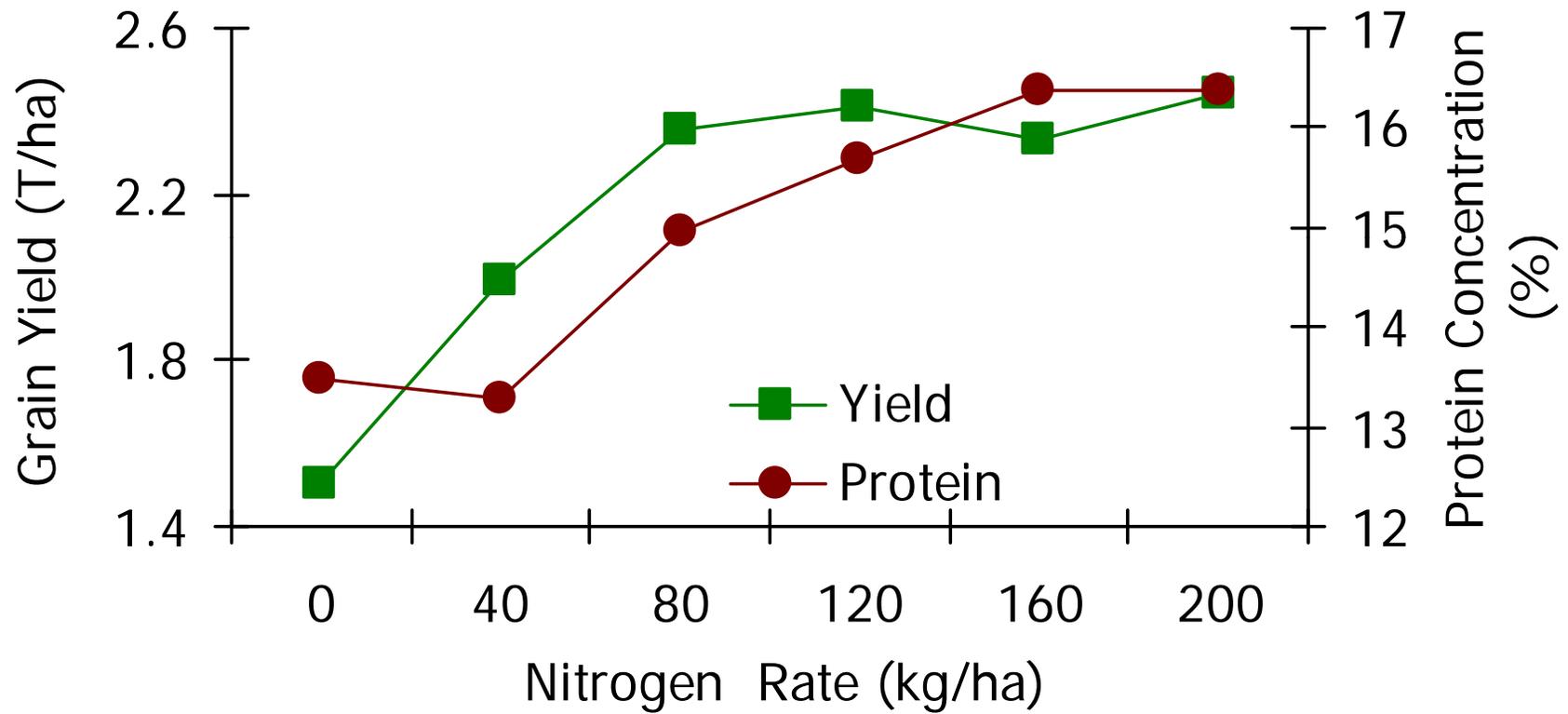


Selenium-Enhanced Foods in Cancer Prevention (Combs)

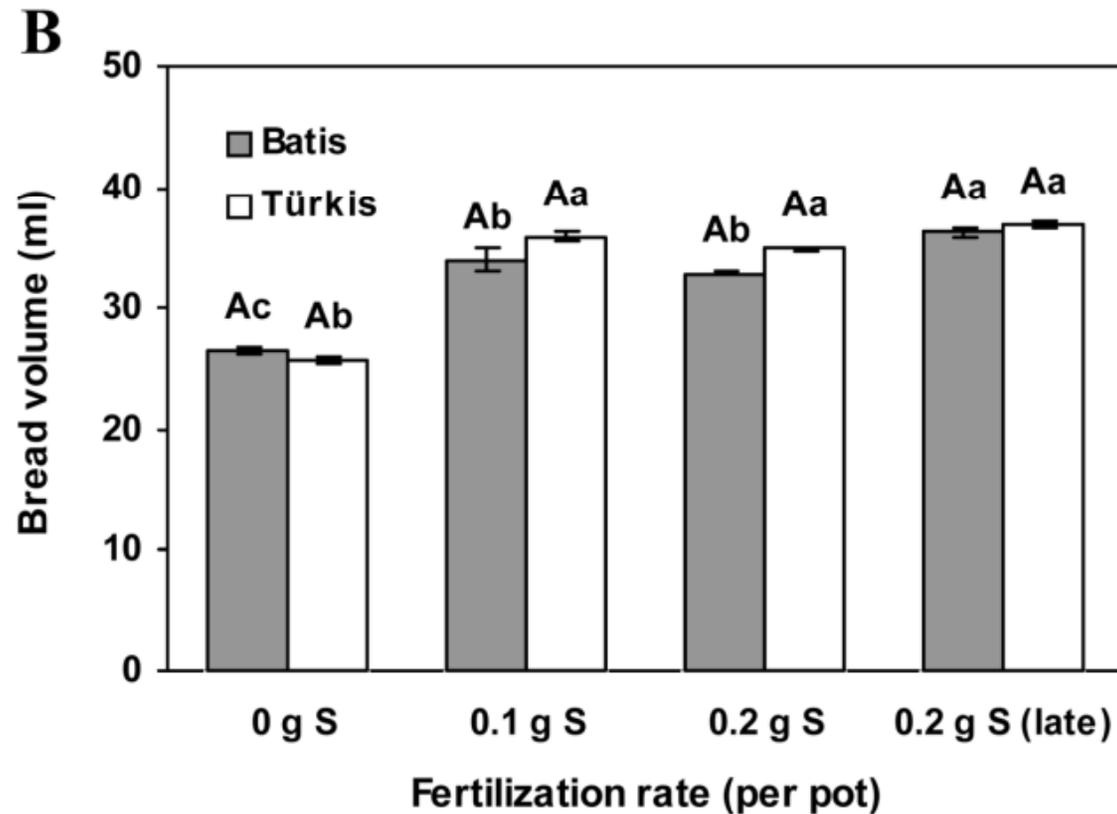
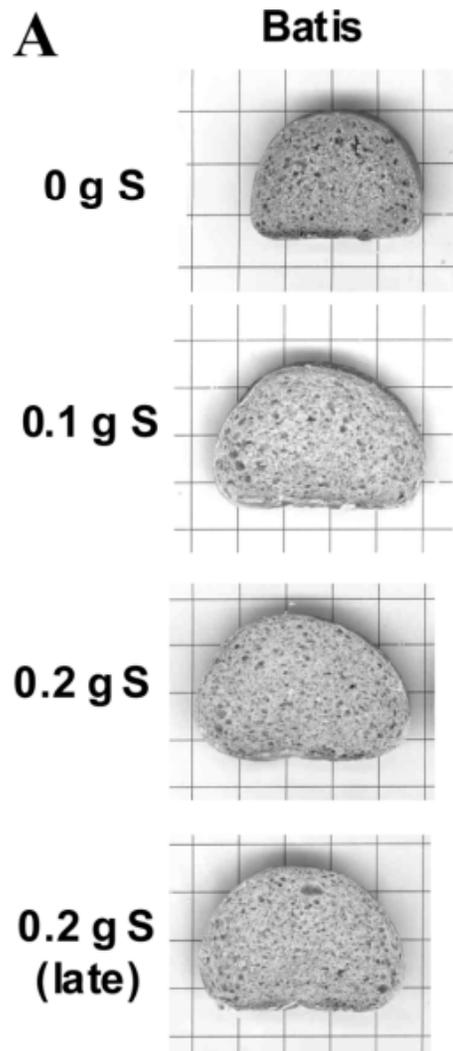
- Selenoproteins – Se essential to the antioxidant enzyme glutathione peroxidase (GPX)
- In 1983, Finnish Ministry of Agriculture and Forestry directed that all agricultural fertilizers contain Se.
- By 1990, the per-capita intake of Se in the Finnish diet more than quadrupled.
- Average serum Se in Finnish adults increased from 70 to nearly 119 ng/ml
- Epidemiological studies have found Se status to be inversely associated with cancer risk. While relatively few clinical trials have been conducted, all but one have shown cancer risk reduction due to increased Se intake.



N applications increase both yield and protein (Grant & Bruulsema)



Sulfur and Wheat Breadmaking Quality (Grant and Bruulsema)



S is an important component of several amino acids which determine protein content and quality in flour



Functional Quality of Fruits and Vegetables (Jifon, Lester, Stewart, Crosby & Leskovar)

- Foliar K with S enhanced sweetness, texture, color, vitamin C, beta-carotene and folic acid contents of musk-melons
- In pink grapefruit, supplemental foliar K resulted in increased lycopene, beta-carotene, and vitamin C concentrations
- Several studies have reported positive correlations between K nutrition and banana fruit quality parameters such as TSS, reducing sugars, non-reducing sugars, total sugars and ascorbic acid, and negative correlations with fruit acidity



Health Risks Associated With Plant Diseases (Huber)

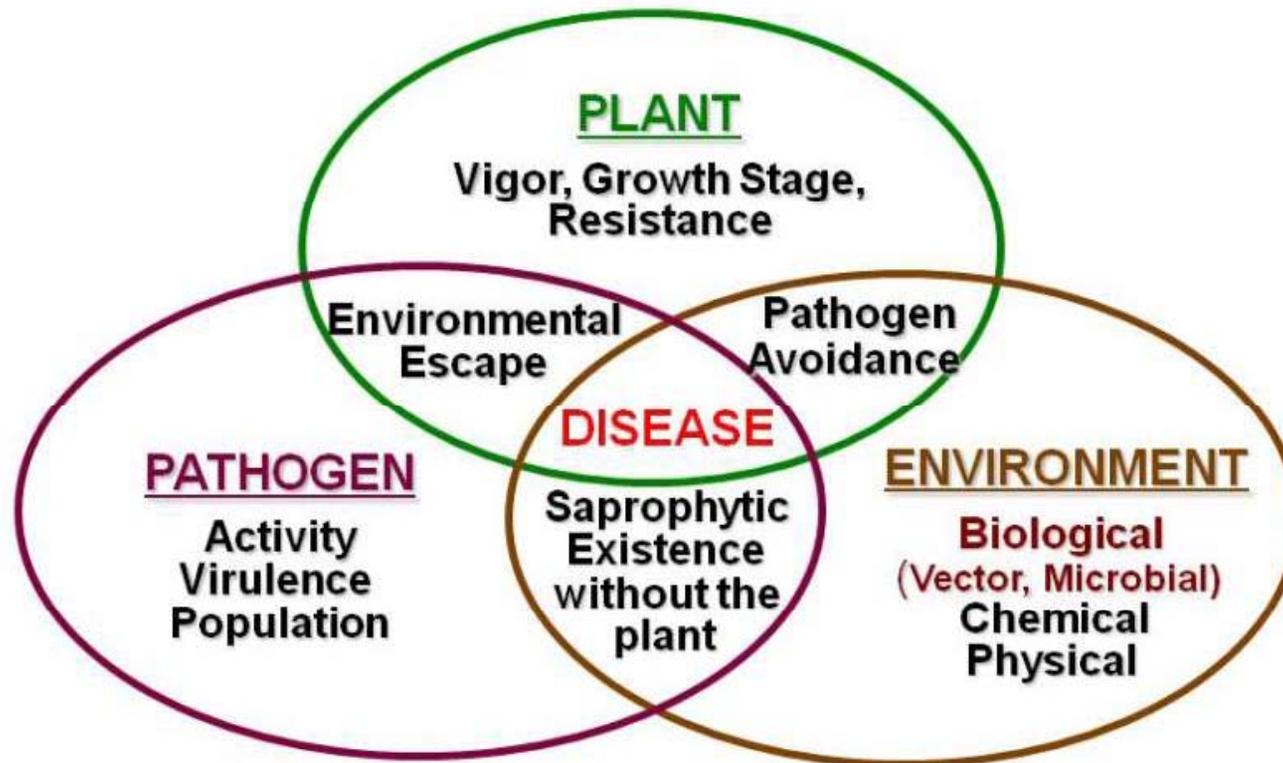


FIGURE 1. INTERACTING COMPONENTS OF PLANT, ENVIRONMENT, AND PATHOGEN AFFECTING DISEASE AND NUTRIENT QUALITY



Conclusion

The New Agricultural Paradigm



The New Agricultural Paradigm: Linking Agriculture to Human Health

What influences consumer choice?



What makes food healthful?

How does the food people eat impact health?



Fertiliser Use and Human Health



(Adapted from Combs, 2005)



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 civilisation is suffering from a subtle form of famine – a famine of quality.” – November, 1947





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Summary

- Fertiliser applications impact the health of humanity in myriad ways, not all of which are fully understood.
- A thorough scientific review of the impacts of fertilizer use on human health will benefit the industry and humanity, helping to find solutions that reduce the risks while enhancing the beneficial.
- The relationship of fertilizer use to human health needs full consideration in sustainability initiatives (e.g. involving Nestle, PepsiCo, IFPRI, etc.).
- Next step: identify priorities for future R&D among the many opportunities and challenges identified.



THANKYOU FOR YOUR ATTENTION TODAY

And with gratitude to:

Patrick Heffer of the IFA Secretariat for his immeasurable contribution in supporting and administering the initiative;

Tom Bruulsema, Ismail Cakmak and Ross Welch for their enthusiasm, commitment and hard work on the editorial team;

Thorleif Enger, past President and CEO of Yara, for his vision and inspiration which has kept me focussed on the concept of 'Farming for Health' since 2004; and to Yara for their ongoing support given willingly to pursue this initiative;

And again to Ismail Cakmak for the now 'iconic' back-ground picture shown here which demonstrates the dramatic impact that the right fertiliser, in right amount, in right place, at right time, can have on crop growth.

