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Functional food for the poor:
the potential impact of "biofortification" on public health in India

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Deutscher Tropentag 2005
Stuttgart-Hohenheim, October 11-13, 2005
Conference on International Agricultural Research for Development

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Introduction

Introduction
2.
3.
4.
5.
6.

What is biofortification?

- Breeding food crops for higher contents of essential micronutrients (e.g. *Fe* & *Zn*)

Why biofortification?

- Iron and zinc deficiencies (ID, ZnD) affect billions of people world-wide

  They affect physical activity & mental development and increase mortality, diarrhoea, pneumonia and stunting
- It is potentially cheaper than alternatives

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1. Quantifying benefits 3. 4. 5. 6.

Quantifying health benefits

- Health improvements result in reduced mortality or in reduced morbidity
- Morbidity can be weighted to be comparable with premature mortality
- The “burden” of a disease is then the
  - years of life lost (YLL) due to mortality
  - years lived with disability (YLD)
- Or: disability-adjusted life years (DALYs)
  - Burden = $DALYs_{lost}$ = YLL + YLD

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Quantifying health benefits

More formally:

$$DALYs_{lost} = \sum_j T_j M_{ij} \left(\frac{1 - e^{-rL_j}}{r} \right) + \sum_i \sum_j T_j I_{ij} D_{ij} \left(\frac{1 - e^{-rd_{ij}}}{r} \right)$$

T = size of target group j
M = mortality rate in target group j
L = remaining life expectancy for target group j
r = discount rate of 3 percent
I = incidence rate of disease i in target group j
D = disability weight of disease i in target group j
d = duration of disease i in target group j

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1.
2.
Current situation
4.
5.
6.

Current situation in India

Annual burden of ID and ZnD in India

	DALYs lost	YLLs lost
Iron deficiency	4.0 m	0.2 m
Zinc deficiency	2.8 m	2.7 m

Available interventions

- Medical supplementation (iron pills)
- Industrial fortification (enriched flour)
- Food-based approaches (education)

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1.
2.
Current situation
4.
5.
6.

Current situation in India

- Biofortification
  - Wide potential coverage
  - Self-targeting if focussed on staples
  - Targeting of rural populations
  - Continuous benefit stream

Zinc-rich wheat	Pessimistic	Optimistic
Current *Zn* content	31 ppm	
Potential increase	20%	120%
Consumption share	30%	50%

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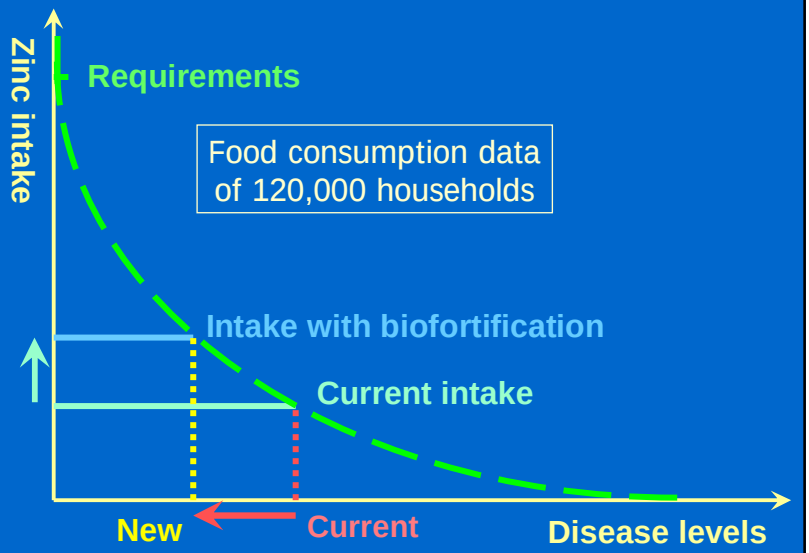
Potential impact of biofortification

1. 2. 3. Potential impact 5. 6.



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Potential impact of biofortification

1. 2. 3. Potential impact 5. 6.

	Scenario	DALYs saved	Decrease of burden
Iron (rice & wheat)	pessimistic	0.8 m	-19%
	optimistic	2.3 m	-58%
Zinc (rice & wheat)	pessimistic	0.6 m	-20%
	optimistic	1.1 m	-38%

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1.
2.
3.
4.
Evaluation
6.

Economic evaluation

- With only limited resources available "effectiveness" is a poor yardstick
- To "compete" with alternatives biofortification has to "pay off"
- Juxtaposing DALYs saved with R&D costs yields "Cost per DALY"
- This cost per healthy life year can be compared with other interventions

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1.
2.
3.
4.
Evaluation
6.

Economic evaluation

- Cost-effectiveness of biofortification

	Iron	Zinc
Rice & wheat	$/DALY	
Pessimistic	5.39	7.34
Optimistic	0.48	1.04

- World Development Report 1993:
  < 150 $/DALY = "highly cost-effective"
- Gillespie (1998):
  4.4-12.8 $/DALY for iron interventions

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2.
3.
4.
5.
Conclusion

Conclusion

- We developed a new DALY framework for ID and ZnD and, as a first, we used detailed household data as basis
- Biofortification can be effective in reducing the burden of ID and ZnD
- Biofortification ranks amongst the “cheapest” micronutrient interventions
- Where hidden hunger is wide-spread, breeding for micronutrient-rich crops is an economically viable intervention

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Thank you

for your attention!

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