Biofortification, an agricultural micronutrient intervention: its potential impact and cost-effectiveness in India

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Introduction

Biofortification is the breeding of staple crops for higher micronutrient content. This approach seems to be promising (Fig. 1 below). But could it be useful for controlling micronutrient deficiencies? And would it be cost-effective?

Fig. 1. Estimated micronutrient content of biofortified crops

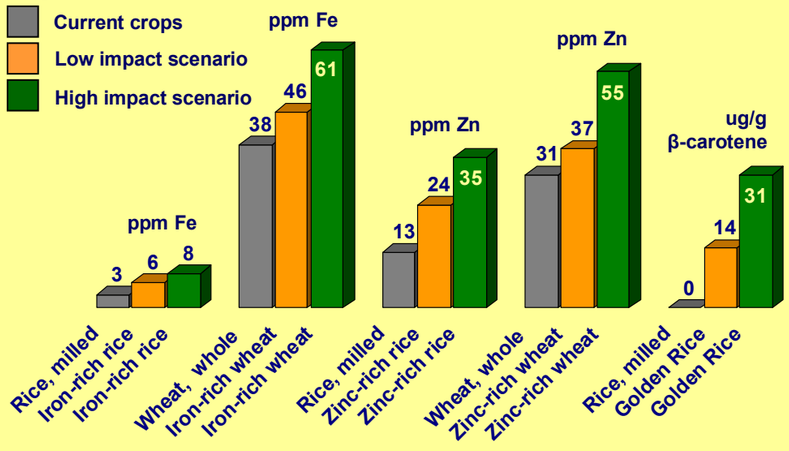


Fig. 2. Scheme of a cumulative distribution function to relate higher iron intakes to lower prevalence rates

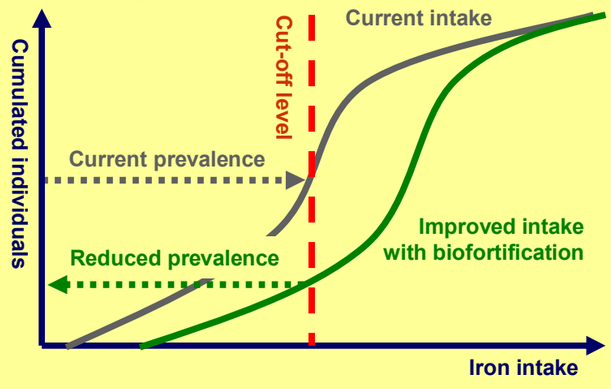
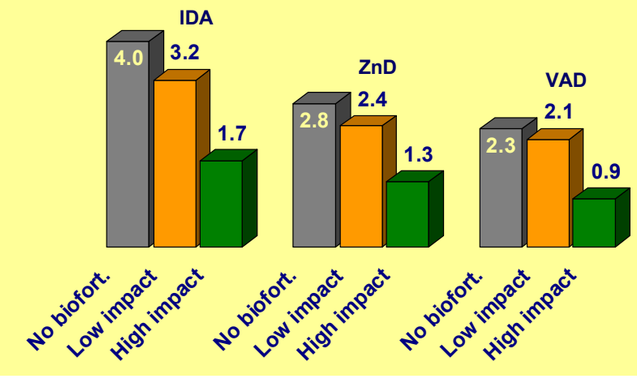


Fig. 5. Burdens of IDA, ZnD & VAD in India (million DALYs lost) and projected reductions through biofortification



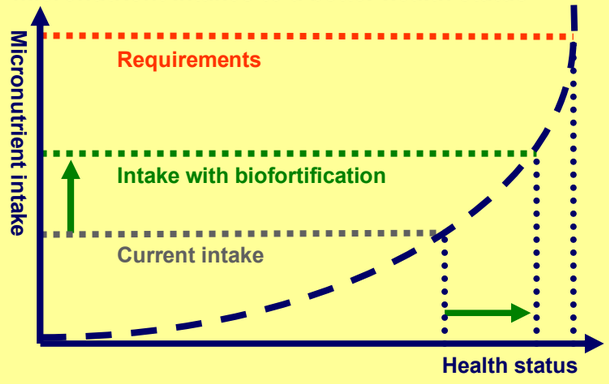
Objectives

To project the impact of biofortification on the burden of micronutrient deficiencies and to estimate its cost-effectiveness.

Methods

- The burden of disease of iron deficiency anaemia (IDA), zinc deficiency (ZnD) & vitamin A deficiency (VAD) in India was computed using a "disability-adjusted life years" (DALYs) framework.
- Individual intakes of Fe, Zn & vitamin A (VA) were computed using the 1999/2000 Indian national household food consumption survey (30-day recall, n=119,554) and adult equivalent weights.
- Simulations were run by replacing part of the current crop consumption with biofortified crops for two scenarios, thus projecting two sets of new individual intakes of Fe, Zn & VA.
- Current and projected intake levels were linked to prevalence (IDA) and incidence (ZnD, VAD) rates of relevant health outcomes, using cumulative distribution (Fig. 2 left) and dose-response functions (Fig. 3 right).
- These calculations were carried out separately for predominantly rice-eating, wheat-eating and mixed-diet regions in India. For the cumulative distribution, new prevalence rates for both moderate and sever IDA were computed.
- The new burden of each deficiency (DALYs lost) was calculated using these epidemiological projections (Fig. 4 bottom).
- Costs for development and dissemination of the biofortified crops are based on expert estimates.
- Cost-effectiveness was calculated as US$/DALY saved and compared with international benchmarks.
- Robustness was tested through sensitivity analyses.

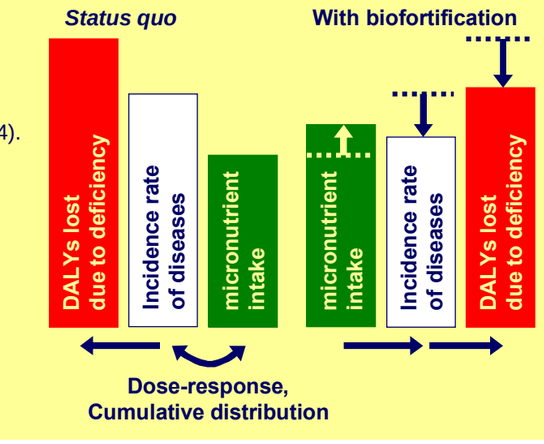
Fig. 3. Scheme of a dose-response to relate higher micronutrient intakes to a better health status



Key results

- Without biofortification, the annual burden of IDA, ZnD & VAD in India is estimated to be 4.0, 2.8 & 2.3 million DALYs lost, respectively (Fig. 5 left).
- Biofortification of rice & wheat may reduce the burden of the major micronutrient deficiencies in India by 10-60%, depending on the assumptions used (Fig. 5).
- Saving one healthy life year (DALY) through Fe biofortification of rice & wheat would cost US$ 0.46-5.39, depending on the scenario. Corresponding values are US$ 0.68-8.80 for Zn biofortification of wheat & rice, and US$ 3.06-19.40 for GR.

Fig. 4. Linking micronutrient intakes with related diseases and the burdens of IDA, ZnD & VAD



Discussion

- The World Bank defines health interventions that cost less than 200 US$/DALY as cost-effective; the WHO uses the national per-capita income as threshold (US$ 620 for India in 2004).
- The cost per DALY saved through any of the biofortified crops is far below either benchmark.
- Biofortification appears to be an economically viable and efficient intervention that may complement the existing mix of strategies to control micronutrient deficiencies.

Logos