



Food System Strategies for Preventing Micronutrient Malnutrition

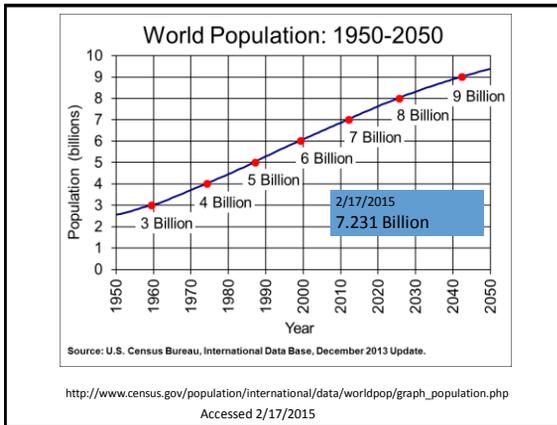
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March 19, 2015



Greatest Challenges of 21st Century

- Providing a sustainable, safe, and nutritious food supply to meet needs of an expanding world population
- Adapting to and slowing climate change


Triple Burden of Malnutrition

- 805 million **undernourished** (not enough calories)
- 2,000 million **micronutrient deficient** (not enough vitamins and minerals)
- 500 million **obese** (too many calories)

Pinstrup-Andersen. *Agricultural Economics*. 2007; Volume 37, Supplement S1, pp. 187-198.

FAO, 2013

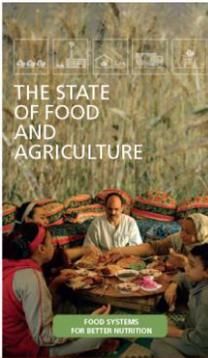


2013

FAO

- Economic and human costs of malnutrition are unconscionably high
- Good nutrition begins with food & agriculture

<http://www.fao.org/docrep/018/i3300e/i3300e.pdf>



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Food system strategies for preventing micronutrient malnutrition

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ABSTRACT

Micronutrients are defined as substances in foods that are essential for human health and are required in small amounts. They include all of the known vitamins and essential trace minerals. Micronutrient malnutrition affects 1/3 of the global population. It causes untold human suffering and leaves huge costs on society in terms of unrealized human potential and lost economic productivity. The goal of this paper is to identify deficiencies in the food system that lead to micronutrient malnutrition and explore and evaluate strategies for its prevention. We examine the impact of agricultural practices on micronutrients in the food supply, including cropping systems, soil fertility and animal agriculture. We then discuss the potential of biofortification – i.e. increasing the concentration of micronutrients in staple food crops through conventional plant breeding or genetic engineering – as a means to reduce micronutrient deficiency. In addition, we discuss the impact of food losses and food waste on micronutrients in the food supply, and we explore successful strategies to preserve micronutrients from farms to plates, including food fortification. Our review of the literature sheds light on the advantages and limitations of alternative interventions to reduce micronutrient deficiencies along the supply chain. We end with recommendations for actions that will reduce the prevalence of micronutrient malnutrition.

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Food System

“All the people, institutions and processes by which agricultural products are produced, processed and brought to consumers.”

FAO, 2013



Strategies for preventing micronutrient malnutrition

Strategy 1

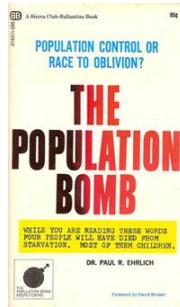
Produce sufficient food (calories) for all



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The Population Bomb

- Published in 1968
- Best seller
- Warned of mass starvation in 1970's and 80's



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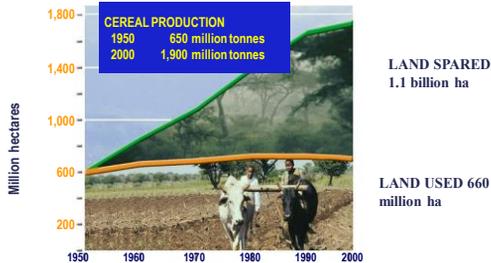
Green Revolution

- Started in the 1950's
- High yielding varieties of wheat, rice, and maize
- Improved farming practices
 - Fertilizer
 - Pesticides
 - Irrigation



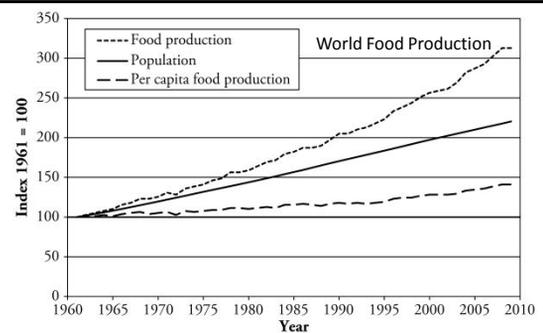
Dr. Norman Borlaug

World Cereal* Production—Areas Saved Through Improved Technology, 1950-2000



* Uses milled rice equivalents
Source: FAO Production Yearbooks and AGROSTAT

Borlaug, 2005



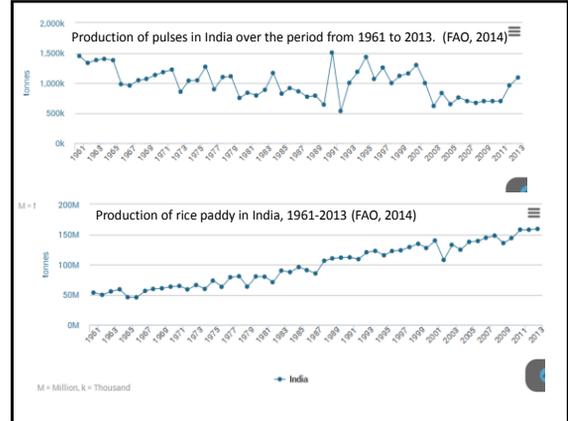
World food production and population, 1960-2010. Lam D. How the world survived the population bomb: lessons from 50 years of extraordinary demographic history. Demography, 2011 Nov;48(4):1231-62.



Green Revolution

Unintended Consequences

- **Reduced cropping diversity**
 - Cereals displaced pulses and other nutrient dense crops
- **Reduced availability of micronutrients**



Nutrient Concentrations in Rice and Lentils (per 100 g)

	Brown Rice	Polished Rice	Lentils
Protein (g)	7.5	6.5	24.6
Iron (mg)	1.8	0.08	6.61
Zinc (mg)	2.0	1.1	3.3
Thiamin (mg)	0.41	0.07	0.87
Folate (µg)	20	6	479
Vitamin B-12	0	0	0

Source: USDA Nutrient Database. <http://ndb.nal.usda.gov/>



Strategies for preventing micronutrient malnutrition

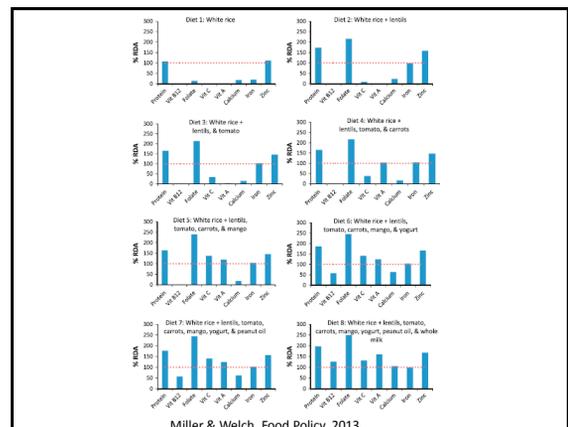
Strategy 2

Diversify Diets



MyPlate

- Designed to help consumers make better food choices
- Emphasizes variety



Folic Acid Fortification in U.S. began in 1996

- Prevalence of low serum folate decreased from 21% to < 1%
- Prevalence of NTDs decreased by 36%



Neural Tube Defect (NTD)

CDC. 2010. <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5931a2.htm>



Fortified foods are major contributors to nutrient intakes in diets of US children and adolescents

ILSI North America Fortification Committee
Discussion Meeting, January 22, 2013

Louise Berner, PhD
California Polytechnic State University
San Luis Obispo

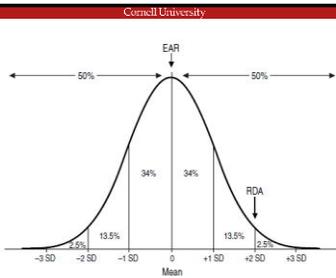
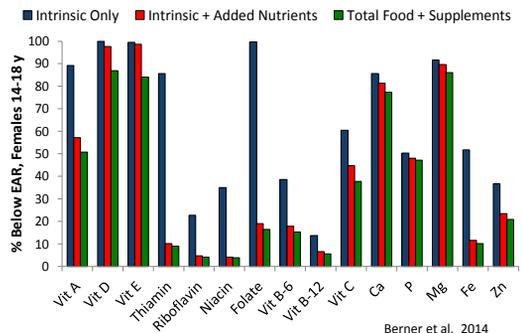


FIGURE 2. Normal requirement distribution of hypothetical nutrient showing percentile rank and placement of EAR and RDA on the distribution.

J.J. Otten, J.P. Hellwig, L.D. Meyers (Eds.), Dietary Reference Intakes. The Essential Guide to Nutrient Requirements, National Academies Press, Washington, DC (2006)

Impact of Added Nutrients and Supplements in Females 14-18



Berner et al. 2014



Example

Global Universal Salt Iodization Program



Iodine Deficiency

- Consequences
 - Goiter
 - Cretinism
 - Impaired mental and physical development
 - Poor pregnancy outcomes
 - Increased infant mortality



In iodine deficiency, the thyroid gland enlarges—a condition known as simple goiter.



Iodine Deficiency

- 1990: UN World Summit for Children set goal to eliminate iodine deficiency
- Universal Salt Iodization Programs (USI) established in many countries
- Household access to iodized salt
 - 1990: < 10%
 - 2013: > 90%

Elizabeth N. Pearce, Maria Andersson, and Michael B. Zimmermann. *Thyroid*. May 2013, 23(5): 523-528.



Benefits and Limitations of Food Fortification



Benefits of Fortification

- Fortified foods deliver a consistent, regular amount of nutrients
- Fortified foods can deliver multiple nutrients
- Fortified foods can be tailored to meet the needs of populations

Allen L et al. *Guidelines for food fortification with micronutrients*. WHO/FAO, 2006



Benefits of Fortification

- Fortified foods have potential to reach everyone in a population, rich and poor alike

Allen L et al. *Guidelines for food fortification with micronutrients*. WHO/FAO, 2006



Benefits of Fortification

- Does not require changes in existing food patterns
- Does not require compliance by individuals

Allen L et al. *Guidelines for food fortification with micronutrients*. WHO/FAO, 2006



Benefits of Fortification

- Often more cost effective than other strategies for reaching large numbers of people

Allen L et al. *Guidelines for food fortification with micronutrients*. WHO/FAO, 2006



Limitations of Fortification

- The fortified food may not be consumed by everyone
- Fortified foods will be consumed by many who do not need the extra nutrients

Allen L et al. Guidelines for food fortification with micronutrients. WHO/FAO, 2006



Limitations of Fortification

- Potential harm to non-target people
 - Folic acid may mask symptoms of B-12 deficiency in elderly
 - Excess folic acid may promote growth of pre-neoplastic lesions



Limitations of Fortification

- Fortified food may not reach the people who need them the most
 - Poorest of the poor
 - People consuming “own grown” food

Allen L et al. Guidelines for food fortification with micronutrients. WHO/FAO, 2006



Limitations of Fortification

- Cost
 - Nutrients are inexpensive by our standards but not by everyone's
 - Requires specialized processing equipment and trained workers
 - Requires government surveillance system
 - May require educational programs

Allen L et al. Guidelines for food fortification with micronutrients. WHO/FAO, 2006



Strategies for preventing micronutrient malnutrition

Strategy 4

Biofortify foods



Biofortification

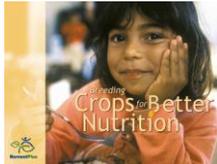
- Increasing the concentration and/or bioavailability of nutrients in foods through genetic selection or manipulation
 - Conventional plant breeding
 - Genetic engineering (e.g. golden rice)

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HarvestPlus

- Global alliance of institutions and scientists
- Coordinated by
 - International Center for Tropical Agriculture (CIAT)
 - International Food Policy Research Institute (IFPRI)
- Directed by Howarth Bouis



<http://www.harvestplus.org/about.html>

Cornell University



HarvestPlus

- “HarvestPlus seeks to reduce micronutrient malnutrition among the poor by breeding staple food crops that are rich in micronutrients through a process called biofortification.”

<http://www.harvestplus.org/about.html>

Cornell University



HarvestPlus

- Target Nutrients
 - Vitamin A
 - Iron
 - Zinc
- Target Crops
 - Beans
 - Cassava
 - Maize
 - Pearl Millet
 - Rice
 - Sweet Potato
 - Wheat

<http://www.harvestplus.org/about.html>

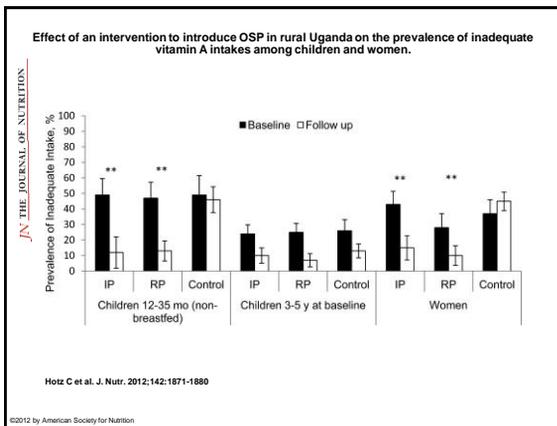
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Advantages of a Biofortification Strategy

- One time cost to develop biofortified seeds
- Biofortified foods can reach the poor in remote areas

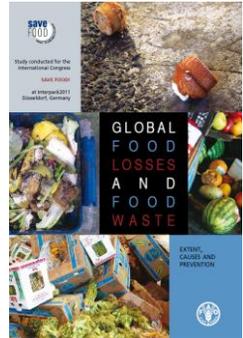
<http://www.harvestplus.org/about.html>



Strategies for preventing micronutrient malnutrition

Strategy 5

Reduce food losses and food waste





Food Losses and Waste

- Between 30 and 50% of food produced is wasted
- Developing countries:
 - Most food is lost before it reaches the consumer
 - Insects/rodents
 - Spoilage (bacteria, enzymes)
 - Limited access to markets
- Developed Countries:
 - Most food waste is post-consumer
 - Past sell-by date
 - Blemishes
 - People purchase more than they need
 - Serving sizes are too large



Strategies for reducing food waste

- Developing countries
 - Develop infrastructure (e.g. roads, railroads, cold chains)
 - Introduce food processing technologies (drying, canning, freezing)
 - Develop markets for raw and processed foods
- Developed countries
 - Reduce serving sizes
 - Educate consumers on proper storage and handling of foods
 - Reevaluate “best if used by” labeling



Key Message

Expand commercial fortification programs



Key Message

Develop and implement technologies to biofortify foods



Key Message

Reduce food losses and food waste



Key Message

Build human capacity in agriculture, food processing, and nutrition



Key Message

Adopt a holistic systems approach to the problem



“It is no longer acceptable to delay the use of any strategy that is safe and will help us achieve the ability to feed the world’s people.”

Raven, Transgenic Research, 2013



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- Per Pinstrup-Andersen

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Thank you!

