

# Food Fortification as a Strategy for Prevention and Control of Micronutrient Deficiencies

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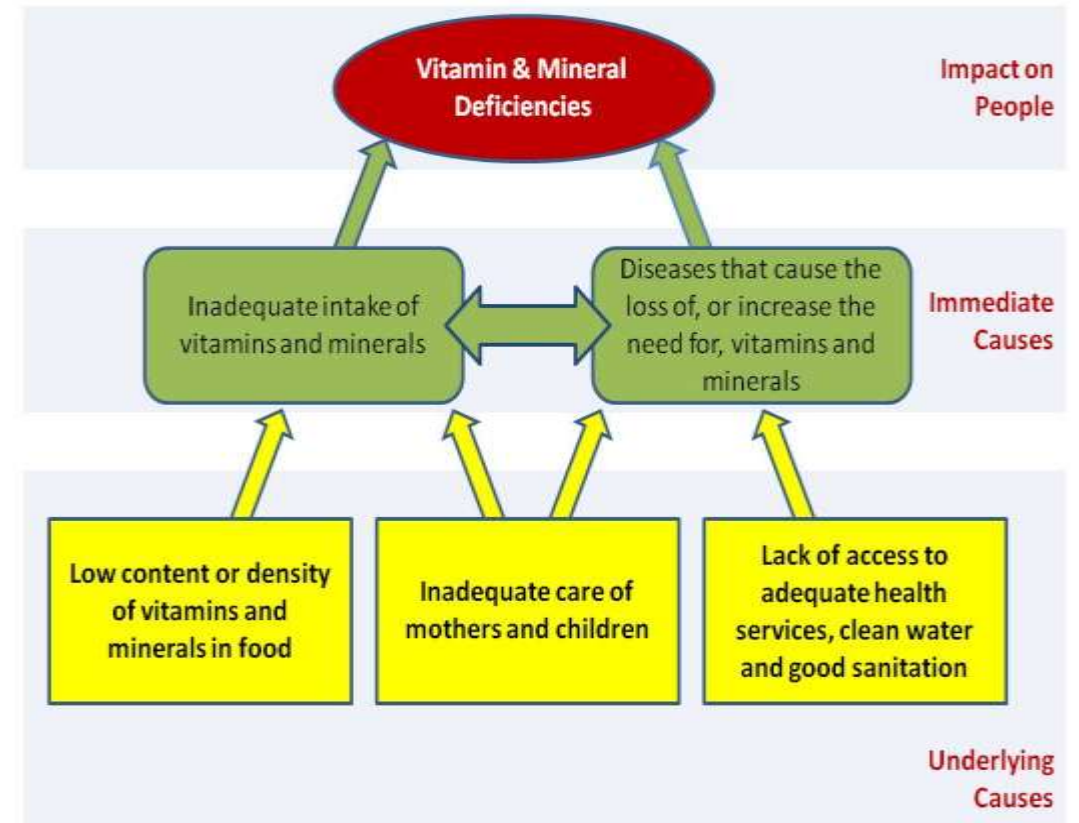
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# The Role of Micronutrients in the Human Body

- ▶ Vitamins and minerals cannot be synthesized by the human body. They must be provided by the diet.
- ▶ The amounts needed are small - micrograms or milligrams a day - so they are called "micro" nutrients.
- ▶ They are necessary for the regulatory systems in the body, for efficient energy metabolism and for other functions such as cognition, immune system and reproduction.
- ▶ During rapid growth, micronutrient intake must increase or else growth failure or deficiency diseases develop.
- ▶ Preschool-aged children, adolescents and reproductive age women are high priority groups

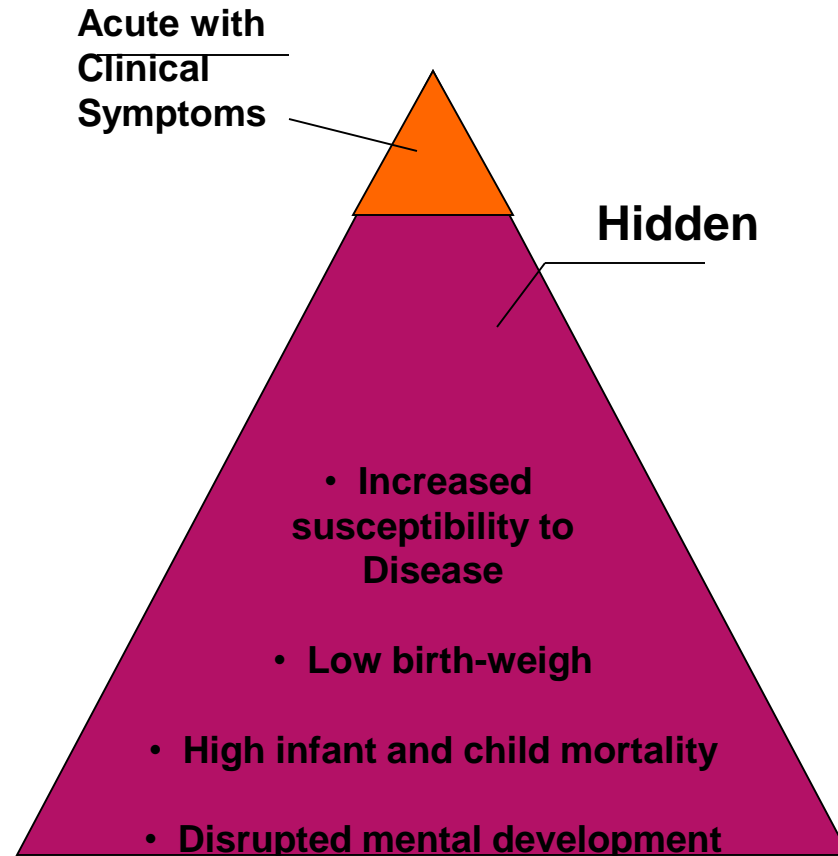
# Causes of micronutrients deficiencies

- ▶ Poor diet
- ▶ Illness
- ▶ Lack of provision of nutrition and child-care education, particularly to women to:
  - ▶ ensure exclusive breastfeeding for the first six months of life
  - ▶ provide nutrient-rich foods for both boys and girls once complementary feeding begins
  - ▶ ensure timely visits to health service providers for micronutrient supplementation and immunization.



# The Severe Impact of Vitamin and Mineral Deficiencies

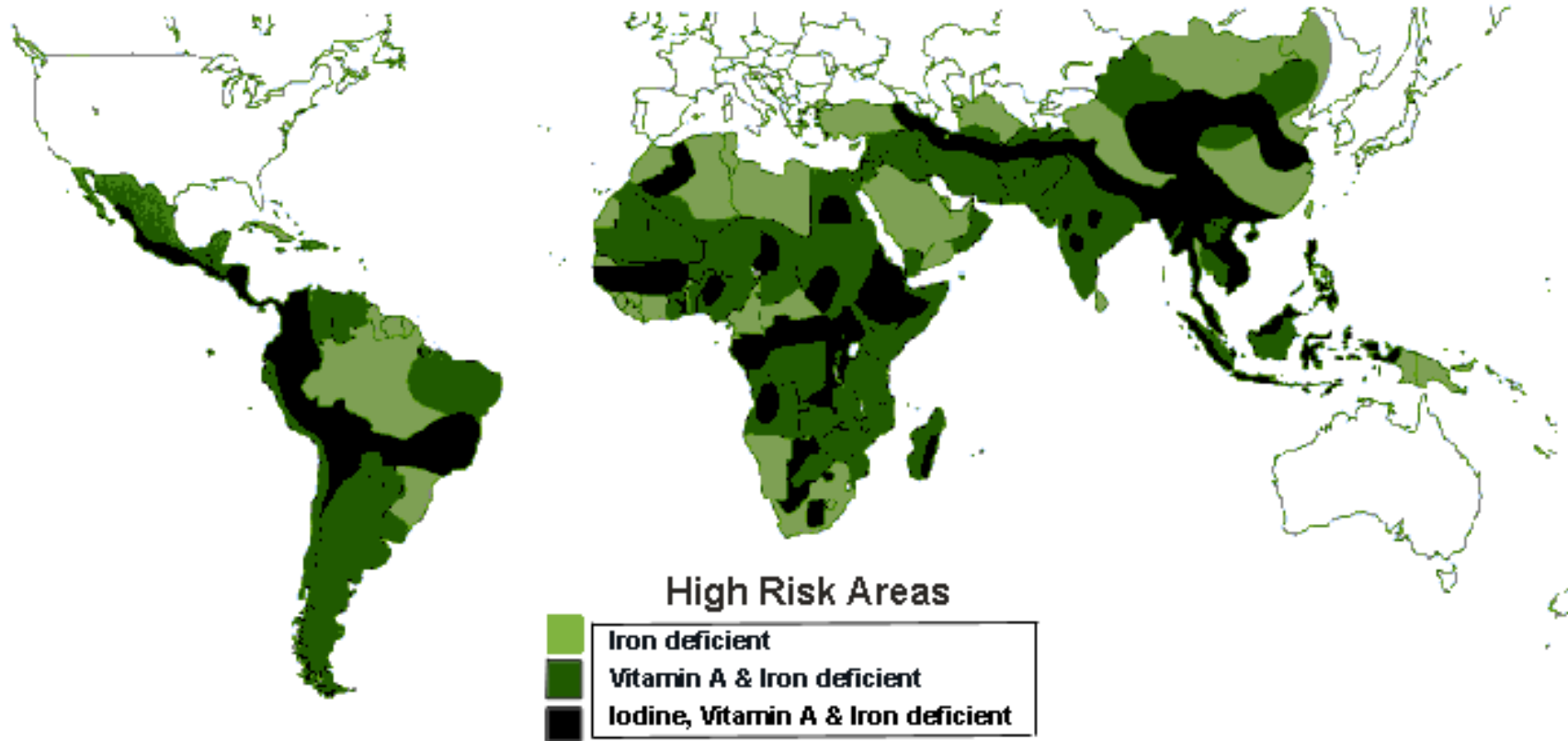
- ▶ Vitamin and mineral deficiencies have a profound impact on morbidity, mortality, education, economic growth, and gender equity in terms of
  - ▶ Compromised immune systems that make ordinary childhood diseases like diarrhea and measles fatal
  - ▶ High rates of maternal and child deaths
  - ▶ Reduced cognitive ability rendering investment in education less effective
  - ▶ Reduced adult labor capacity and productivity



# Priority for Global Action

- Thirty Percent of the World's population is affected by Vitamin A, iron or iodine deficiencies. Several million people also suffer deficiencies in other micronutrients such as folic acid, zinc, calcium, B, C and D Vitamins
- Clinical Manifestations
  - 735 Million
  - Human impact : suffering & mortality
  - Economic impact: burden of disease
- Sub-Clinical
  - 2 Billion
  - Human impact : performance deficits
  - Economic impact: productivity deficits

# Global Prevalence of Iron, Vitamin A and Iodine Deficiencies



Source: USAID

# The Looming Crisis

- ▶ By 2020, prices for basic foods such as wheat, maize, and oil will be, respectively, 40%, 60%, and 80% higher than the average prices in 1998–2007 (FAO)
- ▶ Reductions in household purchasing power, even greater than those recently faced, are expected in the future.
- ▶ Families in crises and households with reduced purchasing power substitute expensive nutritious foods with cheaper, less nutritious, but “stomach-filling” foods.
- ▶ Practiced over a longer period of time, this will ultimately lead to malnutrition, in particular micronutrient deficiencies

# Key Global Development Priorities: The Copenhagen Consensus 2012

- ▶ Objective: To identify smartest ways to allocate \$75 Billion to respond to ten of world's biggest challenges
- ▶ 65 researchers
- ▶ Panel of 8 economists
- ▶ Four Nobel laureates
- ▶ 40 Development Challenges
- ▶ Top 16 solutions

1. Bundled micronutrient interventions
2. Malaria Combination Treatment
3. Expanded Childhood Immunization Coverage
4. Deworming of Schoolchildren,
5. Tuberculosis Treatment
6. R&D to Increase Yield Enhancements,
7. Early Warning Systems against natural disaster
8. Strengthening Surgical Capacity
9. Hepatitis B Immunization
10. Low-Cost Drugs for Acute Heart Attacks
11. Salt Reduction Campaign
12. Solar radiation management
13. Conditional Cash Transfers - School Attendance
14. HIV Vaccine R&D
15. Information Campaigns for schooling
16. Borehole and Public Hand Pumps



# Food Fortification As Part of a Broader Development Strategy

- ▶ Part of an overall health and nutrition strategy that includes food-based strategies, supplementation and public health measures leading to overall human development
- ▶ Part of an overall food-based strategy that includes:
  - ▶ Improved agricultural practices such as plant breeding to improve micronutrient density of crops and expanded production of micronutrient rich foods
  - ▶ Improved food processing and storage
  - ▶ Consumer education
- ▶ Within country-specific cultural, political and market situation

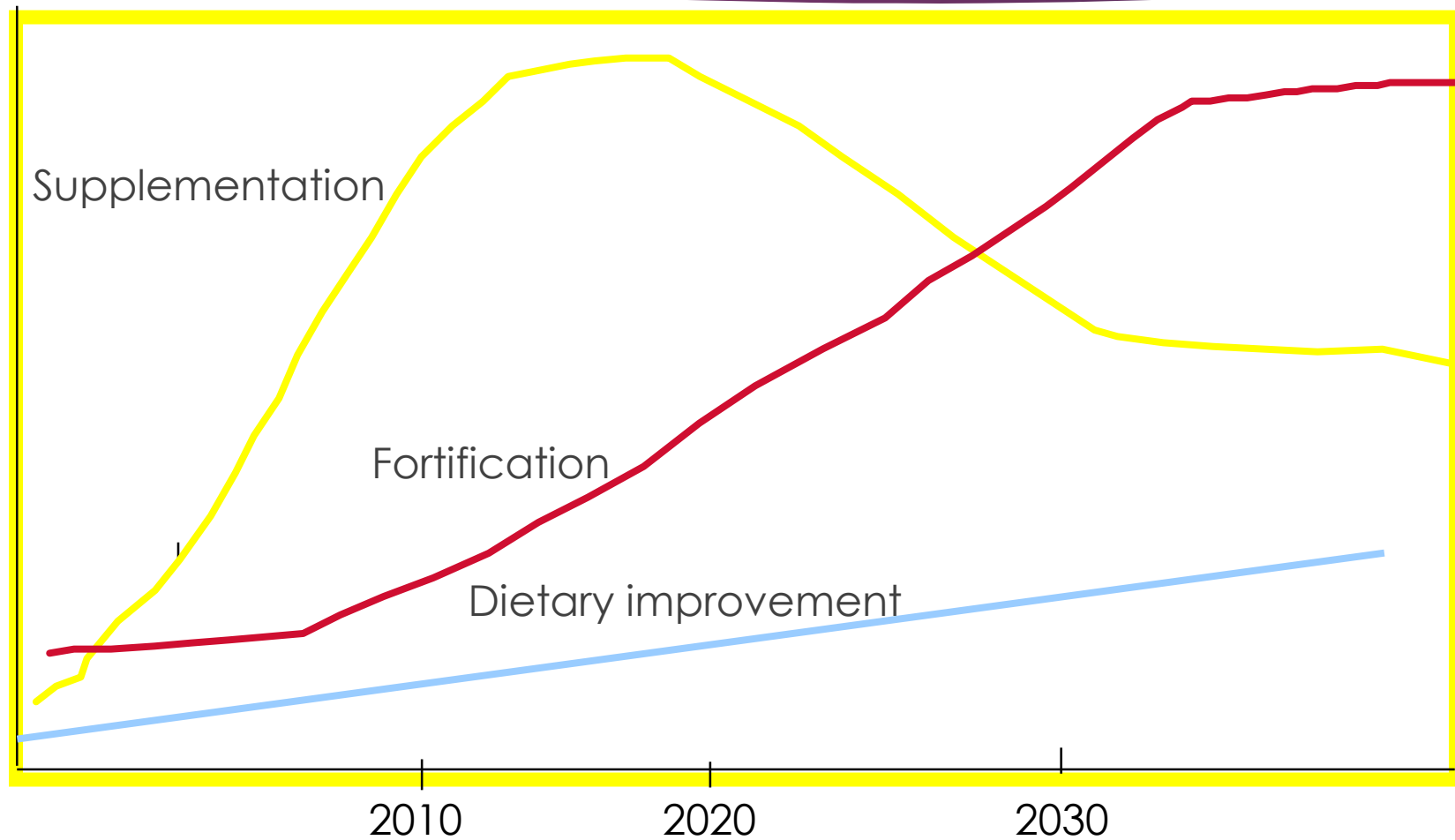
# Strategic Advantages of Food Fortification

- ▶ Consistent Delivery Maximum Benefit
- ▶ Safety in Low Daily Doses
- ▶ Minimal Behavior Change
- ▶ Consumer Cost Affordable
- ▶ Enhances Health & Nutrition Strategies
- ▶ Transfers Costs of Protecting Health to Sectors otherwise not involved

# Implementation Criteria

- ▶ Identifying **commonly eaten foods** that can act as vehicles for micronutrients, processed centrally in large enough units to permit controlled fortification.
- ▶ The food should be **consumed in fairly constant amounts** so that fortification levels can be accurately calculated.
- ▶ Feasibility of providing meaningful levels of the nutrient (usually 30% to 50% of the daily adult requirements) at normal consumption of the food vehicle.
- ▶ Taking into account variations in food consumption so that the **safety** of those at the higher end of the scale and impact for those at the lower end are ensured.
- ▶ **Compatible** within existing food production and distribution systems. Minimal loss of the nutrient during processing, storage and final preparation of the food.
- ▶ **No change in taste, appearance or colour** of the final product.
- ▶ **Cost, bio-availability**, sensory acceptability and storage stability
- ▶ The food should be affordable so that the low-income groups, which are more vulnerable to malnutrition, consume it.

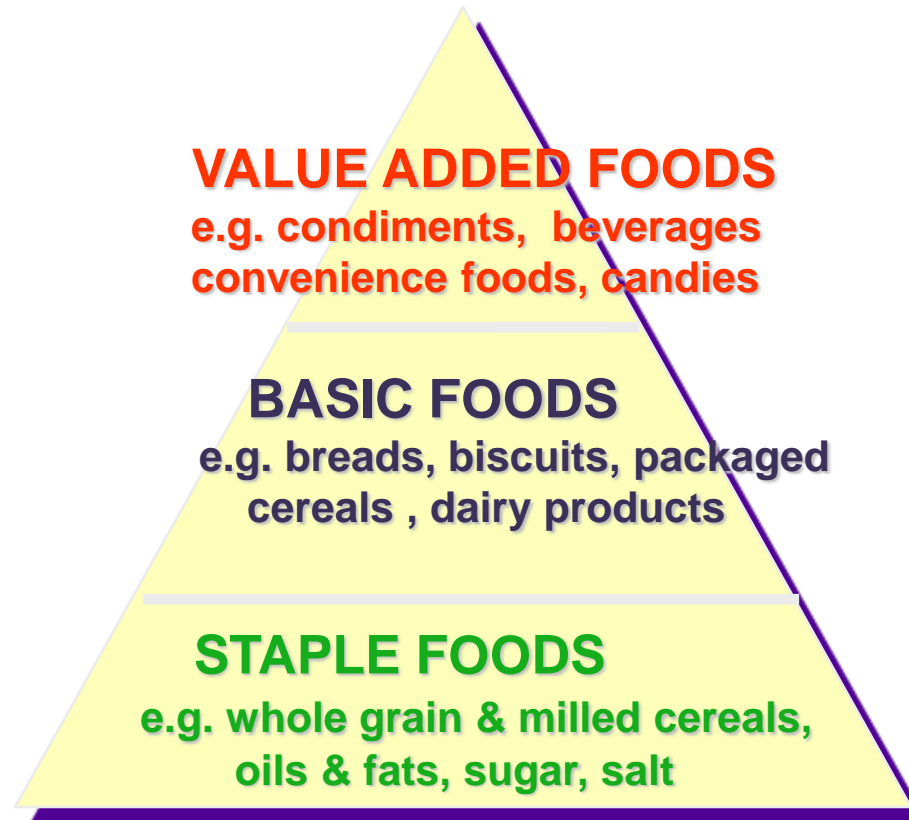
# Complementary Micronutrient Interventions



# Examples of Food Fortification

Food Vehicle	Nutrients
Salt	Iodine (and iron)
Wheat and maize flours	Iron, folic acid, vitamin A and B vitamins
Rice	Iron, vitamin A and B vitamins
Cooking oils and fats	Vitamins A and D
Sugar	Vitamin A
Condiments (sauces)	Iron
Milk	Vitamins A and D; iron
Complementary foods	Multiple vitamins and minerals

# Choice of Food Vehicles



# Common Food Fortification Processes

Process	Application	Mechanism
Dry mixing	Cereal flours, powder milk, powder beverages	Common mechanism for addition of nutrient premixes to foods
Dissolution in water	Liquid milk, drinks, fruit juices and in water used for making bread, pasta and cookies.	
Dissolution in oil	lipid-soluble vitamins for enrichment of oily products like margarine.	
Spraying	Iodized Salt, corn flakes	Where the nutrients do not withstand the cooking or extrusion step.
Adhesion	Vitamin Fortified Sugar	Vitamin A powder is adhered to the surface of the sugar crystal by vegetable oil
Coating	Rice	Vitamins sprayed over the grain as a coating.
Extrusion and dry mixing	Simulated rice shaped premix of micronutrients	Extruded premix dry mixed with regular rice.
Encapsulation	Salt double fortified with iron and iodine	Iron encapsulation to prevent interaction with iodine and the food matrix
Micronization	Salt fortified with iron	Iron compound particle size reduced to increase its bio-availability

# Mandatory vs. Voluntary Fortification

- ▶ **Mandatory fortification:** Stipulated by a country's law that certain foods should be fortified with specified nutrients and levels. Mass fortification, is usually mandatory, though not always. Examples are flour fortification and salt iodization
- ▶ **Voluntary fortification** permits the addition of micronutrients by the food processors for certain foods following specified standards set by the government. Examples are the fortification of breakfast cereals and the addition of Calcium to orange juice in industrialized countries and oil fortification or soy/fish sauce in some developing countries.
- ▶ **Targeted fortification:** When fortification is aimed at specific subgroups of the population, thereby increasing the intake of that particular group rather than that of the population as a whole. Targeted fortification could be mandatory or voluntary. Examples include complementary foods for young children or food rations for displaced populations



# Economics

- ▶ The start-up cost for food fortification is relatively inexpensive for the food industry, and recurrent costs are rapidly passed on to the consumer.
- ▶ The benefits of fortification can extend over the entire life cycle of humans. It can thus be one of the most cost-effective means of overcoming micronutrient malnutrition.
- ▶ The cost of premix is the single greatest expense in fortification programs, accounting for up to 70% to 90% of recurring fortification costs.
- ▶ In higher-income industrialized countries, such costs are generally absorbed into the consumer price of the fortified food.
- ▶ In lower-income countries, processors operate on thin profit margins in risky business environments, and poor consumers are highly price sensitive and cannot necessarily absorb the additional costs of premix. In many instances premix costs can be a serious deterrent to private sector involvement and compliance in fortification programs.

# Partnerships for Effective and Sustainable Food Fortification

## ▶ **Division of Labour**

- ▶ The public sector (Mandate and responsibility to improve the health of population),
- ▶ The private sector (Experience and expertise in food production and marketing) and
- ▶ The social/civic sector (Grass-roots contact with the consumer)

## ▶ **Differing Perceptions/Same Goal**

- ▶ Public sector: considers food fortification one of the cost-effective solutions to the challenge of nutritional deficiency among large segments of world's population.
- ▶ Private sector: needs a business case for food fortification either because it is required by the law or because it can be positioned as value added product

## ▶ **One Partnership is essential**

- ▶ To harmonize issues relating to technology development, food processing and marketing, free-market approaches, standards, quality assurance, product certification, social communications and demand creation, monitoring and evaluation.

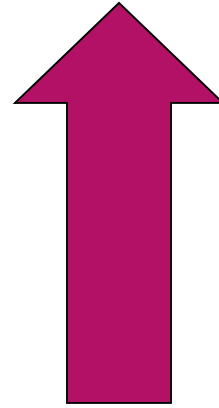
# Food Fortification Impacts: Industrialized World

- ▶ Food fortification has played a major role in the health of the populations in several developed and developing countries over the last 70 years and many nutritional deficiencies have been eliminated.
- ▶ Multiple studies have demonstrated the effectiveness of food fortification in eliminating micronutrient deficiencies. Almost 1/4 of iron intakes in the US diet come from fortified sources, much of that from flour products.
- ▶ In Canada, flour fortification with B vitamins began in Newfoundland in 1944. Within four years, deficiencies that were earlier found in nearly 20% of the population had dropped to negligible levels.
- ▶ After 1998, following the introduction of mandatory folic acid fortification of cereal-grain products in the USA, Canada and Chile, there has been a 30 to 70% reduction of neural tube defects in newborns.
- ▶ In Europe, fortified foods, especially voluntarily fortified breakfast cereals in France, Ireland, the United Kingdom, and Spain have contributed to increasing vitamin and mineral intakes during childhood and adolescence.

The Centers for Disease Control and Prevention reported that neural tube defects has decreased by 19 percent following folic acid fortification in the U.S. food supply.



14.5 ng/ml  
Post-fortification

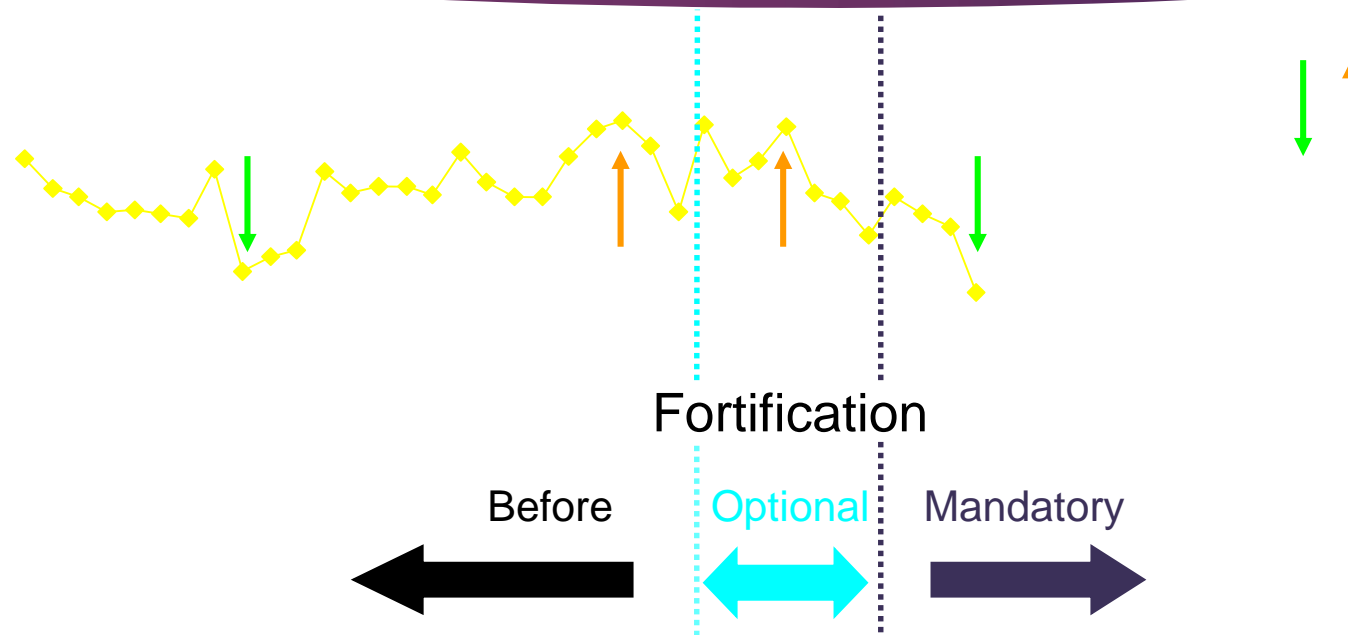


4.8 ng/ml  
Before



*US fortification rapidly increased the serum folate*

# Spina Bifida: Observed birth prevalence, by quarter of birth, and food fortification status, NCHS 1990-1998. Rates per 100,000 births



Year, by Quarter of Birth

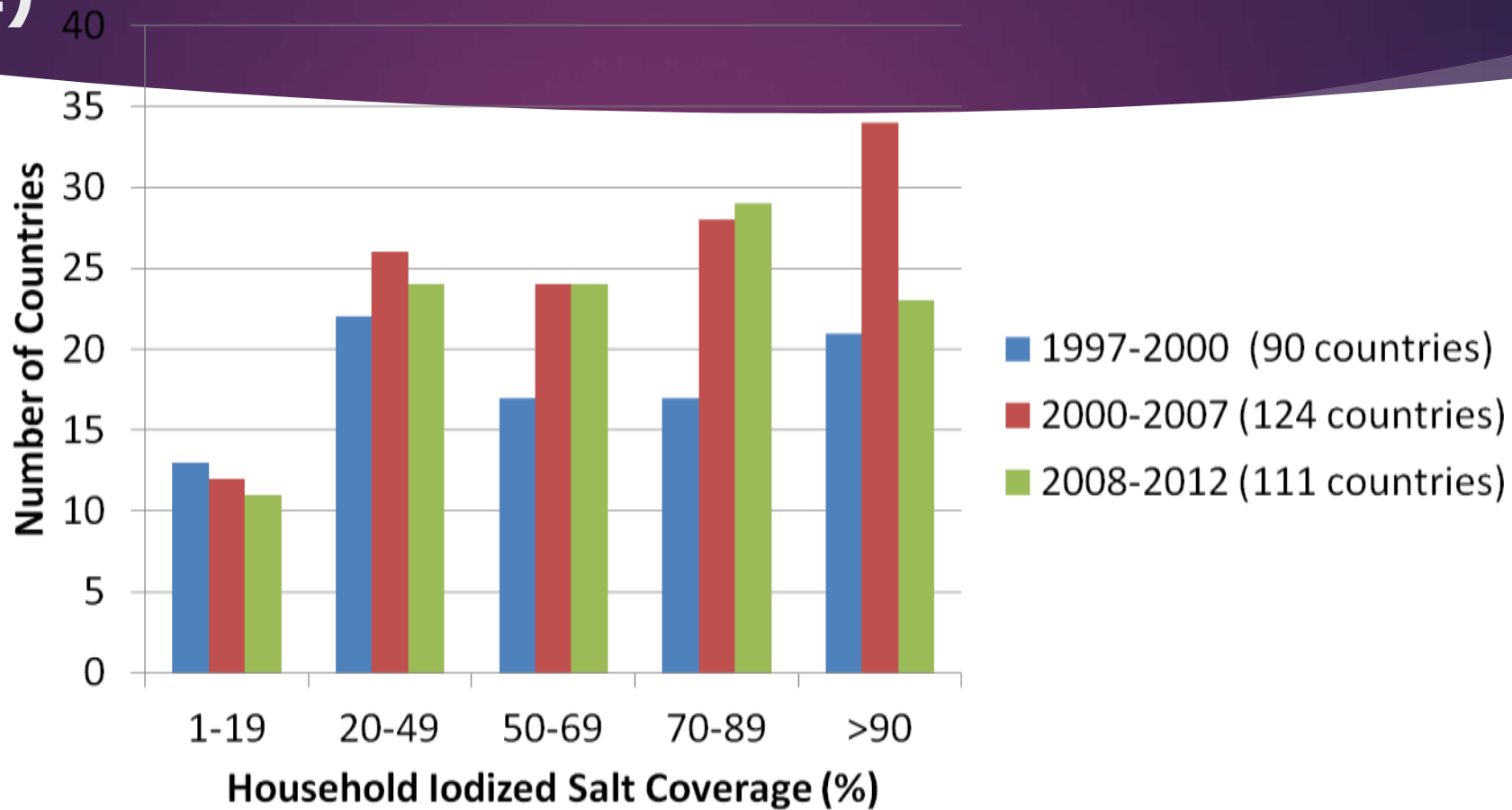
# Food Fortification Impacts: Developing World

- ▶ Rapid growth in fortifying a wide range of foods during the last two decades.
- ▶ The most successful global fortification experience is the fortification of salt with iodine.
- ▶ Fortification of staple foods such as flour, oils, sugar, condiments, dairy products and a range of processed foods with micronutrients is also growing.
- ▶ Double fortification of salt with iodine and iron is gaining ground and can be integrated with established iodization processes.

# Global Progress in IDD Elimination Through Universal Salt Iodization

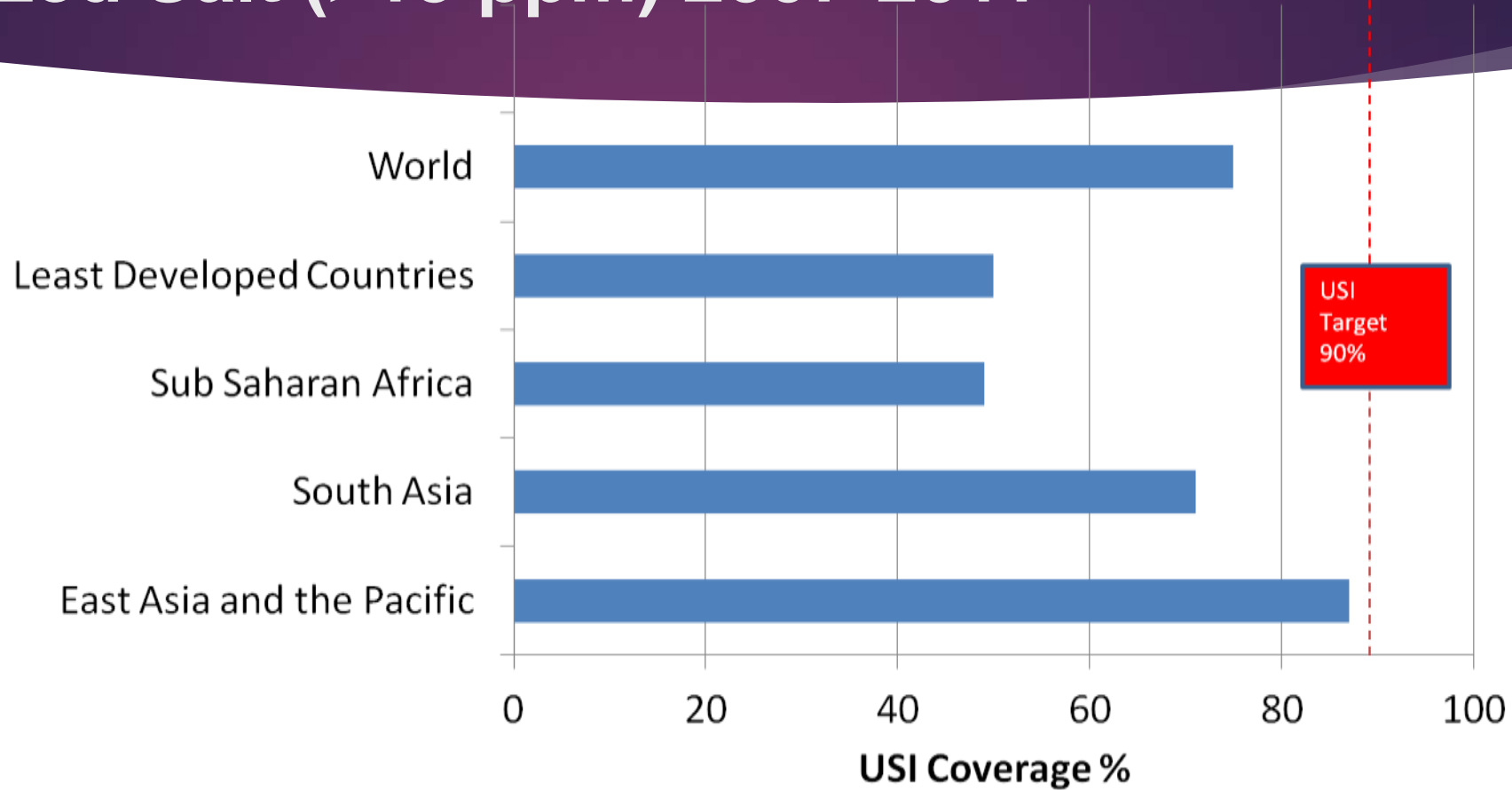
- ▶ 75% of the world has access to iodized salt in more than 87 countries.
- ▶ 130 governments have provided at least some resources for sustained IDD elimination programs.
- ▶ Public and donor investment of \$400 million has leveraged more than \$ 3 billion in private investment in salt refining and iodization.
- ▶ The vast majority of those affected by iodine deficiency will no longer be deficient.

# Progress in Iodized Salt Coverage (1997 - 2012)



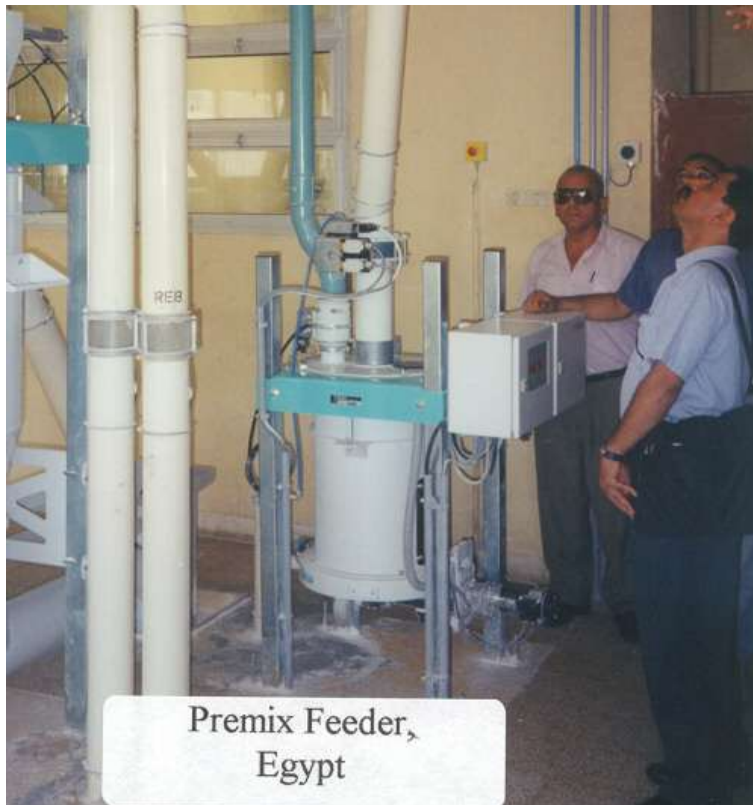


# Percentage of Households with Adequately Iodized Salt (>15 ppm) 2007-2011



Source: UNICEF

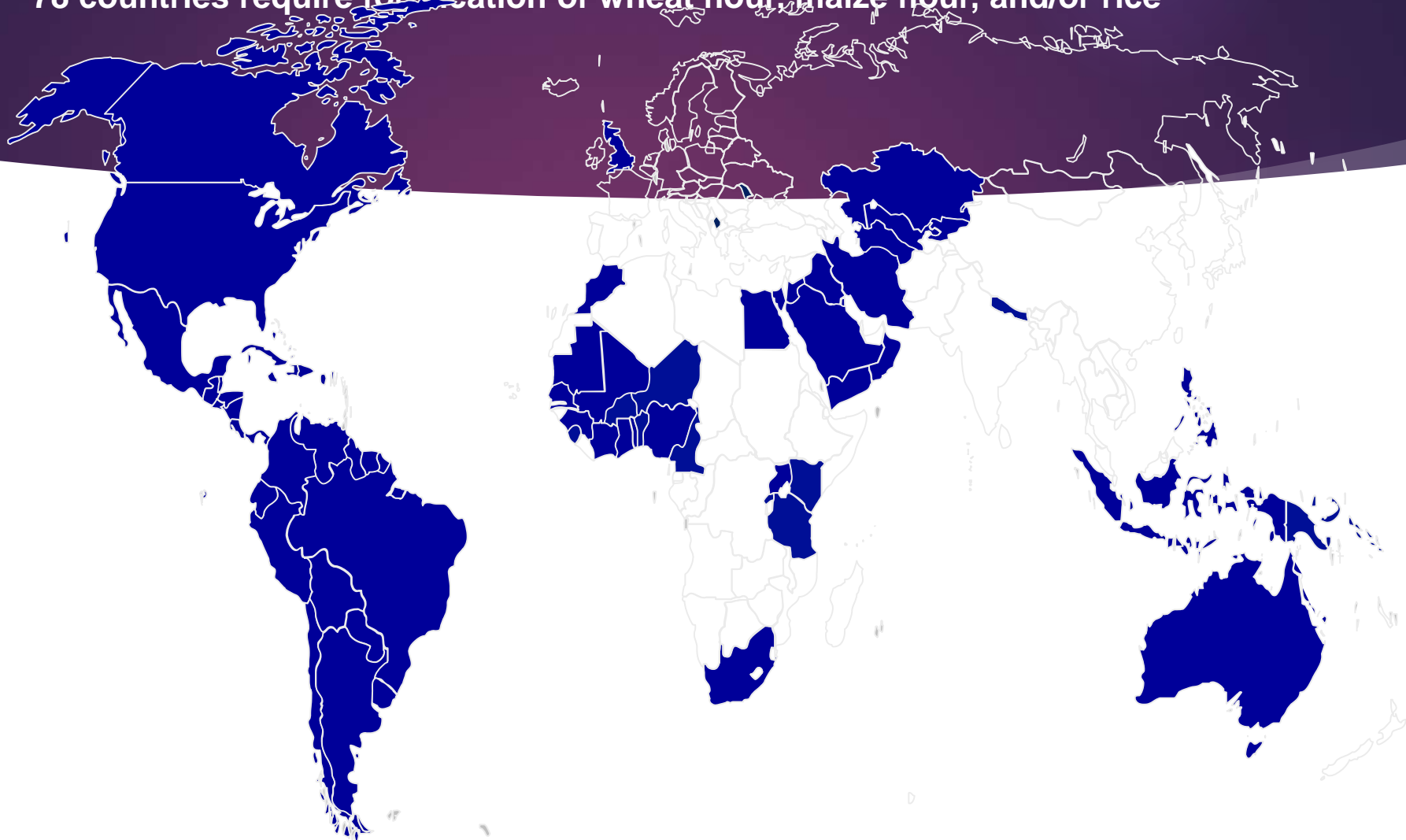
# Micronutrient Fortification of Cereal Flours: An Important Global Strategy



- ▶ In 2013, 78 countries had mandatory flour fortification with iron, folic acid and other nutrients covering 31% of the global market.
- ▶ Fortification is also being extended to cereal flour derivatives and processed baked products, complementary foods, noodles and pastas.
- ▶ USA/Canada: Mandatory and ongoing since 1940s.
- ▶ Americas: Fortification of wheat flour and industrially milled corn flour is almost universal.
- ▶ Middle East and North Africa: Currently 13 countries in the region produce and consume fortified flour on a national or sub-national scale - reaching more than 81 million consumers.
- ▶ Asia, Growing interest and action on wheat flour fortification. national flour fortification is under implementation in Pakistan and Nepal, Indian States.
- ▶ Africa: Fortification of wheat and maize flours has been made mandatory in South Africa and Nigeria. Growing in Kenya, Ethiopia, Senegal

# Grain Fortification Legislation

78 countries require fortification of wheat flour, maize flour, and/or rice



July 2013. Source: Food Fortification Initiative. [http://www.ffinetwork.org/global\\_progress/index.php](http://www.ffinetwork.org/global_progress/index.php)  
To request data, e-mail [info@ffinetwork.org](mailto:info@ffinetwork.org)

# Conclusions - 1

- ▶ There is a huge unmet need for multiple micronutrients in large parts of the developing world.
- ▶ Universal fortification of a range of staple foods could provide significant amounts of micronutrients to millions of deficient people and improve micronutrient status across the board.
- ▶ Projections for 63 low-income countries indicate that fortification could provide significant quantities of key micronutrients to target populations in a cost-effective manner:
  - ▶ **Vitamin A:** grain, oil & sugar fortification can deliver 20%-50% of WHO safe level.
  - ▶ **Iron:** grain fortification can deliver 6%-50% of median absorbed needs for adult women.

# Conclusions - 2

- ▶ Over the past decade there has been significant growth in awareness/action by governments and the private sector to enhance nutrition.
- ▶ Globally there is a growing consolidation of food processing (flour milling, oil and salt refining) that will enable fortification. There is also a steady expansion in consumption of processed foods.
- ▶ Timing is right to catalyze action/expand coverage of fortified foods.
- ▶ Real opportunity to show significant impacts within the next five years.
- ▶ According to the World Bank, “probably no other technology available today offers as large an opportunity to improve lives and accelerate development at such low cost and in such a short time” as fortification, along with other interventions to control MN deficiencies”.

# Upcoming Book: Food Fortification in a Globalized World

- ▶ Causes and Consequences of micronutrients deficiencies and Rationale for Action
- ▶ Comprehensive Strategy to Address Micronutrient Deficiencies
- ▶ Role of Food Fortification to address Nutrient Intake Gaps
- ▶ Principles of Addition of Essential Nutrients
- ▶ Food fortification Processes
- ▶ Fortification Vehicles
- ▶ Nutrient Forms and selection
- ▶ Mass/Targeted Mandatory/Voluntary Fortification
- ▶ Quality Assurance
- ▶ National Policies and Programs
- ▶ Economics
- ▶ Communications and Consumer Awareness
- ▶ Government and Private Sector Roles
- ▶ Safety, regulation and monitoring
- ▶ Key Issues and Challenges
- ▶ Moving Forward on Food Fortification : A Balanced Approach and Strategy