Smarter Futures and The Flour Fortification Initiative
Regional Training of Trainers Workshop on Wheat Flour Fortification
Dakar Senegal 7– 10 December 2009

Making the Economic Case: Cost Benefit Analysis

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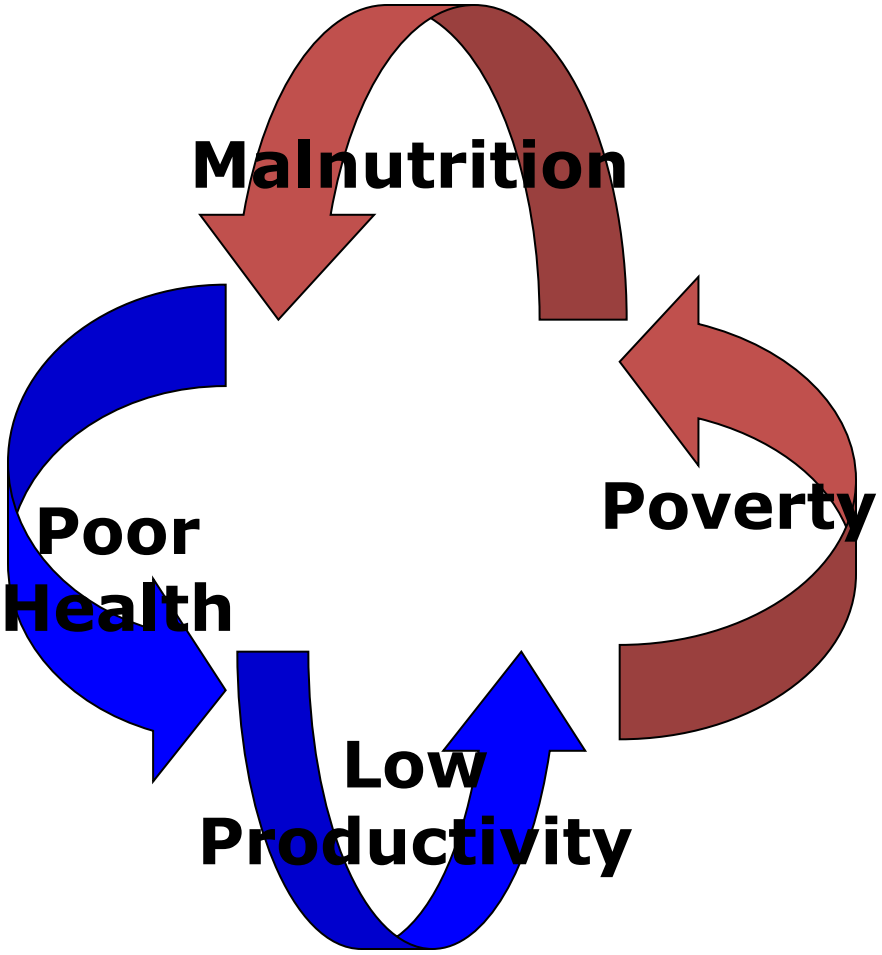
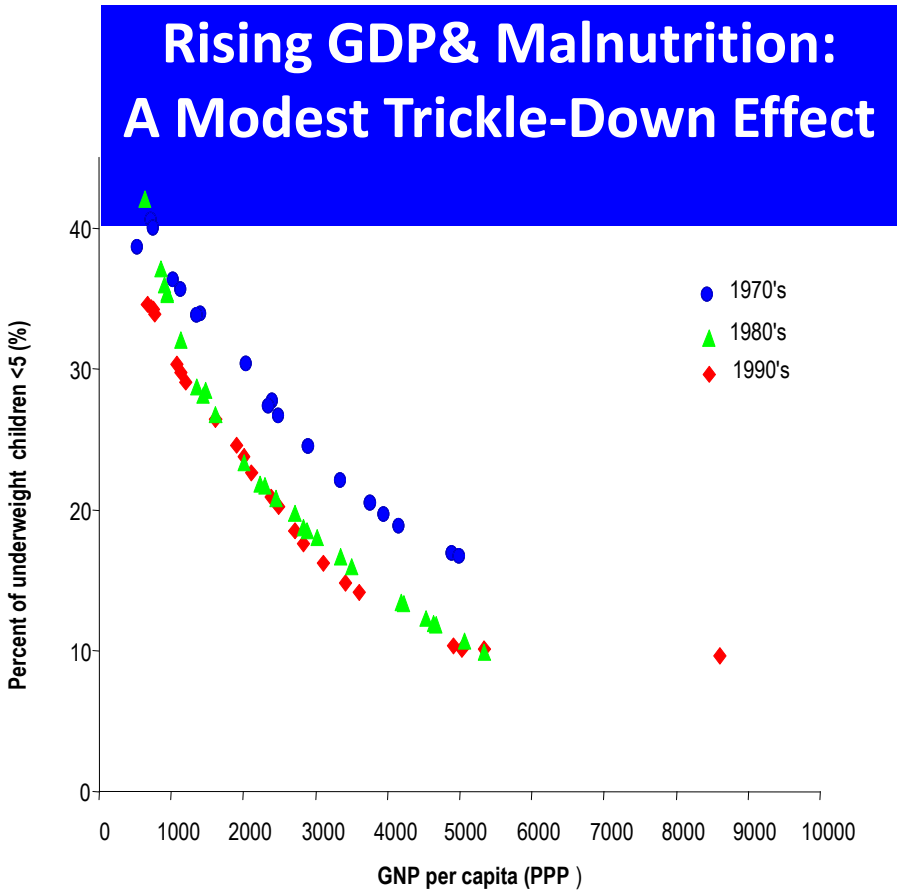
Malnutrition: A Cause or Consequence of Poverty?

- People are Basic Unit of Economic Growth
- Association of poverty and malnutrition.
  - Inverse relation of GDP & Malnutrition
- Two-way Dynamic
  - Poverty is not simply root cause of hunger.
  - Malnutrition causes and reinforces poverty.



Economic Growth Is Not Enough

- More purchasing power and more food reduces malnutrition but…
  - … doubling GDP reduced malnutrition only 2% to 23%
- Public investment in nutrition interventions can close this gap of GDP growth and improved nutrition.



Source: Alderman (2004)

Prioritizing Development Challenges by Economic Criteria

Copenhagen Consensus: 10 Global Development Challenges Considered by Panel of Nobel Prize Winning Economists

Methodology:
Quantify National Economic Losses

- Global scientific literature has established consensus coefficients on Health Risks or Performance Deficits (as % deficit or Relative Risk) related to specific Nutrition and Early Child Development Indicators.
- These Coefficients can be applied to national demographic, health and labor data and statistics to project magnitude of loss.

Risk Group	X	Prevalence Rate	X	Average Wage	X	Labor Force Participation	X	Coefficient Of Loss or Risk	=	Baseline Annual Loss
#		%		$/YR		%		% or RR/PAR		$/YR

Defining Value of Intervention: Benefit Cost Ratio

Baseline Losses		Intervention Effectiveness Estimate		Program Objective Coverage		Reduced Baseline Losses		Program Cost		Benefit Cost Ratio
$/yr	X	% Nutrition Protection for Consumer	X	% Consumers	=	Saved $/yr	/	Cost $/yr	=	#

Baseline Losses from Anemia: Pathways to Impact & Savings

1. Future Costs of Higher Mortality
   - Value of Lost Workforce
2. Current Losses from Lower Adult Productivity
   - Ability to Perform Physical Work
3. Future Losses due to depressed cognitive capacity in young children
   - Cognitive status effects future earnings
   - Applies to all kinds of employment
4. Current Costs of Higher Morbidity
   - Excess health care services utilization

Pathway #1 Anemia Evidence: Maternal & Perinatal Mortality*

- Perinatal mortality decreases 16% for every 1 mg per deciliter increase in maternal hemoglobin
- Coefficient for Workshop Analysis
  - RR 0.84 associated with 1 mg/dL increase in Hb

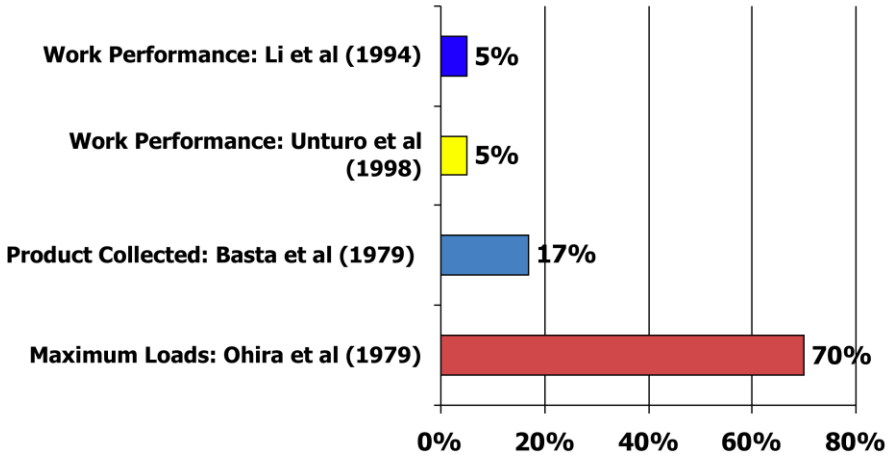
* Where malaria is not significant

Stoltzfus RJ, Mullany L, Black RE. Iron deficiency anaemia. Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors. Geneva: World Health Organization, 2004: 163–209.

Pathway #2 Evidence: Losses in Anemic Adult Workers due to IDA

- Health Impact
  - Lower aerobic capacity
    - 10-75%
  - Weakness & fatigue
- Work Impact:
  - Lower individual performance or output.
- Coefficient for Analysis
  - 5% Deficit in Manual Labor
  - 17% Deficit Heavy Manual Labor
- Parenting & Voluntary activities not calculated

Some Controlled Studies: Improved Work Performance From Correction of Anemia



Horton & Ross The Economics of Iron Deficiency Food Policy 28 (2003) 51–75

Pathway #3 Anemia Evidence: Childhood Cognitive Deficit

- *Lancet* Review:
  - 5 Studies found 1.73 IQ point deficit per 10 g/L in Hb
  - Supplementation trials show 2 IQ Point benefit.
- *Journal of Nutrition* Review:
  - Review of Iron interventions concludes improve cognition in range of 0.5 to 1 SD.
  - "Available evidence satisfies all of the conditions needed to conclude that iron deficiency causes cognitive deficits and developmental delays and that these can be at least partially reversed by iron therapy.*"

Haas, J. and Brownlie T., Iron Deficiency and Reduced Work Capacity: A Critical Review of the Research to Determine a Causal Relationship1 *Journal of Nutrition.* 2001;131:676S-690S

Child Cognition Deficit Associated with Adult Earnings Deficit

Country	Cognitive Deficit	Earnings Deficit	Sources
Chile	0.5 SD	3-5%	Selowsky &Taylor (1973)
U.S.		5%	Altonji & Dunn (1996)
Pakistan		10-12%	Alderman et al. (1996)
Ghana	1 SD	22-33%	Glewwe (1996)
Kenya		17-23%	Boissiere et al. (1985)
Tanzania		8-13%	Boissiere et al. (1985)
Columbia		7-9%	Psacharopoulos et al (1992)
South Africa		35%	Moll PG (1998)

- Consensus workshop on evidence linking cognitive test scores and earnings concludes:
  - "0.25 SD increase in IQ, which is a conservative estimate of the benefit… would lead to a 5%-10% increase in wages."

Galal et al, International Workshop on Articulating the Impact of Nutritional Deficits on Education for All, Food & Nutrition Bulletin, 2005

Coefficient for Workshop Analysis: Chain of Logic

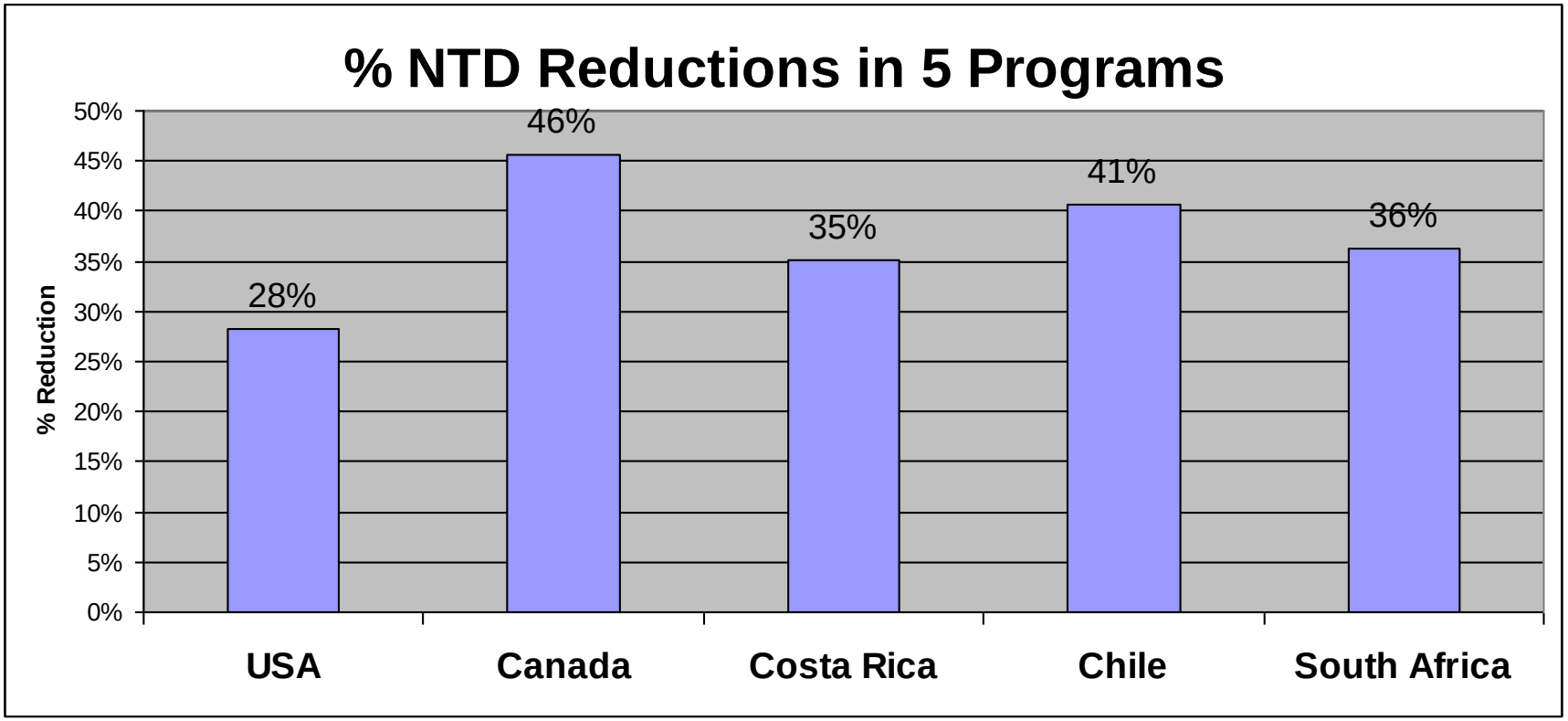
- Intervention trials with children < 5 years show IDA associated with 0.5 SD lower score on cognitive tests.
- 1 SD lower on cognitive tests linked to 8% lower wages in adults
- IDA at 0.5 SD is associated with 4% loss of future productivity in children < 5 years.
- Improvement in cognition requires maintenance of iron status throughout childhood.
  - Diminishing but still significant benefits from pre-school to school aged children indicate **2.5%** over-all improvement through 14 years of age.

Horton & Ross The Economics of Iron Deficiency
Food Policy 28 (2003) 51–75

Folic Acid Deficiency & Neural Tube Defects

- Pathway #1: Mortality
- Pathway # 3: Disability
- Pathway #4: Cost of Care
  - Surgeries, Care & Rehab, Welfare Payments
- Impacts Not Measured
  - Cleft Pallate
  - Neuroblastoma
  - Congenital Heart Defects
  - Adult Heart attack and Stroke

At least 28-46% NTDs Respond to Added Dietary Folic Acid



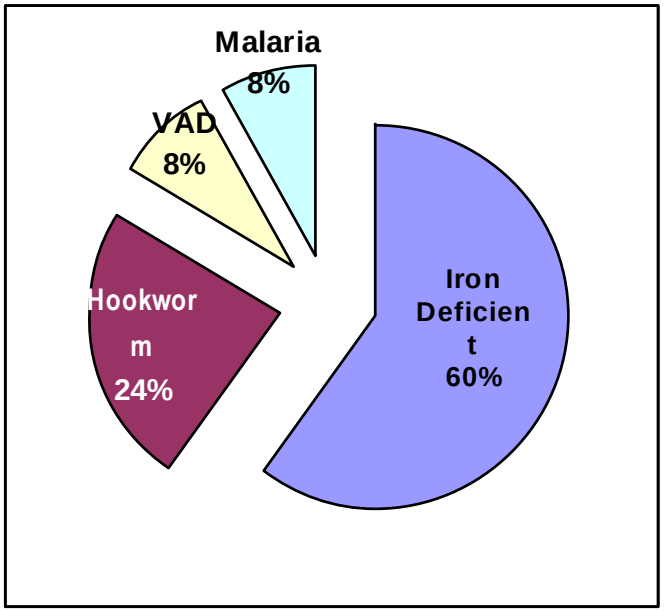
Review of Coefficients of Health Risk or Functional Deficit

- **Iron Deficiency Anemia**
  - Current Productivity in Manual & Heavy Labor from IDA in adult workers: Deficit 5-17%
  - Future Productivity due to cognitive deficits from IDA in children: Deficit 2.5%
  - Perinatal from IDA in pregnant women: RR 0.84
- **Folic Acid Deficiency**
  - Mortality and Disability from NTDs.
    - 1-3/1000 Live Births
    - At least 28%-46% of Cases preventable.

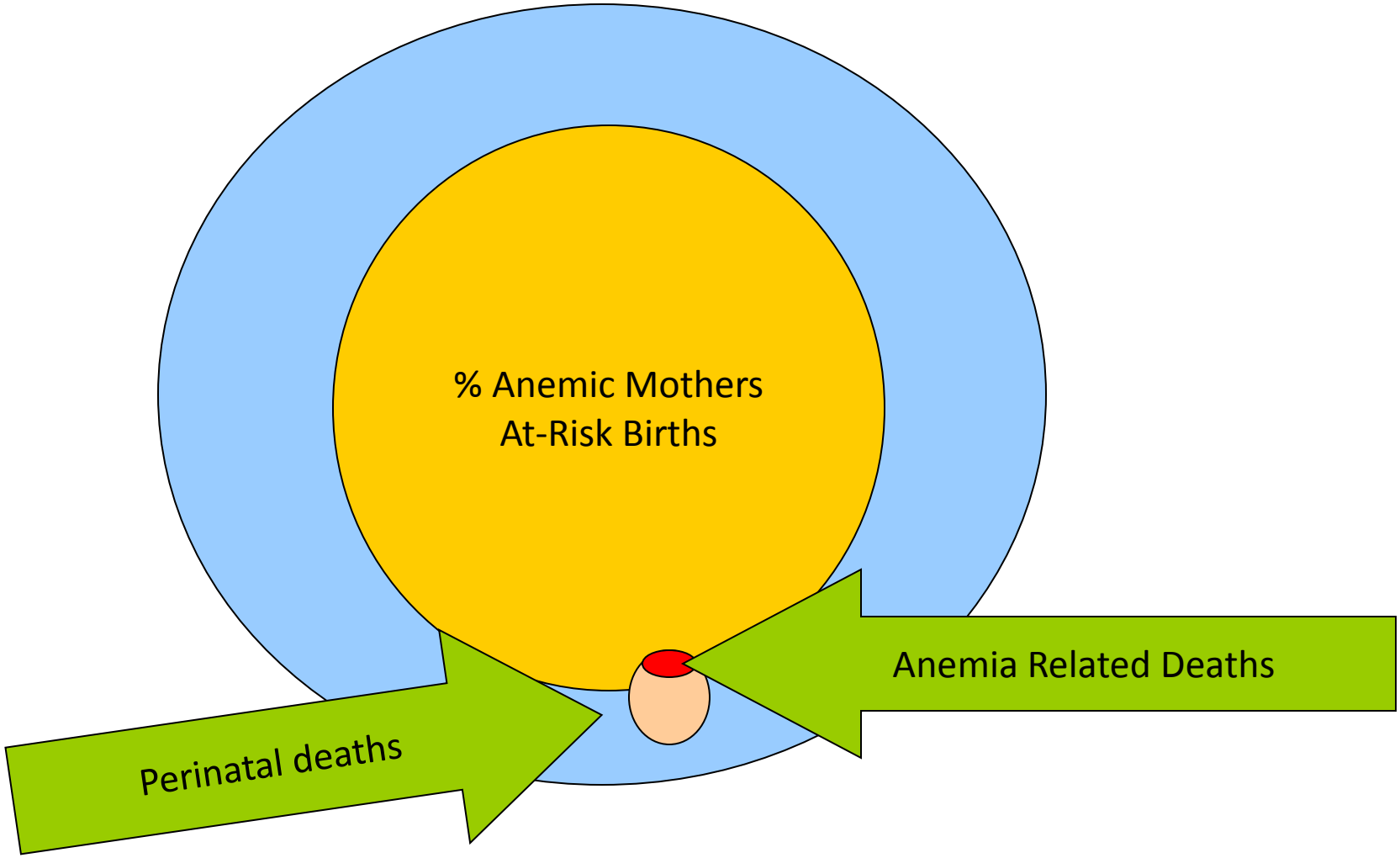
Iron Deficiency as Cause of Anemia

- How much anemia is iron deficiency related?
  - "anemia prevalence can generally be taken as indicator of extent and trends of iron deficiency." (WHO)
- Regional Situation
  - No Malaria
  - Limited VAD
  - Limited Hookworm and parasites
- Provisional Estimate of Iron deficiency as cause of anemia: 90%

Global Causes of Anemia (WHO)



Perinatal Deaths
Projection Methodology



Example: Applying Methodology to National Environment

Health Background Data	
Births	14,704
Perinatal Mortality: Deaths /1000 live births	20
Projected Total Perinatal Death	**294**
Prevalence of anemia among pregnant women:	26.7%
Proportion of maternal anemia due to iron deficiency	90%
Births at Risk due to Iron Deficiency Anemia	**3,529**
Perinatal Death Attributed to Iron Deficiency Anemia	
Mean Hb at Current Prevalence vs Absence of IDA:	1.18/g/DL
RR associated with a 1 g/dL increase in hemoglobin:	0.84 RR
Proportion of Perinatal Mortality Due to IDA	**18.7% PAR**
Total Perinatal Deaths Attributed to IDA	**55**

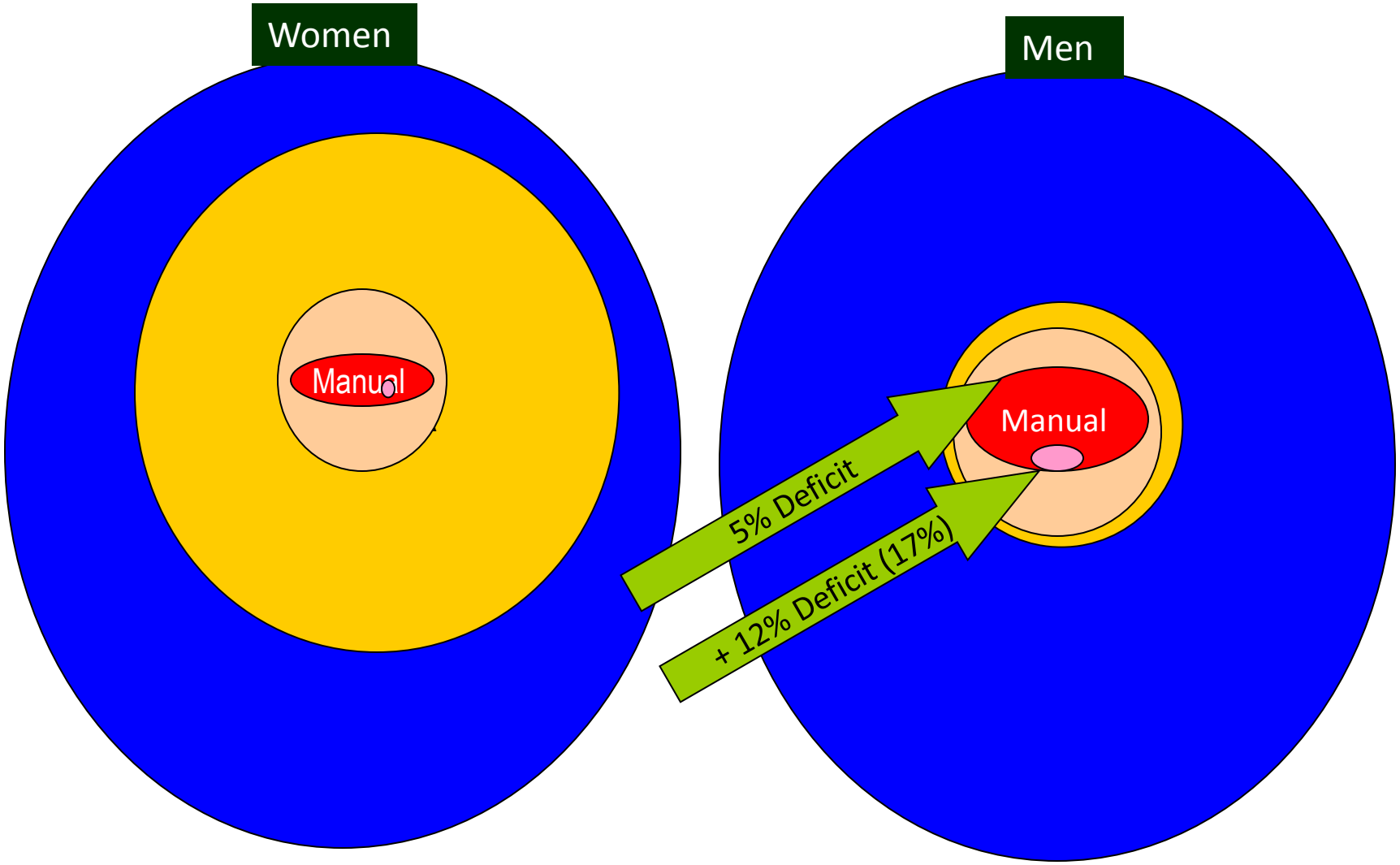
What's a Life Worth?
A Cold Banker's Perspective

- Present Value of Lost Future Workforce:
  - Current Resources more Valuable than Future Resources
  - Need to compensate for:
    - 15-20 year delay in beginning of earnings stream
    - 40-50 Years of earnings in future
- Present Value "Borrows" from Future at Discounted Rate
  - Current 5% rate values life at 15-20% of Gross Lifetime Wages

Child Deaths Attributed to Malnutrition	X	Average Wage	X	Labor Force Participation Rate	X	Discount For Net Present Value	=	Net Present Value (NPV) of Losses
55		$845		70%		17.4%		$225,172

Gross Earnings $1.3 million earnings. $4,102 per life saved

Adult Productivity Deficits Projection Methodology

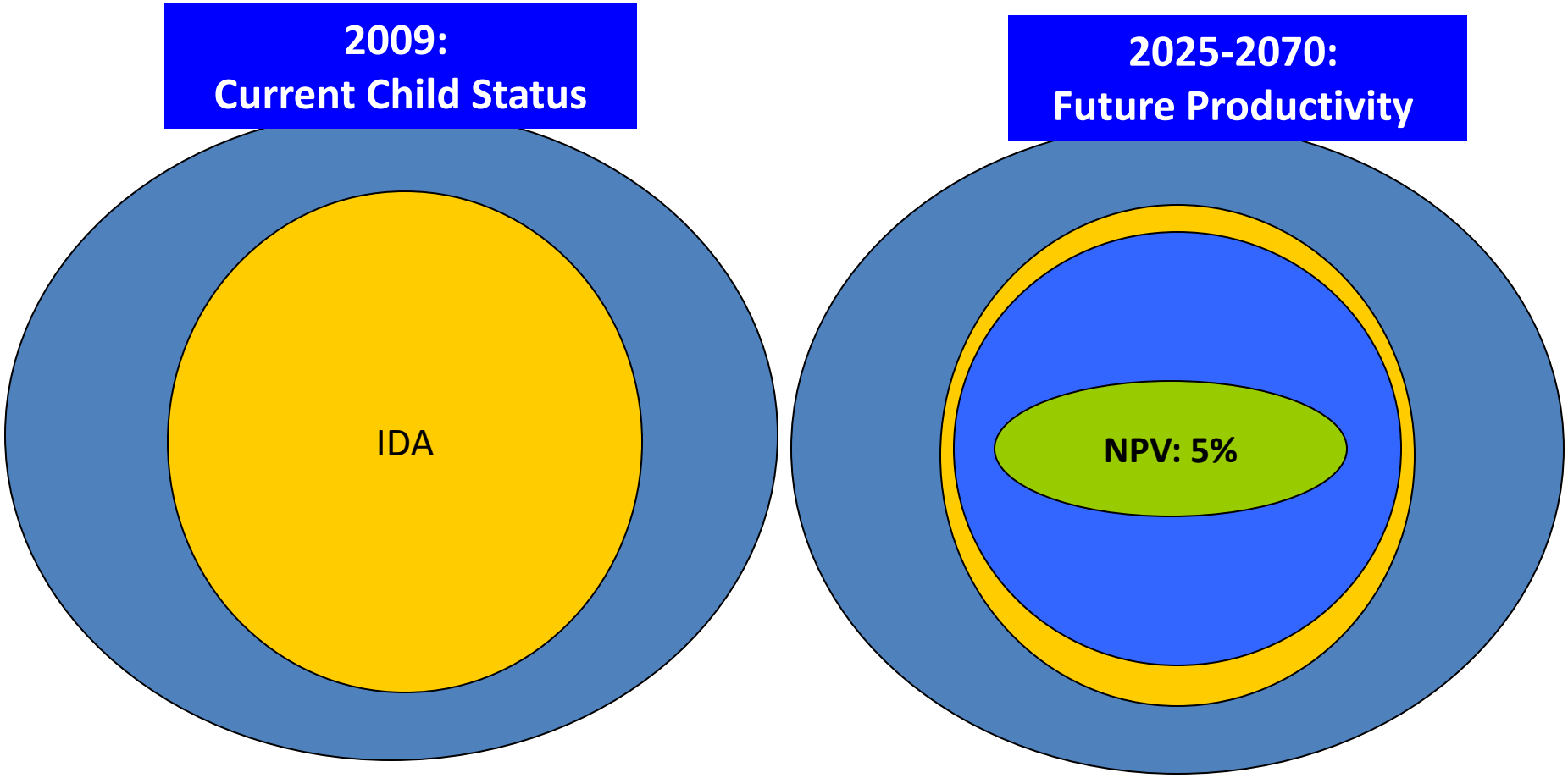


Example: Applying Methodology to National Environment

	Women	Men
Health Data Background		
Prevalence of anemia in women	27%	7%
% Anemia from Iron Deficiency	90%	90%
Demographic and Labor Data Background		
Working Age Population	2,502,397	2,465,120
Labor Participation Rate	54.1%	71.3%
Average Wage	$7,467	$9,956

	Women	Men
Workforce with Productivity Deficit		
Anemic Working Adults	1,353,046	1,756,891
% Working in Manual Labor	36.0%	36.0%
# Working in Manual Labor	487,097	632,481
% Manual Labor Assumed Heavy Manual	3%	10%
# Working in Heavy Manual Labor	14,613	63,248
Economic Productivity Loss Projections		
Productivity Deficit in Manual Labor	5%	5%
Manual Labor Loss Subtotal	$181,857,508	$314,848,927
Additional Heavy Manual Labor Deficit	12%	12%
Additional Loss for Heavy Manual Labor	$ 13,093,741	$ 75,563,742
Annual Economic Losses by Sex	$ 194,951,249	$ 390,412,669
Total Annual Economic Losses		**$585,363,918**

Loss from Childhood Anemia: Projection Methodology



Example: Applying Methodology to National Environment

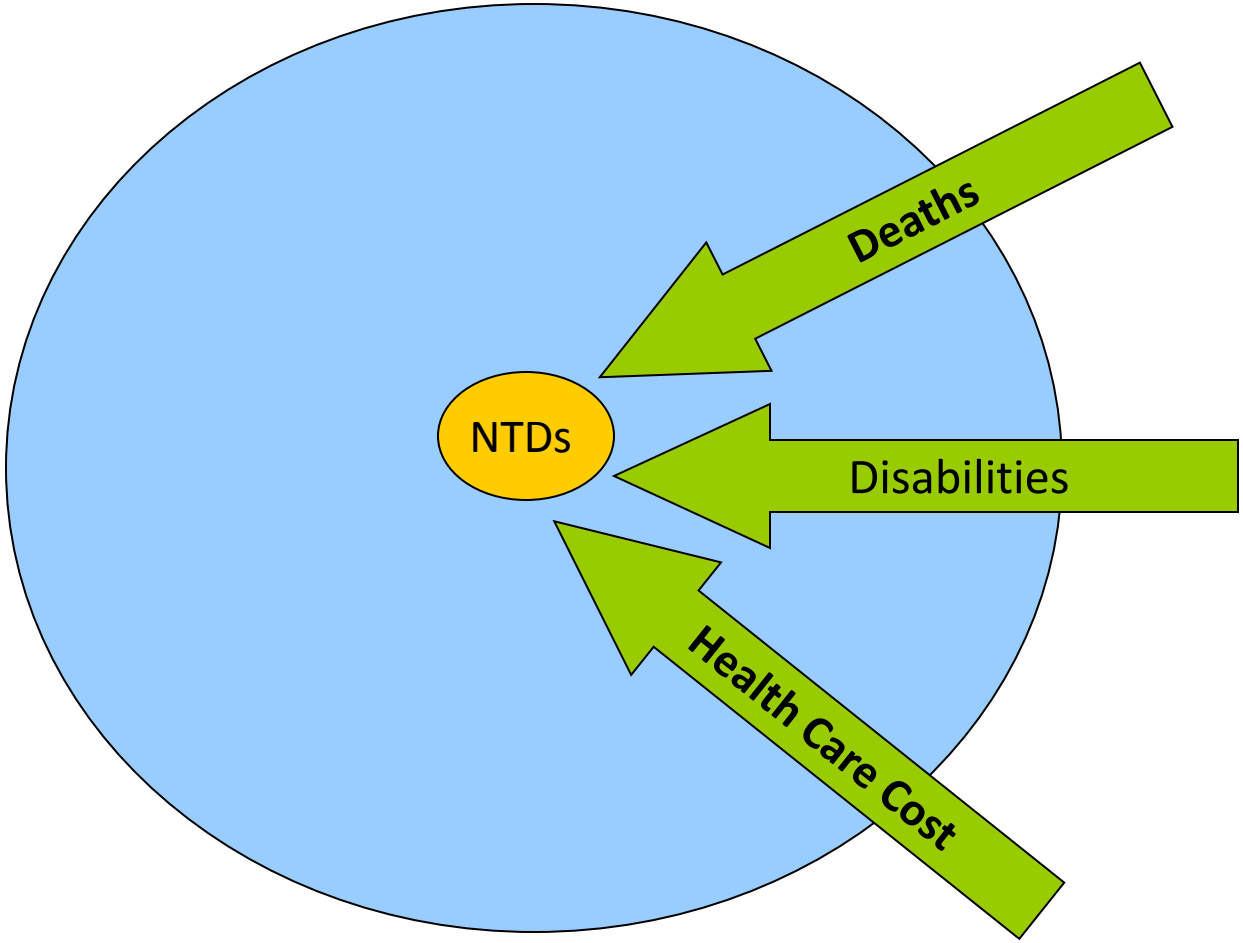
Health Data Background		
Prevalence of anemia 0-14 yrs		14.3%
% Anemia from Iron Deficiency		99%
Children with Iron Deficiency Anemia		109,333
Demographic and Labor Background Data		
Average Annual Wage in All Sectors		$1,719
Effective employment rate all sexes		67%
Economic Productivity Loss Projections		
Reduction in future productivity (all sectors) due to anemia		2.50%
Gross Lifetime Earnings Loss	$	142,695,134
Net Present Value of Future Losses @ 5% (NPV)	$	2,651,300

Folic Acid Deficiency & Neural Tube Defects:

- Pathway #1 and #3:
  - Lost future productivity from mortality & disability
- Pathway #4:
  - Current annual costs for surgeries and continyuing care, rehab and social security.

Number Births At Risk	X	Rate	X	Annual Cases	X	Mortality Rate	=	Annual Deaths Disability
Birth Rate		1-3/1000		#/yr		%		#/yr

Losses from Neural Tube Defects: Projection Methodology



Example: Applying Methodology to National Environment

Health Background Data	
Annual Births	240,320
Annual NTD Rate	2/1000
Annual NTDs	481
Proportion Deaths	70%
Proportion Severe Disability	15%
Proportion Moderate Disability	15%
Estimated Impact	
Number Deaths	336
Number Disability	144

Example: Applying Methodology to National Environment

Demographic and Labor Background Data		
Average Annual Wage in All Sectors		$551.00
Effective employment rate all sexes		65%
Annual Cost of Surgery/Care for Severely Disabled	$	845
Annual Cost of Care for Moderate Disabled per Case	$	360
Annual Cost of Welfare/Social Security Payments Per Case	$	360
Access to Pediatric Surgery		75%

Example: Summary 10-Year Baseline Losses:

Year	Iron Deficiency Anemia				Folic Acid Deficiency			
	Perinatal Mortality Future Productivity	Adult Anemia Current Productivity	Childhood Anemia Future Productivity	Total IDA	Death & Disabilty Future Productivity	Medical & Welfare Current Expenses	Total Folic Acid	Total Projected Damage
	$000,000/yr	$000,000/yr	$000,000/yr	$000,000/yr	$000,000/yr	$000,000/yr	$000,000/yr	$000,000/yr
2009	$ 1.57	$ 76.61	$ 4.77	$ 82.95	$ 1.39	$ 0.34	$ 1.73	**84.7**
2010	$ 1.58	$ 77.37	$ 4.82	$ 83.78	$ 1.40	$ 0.34	$ 1.75	**85.5**
2011	$ 1.60	$ 78.15	$ 4.87	$ 84.62	$ 1.42	$ 0.35	$ 1.77	**86.4**
2012	$ 1.62	$ 78.93	$ 4.92	$ 85.46	$ 1.43	$ 0.35	$ 1.78	**87.2**
2013	$ 1.63	$ 79.72	$ 4.97	$ 86.32	$ 1.45	$ 0.35	$ 1.80	**88.1**
2014	$ 1.65	$ 80.52	$ 5.02	$ 87.18	$ 1.46	$ 0.36	$ 1.82	**89.0**
2015	$ 1.67	$ 81.32	$ 5.07	$ 88.05	$ 1.48	$ 0.36	$ 1.84	**89.9**
2016	$ 1.68	$ 82.13	$ 5.12	$ 88.93	$ 1.49	$ 0.37	$ 1.86	**90.8**
2017	$ 1.70	$ 82.96	$ 5.17	$ 89.82	$ 1.51	$ 0.37	$ 1.87	**91.7**
2018	$ 1.72	$ 83.79	$ 5.22	$ 90.72	$ 1.52	$ 0.37	$ 1.89	**92.6**
	$ 16.4	**$ 801.5**	**$ 49.9**	**$ 867.8**	**$ 14.5**	**$ 3.6**	**$ 18.1**	**885.9**
	1.9%	90.5%	5.6%	98.0%	1.6%	0.4%	2.0%	

Context: Projection not Reality

- Project Magnitude of Costs & Consequences
  - Quantifying Lost Human Economic Potential
  - Wide Error Band
- Projections not reality
  - Based on best evidence and best national data
  - Similar to methodology used in other development investments
- Moral Imperative for health and nutrition
  - Not only Economic Benefit

First Step in Projection for Economic Benefit Cost Ratio

Baseline Losses		Intervention Effectiveness Estimate		Program Objective Coverage		Reduced Baseline Losses		Program Cost		Benefit Cost Ratio
$/yr	X	Expected % Prevention by Risk-Group	X	% Regularly Consume Fortified Flour		$/yr	/	$/yr	=	#

Step by Step: Working to Defining a Benefit Cost Ratio

Baseline Losses		Intervention Effectiveness Estimate		Program Objective Coverage		Reduced Baseline Losses		Program Cost		Benefit Cost Ratio
Today	X	Today and Tomorrow	X	Tomorrow Thursday	X	Thursday	/	Tomorrow	=	Friday

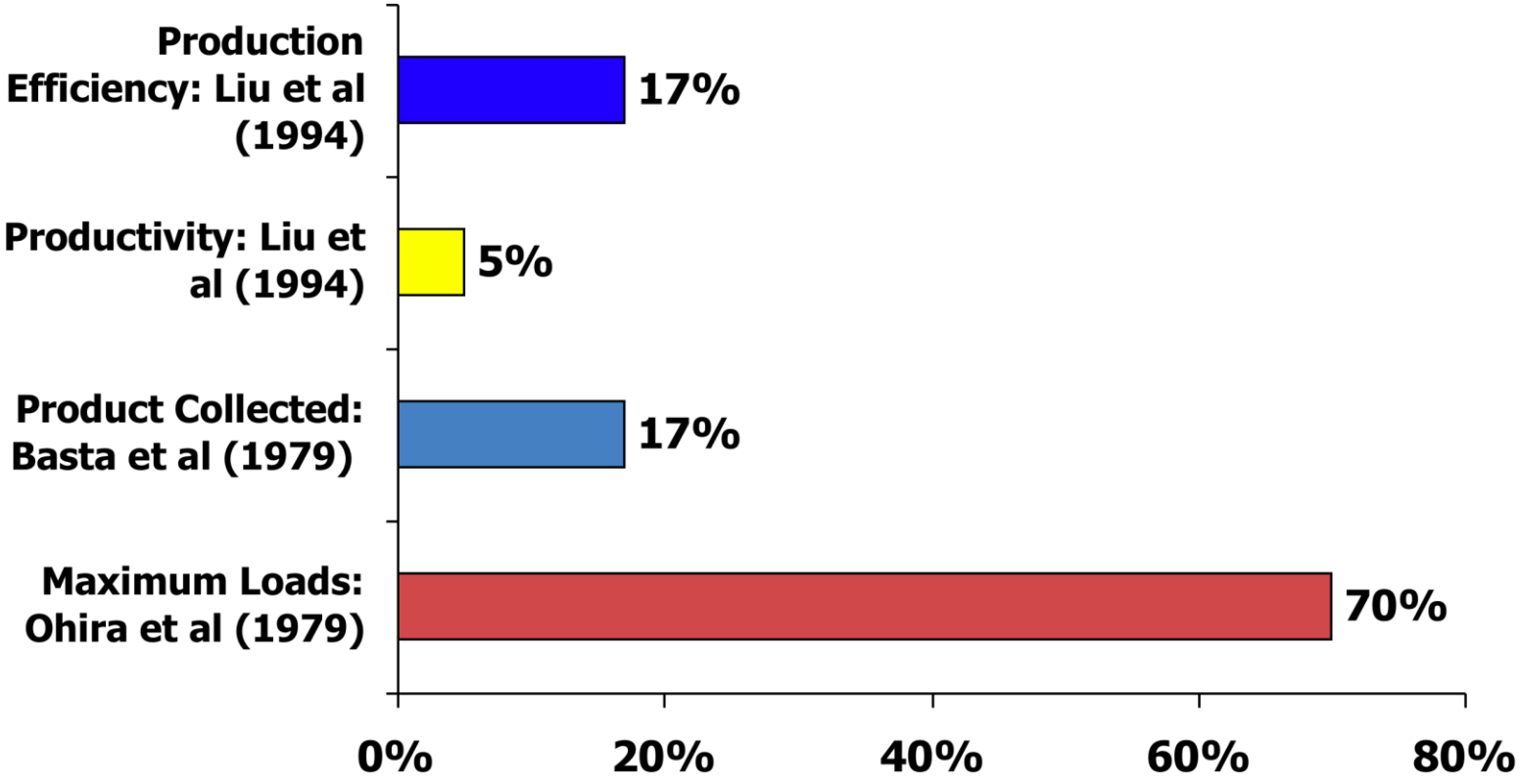
Review Spreadsheet and Methodology

- Complete the Spreadsheets
  - Fill in the yellow cells
  - For the workshop, if data is not available agree on an educated estimate.
  - Identify which data or assumptions need further data gathering or research.
- Consider Projections for mortality, morbidity and economic loss.
  - Are the conclusions credible/believable? Why or Why Not?
  - Which conclusions will be most powerful with what kinds of decision-makers/institutions?
  - Are there any conclusions that may be controversial? How can this be addressed?

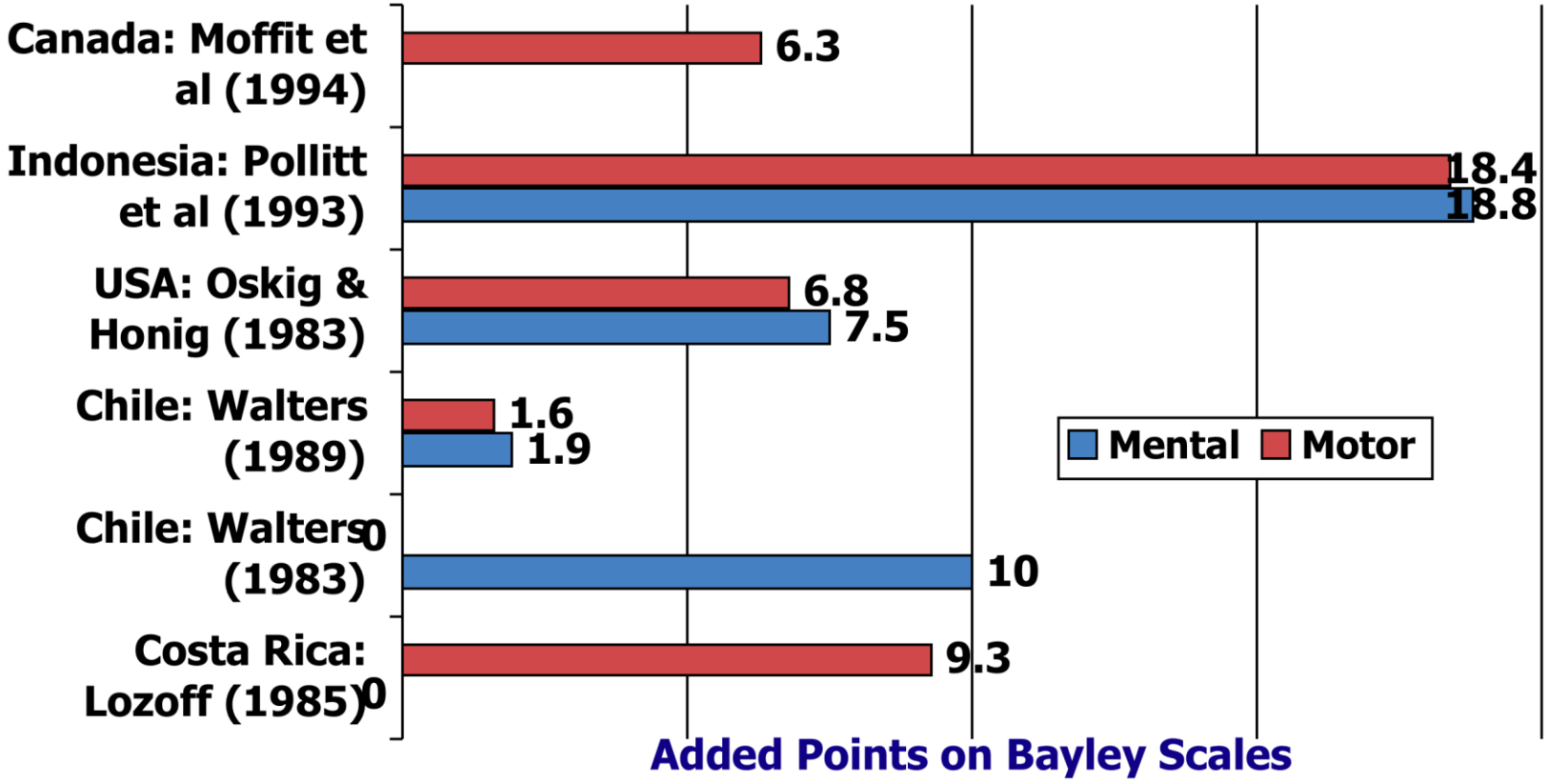
Making the Problem Statement

- Make 3-5 Power Point Slides
  - Define Official Public Health Problem
    - Prevalence relative to WHO Thresholds
  - How Many People Are Affected
    - Include Clinical and Subclinical Cases of Disease
    - Numbers for mortality and disability
  - National Economic Consequences
    - Current Losses
      - Adult Workforce
      - Health and welfare costs
    - Future Losses
      - Child Cognitive Development
      - Lost Workforce

Productivity Increase with Intervention to Correct IDA



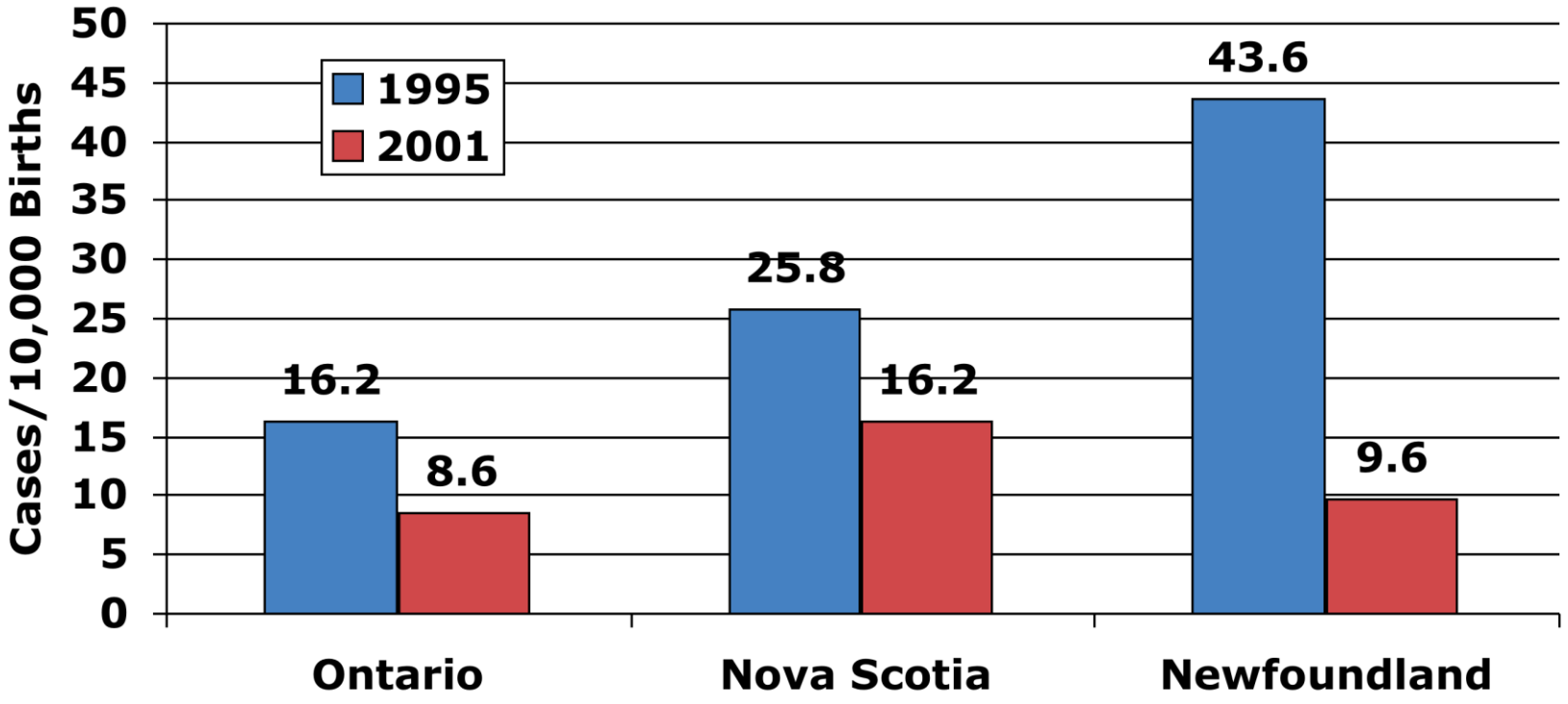
Behavioral & Cognitive Impact on Children



Benefits of Increased Folic Acid Intake

- Lower Rates of Birth Defects
  - Associated with 30-50% reduction in NTDs
  - Decreased mortality and health care costs
- Reduction in Myocardial Infarctions:
  - Associated in USA with 10.5% reduced CVD cases and reduced mortality and health care costs
- Emerging evidence on several cancers, other cardio vascular deaths, alzheimers disease

Canada Folic Acid Fortification: 37-78% Decrease in NTDs



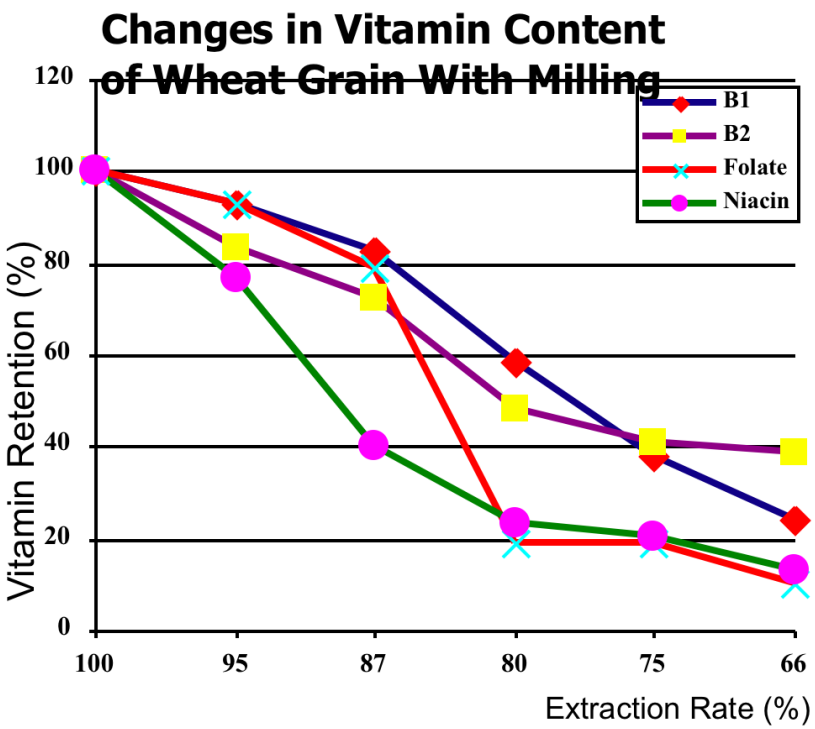
Why is Flour a Good Vehicle for Fortification to Address IDA & FAD?

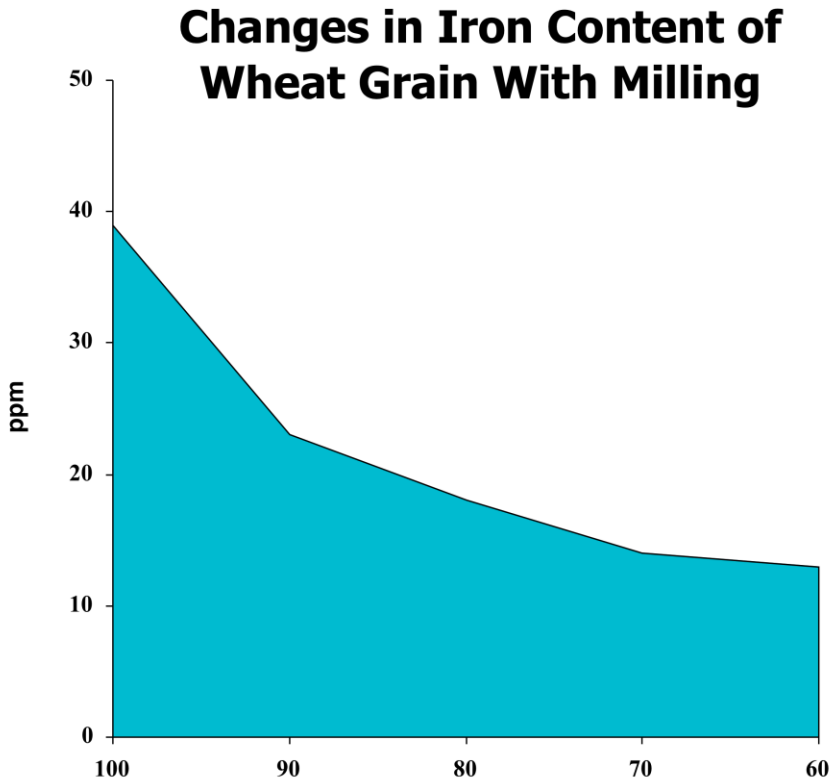
Some Basic Principles

Safe & Effective

- **Food staple** consumed in large quantities by all ages and economic classes covering the whole population.
- **Small Daily Doses** optimally utilized by the body.
- **Safe** because people cannot eat quantity to exceed established safety thresholds.
- **Proven** public health measure with **widespread support** by the medical and milling communities.
- Vital component of **integrated strategy** to control vitamin and mineral deficiencies.
- Added vitamins **naturally present** in the whole grain but reduced by milling process. Nothing new added.

Flour Milling Depletes Whole Grain of Natural Vitamins & Minerals



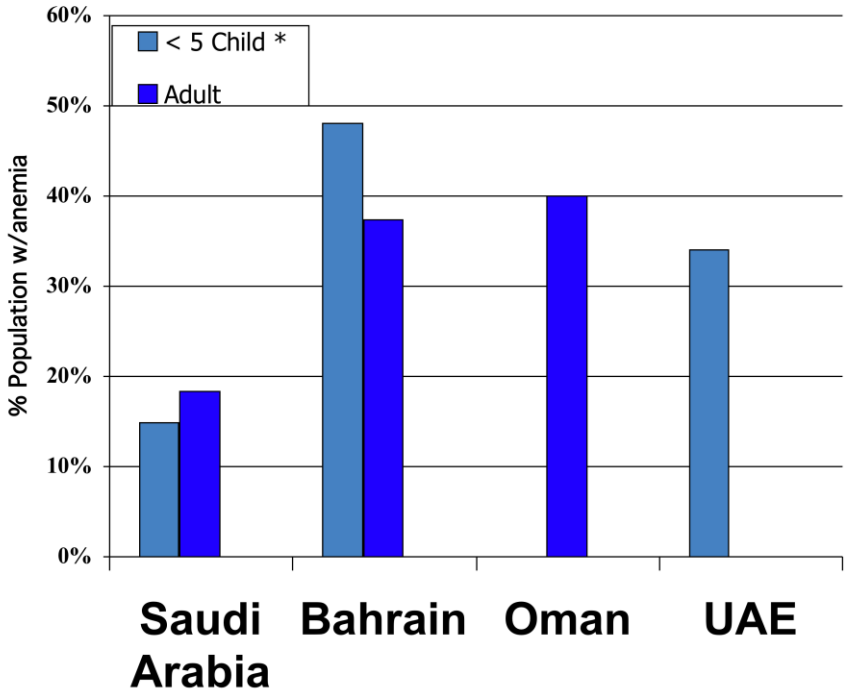


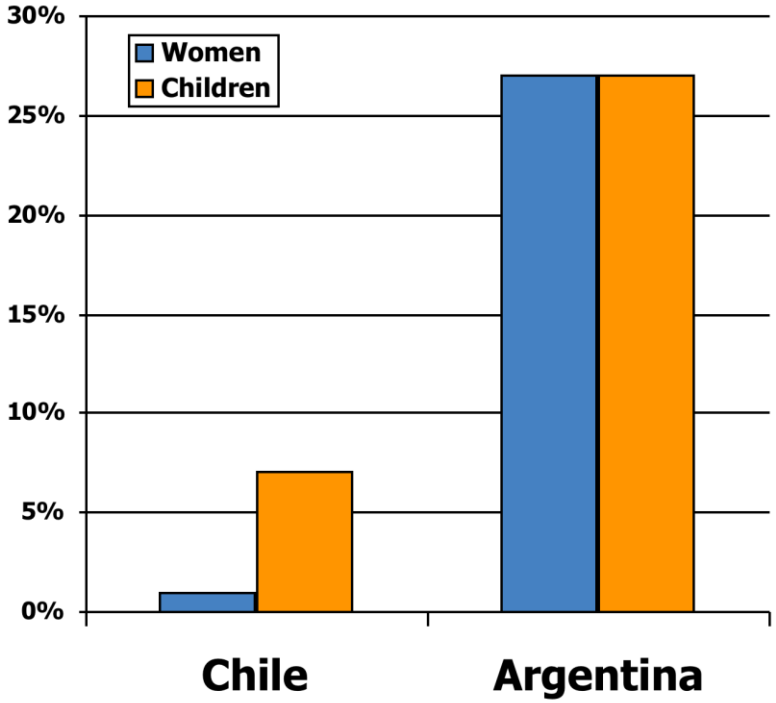
Source: Hegedüs et al. (1985)

What is the Impact of Flour Fortification Programs?

The World Wide
Public Health Evidence

Comparing Rates of Anemia: Countries **with** vs **without** Fortification

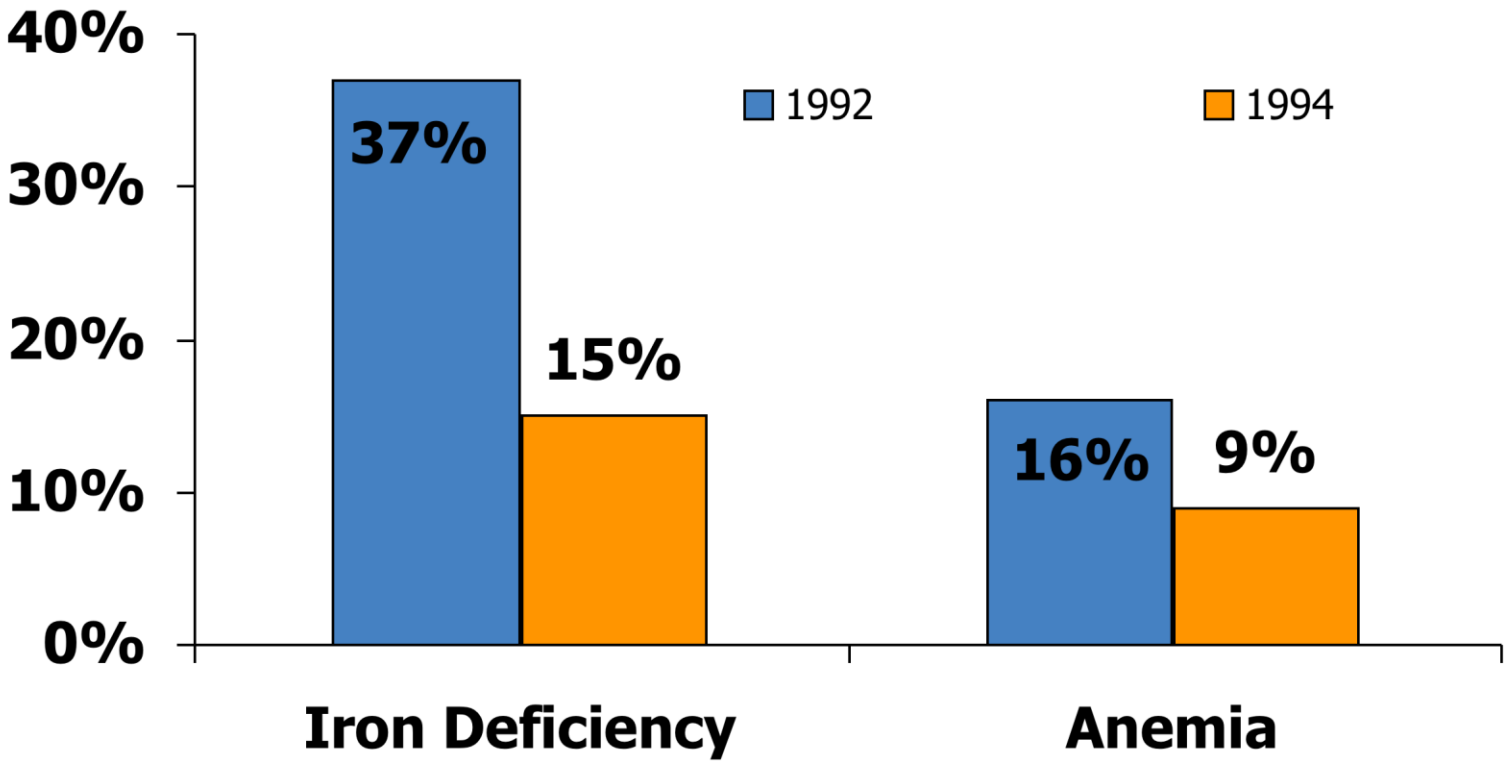




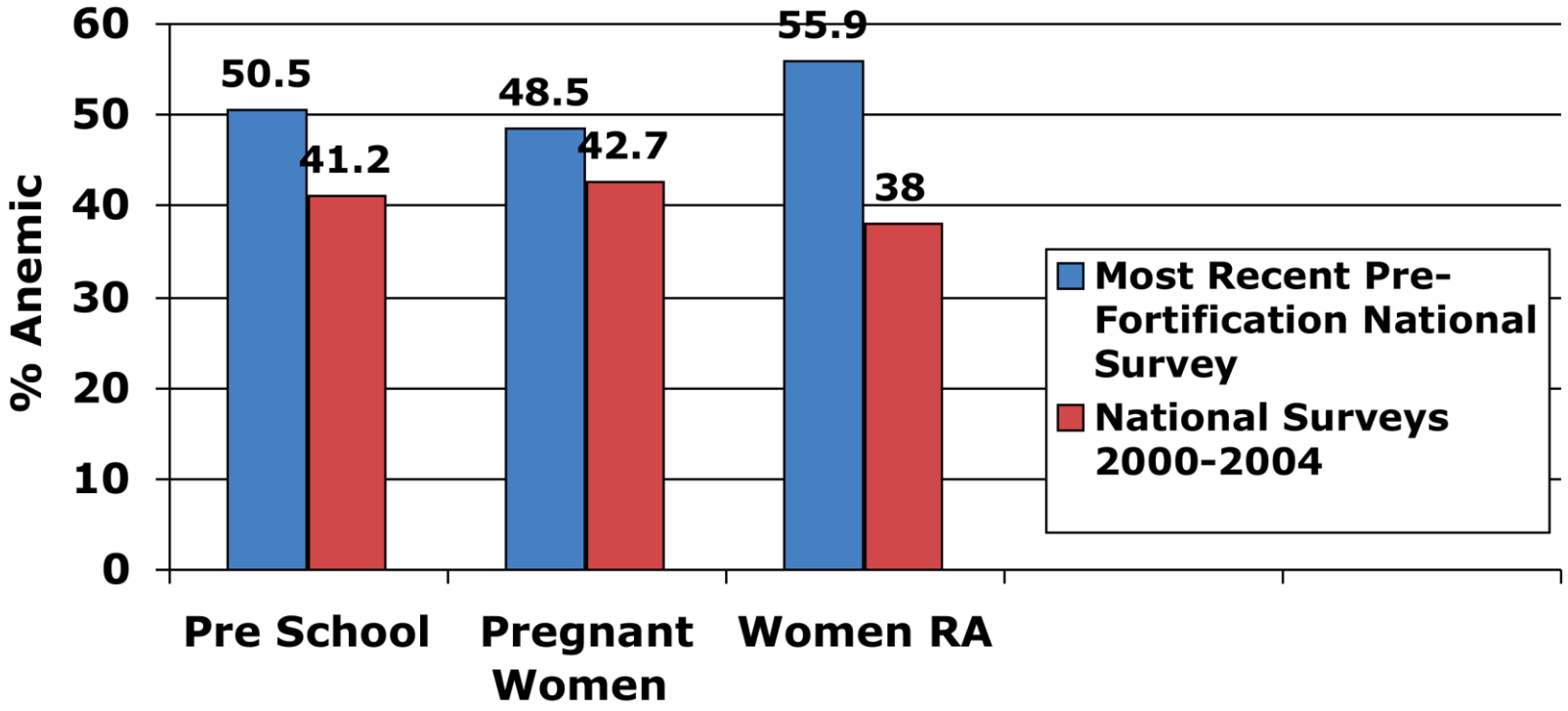
GDP: $8,690 $12,135 $7,640 $17,220

*Reported at WHO EMRO Consultation July 2000

Venezuela: Pre-Post Fortification Changes in Anemia & Iron Deficiency



Oman: Pre-Post Fortification National Decrease in Anemia 18-32%



Chile Folic Acid Fortification: 40% Decrease in NTDs