Rice Fortification: A key Part of the Solution to Micronutrient Deficiencies

Agriculture and Rural Development and the Health, Nutrition and Population Team
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Acknowledgements

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Members of the Rice Fortification Resource Group
Why invest in rice fortification?

"... investments in micronutrients have higher returns than those from investments in trade liberalization, in malaria, or in water and sanitation.... No other technology offers as large an opportunity to improve lives at such low cost and in such a short time."
—Copenhagen Consensus, 2004

"Micronutrient deficiencies alone may cost India US$2.5 billion annually and the productivity losses (manual work only) from stunting, iodine deficiency, and iron deficiency together are responsible for a total loss of 2.95 percent of GDP."
—S. Horton, 1999
Millennium Development Goals

1. **Goals 1 & 3**
   - IRON $\rightarrow$ improves productivity $\rightarrow$ improved income
   - IRON $\rightarrow$ improves cognition $\rightarrow$ improved education & income

2. **Goal 2**
   - IRON $\rightarrow$ improves cognition $\rightarrow$ improved school attendance & achievement

3. **Goal 4 & 5**
   - IRON $\rightarrow$ lowers anaemia $\rightarrow$ reduces peri natal mortality
   - ZINC $\rightarrow$ increases immunity $\rightarrow$ reduces under 2 mortality
   - FOLATE $\rightarrow$ lowers neural tube defect $\rightarrow$ reduces under 5 mortality

4. **Goal 6**
   - VIT.A & ZINC $\rightarrow$ Strengthen immunity $\rightarrow$ combats infection
Global rice production

430 million metric tons produced annually

Each dot represents 5,000 hectares of rice
<table>
<thead>
<tr>
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<tbody>
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<td>31,000</td>
<td>30,000</td>
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<td>37,090</td>
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<td>4,972</td>
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<td>5,100</td>
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<td>10,400</td>
<td>13,650</td>
<td>13,785</td>
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<td>Thailand</td>
<td>19,400</td>
<td>20,000</td>
<td>10,292</td>
<td>9,600</td>
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<td>Vietnam</td>
<td>24,430</td>
<td>23,795</td>
<td>19,150</td>
<td>19,150</td>
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<tr>
<td><strong>11 Country % Global</strong></td>
<td><strong>36%</strong></td>
<td><strong>37%</strong></td>
<td><strong>34%</strong></td>
<td><strong>34%</strong></td>
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<tr>
<td>China</td>
<td>134,330</td>
<td>136,000</td>
<td>129,300</td>
<td>132,500</td>
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<tr>
<td>India</td>
<td>99,150</td>
<td>83,000</td>
<td>93,150</td>
<td>89,000</td>
</tr>
<tr>
<td><strong>2 Country % Global</strong></td>
<td><strong>52%</strong></td>
<td><strong>51%</strong></td>
<td><strong>51%</strong></td>
<td><strong>51%</strong></td>
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<tr>
<td><strong>Global Total</strong></td>
<td><strong>445,772</strong></td>
<td><strong>432,091</strong></td>
<td><strong>435,494</strong></td>
<td><strong>436,841</strong></td>
</tr>
</tbody>
</table>
Rice Imports/exports 2008

30 million metric tons traded internationally
Low Income & Food Deficit Nations Import Proportionately More Rice

Rice Proportion All Cereal Imports

% Rice

World  Least Developed  Developing Food  Low Income Food
Countries    Countries    Importing Countries    Deficit Countries


0%  5%  10%  15%  20%  25%  30%  35%
Rice is Well Targeted Food Vehicle to Reduce Vitamin & Mineral Deficiencies

- **Consumption Patterns**
  - Poorer and Least Developed Countries Rely More on Rice as their Primary Staple than Global Average.
  - Food Deficit Countries Rely More on Rice than Average Food Importing Developing Countries.

- **Trade Patterns**
  - Least Developed Countries Import Much More Rice than Average Food Importing Countries.
  - Food Deficit Countries Import Much More Rice than Average Food Importing Developing Countries.
Nutrition Protection Scenario: What If Current Average Intake Fortified?

Iron from Fortified Rice When Average Consumption Fortified to WHO Flour Fortification Recommendation

- **SE Asia**: 7.2 ppm
- **South Asia**: 6.2 ppm
- **South America**: 5.0 ppm
- **West Africa**: 5.7 ppm
- **North Africa**: 3.5 ppm
- **Near East Asia**: 3.5 ppm
- **Central America**: 2.9 ppm
- **WHO EAR**: 13.4 ppm

![Bar Chart]

- Native Iron @ 8 ppm
- Fortification @ WHO Recommendations
West Africa Nutrition Protection Scenario: What if Current Average Intake of Rice & Flour was Fortified?

% EAR for WRA: 13/4 mg/dy

- Wheat Flour
- Rice

Countries: Benin, Burkina Faso, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo
What’s Industrially Feasible in the Short Term?

- **Not Currently feasible:**
  - Decentralized Industry
  - Non-Formal Industry
  - Village Level Mills

- **Currently Feasible:**
  - Domestic Production:
  - Large Mills
  - Public Programs Warehouses

- **Imports:**
  - Large Facilities & Companies
  - Only few Exporting Nations
  - 30 million MT
  - ~ 7% global consumption

Rough Segmentation for Philippines Country:

- Private Small & Old 65%
- Imports 14%
- Public Mills 7%
- Large Private Mills 14%

35% Feasible to Fortify
Production Options: Older Technologies

Most current commerce in fortified rice uses these technologies. No evidence and in fact some doubts about effectiveness.

Dusting with powder premix

Vitamins and minerals are applied to rice kernel, followed by coatings of water insoluble substance to avoid rinse off

- Lowest Price Option
- Removed by washing and cooking
- Segregation in packaging and storage
- No efficacy/effectiveness data – But doubtful
- Widely Used in US and traditional fortified rice markets

Coating with premix in waxes and gums

The fortificant mix is combined with waxes and gums. The mixture is sprayed to the rice on the surface of grain kernels in several layers to form the rice-premix

- Product discoloration and consumer acceptance issues
- Losses during washing
- No efficacy/effectiveness data
Simulated rice kernels: Extruded fortified “faux rice” kernels added to rice during milling at 10-20 kg per Metric Ton.

Hot extrusion

Dough of rice flour, fortificants, and water passed through a single or twin screw extruder at 70-110°C and cut it into grain-like structures that resemble rice kernels, to form premix.

- Sophisticated technology
- High product quality
  - Similar sheen, consistency, transparency as natural rice
- Efficacy studies ongoing
- Implemented via small or large scale extrusion facilities.
  - Relatively high capital investment, relatively lower running costs
  - One large and one small facility in Asia
  - Global Milling and Vitamin Companies (DSM, Buhler, Taiyo, Sataki)
Cold extrusion

Rice-shaped simulated kernels are produced by passing a dough of rice flour, fortificant mix, and water through a simple past press at normal temperature to produce a premix.

- Appearance close to natural rice – though a bit opaque
- Efficacy/effectiveness proven
- Implemented via small to medium scale rice manufacturers
- Relatively lower start-up and capital costs, but relatively higher running costs
- NGO/Gates Foundation supported effort
Biological efficacy of iron fortified rice in Indian school children

Iron deficiency prevalence reduced: (measured by serum ferritin/transferrin receptor)

- 78% to 25% (iron group)
- 79% to 48% (control)

Significant time x treatment interaction (p<0.01)

IDA prevalence reduced:
- 30% to 15% (iron group)
- 28% to 27% (control)

Moretti et al, 2006
Efficacy in Young Children in Brazil, age 6-24 months

- Compared effectiveness of iron-fortified rice and iron drops (control)
- Statistically significant decrease in iron deficiency and anemia between fortified rice group and control (P<0.01)

Decrease in iron deficiency:
Iron Group: 69% to 25%
Control Group: 77% to 53%

Decrease in anemia:
Control: 100% to 85.6%
UR Group: 100% to 62%

• 80% reduction in anemia in fortified rice group
• 29% reduction in iron deficiency
• Statistically significant reduction (P<0.05)

Both Hot and Cold extruded rice performed well in comparison to traditional rice, in fact they both performed better than traditional rice in the area of “taste good.”
Acceptability in Nicaragua
Results of a study commissioned by MINSA and UNICEF in January 2010

Both hot (NutriRice) and cold extruded (UltraRice) rice performed well in these organoleptic tests against traditional rice.

Note: NutriRice made on cold-extrusion equipment
## Affordability

<table>
<thead>
<tr>
<th>Country</th>
<th>Retail rice price (US$/kg)</th>
<th>Technology</th>
<th>Estimated Rice-premix cost (US$/kg)</th>
<th>Estimated cost of rice fortification (US$/MT)</th>
<th>Retail price increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>0.50</td>
<td>Hot extrusion</td>
<td>$2.00</td>
<td>$10-$20</td>
<td>2 - 4%</td>
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<tr>
<td>The Philippines</td>
<td>0.55</td>
<td>Coating</td>
<td>$2.00</td>
<td>$10.00</td>
<td>1.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hot Extrusion</td>
<td></td>
<td>~$12.00</td>
<td></td>
</tr>
<tr>
<td>Costa Rica</td>
<td>0.63</td>
<td>Cold extrusion</td>
<td>$2.11</td>
<td>$10.55</td>
<td>1.7%</td>
</tr>
<tr>
<td>India</td>
<td>.52</td>
<td>Cold Extrusion</td>
<td>$1.43 - $1.57</td>
<td>$14.7</td>
<td>1.5 - 2.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hot Extrusion</td>
<td>$3.10</td>
<td>$31</td>
<td>6%</td>
</tr>
</tbody>
</table>

As Production Scales-Up and Volume Rises, Price should come down.
In recent years, rice price has fluctuated roughly between 30 – 78 US cents per kg of rice; additional costs to fortify rice is minimal compared to price fluctuations – 0.8 to 2.5 US cents per kg.
Everybody wants it but Efforts Scattered and Relatively Small Scale

- **China**: Large scale facility but very small market penetration ‘specialty rice’, upscale market (*hot extrusion*)

- **Philippines**: mandatory rice fortification: 2-4% of national rice consumption being fortified through government safety net program
  - coating –imported (from US) and *some hot extrusion* (domestic)

- **India**: Pilot fortification of rice in MDM program (Akshaya Patra and Naandi Foundation (*cold extrusion*)

- **Indonesia**: Pilot program to reach 800 thousand poor families by mid 2012 via government distribution program (*extrusion*)
Everybody wants it but Efforts Scattered and Relatively Small Scale

- **Costa Rica**: mandatory rice fortification – variable implementation (*coating and cold extrusion*)
- **USA**: 70% rice voluntarily fortified under national FDA standards (*dusting*) Mandatory in 6 states
- **Brazil**: Fortified rice introduction in 3 Municipal school meal programs (Mato Grasso do Sul, Minas Gerais, Sao Paolo) (*cold extrusion*)
- **Nicaragua**: Ministerial resolution requiring fortification; lack of implementation (*cold extrusion*)
Opportunities

- **Large Producing Countries**
  - Fortify at large facilities for:
    - Potential Commercial Markets (Urban Poor)
    - Targeted Public Programs: Indonesia RASKIN, Philippines NFA, India PDS

- **Exporting Countries**
  - 30 million MT in formal large scale trade. (several large facilities in Vietnam and Thailand represents 50% of this trade).
    - Increasing market shares in Africa and Asia

- **Food Aid**
  - ~ 1 million MT/year
  - WFP Programs
    - Not in newer technologies.
  - US Title II: Recent Recommendation
    - Tufts Food Aid Quality Review to Fortify Rice at same fortification profile as milled wheat flour or cornmeal – but with efficacy confirmed.

- **World-Class Technology Partners**
  - Global Companies developing hot extrusion
  - Gates Foundation & Global NGO developing cold extrusion
Limited Supply of Rice Premix:
- Few facilities
- Increasing supply involved start-up of new facilities

Investment:
- Cold extrusion:
  - Decentralized and relatively small scale (size/output of pasta plant)
  - Capital Investment ~$1-300k
- Hot extrusion
  - Centralized and Large (size of Buhler Mill?)
    - Smaller scale possible but running costs thought higher
    - Facilities require multi-million investment (do you have the figures?)

Issues:
- For efficiencies of scale is there room for investment in more than one option?
- How much will it really cost at a commercially sustainable scale?
- Who will make a clear and unbiased investment case?
- How can the risk of initial investment be mitigated?
Challenges to Introducing Newer Technologies

- **Need level or transparent playing field recognizing different technologies**
  - Widely varying cost, performance and effectiveness.
  - Cooperative yet Competitive Technical Partners
  - Need for credible technical and commercial guidelines

- **Status of R & D:**
  - GAIN Stability Trials
  - WHO Guidelines
  - Effectiveness and Efficacy Trials:
    - Several efficacy studies competed
    - Future effectiveness from Programs in India, Indonesia etc.

- **Issues:**
  - What is the process to decide among technologies?
  - With completion of initial R&D what is the process to “endorse” or prioritize technologies?
Challenges to Introducing Rice Fortification: Market Data

- **Analysis to Determine how much is market share feasible?**
  - Need data on Potential Market Share for Fortified Domestic Production. More in depth market analysis needed.

- **Research/Open Communications Channels to big players in rice Industry?**
Challenges to Introducing Rice Fortification: Leadership & Coordination

- Scattered Efforts
- Lost Opportunities & Synergies
- Lack of guidance on the different fortification methods
- Skepticism on feasibility of rice fortification/ potential benefits
- Inadequate scientific and technological information for planning and decision making
Global Multi-sectoral Rice Fortification Alliance Meeting
Sydney, Australia, Dec 1-4, 2009

Civic Sector

RiFoRG

Private Sector

Public Sector

Advocacy associations, civil organizations

Millers, equipment & rice-product companies, rice traders

UN Agencies, government agencies, NGOs, academia
Integrated plan of action

Catalyse, support and sustain the operation of this global partnership

- Bring together stakeholders and help them build and support rice fortification nationally and regionally

Support rice eating countries to move forward in their fortification programs

- Assess rice supply chain structure and market size, need/demand for fortification, feasibility and cost-effectiveness of rice fortification

Develop international guidelines for rice fortification

- Information on the optimum level of fortification, choice of appropriate micronutrients, the selection of the fortificant compounds

Establish technical support and advocacy groups

- Create and disseminate communication & training and technical support materials in key areas
**Pacific Region**

**Challenge: Developing a Regional standard**
- Agreed that rice fortification should be included on the agenda of the Food Summit
- Create a regional standard for fortification
- Mobilising support from a range of stakeholders
- Develop cost benefit analysis

**Key countries:** Fiji, Samoa, Solomon Islands and Vanuatu (PNG already fortifying using coating techniques)

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**Vietnam**

**Challenge: Advancing rice fortification**

**Government requesting to move on rice fortification**

- Advocacy & development of political commitment to food law
  - Development of standards & regulation for mandatory food law
  - Study rice milling industry and structure
  - Building country capacity for enforcement & implementation

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**Sri Lanka**

**Challenge: Moving the law into application**
- Impact evaluation of micronutrient fortification
- Study rice milling industry and structure
- Advocate government to adopt fortification
- Cost benefit analysis
Key Opportunities

**West Africa**
- Rice provides ¼ average Calorie and Protein Intake
- 60% imported via large scale industry
  - Mainly parboiled rice
- Food Aid ½-1 million MT/yr globally (3-4% of Imports)

**Asian Public Programs**

**Indonesia**: Rice fortification for the poor (Raskin Program)
- Build the capacity of rice mills contracted by the National Procurement Corporation
- 24,000 metric tons of iron-fortified rice to be delivered to 800,000 people over 2 years.

**India**: Nationwide Public Distribution System targeting the poor
- Potential to deliver micronutrients to large sections of the population

**Philippines**: National Food Authority to fortify all of the rice it distributes

**Challenges**
- Unfavourable political climate (Thailand, Myanmar, Cambodia)
- Difficulty in penetrating rice supply chains
Summary

How could the World Bank be an active partner:

- Help put rice fortification on the development agenda:
  - Link it to the Bank’s nutrition improvement strategy
  - Advocate support for expansion of rice fortification

- Provide support to scale up rice fortification
  - Identify and support key countries regions/countries for implementing rice fortification at national scale

- Develop cost benefit models
  - Build cost effectiveness models for major rice consuming nations

- Convene a Nutrition Science meeting to bring this issue to the fore of the public health agenda
  - Dispel some of the skepticism surrounding the feasibility and impact of fortifying rice