Rice Fortification: Why, What, How and Global Evidence

5 November, 2014

2nd International Workshop on Micronutrients and Child Health

New Delhi

Content

Provide a summary of the evidence on rice fortification and rationale for it being part of the solution to micronutrient deficiencies

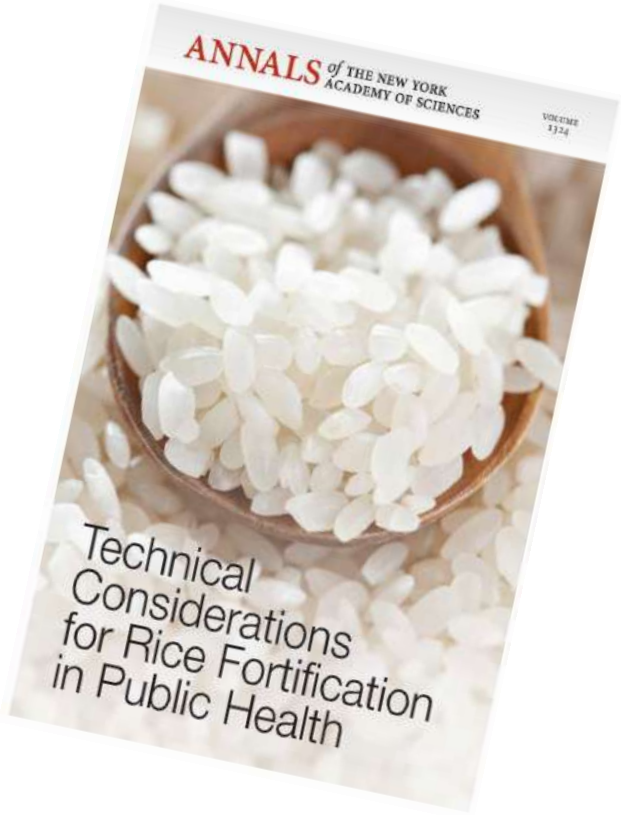
Provide update on WFP's work in nutrition for MNCH

1. Why, What and How
2. Summary of the current evidence
3. Way forward, including challenges and next steps

Building Consensus on Rice Fortification

- **Technical Consultation meeting organized by WHO in collaboration with GAIN for Rice Fortification in Public Health, September 2012**

Review the industrial and regulatory technical considerations in rice fortification



Bangkok Meeting on Rice Fortification – September 2014

Scaling Up Rice Fortification in Asia, hosted by FFI, PATH, WFP, MI, UNICEF and GAIN

Consensus:

1. Evidence of widespread micronutrient deficiencies
2. Rice consumption is high
3. There are different technologies that can be used to fortify rice, of which extrusion is the best researched
4. Evidence of impact for a number of nutrients
5. We should build on existing cereal fortification guidelines, including the interim statement on flour fortification

Why rice fortification?

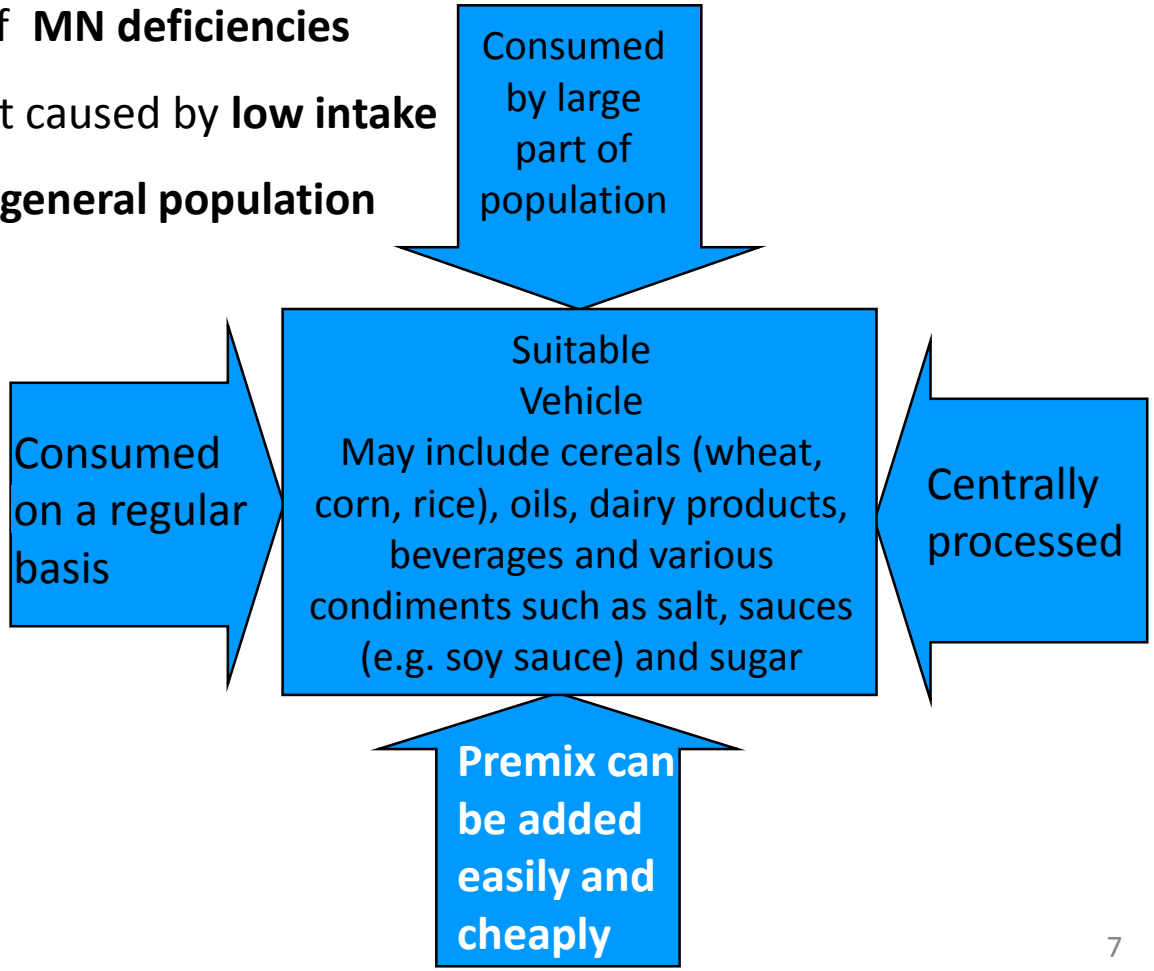
- Large % of the population relies on rice as the main staple food
- Rice provides a large share of caloric intake (50-70%)
- MNDs are high in rice-consuming areas
- Polished rice is a poor source of key vitamins and minerals
- Fortification has been identified as a very cost effective intervention
- Technology now exists

‘Rice’ Fortification

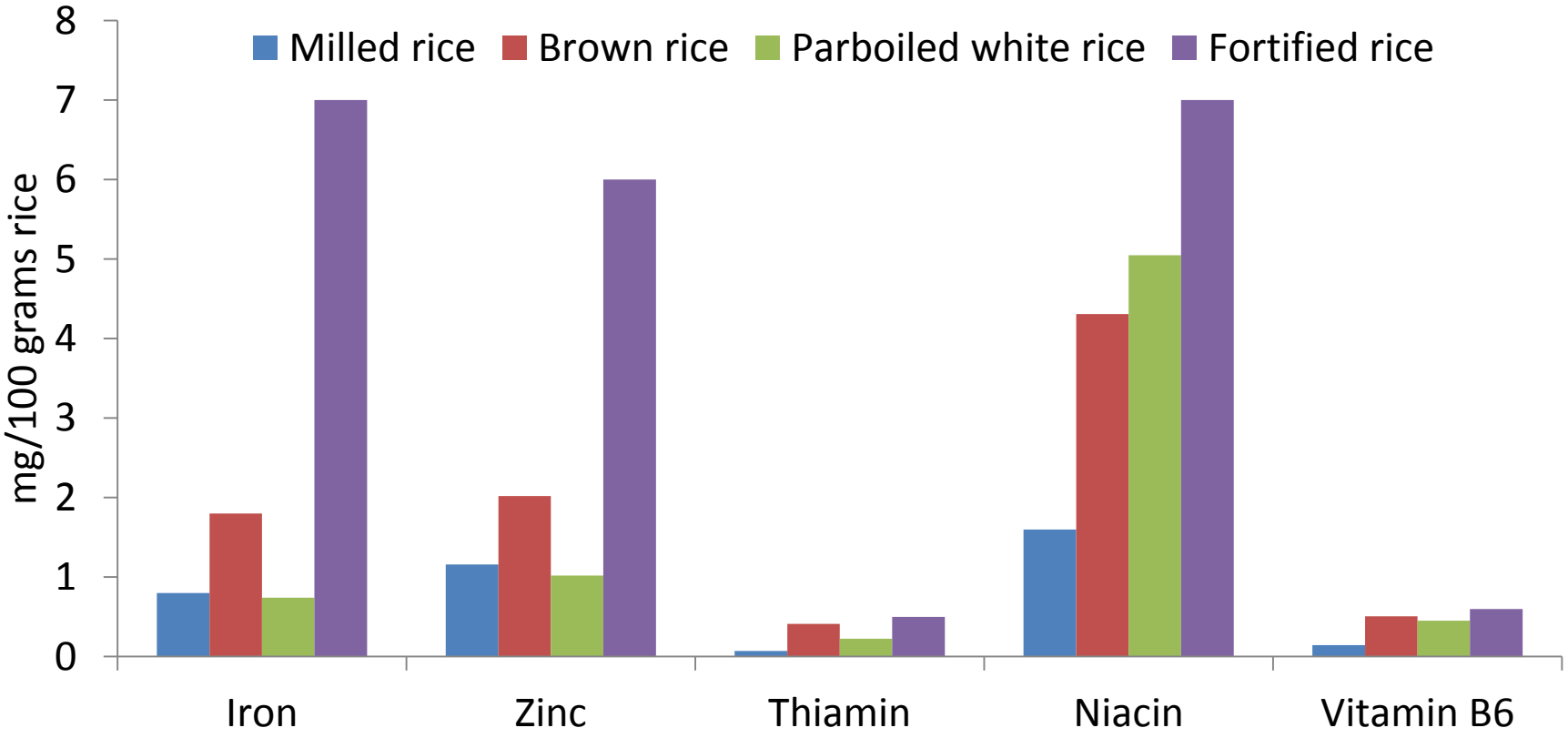
Does micronutrient (MN) intake need to be increased & selecting the vehicle

Micronutrient fortification may be appropriate if…

- Evidence indicates presence of **MN deficiencies**
- Deficiencies are to large extent caused by **low intake**
- MN deficiencies exists among **general population**



Other ways to improve micronutrient content of rice



Available technologies

Coating

Extrusion

- Cold
- Warm
- Hot

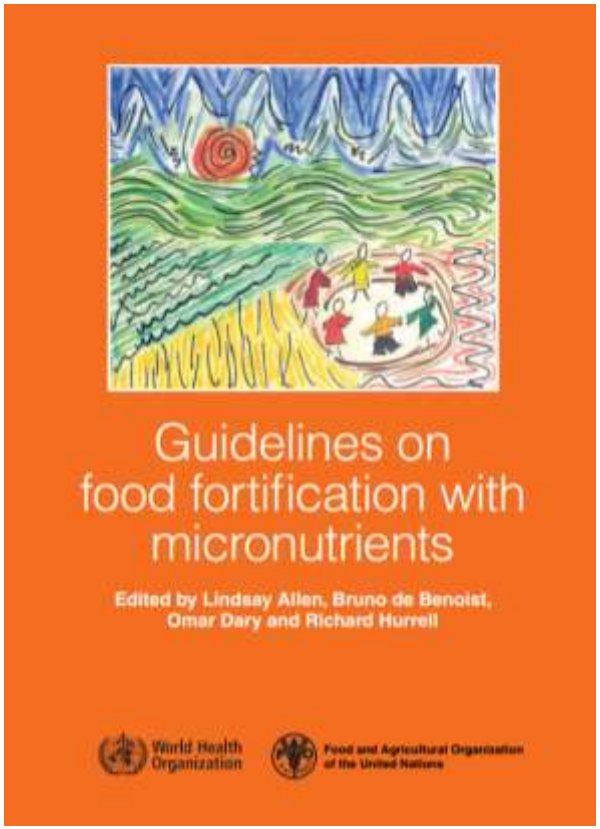
Biofortification

Saman Rice Mill in Uruguay. Photo by Angela Rowell.

Objective of rice fortification?

- For staple food fortification, the target is getting consumers above the Estimated Average Requirement
- Improved micronutrient intake, but not eliminate all MNDs
- Who has high needs, who is likely to benefit from fortified rice?
  - WRA, adolescent girls, men, SAC
  - PLWs will benefit but not meet needs
  - 6-23 months need more nutrient dense foods

Which MN to consider for rice fortification & ensuring it is effective



Consider wider food fortification expertise & experience

Which micronutrients are of interest?

- Consider public health needs and nutrient gap
- Refer to WHO's guidelines on food fortification and interim consensus statement on flour fortification
- Compare maize and wheat flour fortification to rice

Can micronutrients be **successfully added** to rice and **absorbed** by the body?

Several requirements for successful rice fortification

Storage → Preparation → Acceptability → Absorption

Impacted by: choice of fortificant forms, choice of fortificant mixture, fortification technology

Stability during storage

Limited losses during preparation: washing, cooking, discarding excess water

Acceptability to consumer: appearance (shape and colour), taste

Availability for absorption by the body

Efficacy

Effectiveness

Which Micronutrients to Add to Rice

As for maize and wheat flours:

Iron

Folic Acid

Vitamin B12

Vitamin A

Zinc

For rice, also add MN lost through polishing:

Thiamin

Vitamin B6

Niacin

Many others also possible, such as:

- Vitamin E
- Vitamin D
- Selenium
- Lysine

Possible, but:

- Riboflavin
- Beta-carotene
- Calcium
- Vitamin C
- DHA
- Iodine

De Pee S. Annals NY Acad Sci 2014

Evidence

Impact of fortifying rice with different MN – 15 published papers

Micronutrient	Fortificant forms	No. of studies that included the micronutrients
Iron	MFPP (ferric pyrophosphate) / FeSO4	14 / 1
Zinc	Zinc oxide	1
Folic acid	Folic acid	1
Vit B12	Cyanocobalamin	1
Vit A	Vit A palmitate	4
Thiamin	Thiamin	2
Niacin	Niacinamide	0
Vit B6	Pyridoxine hydrochloride	1

Characteristics of Study Populations

Study populations:

- Philippines, India, Thailand, Nepal, Brazil, Mexico
- School-age children , women of reproductive age, preschoolers, 6-23 mo old children
- Some studies targeted anemic individuals

Important to note:

- First study ‘47-’49, Philippines, coated rice, iron, B1, B3 – focused on beri-beri
- All other studies on extruded rice (hot & cold)
- 13 Efficacy, 2 effectiveness studies
- 10 studies on Fe only, 4 multi-MN, 1 VA only
- School children, one meal per day

Impact of fortifying rice with different MN – study results

Micronutrient		Study details
Iron		14 studies
Zinc		1 – Pinkaew (2014) – Thailand – 20 mg/meal**, non-sign increase**
Folic acid		1 – Thankachan (2012) – India – 75 ug/meal, **sign decrease of homocysteine**
Vit B12		1 – Thankachan (2012) – India – 0.75 ug/meal, **sign increase of plasma B12**
Vit A		4 studies
Thiamin		Salcedo (1950) – Philippines – 0.44 mg/100 g **– beri beri prevalence dropped** (14.3 to 1.5%); Thankachan (2012) – India – 0.38 mg/meal – **non-sign increase**
Niacin	-	0 studies
Vit B6	-	1 study, but B6 status not assessed

Studies on Vitamin A fortified rice

Reference	Country	Study group	Dosage	Findings
Pinkaew 2014	Thailand	8-12 y olds	3000 RE/d	BL serum retinol 1.21 umol/L – total body retinol increased – BL serum retinol unchanged
Pinkaew 2013	Thailand	4-12 y **old**	2500 RE/d	BL serum retinol 1.01 umol/L - No sign increase
Thankachan 2012	India	6-12 y old	500 RE/d	BL serum retinol 2.1-2.6 umol/L – No change
Haskell 2003	Nepal	Nightblind pregnant women	850 RE/d	Serum retinol increased in all groups, most in liver & high-dose capsule groups

Conclusion: Improvement of VA status depends on baseline status & indicator used

Studies on Iron Fortified Rice

Characteristics:

- 13/14 studies MFPP, 1 study both MFPP & FeSO4
- 10 iron only fortification
- 3 papers, Arcanjo et al (Brazil), one 50 g meal/wk, 56.4 mg Fe
- Other studies 6-30 mg Fe/meal, mostly 1 meal/d – school children = efficacy
- More than one meal per day: 1 study – effectiveness, fortified rice given to households (Angeles-Agdepa 2011)
- Blending: 0.5-2.5%
- No reporting on color of kernels – controlled studies, no acceptability issue
- If blending at 1%, max iron content without color change: 7 mg/100 g. If consuming 200-300 g/d = 15-20 mg/d

Thus, mostly well-controlled studies, 1 meal/d among school children

Studies on iron fortified rice (n=14)

Results:

- 2 did not report on Hb or iron status
- Hb improvement / anemia decline – 6/12 studies
- Iron status parameters improved – 6/8 studies

Note:

- Hb not only affected by iron deficiency
- Baseline Hb not that low in some of the studies
- One meal per day studies have higher ratio for iron to absorption inhibitors – thus, under real life, iron absorption may be lower

Summary:

* Most found impact on iron status and anemia
* Studies mostly one-meal-per-day studies
* MFPP not most bioavailable iron fortificant, but only one that does not affect colour and taste

Summary of Evidence

Evidence for impact on MN status:

- Good enough for: Iron, vit A, folic acid, thiamin, vit B12
- Plausible for: Niacin
- To be confirmed for: Zinc, vit B6

Research for further optimization:

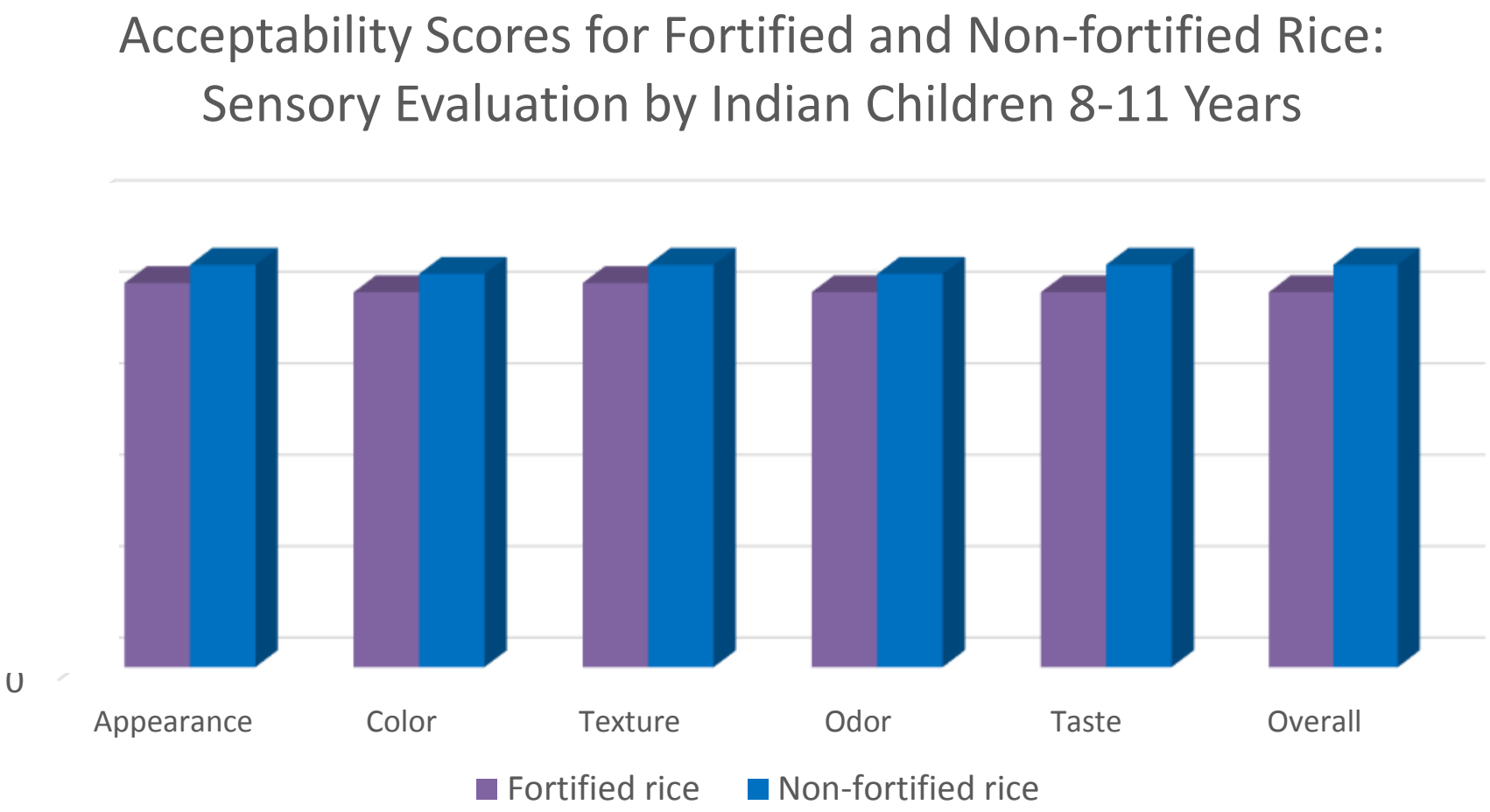
- Iron form – higher absorption, while maintaining good acceptability
- Study multi-MN fortified rice & different technologies
- Scenario's: every meal from fortified rice, e.g. social safety net

When assessing PROGRAM impact – monitor process & outcome

Fortification	Distribution	Consumption	MN retention	MN status & function
				
Is rice fortified as agreed (QA & QC)?	Does rice reach the population as intended?	Do people consume the rice at expected level?	Does the rice contain the expected MN at consumption?	Does MN status and function (morbidity, cognition) improve?

Effectiveness

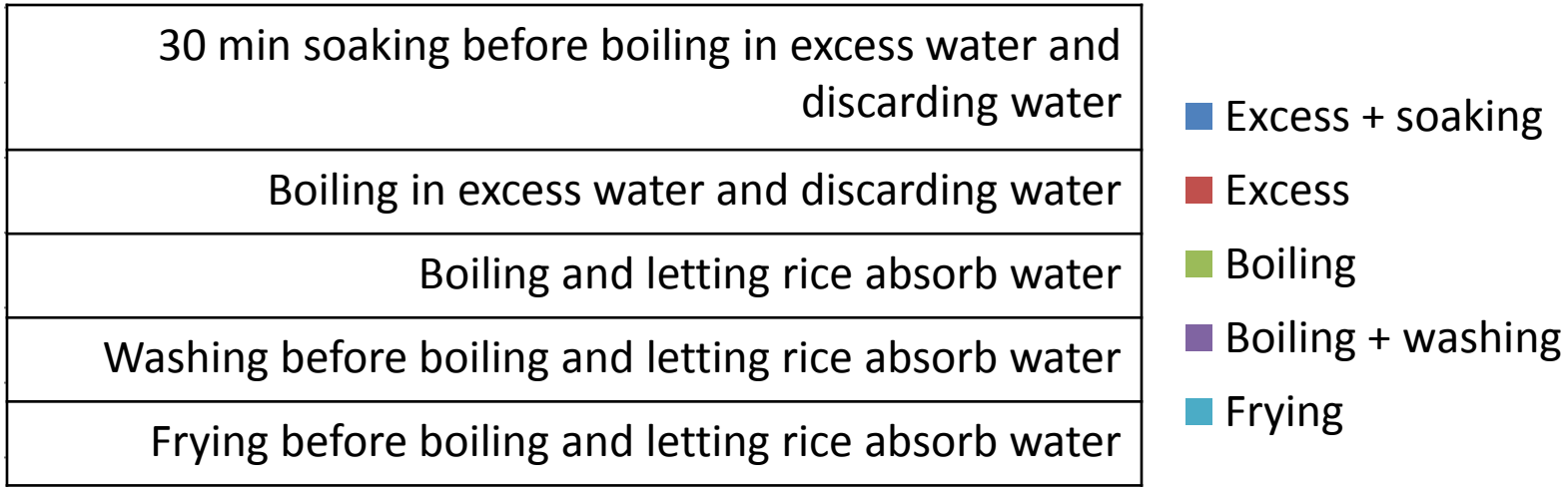
Is fortified rice acceptable?



Radhika 2011; extruded rice

Are the nutrients in fortified rice retained after preparation and cooking?

Percent Retention of Nutrients Exposed to Different Preparation and Cooking Methods: Average for Coating, Cold Extrusion & Hot Extrusion



Wieringa 2014

Next Steps – Opportunities and Further Work

- Significant progress has been made
- Growing interest and consensus among many stakeholders
- Important opportunity to address micronutrients

- Complexity of implementation
- Kernel availability
- Local production and small-scale milling
- Policy and regulation – leadership and a coalition
- Optimization of fortificants: ongoing, especially for iron, and these findings can be incorporated when available
- Costs – who picks up the additional costs -- Cost-benefit

Thank you and Acknowledgements

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Scott Montgomery, FFI

Additional Slides

Parboiling – indirect fortification

- Treating with hot water and/or steam enhances intrinsic nutrients
- Additional nutrients not usually included
- Efforts to get external nutrients into the grain (iron, zinc, folic acid) have been studied

DSM research and C. Prom-u-thai, 2011

Dusting

- All rice grains dusted with a fortificant mix
- Limited nutrient protection
- Sedimentation risk
- Frequently done in USA
- Due to nutrient loss, not suitable in countries where rice is washed or where excess cooking water is discarded

Overview: creating fortified kernels to blend with non-fortified rice grains

Applies to coating and extrusion

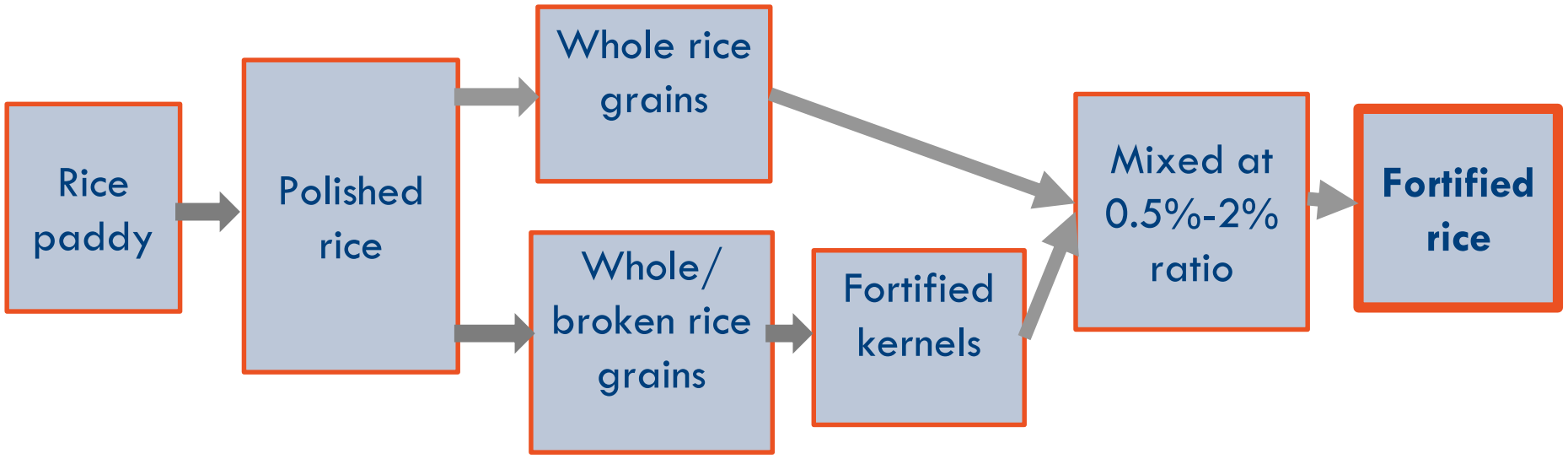


Chart adapted from Steiger 2012

Coating

- Nutrients are added in coating layer on the rice surface
  - Several coating technologies; different performance of FK
  - Some rinse-resistant; some not
- Native rice variety can be coated
- Either broken or whole grains can be coated
- Nutrients disperse in rice upon cooking; allows higher concentration of nutrients in FK

Examples of fortified rice made by blending coated kernels with non-fortified rice. Wright Group photo.

DSM and Wright Group research

Extrusion

1. Broken rice grains can be used as starting material
2. Micronutrients are equally distributed inside the fortified kernel
3. Only few particles are on the surface, thus reducing exposure to environment and nutrient degradation
4. Color impact from micronutrients depends on nutrient formulation

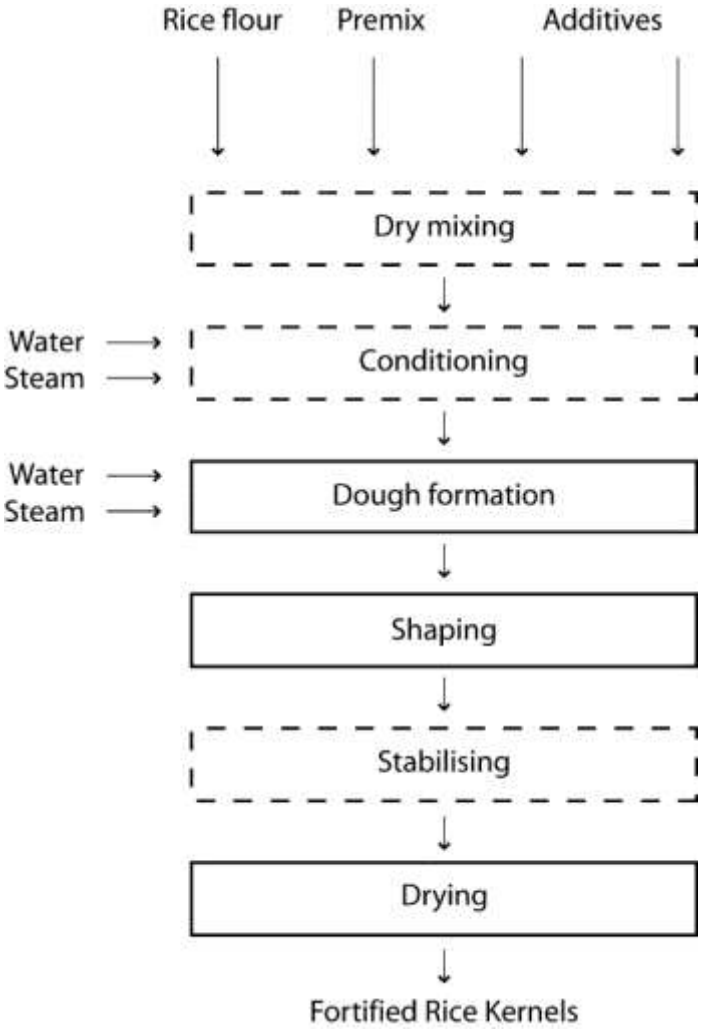
Extrusion technologies

Temperature influences appearance and cooking characteristics of final fortified kernels

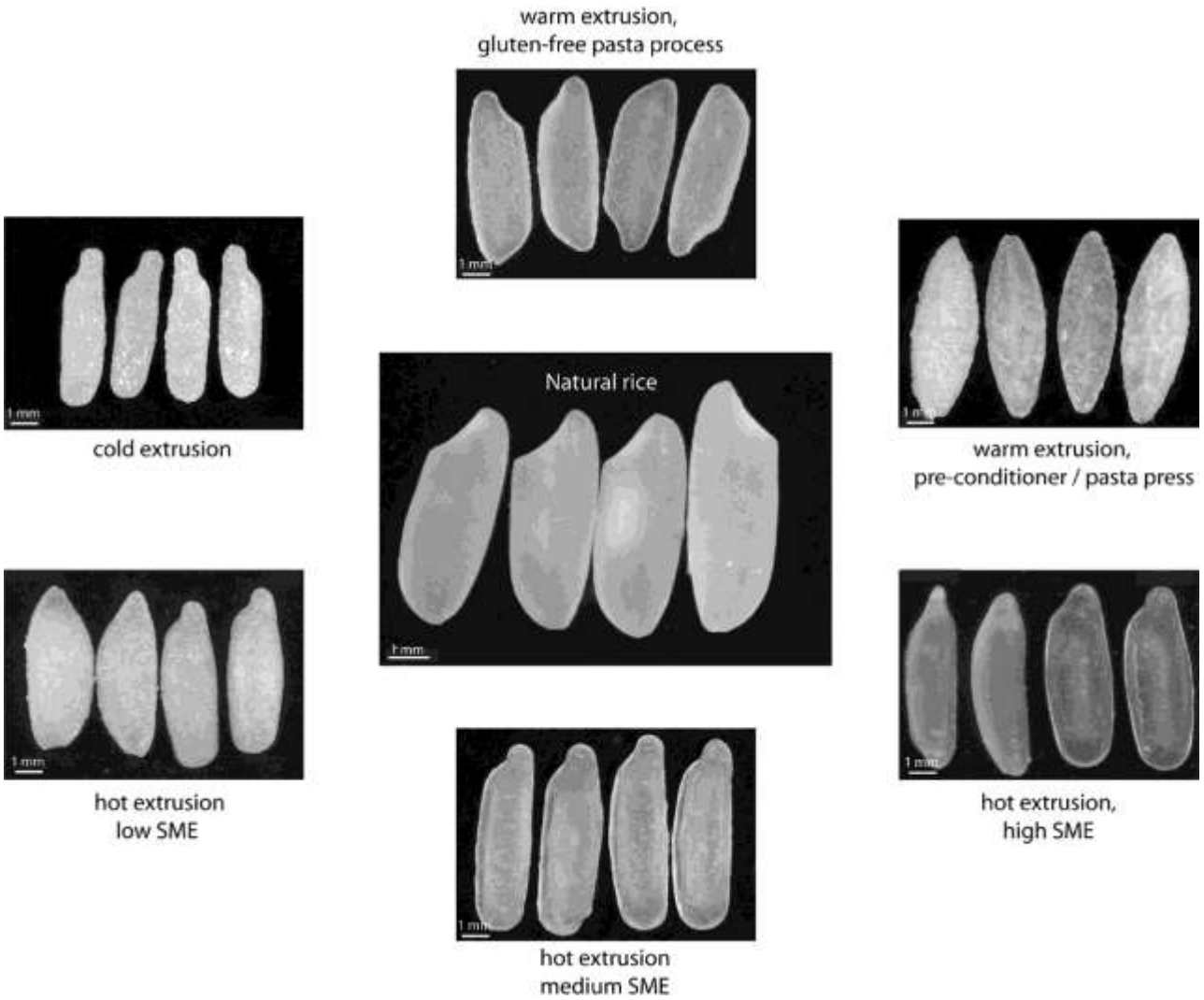
- Cold extrusion uses a pasta press at 30 – 50°C
- Warm extrusion includes a preconditioner and uses a pasta press or extruder (single or double) at 60 – 80°C
- Hot extrusion includes a preconditioner and uses a extruder (single or double) at 80 – 110°C

DSM research
Photo: Bühler Group hot extrusion equipment

Basic extrusion steps



Appearance of fortified kernels



From: Steiger et al. Fortification of rice: technologies & nutrients. NY Anals 2014