

# Evidence & Current Status of Rice Fortification and Lessons Learned from Grain Fortification



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**Food Fortification Initiative**  
Enhancing Grains for Healthier Lives

First Workshop for the Promotion  
of Rice Fortification in Latin  
America and the Caribbean  
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Republic

I am pleased to make this presentation on behalf of my colleague Becky Tsang. We thank the organizing committee for the opportunity to share these experiences with you.

We are happy to make this presentation available to you as well as all of the documents we cite—please contact me if you would like these.



We will start with the key messages from this presentation.



Rice fortification can produce a  
public health impact.  
Evidence is strongest for iron.  
There is less research for other  
nutrients.

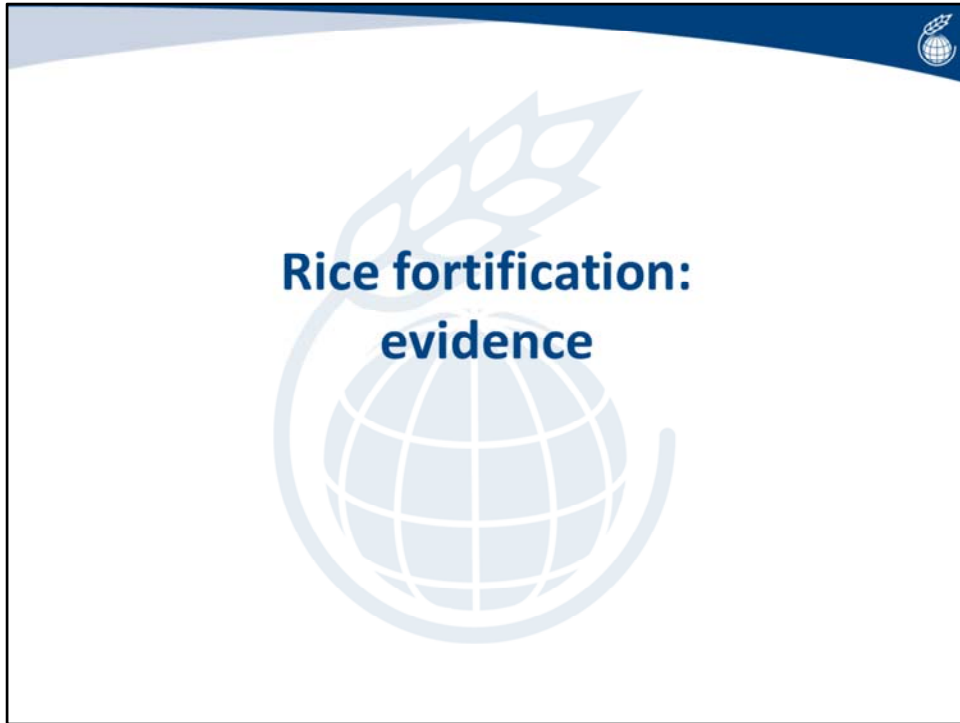


Rice fortification at national scale is only implemented in a few countries.

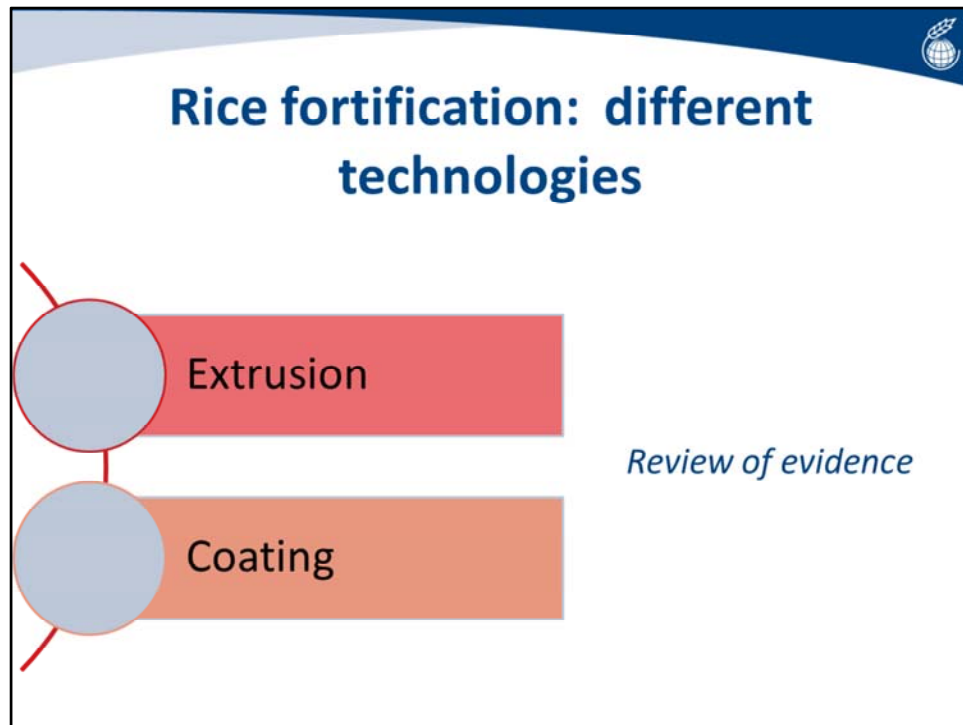
Several sub-national efforts indicate that rice fortification is growing.



Lessons learned in past grain fortification can be applied towards successful rice fortification programs in Latin America and the Caribbean.



Now we will move to the evidence of the impact rice fortification can make on nutrition and health outcomes.



Extrusion and coating are two of the main technologies used globally to fortify rice.

We will hear about these in further detail later on in the workshop.

I am going to review with you the evidence we have for extrusion and coating.



## Does rice fortification have a health impact?

<p><u>Efficacy</u></p> <ul style="list-style-type: none"><li>• “The extent to which a specific intervention, procedure, regimen, or service produces a beneficial result <u>under ideal conditions</u>...Ideally, the determination of efficacy is based on the results of a <u>randomized controlled trial</u>.”</li></ul>	<p><u>Effectiveness</u></p> <ul style="list-style-type: none"><li>• “...the extent to which a specific intervention, procedure, regimen, or service, <u>when deployed in the field in the usual circumstances</u>, does what it is intended to do for a specified population.”</li></ul>
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Porta 2008

The question we are often asked is whether rice fortification has a health impact.

We have two kinds of studies to answer that. The first are efficacy studies which tell us the extent to which fortification produces a beneficial result under ideal conditions. Usually, efficacy is based on the results of randomized controlled trials.

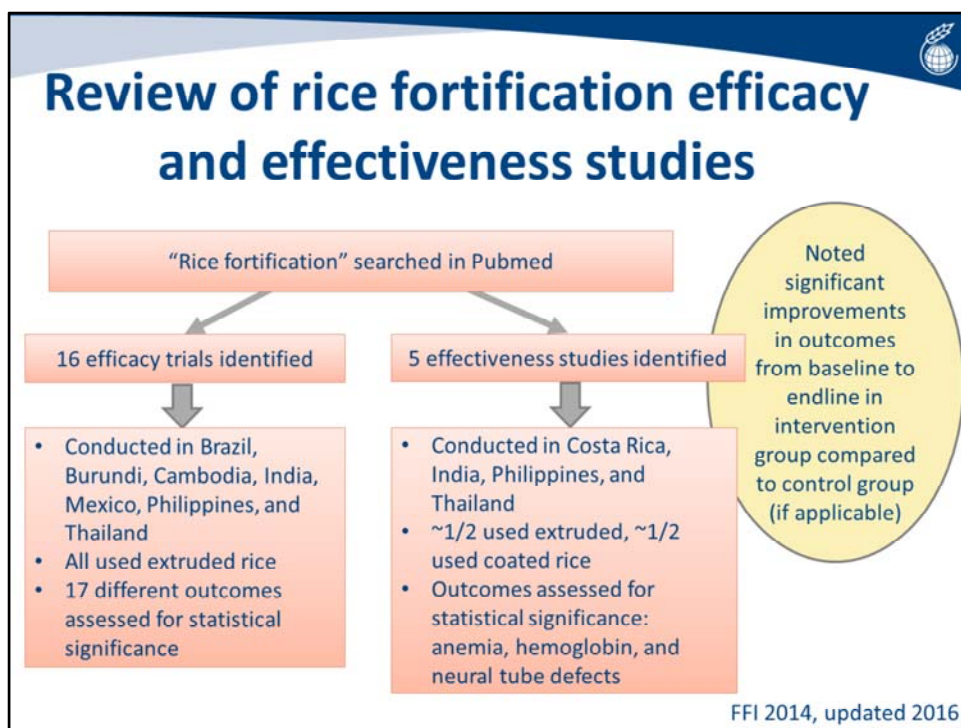
[CLICK TO ADVANCE] In comparison, effectiveness studies tell us the extent to which fortification produces a beneficial results when deployed n the field in the usual circumstances.

We need evidence from efficacy studies to ensure that fortification can have a beneficial impact and we use evidence from effectiveness studies to tell us if these benefits are observed when programs are implemented under real-life conditions.

#### Reference

Miquel Porta. A dictionary of epidemiology, 5<sup>th</sup> edition. Oxford University Press, 2008.





In 2014, we undertook a review of published literature to assess whether rice fortification could effectively improve the studied health outcomes. The term rice fortification was searched in Pubmed to identify efficacy and effectiveness trials. We updated the review in August 2016.

[CLICK TO ADVANCE] From each paper the baseline and final outcome measurements for the intervention group and control groups were abstracted. For each outcome measured, it was noted whether a statistically significant improvement from baseline to study end was observed in the intervention group receiving fortified rice compared with the control group that received non-fortified rice.

[CLICK TO ADVANCE] We found 16 efficacy and 5 effectiveness trials. 3 additional efficacy trials were identified, but were analyzed separately because there was no true comparison group that received non-fortified rice.

[CLICK TO ADVANCE] 17 different outcomes were evaluated in the efficacy trials; these outcomes will be summarized on the following slide. These trials were conducted in Brazil, Burundi, Cambodia, India, Mexico, Philippines, and Thailand and all used extrusion technology.

[CLICK TO ADVANCE] The effectiveness trials assessed fewer outcomes for their statistical significance (anemia, hemoglobin, and neural tube defects). These trials were conducted in Costa Rica, India, the Philippines, and Thailand and used extrusion or coating fortification technologies.

#### Reference:

Food Fortification Initiative (FFI). Rice fortification's impact on nutrition. Atlanta, USA: FFI, 2014. Available from [www.FFInetwork.org](http://www.FFInetwork.org)

#### Notes:

All 16 efficacy trials were conducted using extruded rice.

1 effectiveness trial used both extruded and coated rice (Costa Rica). 2 other effectiveness trials used extruded rice, 1 other effectiveness trial used coated rice, 1 other effectiveness trial did not specify the type of rice used.

## Summary of rice fortification efficacy studies (1)

Outcome assessed (unit)	Number of studies that found significant improvement in this outcome	Total number of studies that investigated this outcome
Hemoglobin (g/L)	5	15
Anemia (%)	5	9
<b>Iron status</b>		
Ferritin (µmol/L)	7	11
Iron deficiency (%)	6	7
Transferrin receptor (mg/L)	3	5
Iron-deficiency anemia (%)	0	3
Iron body stores (mg/kg)	2	3
Zinc protoporphyrin (µmol/mol heme)	1	2
Total iron binding capacity (µg/dL)	1	1

n=16 efficacy studies

FFI 2014, updated 2016

This table summarizes the outcomes that were studied among the 16 efficacy trials which compared an intervention group receiving fortified rice to a control group receiving non-fortified rice. For each outcome listed in the first column, we noted the number of studies that found a statistically significant improvement in that outcome, as noted in the middle column, out of the total number of studies that investigated the outcome, as noted in the last column. In the table, the outcomes are ordered in descending order based on the number of studies that investigated each outcome.

Statistically significant improvements were observed in 5 out of the 15 studies that assessed hemoglobin and 5 out of the 9 studies that assess anemia prevalence.

Overall, the strongest evidence for rice fortification was observed for some of the outcomes related to iron status. For example, statistically significant improvements were observed in 7 out of 11 studies that assessed serum ferritin, 6 out of 7 of the studies that assessed iron deficiency, and 3 out of the 5 studies that assessed transferrin receptor.

We have an Excel sheet which summarizes the results of these studies and we are happy to make it available to you.

#### Reference:

Food Fortification Initiative (FFI). Rice fortification's impact on nutrition. Atlanta, USA: FFI, 2014. Available from [www.FFInetwork.org](http://www.FFInetwork.org)

Optional to discuss: Two studies fortified rice with Vitamin A, but were not included in the table because there was no comparison group that was given non-fortified rice. Both of these studies were conducted in night blind pregnant women. One study compared an intervention group that received Vitamin A fortified rice plus iron and riboflavin delivered via capsule to a comparison group that received Vitamin A fortified rice only. Compared to the comparison group, a statistically significant improvement was observed in pupillary threshold, but not in plasma retinol. The other study compared 6 groups that were given Vitamin A through various forms, one of which was through fortified rice. A statistically significant improvement in pupillary threshold and plasma were observed in all groups. Future studies that investigate other populations and include a non-fortified rice comparison group will be helpful in better understanding the efficacy of Vitamin A rice fortification.

## Summary of rice fortification efficacy studies (2)

Outcome assessed (unit)	Number of studies that found significant improvement in this outcome	Total number of studies that investigated this outcome
Plasma retinol (µmol/L)	2	5
Vitamin A deficiency (%)	1	2
Total body retinol reserves (µmol)	1	1
Serum zinc (µmol/L)	2	2
Zinc deficiency (%)	0	1
Folate (ng/mL)	1	1
Homocysteine (µmol/L)	1	1
Plasma B12 (pmol/L)	1	1
Thiamin (nmol/L)	0	1

n=16 efficacy studies

FFI 2014, updated 2016

This table has the same format as in the previous slide. The first three rows are vitamin A-related outcomes. 2 out of 5 studies showed improvements in retinol, 1 out of 2 in the prevalence of vitamin A deficiency and 1 out of 1 study in total body retinol reserves.

The next two rows assessed c-reactive protein and found elevated CRP in 1 study.

The next two rows assessed zinc status. 2 out of 2 studies found improvements in serum zinc while the 1 study that assessed the prevalence of zinc deficiency found no reduction due to rice fortification.

The rest of this slide has outcomes for more nutrients that were assessed in 1 study each.

For further analysis, the studies shown in this table were separated into studies that fortified rice with iron only, and studies that fortified rice with multiple micronutrients including iron.

These studies are shown on the next slides.

### Reference:

Food Fortification Initiative (FFI). Rice fortification's impact on nutrition. Atlanta, USA: FFI, 2014. Available from [www.FFInetwork.org](http://www.FFInetwork.org)

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## Summary: efficacy studies

- Hemoglobin/anemia is an insensitive indicator and will not necessarily improve with rice fortification
- Several studies have recorded statistically significant improvements in iron status
- Limited research has been conducted on the impact of fortified rice on other nutrient biomarkers



<http://thumbs.dreamstime.com/1784-boy-eating-rice-happy-face-white-background-id-43733779.jpg>

FFI 2014, updated 2016


From the efficacy trials we observed that hemoglobin and anemia will not necessarily improve when fortified rice is fed to individuals. This is because the anemia in the populations have non-nutritional causes, or are caused by a deficiency in nutrients not added to the fortified rice.

Iron-only trials, in which fortified rice provided at least 13 mg of iron per day, recorded statistically significant improvements in iron status and the prevalence of iron deficiency. Therefore, the amount of iron provided seems to be an important factor in observing nutritional impact.

Limited evidence exists of the impact of fortified rice on other nutrient deficiencies.

Reference:

Food Fortification Initiative (FFI). Rice fortification's impact on nutrition. Atlanta, USA: FFI, 2014. Available from [www.FFInetwork.org](http://www.FFInetwork.org)



## Summary of results: effectiveness studies

Study & Country	Study population (sample size)	Nutrients in fortified rice	Result
Arguello (2011) Costa Rica	Births in country (n=65,000-75,000 per year)	Folic acid†, vitamin B12, niacin, thiamin, zinc, vitamin E, selenium	Statistically significant decrease in NTDs from pre to post rice & milk fortification†


n=5  
NTD, neural tube defect  
† Wheat flour, maize flour, and milk are also fortified with folic acid

FFI 2014, updated 2016

Five effectiveness studies were identified.

Arguello reported births affected by neural tube defects in Costa Rica. Initially, Costa Rica only added folic acid to wheat and maize flour and saw a decline in neural tube defects. A further decline was observed after rice and milk were fortified with folic acid. This suggests that rice and milk fortification may have contributed to the additional decreases in the birth prevalence of neural tube defects.

Reference:  
Food Fortification Initiative (FFI). Rice fortification’s impact on nutrition. Atlanta, USA: FFI, 2014. Available from [www.FFInetwork.org](http://www.FFInetwork.org)



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Angeles-Agdeppa (2011) Philippines	Mothers (n=392) and their children 6-9 years (n=424)	Iron	Statistically significant improvement in hemoglobin and anemia for children, but not their mothers


n=5  
NTD, neural tube defect  
† Wheat flour, maize flour, and milk are also fortified with folic acid

FFI 2014, updated 2016

Angeles-Agdeppa and colleagues reported the addition of iron to fortified rice. It led to improvements in hemoglobin and anemia for children, but not their mothers. [This study was completed in the Philippines].

Reference:

Food Fortification Initiative (FFI). Rice fortification's impact on nutrition. Atlanta, USA: FFI, 2014. Available from [www.FFInetwork.org](http://www.FFInetwork.org)



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Angeles-Agdeppa (2011) Philippines	Mothers (n=392) and their children 6-9 years (n=424)	Iron	Statistically significant improvement in hemoglobin and anemia for children, but not their mothers
Gershoff (1977) Thailand	Children 1.5-9 years (n=2,250)	Thiamin, riboflavin, retinol, iron, lysine, threonine	No statistics reported. Authors stated no differences in hemoglobin or morbidity between high (67% of time) and low (10% of time) consumers


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FFI 2014, updated 2016

Through the Gershoff study, multiple nutrients were delivered in fortified rice. No statistics were reported in the article. However, the authors stated there were no differences in hemoglobin or morbidity between high (67% of time) and low (10% of time) consumers of fortified rice. They go on to speculate that this lack of impact is likely due to high infectious disease incidence. [This study was completed in Thailand].

Reference:

Food Fortification Initiative (FFI). Rice fortification's impact on nutrition. Atlanta, USA: FFI, 2014. Available from [www.FFInetwork.org](http://www.FFInetwork.org)



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Paithankar (2015) India	Children 6-15 years (n=945)	Iron	Statistically significant increase in hemoglobin and reduction in anemia prevalence for fortification group compared with control group

n=5  
NTD, neural tube defect  
† Wheat flour, maize flour, and milk are also fortified with folic acid


FFI 2014, updated 2016

The most recent study is by Paithankar where iron-fortified rice was delivered to school children in one district. Children from the fortification district had an increase in hemoglobin and decrease in anemia that was statistically different from children in a control district.

Reference:

Food Fortification Initiative (FFI). Rice fortification's impact on nutrition. Atlanta, USA: FFI, 2014. Available from [www.FFInetwork.org](http://www.FFInetwork.org)





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Paithankar (2015) India	Children 6-15 years (n=945)	Iron	Statistically significant increase in hemoglobin and reduction in anemia prevalence for fortification district compared with control district
Salcedo (1950) Philippines	Infants, children >2-15 years old, mothers, pregnant mothers, and other adults (n=11,492)	Thiamin, niacin, iron	No statistics reported. Beriberi incidence and infant beriberi deaths decreased in fortification areas. In the non-fortification areas, these increased.

n=5  
NTD, neural tube defect  
† Wheat flour, maize flour, and milk are also fortified with folic acid

FFI 2014, updated 2016

The final study added thiamin, niacin and iron to fortified rice. No statistics were reported. However, beriberi incidence and infant beriberi deaths decreased in fortification areas, while in the non-fortification areas, these increased. [This study was completed in the Philippines].

Reference:

Food Fortification Initiative (FFI). Rice fortification's impact on nutrition. Atlanta, USA: FFI, 2014. Available from [www.FFInetwork.org](http://www.FFInetwork.org)



## Summary: effectiveness studies

- Studies in India and the Philippines recorded statistically significant improvements in hemoglobin and anemia and in children
- Data on NTDs before and after rice (and milk) fortification started in Costa Rica suggest rice fortification contributed to reductions in NTDs
- Older studies reported no impact on hemoglobin and morbidity (Thailand) and decreases in beriberi incidence and deaths from beriberi (Philippines)
- There is limited data on effectiveness

NTDs, neural tube defects

FFI 2014, updated 2016

Effectiveness studies completed in India and the Philippines recorded statistically significant improvements in anaemia and hemoglobin in children.

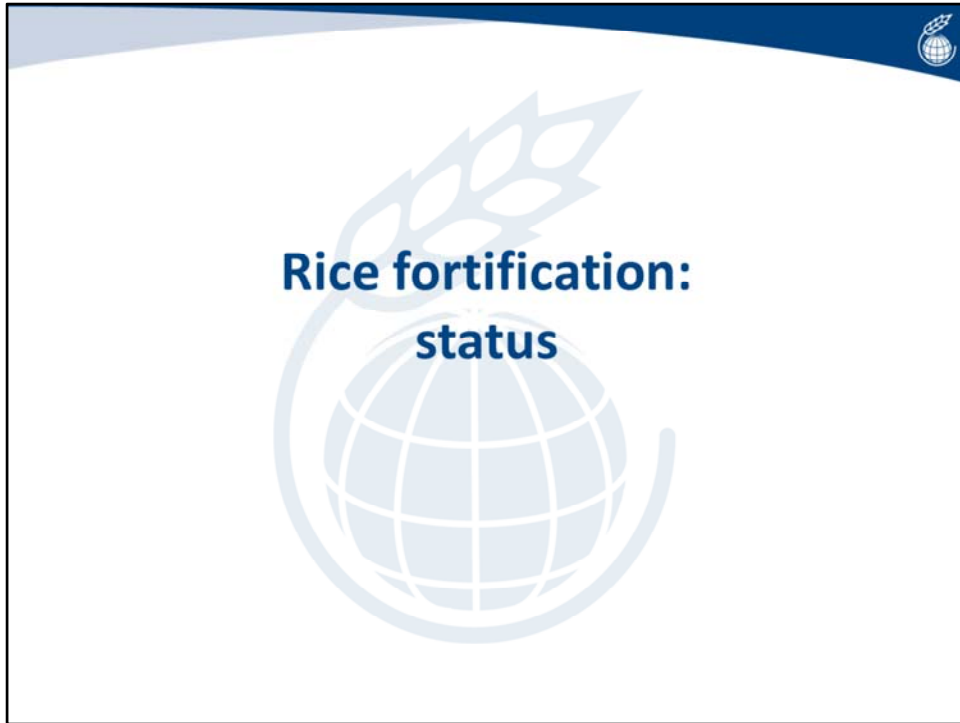
Data on neural tube defects before and after rice and milk fortification started in Costa Rica suggest rice fortification contributed to reductions in neural tube defects.

Two older studies that did not report statistics did note that fortified rice had no impact on hemoglobin and morbidity in Thailand, while another observed decreases in beriberi incidence and deaths due to beriberi.

Few effectiveness trials have been conducted making it difficult to assess the impact of rice fortification at the population level when it is eaten normally and not under controlled conditions.

Reference:

Food Fortification Initiative (FFI). Rice fortification's impact on nutrition. Atlanta, USA: FFI, 2014. Available from [www.FFInetwork.org](http://www.FFInetwork.org)



Now we'll look at the current status of rice fortification efforts around the globe.



# Fortified rice delivery options

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**TITLE 21—FOOD AND DRUGS**  
**Chapter I—Food and Drug Administration, Department of Health, Education, and Welfare**  
**Subchapter B—Food and Food Products**  
**PART 15—CEREAL FLOURS AND RELATED PRODUCTS**  
**SUBPART C—RICE AND RELATED PRODUCTS**

**ORDER CORRECTING WORDING OF DEFINITION AND STANDARD OF IDENTITY FOR ENRICHED RICE, STAYING EFFECTIVENESS OF REQUIREMENT AS TO RIBOFLAVIN, AND CONFIRMING EFFECTIVE DATE**

In the matter of adopting a definition and standard of identity for enriched rice.

An order ruling on proposals to adopt a definition and standard of identity for enriched rice was published in the FEDERAL REGISTER OF AUGUST 27, 1957 (22 F. R. 6887, 6993). That order provided that the definition and standard of identity for enriched rice should become effective 6 months from the date of publication of the order, except as to any provision

US Federal Register 1957



<http://www.mars.com/mars/home.php?product=fortified-rice-2kg>



<http://www.org/tag/1644444444>



**Mandatory**



**Voluntary**



**Social Safety Net**

Codling 2014

There are three potential delivery options for rice fortification.

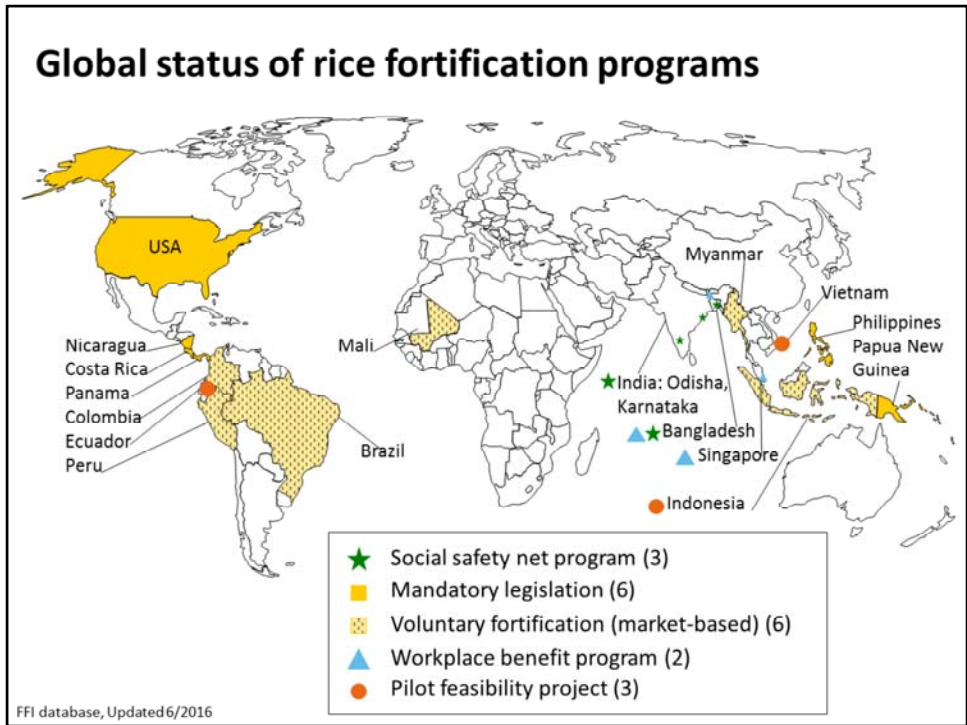
1. Mass fortification on a mandatory basis. [CLICK TO ADVANCE]
2. Voluntary or market-driven fortification with the intention to achieve mass fortification because our objective is public health. [CLICK TO ADVANCE]
3. Targeted fortification of rice for specific population groups, with the intention of improving their public health. The best way of achieving this is to fortify rice distributed in social safety net programs. Thus the delivery option for targeted rice fortification is referred to as social safety net rice fortification.

These are not mutually exclusive however; social safety net fortification could be implemented alongside both voluntary and mandatory fortification, and social safety net fortification may itself be mandatory.

**Reference:**

Codling K. Delivery options and current status of rice fortification. Presentation at Scaling Up Rice Fortification in Asia workshop. 2014.

[http://www.ffinetwork.org/about/calendar/2014/RiceMtg\\_Bangkok.html](http://www.ffinetwork.org/about/calendar/2014/RiceMtg_Bangkok.html)



By contacting active partners in countries, FFI collected the status of rice fortification programs globally.

The green stars indicate places where rice fortification is implemented in social safety net programs: Odisha and Karnataka, India; Bangladesh

The yellow color indicates the six countries with mandatory rice fortification legislation: the USA, Nicaragua, Costa Rica, Panama, Philippines and Papua New Guinea.

The beige color indicates six countries where voluntary, market-based fortification takes place: Colombia, Brazil, Peru, Mali, Myanmar, and Indonesia. However, voluntary fortification here means simply that there is fortified rice available in the marketplace – it does not mean that fortified rice is widely consumed or available country-wide.

Additionally, there are workplace benefit programs in place in Bangladesh and Singapore, as well as feasibility pilot studies in Viet Nam’s open market and Indonesia’s social safety program. There is a pilot project in Ecuador but FFI still needs to confirm the nature of this pilot - whether it is a feasibility project or acceptability, bioavailability, etc.

Note: DSM (Judith) informed us that there are studies in progress in Ecuador and Ghana; however Ghana is an efficacy study. Ecuador is unknown.

Reference:  
FFI. Global status of rice fortification programs. June 2016

Note: Does not include research studies involving fortified rice, but includes pilot studies that are intended to demonstrate feasibility of rice fortification (rather than efficacy).

## Current status of mandatory rice fortification

Country	Legislation year	Implementation
Costa Rica	2001	100% fortified
Nicaragua	2009	No implementation
Panama	2009	No implementation
Papua New Guinea	2007	≥ 80% fortified
Philippines	2001	<1% fortified
USA	1957	70% fortified

FFI 2016

These are the six countries with mandatory rice fortification: Costa Rica, Nicaragua, Panama, Papua New Guinea, the Philippines, and the USA.

Here is information on the current status of mandatory rice fortification. In the first column we have the countries with legislation that requires the fortification of rice. This is followed by the year when legislation was passed, information on the milling industry and in the final column the current status of implementation.

Costa Rica is the country in the world with the most successful rice fortification program. All of Costa Rica's rice is fortified, in addition to other staple foods such as wheat flour, maize flour, milk and oil.

Papua New Guinea is probably the country with the second most successful rice fortification program. PNG grows almost no rice; instead the national rice supply is provided by a limited number of rice importers. The largest of these estimates they have about 80% market share and has confirmed they are fortifying with imported extruded kernels.

The Philippines passed legislation in 2001 and has been attempting to enforce it since 2004. The National Food Authority implements a large social safety net program of subsidized rice when rice prices are high. Nevertheless, almost no rice is being currently being fortified.

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Papua New Guinea is probably the country with the second most successful rice fortification program. PNG grows almost no rice; instead the national rice supply is provided by a limited number of rice importers. The largest of these estimates they have about 80% market share and has confirmed they are fortifying with imported extruded kernels. Other importers are also believed to be fortifying at least some of their rice. This is despite the fact that the government is not enforcing the legislation. In this case, fortification has been facilitated by the fact that all rice is supplied by only a few importers.

The Philippines passed legislation in 2001 and has been attempting to enforce it since 2004. A work plan was developed that planned for implementation in phases with the biggest mills fortifying first. The National Food Authority implements a large social safety net program of subsidized rice when rice prices are high. NFA purchased blenders and fortified kernels in order to fortify their rice. Multiple sub-national governments passed local ordinances requiring all rice to be fortified and efficacy, effectiveness and acceptability trials have been undertaken on rice fortification. Despite all these efforts and others, almost no rice is being currently being fortified.

In Nicaragua and Panama the governments are not actively enforcing the legislation in either country. However, Nicaragua recently gazetted a rice fortification regulation which is to go in effect June 2015.

Reference:  
FFI. Food Fortification Initiative database. 2016.

USA:  
August 1957 for implementation within 6 months – so should have been implemented by 1958. Although, SC was the first state to mandate rice fortification in 1956  
<http://www.nap.edu/read/18506/chapter/12#10>



### Vitamins in rice standard (mandatory countries)

Country	Fortification Levels (mg/kg)					
	Thiamin (B1)	Niacin (B3)	Pyridoxine (B6)	Folic Acid (B9)	B12	Vitamin E
Costa Rica	5.3	35	--	1.8	0.01	10.1
Nicaragua	5	40	4	1	0.01	--
Panama	5	40	4	1	0.01	--
Papua New Guinea	5	60	--	--	--	--
Philippines	--	--	--	--	--	--
USA	4.4-8.8	35.2-70.4	--	1.54-3.08	--	--
<i>No. countries</i>	<i>5</i>	<i>5</i>	<i>2</i>	<i>4</i>	<i>3</i>	<i>1</i>

FFI 2016

Upon review of countries' fortification legislation and/or standards, these are the vitamins that are supposed to be added to rice. These values are expressed in mg/kg which is the same as parts per million.

The countries are organized in alphabetical order. The vitamins are in alphabetical order across the top: vitamins B1, B3, B6, B9, B12, and E.

By looking at the last row, we can see the number of countries that mandate the addition of the vitamins specified here, with 5 countries requiring addition of B1 and B3, 2 of B6, 4 of folic acid, 3 of B12, and 1 of Vitamin E.

Reference:

FFI. Food Fortification Initiative database. 2016.

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Riboflavin is not added because it imparts a yellow color to foods and this is not acceptable for rice fortification.



## Minerals in rice standard (mandatory countries)

Country	Iron (mg/kg)	Type of Iron	Selenium (mg/kg)	Zinc (mg/kg)
Costa Rica	--	--	0.105	7.5
Nicaragua	24	Ferric pyrophosphate	--	25
Panama	24	Ferric pyrophosphate	--	25
Papua New Guinea	30	Not specified	--	--
Philippines	60-90	Ferrous sulfate	--	--
USA	28.6-57.2	Not specified	--	--
<i>No. countries</i>	5	3	1	3

FFI 2016

This slide lists the minerals which are supposed to be added to rice in the mandatory countries: iron, selenium and zinc. In the third column we can see the type of iron which must be added.


Five countries mandate rice fortification with iron, 1 mandates fortification with selenium and 3 with zinc.

The iron compounds added include ferric pyrophosphate in Nicaragua and Panama, and ferrous sulfate in the Philippines. In PNG and the USA, the iron compound is not specified in the standards.

Reference:

FFI. Food Fortification Initiative database. 2016.





## Rice fortification monitoring

Monitoring item	CR	Nica	Pan	PNG	Phil
Is there a <u>national committee</u> that oversees the rice fortification program?	Yes	Yes	Yes	No	Yes
Are rules and operating procedures for <u>external monitoring</u> of rice fortification at mill level by national authorities stipulated in a document?	Yes	Yes	--	No	No
Are rules and operating procedures for <u>commercial monitoring</u> of rice fortification at retail level by national authorities stipulated in a document?	No	No	--	No	No
If import rice, are rules and operating procedures for verification of rice fortification at <u>import level</u> by national authorities stipulated in a document?	Yes	Yes	NA	No	No
In the past five years, has a <u>national report</u> on the status of rice fortification monitoring and compliance been compiled?	Yes	No	--	No	No

CR, Costa Rica; Nica, Nicaragua; Pan, Panama; PNG, Papua New Guinea; Phil, Philippines; NA, not applicable; --, No answer; No data for USA

FFI 2015, FFI 2016

In the past two years the Food Fortification Initiative queried countries that mandate rice fortification about their monitoring activities. We did not get any information from the USA.

Most countries have a national committee that oversees the rice fortification program.

Half of the countries that responded have documented rules and operating procedures for external monitoring and import monitoring of rice fortification by national authorities.

And, none of the countries have documented rules and operating procedures for commercial monitoring, and only one has compiled a national report on the status of rice fortification monitoring and compliance.

The lack of rules and operating procedures in place for monitoring of rice fortification does not portend well for the probability that any relevant monitoring activities are being undertaken by national authorities.

Reference:

FFI. 2014 annual report. Published in 2015.

[http://www.ffinetwork.org/about/stay\\_informed/releases/2014Review.html](http://www.ffinetwork.org/about/stay_informed/releases/2014Review.html)

FFI. 2015 annual report. Published in 2016.

[http://www.ffinetwork.org/about/stay\\_informed/releases/2015Review.html](http://www.ffinetwork.org/about/stay_informed/releases/2015Review.html)



## Lessons learned on mandatory rice fortification

- Impactful if properly implemented
- Political commitment and capacity to enforce legislation are essential
- Difficult/cost-prohibitive with decentralized industry
- Large, cost-effective and sustainable supply of fortified kernels is needed: domestic production may be necessary
- Private sector needs to be persuaded to make investments for rice fortification (kernel production & blending)

Codling 2014

A review by our colleague Karen Codling yielded these lessons learned from mandatory rice fortification.

Although there are few mandatory rice fortification programs being implemented today, extrapolating from rice fortification efficacy studies and lessons learned from fortification of other staple foods, such as wheat flour, there is every reason to believe mandatory rice fortification would be an effective strategy for increasing nutrient intake.

However mandatory rice fortification programs can only be effective if they are properly implemented which means legislation has to be enforced. Simply passing the legislation is insufficient. However generating sufficient political will, manpower and resources to effectively enforce the legislation has not been possible in several countries.


Rice milling, in many countries in the region, is not a consolidated industry. In rice-producing countries, rice milling has traditionally been done on a very small scale, such as one mill per village. Although the rice milling industry is modernizing and consolidating, in many countries in Asia, for example, many small mills remain. This problem appears to be one of the main reasons the Philippines has not yet managed to implement mandatory rice fortification, whereas Costa Rica has.

Mandatory fortification on a national scale requires a large, cost-effective and sustainable supply of fortified kernels. For most countries the development of domestic capacity to produce fortified kernels will be necessary. This is because the volume of fortified kernels to fortify an entire country's rice supply is considerable and transport costs to import fortified kernels would be prohibitive. This will require private companies making the necessary investments to make fortified kernels; they will only take this risk however if they perceive that national governments will enforce the legislation and millers will comply. Alternatively, existing fortified kernel producers outside the country need to significantly increase their production capacity and be in a position to sell their products at highly competitive rates that compensate for transport costs. They too will only do this if they believe there will be a sustained market for the fortified kernels.

The cost of fortifying rice is not insignificant. While it is affordable, rice fortification is more expensive than flour fortification. This is because the technology is more complicated, the proportion of fortificant to the rice is larger, and consumption amounts of rice are so large. In mandatory fortification, millers will have to make investments in feeders and purchase of fortified kernels, but, as for fortified kernel production, they will not be willing to make the necessary investments if they do not believe the government will ensure a safe business environment.

Reference:

Codling K. Delivery options and current status of rice fortification. Presentation at Scaling Up Rice Fortification in Asia workshop. 2014. [http://www.ffinetwork.org/about/calendar/2014/RiceMtg\\_Bangkok.html](http://www.ffinetwork.org/about/calendar/2014/RiceMtg_Bangkok.html)



### Current status of voluntary rice fortification

Country	Start Year	Implementation
Brazil	2010	1-2% fortified
Colombia	2002	~35% fortified
Peru	2016	<1%*
Myanmar	2016	<1% (availability only in Yangon City)
Mali	?	<1% *
Indonesia	2016	<1%*

\*FFI estimate Codling 2014, updated 2016; Tsang 2016

This table shows the voluntary rice fortification we are currently aware of. In addition to these, there are undoubtedly numerous small-scale fortification efforts being implemented, such as special brands of fortified rice in low-, middle-, and high-income countries.

The table provides an indication of when the programs started, and information on the coverage of total domestic rice supply.

Total coverage with fortified rice is unknown for most countries. For Brazil it is estimated at 1-2 % and for Colombia at 35%.

**Reference:**

Codling K. Delivery options and current status of rice fortification. Presentation at Scaling Up Rice Fortification in Asia workshop. 2014.

[http://www.ffinetwork.org/about/calendar/2014/RiceMtg\\_Bangkok.html](http://www.ffinetwork.org/about/calendar/2014/RiceMtg_Bangkok.html)

Tsang BL, Moreno R, Dabestani N, Pachón H, Spohrer R, Milani P. "Public and private sector dynamics in scaling up rice fortification: The Colombian experience and its lessons." Food and Nutrition Bulletin, 2016.

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In the Philippines for example a number of brands of rice from individual millers are being fortified.

All of these countries have multiple millers supplying rice to the market. As is common in such a situation, total coverage with fortified rice is low for almost all countries as it is dependent upon promotion of the fortified brands and consumer awareness and motivation to purchase the more expensive brand of rice. Thus coverage is only about 1-2% in Brazil and 4% in South Africa.

In Aug 2016 Caroline Manus/GAIN noted that PATH started working in Brazil in 1999 and GAIN with PATH in 2010. Thus, she suggested changing the initiation year from 2006 to 2010.

## Lessons learned on voluntary rice fortification

- Voluntary fortification has not achieved high coverage of total rice supply
- Standards for fortified rice are important even for voluntary fortification
- Sustainability of voluntary rice fortification dependent on millers' decision



<http://cdn.marksdailyapple.com>

Codling 2014

From countries' experience with voluntary rice fortification, there are several lessons learned.

First, voluntary fortification has not achieved high coverage of total rice supply.

Nutrient standards for fortified rice are important for mandatory and voluntary fortification.

Finally, sustainability of voluntary rice fortification is dependent on millers' decision.

Reference:

Codling K. Delivery options and current status of rice fortification. Presentation at Scaling Up Rice Fortification in Asia workshop. 2014.

[http://www.ffinetwork.org/about/calendar/2014/RiceMtg\\_Bangkok.html](http://www.ffinetwork.org/about/calendar/2014/RiceMtg_Bangkok.html)



## Current status of social safety net rice fortification

- Bangladesh
  - Government programs: Vulnerable Group Feeding/Development
  - World Food Program school feeding
  - Garment factory rice ration for workers
- Indonesia: RASKIN rice for the poor (pilot)
- School feeding program in India (Odisha & Karnataka)

Codling 2014, updated 2016

Fortified rice is currently being distributed in the following social safety net program. The majority are implemented by governments, and funded by government and donors.

Successful implementation of rice fortification in social safety nets in Bangladesh is being expanded to other social safety nets in the country. For example, a garment manufacturer has decided to provide fortified rice for his workers.

The Indonesia RASKIN program provides the rural poor with subsidized rice. A pilot fortification program has just started with imported fortified kernels. The efficacy and effectiveness of the program will be assessed and if effective, consideration will be given to fortification of all RASKIN rice.

The World Food Program is supporting the distribution of fortified rice in a school feeding program in one district of Odisha state in India. The rice is fortified with Indian-made fortified kernels which are blended into the non-fortified rice at district level by an NGO. The impact of the program is being evaluated and the government of Odisha is interested in expanding the program to the whole state.

PATH and Sight & Life have partnered together with Akshaya Patra a nonprofit running a nationwide school feeding program. Using their centralized kitchens, the project expects to reach 450,000 thousand children in 2600 schools in Karnataka, southern India, with iron fortified rice, alongside WASH and de-worming interventions. The state government approved the use of fortified rice in June this year.

Sources: <http://www.thehindu.com/todays-paper/tp-national/tp-karnataka/akshaya-patra-to-give-fortified-rice-in-midday-meals/article8734572.ece>  
<http://blog.path.org/2014/11/path-journeys-day1/>

#### Reference:

Codling K. Delivery options and current status of rice fortification. Presentation at Scaling Up Rice Fortification in Asia workshop. 2014.  
[http://www.ffinetwork.org/about/calendar/2014/RiceMtg\\_Bangkok.html](http://www.ffinetwork.org/about/calendar/2014/RiceMtg_Bangkok.html)

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Fortified rice is currently being distributed (or has been distributed in the recent past) in the following social safety net program. The majority are implemented by governments. Funding for the programs, and the fortification, come from government sources and donors.

Successful implementation of rice fortification in social safety nets in Bangladesh is being expanded to other social safety nets in the country and the World Bank has advocated fortification of all rice stored in government silos. Advocacy by the World Food Program and the success of the government programs has convinced a garment manufacturer to source and provide fortified rice for his workers.

The Indonesia RASKIN program provides the rural poor with subsidized rice. A pilot fortification program has just started with imported fortified kernels. The efficacy and effectiveness of the program will be assessed and if effective, consideration will be given to fortification of all RASKIN rice. Considerable logistical complications will need to be resolved however including the development of sufficient domestic capacity to produce fortified kernels and identifying cost-effective opportunities to blend the fortified kernels with the non-fortified rice within the existing system of the RASKIN program.

The National Food Authority of the Philippines sells low-grade rice at subsidized prices intended for the poor. Fortification of some of that rice started in 2006. However fortification of NFA rice in the Philippines ended last year when imported stocks of coated fortified kernels finished. The NFA purchased blending equipment to mix the fortified kernels with rice in their stocks and sold it through accredited retailers at a subsidized price. There were complaints about the acceptability of the rice however as the fortified kernels were identifiable in the rice and when cooked they had a greyish color and particular smell. NFA would now like to consider purchasing alternative fortified kernels in order to resume fortification. It was never possible to fortify all the NFA rice however because of budget constraints.

The World Food Program is supporting the distribution of fortified rice in one district of Odisha state in India. The rice is fortified with Indian-made fortified kernels which are blended into the non-fortified rice at district level by an NGO. The impact of the program is being evaluated and the government of Odisha is interested in expanding the program to the whole state.

PATH and Sight & Life

## Lessons learned from social safety net programs

- Opportunity to target most in need
- If milling industry is fragmented, may be only option for rice fortification to achieve public health impact
- Requires government/implementer commitment to cover fortification
- Logistical complications often a problem – of both SSN program and fortification component
- School feeding programs have provided efficacy & effectiveness data



<http://www.blog.pagcor.ph/tag/schools>

SSN: social safety net

Codling 2014

Here are lessons learned from social safety net programs.

Social safety net programs that include rice distribution, offer a good opportunity to target rice fortification to those most in need.

Moreover, in situations where mandatory fortification is not possible and voluntary fortification will not reach high coverage, they may be the only delivery option for fortified rice that will achieve a public health impact.

These programs require government/implementer commitment, including to cover the cost of fortification.

Logistical complications are often a problem, of both the program and fortification component.

Some of the programs have been highly successful however and several school feeding programs in particular have provided efficacy or effectiveness data on the impact of rice fortification.

Reference:

Codling K. Delivery options and current status of rice fortification. Presentation at Scaling Up Rice Fortification in Asia workshop. 2014. [http://www.ffinetwork.org/about/calendar/2014/RiceMtg\\_Bangkok.html](http://www.ffinetwork.org/about/calendar/2014/RiceMtg_Bangkok.html)

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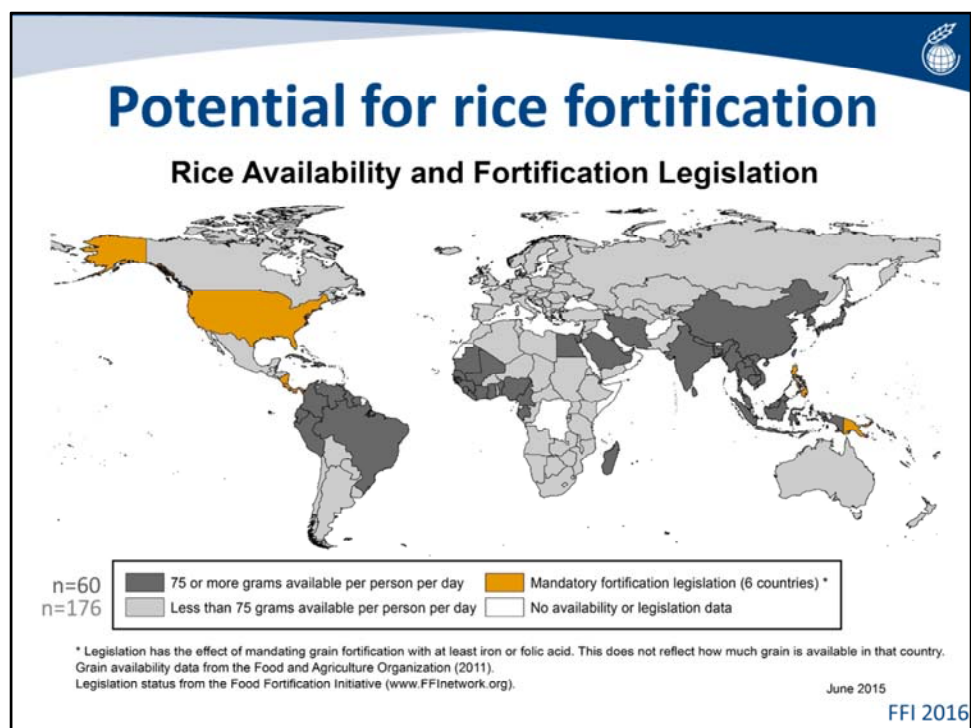
The experience of fortifying rice in social safety nets can be leveraged to consider mandatory fortification.

The burden on the implementer should not be underestimated however. Although the cost of the fortification will be close to insignificant compared to the price of the program (e.g., procurement and distribution of rice), it could still be considerable. The Philippines NFA spent just over **USD1.5 million** on blenders and importing fortified kernels but even with this investment were only able to fortify 15% of the rice they distributed between 2006-2013.

Several of the social safety net programs mentioned have also experienced significant logistical difficulties including:

- Cost and source of rice for distribution
- Mechanism for contracting millers to blend
- Source of fortified kernels
- Transport costs

Further, problems may also exist in the implementation of the social safety net program itself.



We use FAO data on rice availability to estimate what countries may be good candidates for rice fortification.

The countries noted in dark grey are those where FAO statistics report 75 grams per person per day or more of available rice. These 60 countries can be found in South America, West Africa and Asia, mainly. The population of these countries is ~4 billion. These are countries that could perceive a health benefit from fortification of rice alone, if and only if there is a consolidating rice milling industry to make rice fortification feasible.

The light-gray countries are those with FAO rice availability less than 75 grams per person per day. In some of these countries, the fortification of rice \*in combination\* with other foods may have a health impact. Again, the consolidation of the rice milling industry will determine how feasible it is to fortify rice and thus for populations to perceive a health benefit from fortified rice.

Reference:

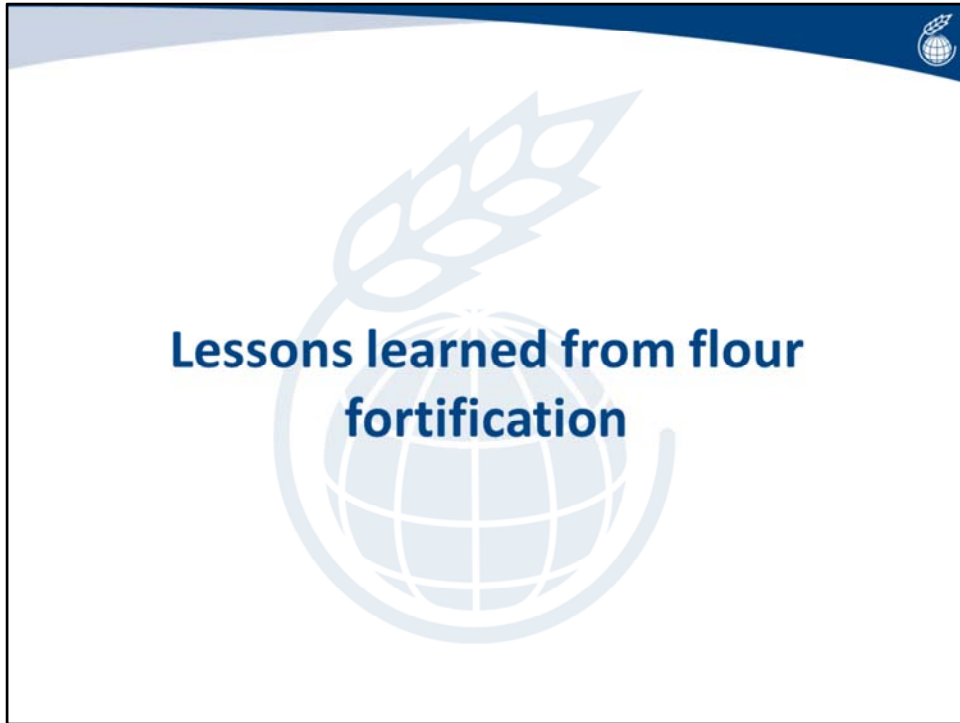
Food Fortification Initiative. Global progress.  
[http://www.ffinetwork.org/global\\_progress/index.php](http://www.ffinetwork.org/global_progress/index.php)



## **Summary: rice fortification status**

- Fortified rice delivery options are mandatory, voluntary and social safety net programs
- Rice fortification at national scale is only implemented in a few countries
- There are several sub-national efforts that indicate rice fortification is growing
- Current experiences point to lessons learned for countries considering rice fortification





Let me share with you country experiences and data to highlight a few lessons learned from flour fortification that apply to rice fortification.



## Fortification is most sustainable in a modern milling industry

- Fortifying at small mills is *technically* feasible but challenging to **sustainably implement**
  - Small mills require consistent personnel training and often financial support (for equipment and premix)
  - Large numbers of mills require high government capacity to monitor and regulate



Suggest that the conclusions on this slide can be attributed to FFI observations from chakki milling projects in India (WFP and GAIN), the Costa Rica v. Philippines experience.

## Mandatory fortification: country comparison

	Costa Rica	Philippines
Rice legislation passed (year)	2001	2001
Rice milling companies (number)	11	~11,000
National rice supply fortified (%)	100%	<1%

“(Costa Rica) MOH was able to demonstrate its authority to enforce the legislation...”

“Limited government budgets to monitor thousands of milling companies...”

Forsman 2014

Reference:

Forsman, C., Milani, P., Schondebare, J. A., Matthias, D. and Guyondet, C. (2014), Rice fortification: a comparative analysis in mandated settings. *Ann. N.Y. Acad. Sci.*, 1324: 67–81. doi:10.1111/nyas.12453



## Social safety nets with centralized distribution are an alternative

- Sample centralized distribution systems for rice:
  - Feeding programs
  - Subsidized food programs



<http://img.path.org/2016/11/16/path-journeys-day-1/>

**Require government or donor commitment to fund**

Suggest that the conclusions on this slide can be attributed to FFI observations from chakki milling projects in India (WFP and GAIN), the Costa Rica v. Philippines experience.



## Lesson learned

Fortification is most sustainably implemented through a modern, centralized milling industry

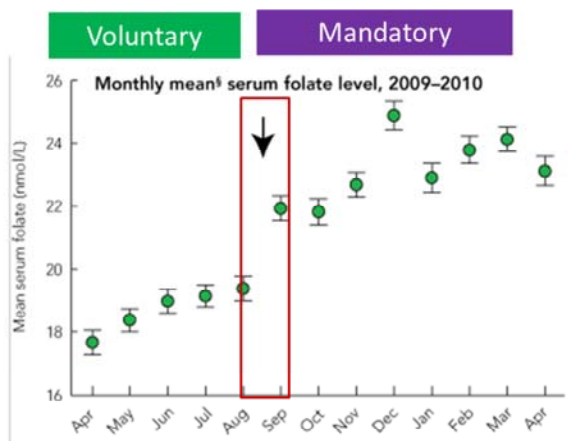
Fortification can be done in a centralized social safety net program

### Reference:

Sarah Zimmerman, Robert Baldwin, Karen Codling, Peter Hindle, Scott Montgomery, Helena Pachón, Glen Maberly. Mandatory policy: Most successful way to maximize fortification's effect on vitamin and mineral deficiency. INDIAN JOURNAL OF COMMUNITY HEALTH / VOL 26 / SUPP 02 / DEC 2014.

## Mandatory flour fortification with folic acid increases serum folate

- Voluntary fortification began in 1995
- Mandatory wheat flour fortification began in September 2009
- Analysis of 20,592 blood samples



Ross 2011

Australia introduced voluntary fortification of wheat flour with folic acid in 1995. Then, mandatory fortification was implemented as of September 2009. When folic acid is consumed, serum folate levels increase in individuals. This slide has the mean serum folate levels in 20,000 blood samples. You can see that the mean levels increased when the country passed from voluntary to mandatory fortification.

Reference:

D. Ross et. al., The impact of mandatory fortification of flour with folic acid on the blood folate levels of an Australian population. *The Medical Journal of Australia*. 2011.

# Mandatory flour fortification with folic acid reduces NTDs

Table 7: NTD birth, NTD birth prevalence by year of birth, state of birth and NTD classification

Year of birth	Total births <sup>(a)</sup>	NTD babies <sup>(b)</sup>			Total	Birth prevalence <sup>(c)</sup>	
		SB	NND	NNS			
Number							
2007	216,472	50	26	44	120	5.6 (4.6, 6.5)	Voluntary
2008	218,851	57	21	41	119	5.4 (4.5, 6.4)	
2009	218,367	66	12	44	122	5.6 (4.6, 6.6)	
2010	218,416	63	14	38	115	5.2 (4.3, 6.2)	Mandatory
2011	220,747	55	18	35	108	4.9 (4.0, 5.8)	

Notes

- (a) Number of total births in participating jurisdictions. These include modified material based on Australian Institute of Health and Welfare and University of New South Wales material published in 'Australia's mothers and babies' reports for the years 2007 to 2011 (Laws et al. 2009; Laws et al. 2010; Laws et al. 2011; Li et al. 2012; Li et al. 2013). Source data for these reports from: Australian Institute of Health and Welfare (AIHW/National Perinatal Data Collection. Details of the collection retrieved 25 February 2016 from <http://www.aihw.gov.au/mothers-and-babies/>.
  - (b) NTD birth outcomes comprise stillbirths (SB), neonatal deaths (NND) and neonatal survivors (NNS).
  - (c) NTD birth prevalence (95% confidence intervals) per 10,000 total births.
- n.p. Not presented - one or more cells with values of 3 or less.

NTDs, neural tube defects

Hilder 2016

Consistent with the previous slide, after serum folate levels increased in Australia, the birth prevalence of neural tube defects decreased. We can see in the last column of this table that the birth prevalence was lower in the mandatory period (5.2-4.9) than in the voluntary period (5.4-5.6).

Reference:

Hilder S. Neural Tube Defects in Australia, 2007–2011: Before and after implementation of the mandatory folic acid fortification standard. The University of New South Wales, 2016.

Note: some children born in 2010 would have been conceived when voluntary fortification was still in force (Jan-Aug 2009).



## Lesson learned

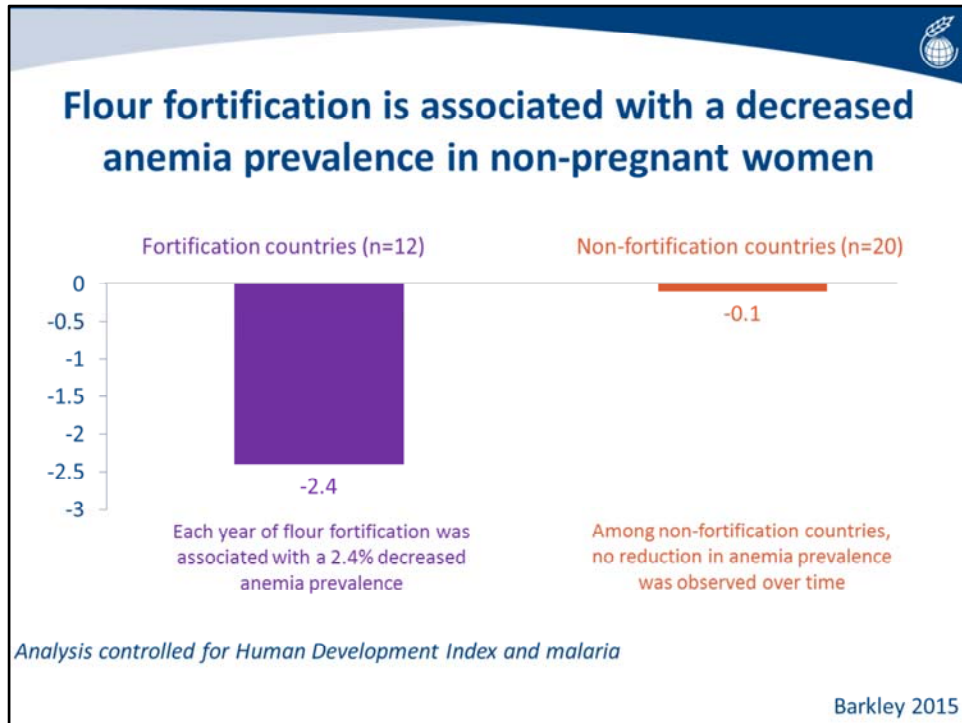
Mandatory fortification with folic acid is more effective than voluntary fortification for reducing the risk of neural tube defects

Zimmerman 2014

### Reference:

Sarah Zimmerman, Robert Baldwin, Karen Codling, Peter Hindle, Scott Montgomery, Helena Pachón, Glen Maberly. Mandatory policy: Most successful way to maximize fortification's effect on vitamin and mineral deficiency. INDIAN JOURNAL OF COMMUNITY HEALTH / VOL 26 / SUPP 02 / DEC 2014.





The first study examined the change in the prevalence of anemia over time in non-pregnant women, using large, national surveys.

Specifically, we looked at the change in anemia prevalence from the pre- to the post-fortification period in 12 countries with flour fortification. That's shown in the bar to the left.

We also looked at the change in the prevalence of anemia across surveys in 20 countries without a flour fortification program present.

In the first bar on the left, we found that each year of flour fortification was associated with a statistically significant 2.4% decreased anemia prevalence in women.

In comparison, among non-fortification countries, no statistically significant reduction in anemia prevalence was observed over time.



Although this type of evidence does not allow us to make a definitive conclusion, overall, the results suggest that flour fortification may be able to significantly reduce anemia burden at the population level.

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Reference:

Barkley JS, Wheeler KS, Pachón H. "Anaemia prevalence may be reduced among countries that fortify flour." *British Journal of Nutrition*, 114(2):265-73, 2015.  
<http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=9887356&fileId=S0007114515001646>

# Most fortification countries followed WHO recommendations

**Recommendations on Wheat and Maize Flour Fortification Meeting Report: Interim Consensus Statement**

Extraction Rate	Compound	Level of nutrient to be added in parts per million (ppm) (by equivalent average per capita wheat flour availability (g/day))			
		<75 g/day	75-100 g/day	100-150 g/day	>150 g/day
Low	NaFeEDTA	40	40	20	15
	Ferrous sulfate	40	40	20	20
	Ferrous fumarate	40	40	20	20
	Electrolytic iron	40	40	20	20
High	NaFeEDTA	40	40	20	15

Low-extraction flour: NaFeEDTA, ferrous sulfate, ferrous fumarate, electrolytic iron  
High-extraction flour: NaFeEDTA

**Use WHO-recommended Iron Compounds**

Yes (n=11)	No (n=1)
Bolivia	Indonesia
Costa Rica (wheat*)	
Fiji	
Honduras	
Jordan	
Mexico (maize*)	
Nicaragua	
Peru	
Philippines	
Senegal	
Uzbekistan	

\*predominant grain in country

WHO 2009, Barkley 2015, Hurrell 2015

All fortification countries in the analysis shown on the previous slide began fortification before the WHO recommendations were issued.

However, most of them use the WHO-recommended iron compound. This was a finding that Dr. Richard Hurrell noted in an invited commentary to the article.

Therefore, we speculate that it is because countries followed WHO fortification recommendations, that fortification countries saw the declines in anemia prevalence that non-fortification countries did not.

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Reference:

WHO, FAO, UNICEF, GAIN, MI, & FFI. *Recommendations on wheat and maize flour fortification. Meeting Report: Interim Consensus Statement*. Geneva, World Health Organization, 2009.

[http://www.who.int/nutrition/publications/micronutrients/wheat\\_maize\\_fortification/en/](http://www.who.int/nutrition/publications/micronutrients/wheat_maize_fortification/en/)

Barkley JS, Wheeler KS, Pachón H. "Anaemia prevalence may be reduced among countries that fortify flour." *British Journal of Nutrition*, 114(2):265-73, 2015.

<http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=9887356&fileId=S0007114515001646>

Hurrell RF. "Invited commentary: Flour fortification as a strategy to prevent anaemia." *British Journal of Nutrition*, 114(4):501-2, 2015.

<http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=9912022&fileId=S0007114515002147>



## Lesson learned

In setting fortification standards, all countries should aim to follow WHO recommendations for flour fortification

WHO recommendations for rice are not yet available but are in process

WHO, World Health Organization

The key message from this research is that all countries should aim to follow WHO recommendations for flour fortification.

One of the challenges for rice fortification is that at present, we do not yet have WHO recommendations. As Gerardo Zamora explained, they are in process.



## Conclusions (1)

- Rice fortification can produce a public health impact.
  - Evidence is strongest for iron
  - There is limited research for other nutrients
- Rice fortification at national scale is only implemented in a few countries.
  - Several sub-national efforts indicate that rice fortification is growing.



## Conclusions (2)

- Lessons learned in grain fortification can be applied towards successful rice fortification programs in Latin America & the Caribbean:
  - Fortification is most sustainable (for producers and regulatory monitoring) in a modern, centralized industry
    - In a decentralized industry, social safety nets offer the opportunity to target those most in need
  - Mandatory fortification has a greater health impact than voluntary fortification
  - Setting standards in line with WHO recommendations can help achieve public health impact

WHO, World Health Organization

**For more information:**

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