FACULTY OF BIOSCIENCE ENGINEERING

DEPARTMENT OF FOOD TECHNOLOGY, SAFETY AND HEALTH
RESEARCH GROUP OF CEREAL AND FEED TECHNOLOGY

COMBATING MICRONUTRIENT MALNUTRITION IN AFRICA WITH FLOUR FORTIFICATION: CURRENT STATUS AND CHALLENGES

Filip Van Bockstaele, 15-12-2017, GAPSYM11

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BASICS OF FORTIFICATION

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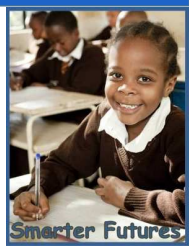


RATIONALE

- Vitamins and minerals = **micro**-nutrients
  - Low presence in foods
  - Play an essential role in biochemical reactions in human body
- Deficiencies in micronutrients
  - Often related to malnutrition
  - Cause diseases, birth defects, reduced immunity, reduced growth and cognitive development

RATIONALE

– Levels of deficiencies around the world

Country	Neural tube defects per 10,000 births	% Anemia in non-pregnant women of reproductive age	% Anemia in pre-school children	% Population at risk of inadequate zinc intake
Afghanistan	20	31	44	20.2
Belgium	9	18	13	6.8
Uganda	13	26	56	20.5
Zimbabwe	23	28	59	48.4
South-Africa	23	27	41	20.0
USA	4.6	12	6	5.0
Tanzania	13	38	61	34.1
DR Congo	20	49	67	54.3
Brazil	38	19	24	7.3

The World Health Organization (WHO) estimates that more than 2 billion people are deficient in key vitamins and minerals, particularly vitamin A, iodine, iron and zinc

SOURCE: http://www.ffinetwork.org/

COPENHAGEN CONSENSUS

	Solution	Challenge
1	Micronutrient supplements for children (A & Zn)	Malnutrition
2	The Doha development agenda	Trade
3	**Micronutrient fortification**	Malnutrition
4	Expanded immunization coverage for children	Diseases
5	Biofortification	Malnutrition
6	Deworming, other nutrition programs in school	Malnutrition
7	Lowering the price of schooling	Education
8	Increase and improve girl's schooling	Women
9	Community-based nutrition programs	Malnutrition

Nobel Prizewinning Economists: Finn Kydland, Robert Mundell, Douglass North, Thomas Schelling, Vernon L. Smith

FOOD FORTIFICATION

Food fortification has been defined as the addition of one or more essential nutrients to a food, whether or not it is normally contained in the food, for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or specific population groups (FAO/WHO 1994).

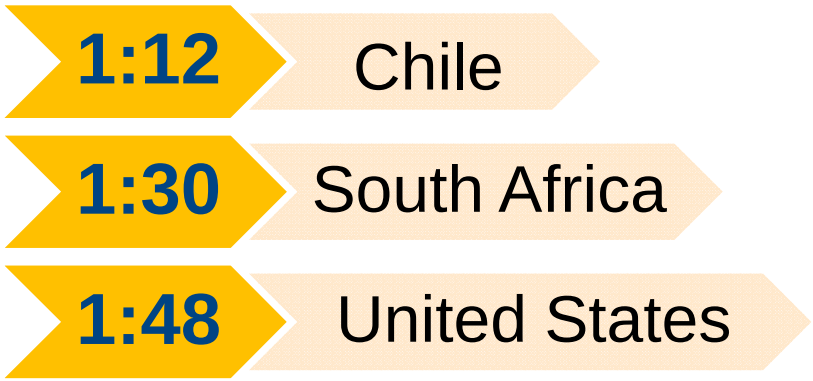
WHY FOOD FORTIFICATION?

- It works!

  Significant reduction in deficiencies when fortifying with iron, folate and iodine

  (Das et al. Micronutrient fortification of food and its impact on woman and child health. Systematic Reviews, 2013, 2:67)

- Cost efficient:



Llanos, A., et. al., Cost-effectiveness of a Folic Acid Fortification Program in Chile. Health Policy 83 2007:295-303.
Sayed, A., et.al., Decline in the Prevalence of Neural Tube Defects Following Folic Acid Fortifcation and Its Cost-Benefit in South Africa. Birth Defects Research 82 2008:211-216.
Grosse, Scott, et. al., Reevaluating the Benefits of Folic Acid Fortification in the United States: Economic Analysis, Regulation, and Public Health. American Journal of Public Health 95 2005:1917-1922.

FOOD FORTIFICATION VEHICLES

OIL

Vitamin A,E

MILK

Vit A,D
Ca

CEREALS

Fe, Zn
Vit. B1, B2, B3, B6
Folic acid
Vitamin A

SALT

Iodine

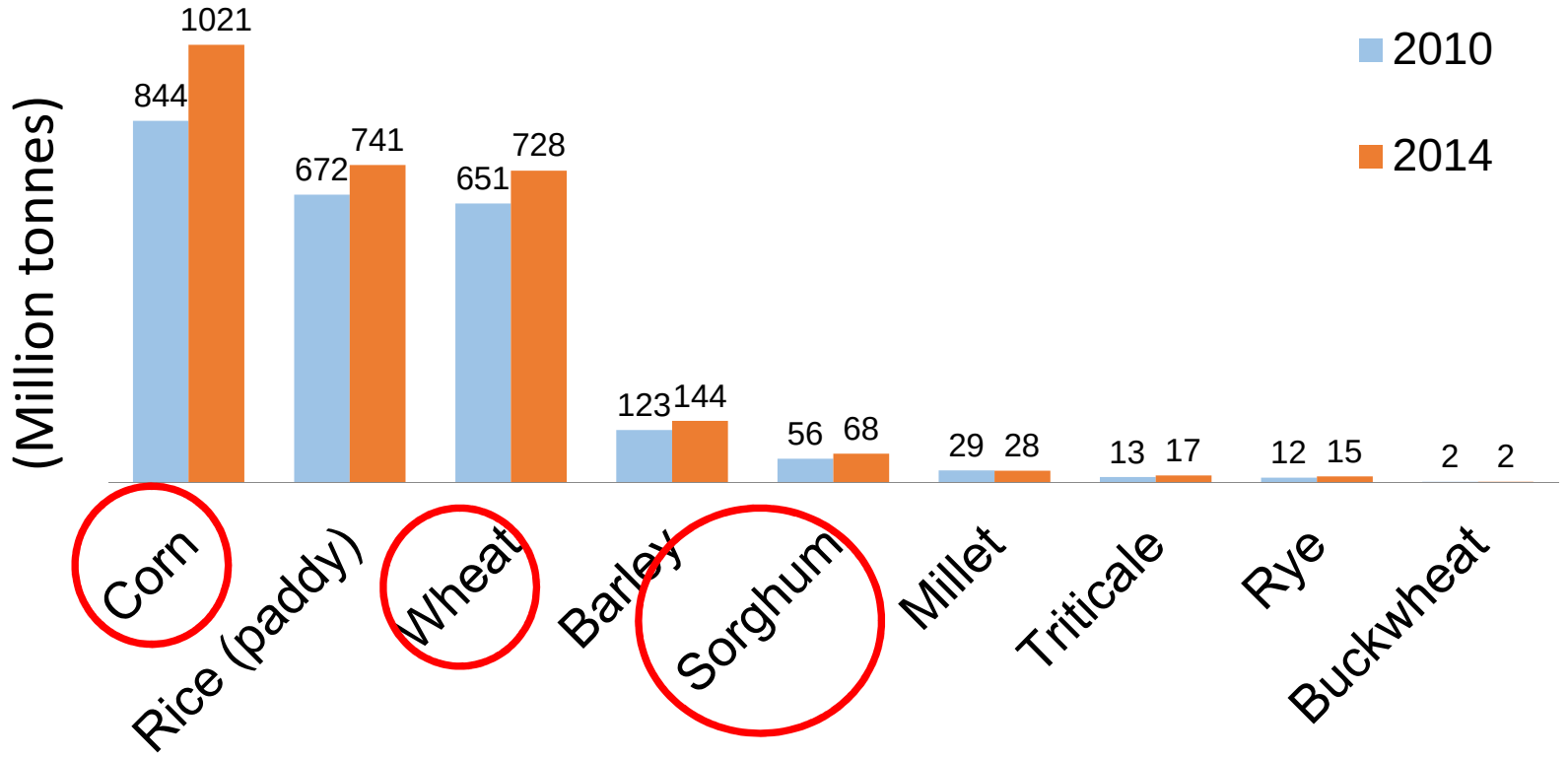
SUGAR

Vitamin A

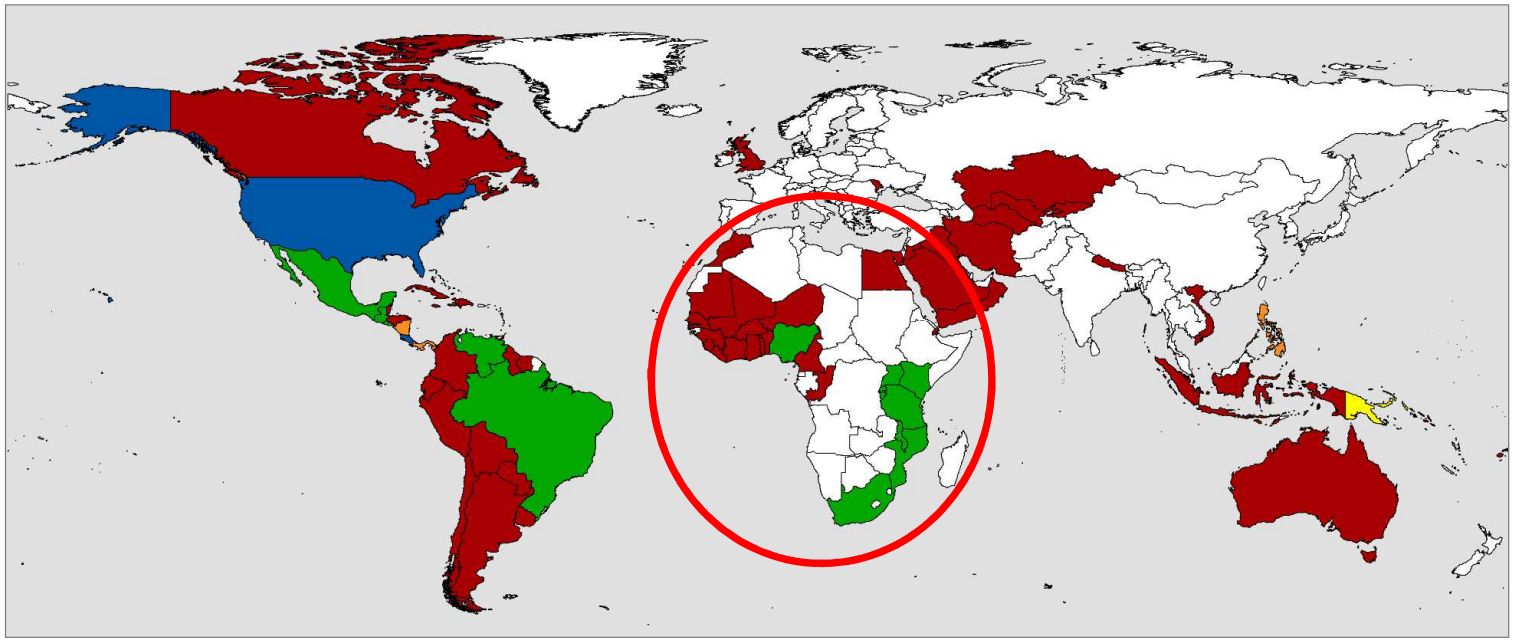
CEREALS IN THE WORLD

- Annual production of major cereals in 2010/2014

(source: faostat.fao.org)



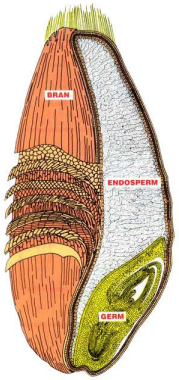
GRAIN FORTIFICATION WORLDWIDE

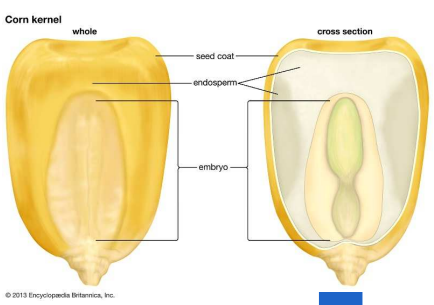


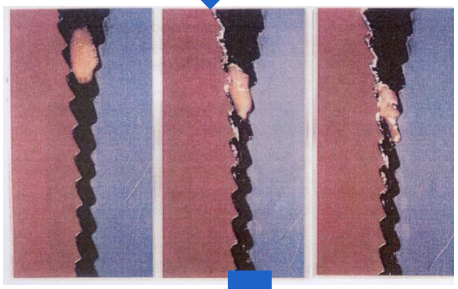
Wheat flour – 66 countries	**Wheat flour and rice – 3 countries (Nicaragua, Panama, Philippines)**
Rice – 1 country (Papua New Guinea)	**Wheat flour, maize flour, and rice – 2 countries (Costa Rica and the United States)**
Wheat flour and maize flour –14 countries	**No grain fortification legislation**

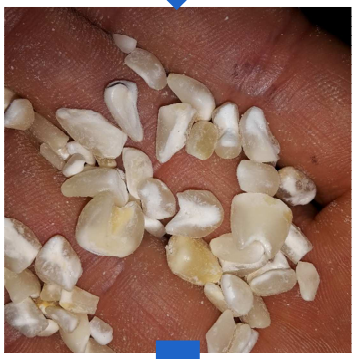
* Legislation has effect of mandating grain fortification with at least iron or folic acid.
Legislation status from the Food Fortification Initiative (www.FFInetwork.org) May 2016

HOW ARE CEREALS FORTIFIED?









Bran

Fine white flour

Powder micronutrient premix

Maize meal

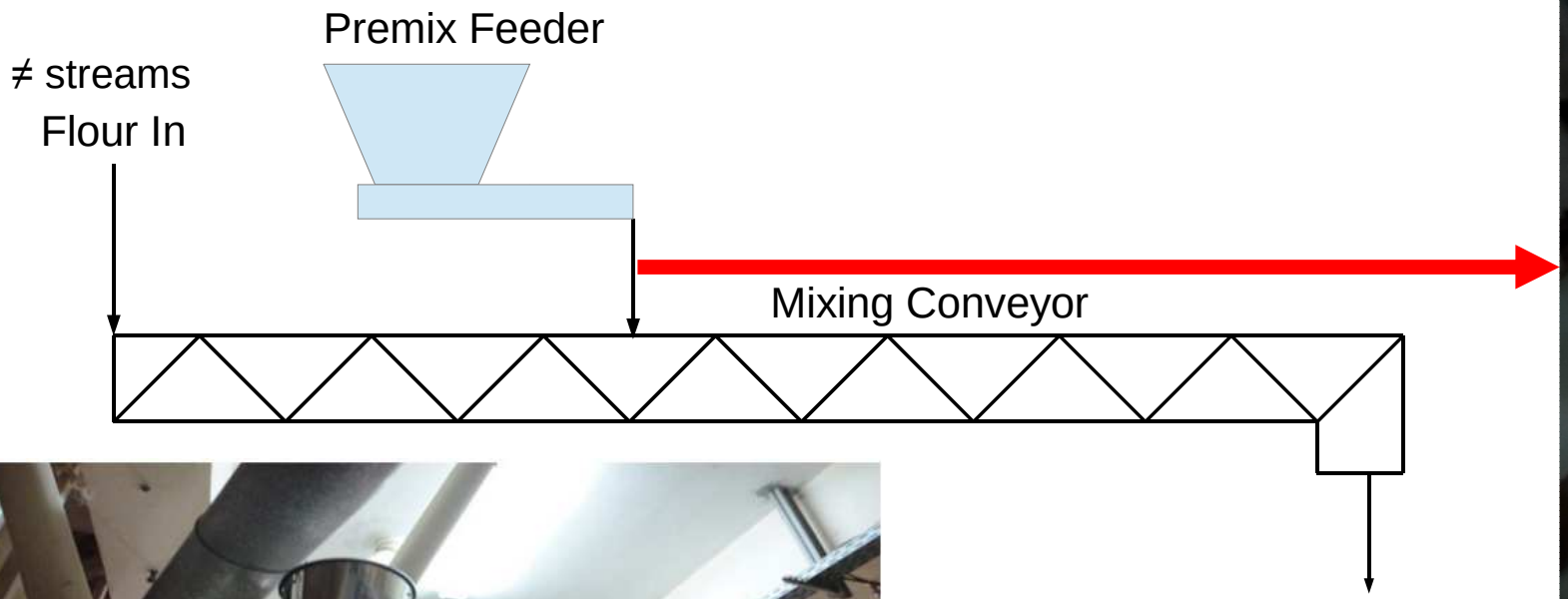
Paddy rice

Polished rice

1. Coating/dusting
2. Micronutrient kernels

HOW ARE CEREALS FORTIFIED?

– Flour fortification @ industry



FLOUR FORTIFICATION IN AFRICA: PROGRESS

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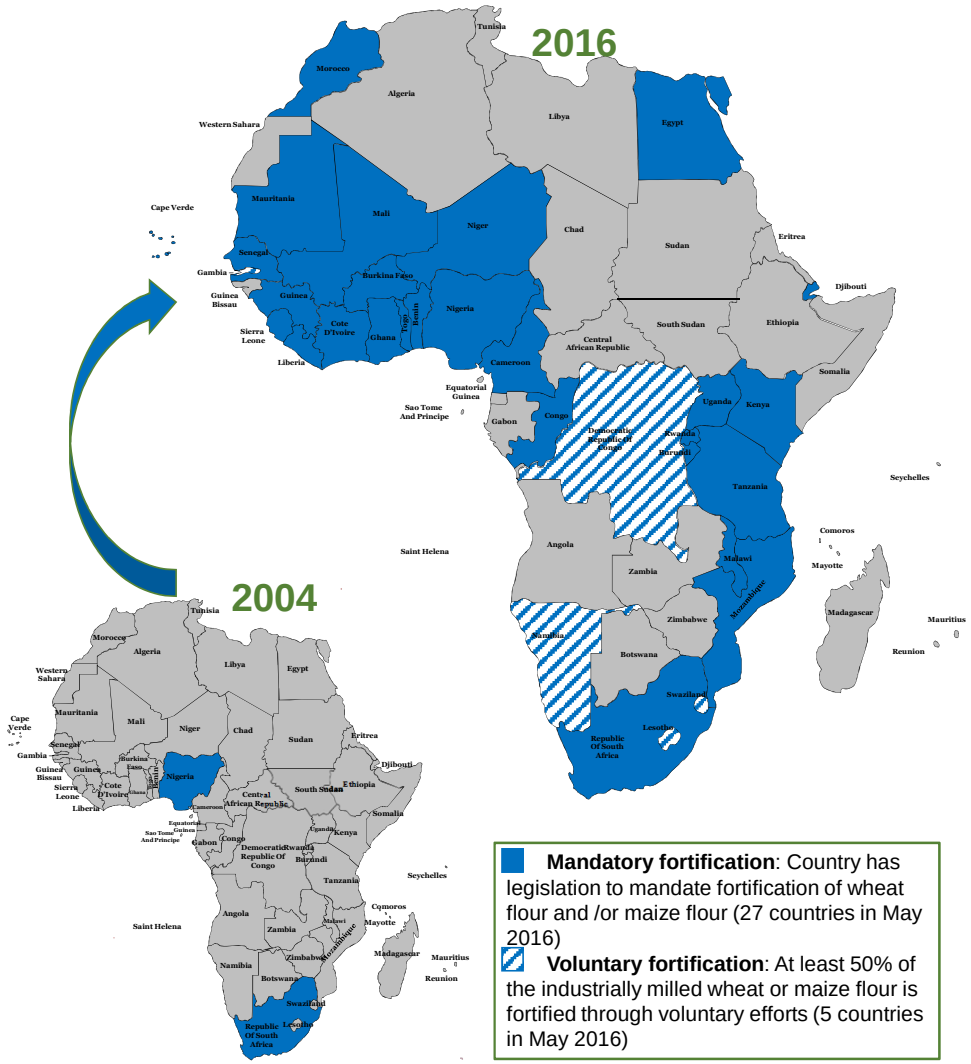
Flour Fortification in Africa: 12 Years of Progress

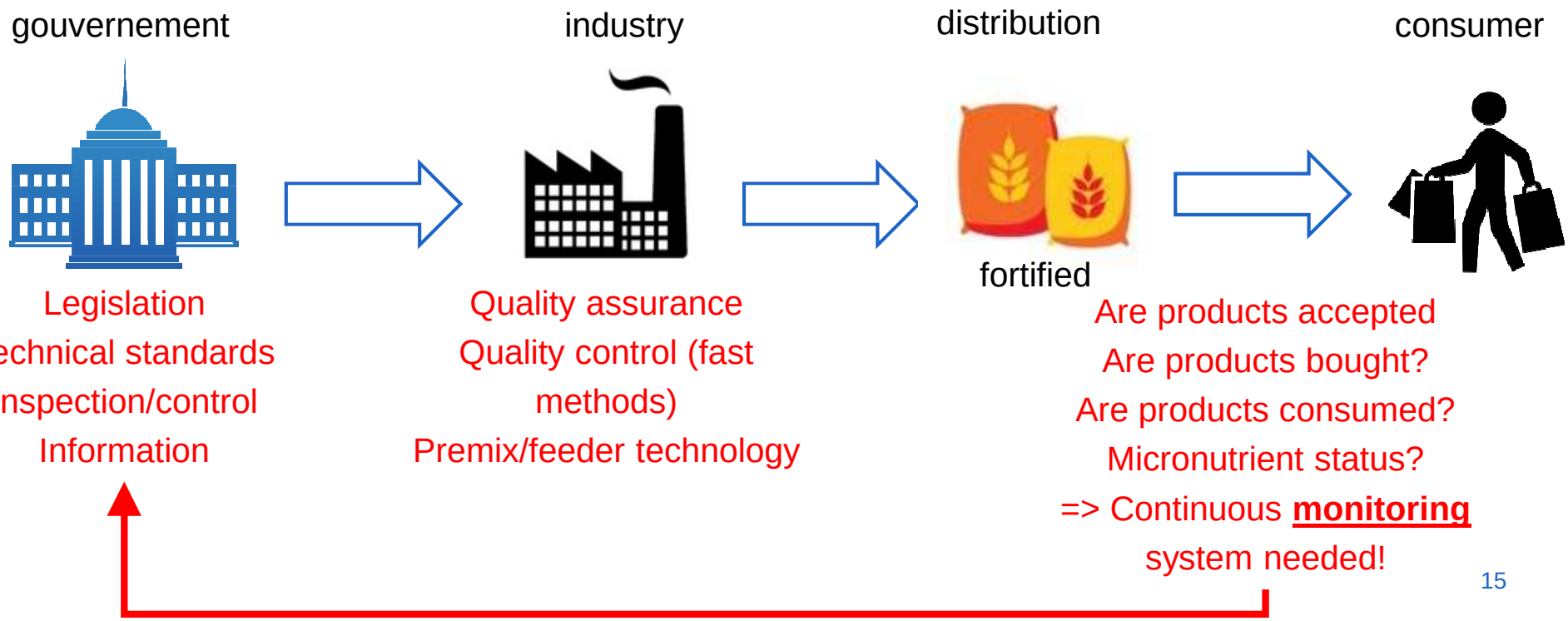


Mandatory fortification: Country has legislation to mandate fortification of wheat flour and /or maize flour (27 countries in May 2016)

Voluntary fortification: At least 50% of the industrially milled wheat or maize flour is fortified through voluntary efforts (5 countries in May 2016)

FORTIFICATION: CHALLENGES

- Fortification operation: relatively easy
- Setting up national fortification programmes: challenge!



SUPPORTING FORTIFICATION IN AFRICA

- Partnership since 2008

Food Fortification Initiative
Enhancing Grains for Healthier Lives

IFSBH

Helen Keller INTERNATIONAL

AkzoNobel

Ministry of Foreign Affairs of the Netherlands

- Aim: **improve health in Africa through the enrichment of wheat and maize flour with essential vitamins and minerals**
- **www.smarterfutures.net**

SMARTER FUTURES

- Supporting fortification efforts:
  - Development of **tools**:
    - Fortimas monitoring system
    - Cost benefit tool
    - Millers toolkit
  - Organising **trainings** and meetings
    - QA/QC of flour fortification
    - Country trainings on tools

Capacity building

Knowledge transfer

Connecting stakeholders

⇒ Governement

⇒ Millers

QA/QC TRAINING

Knowledge transfer:

- cereal processing
- fortification technology legislation&standards
- monitoring
- quality control

Field visits:

- Maize flour mill
- Governement analytical lab

Discussion groups:

- Profession groups
- Country teams

=> Developing strategy for fortification

QA/QC TRAINING KAMPALA MAY 2016

Makerere University
Kampala, Uganda, May 2016
Regional training

Stakeholders: millers, governement and academia: 79 participants (incl. facilitators)
-> 20 student/lecturers from 7 countries: Uganda, Burundi, Rwanda, South-Sudan, Kenya, Tanzania, Mozambique
14 sholarships sponsored by VLIR-UOS (Belgium): Short training initiative (STI)

CHALLENGES: MAIZE

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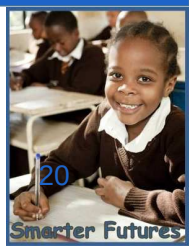
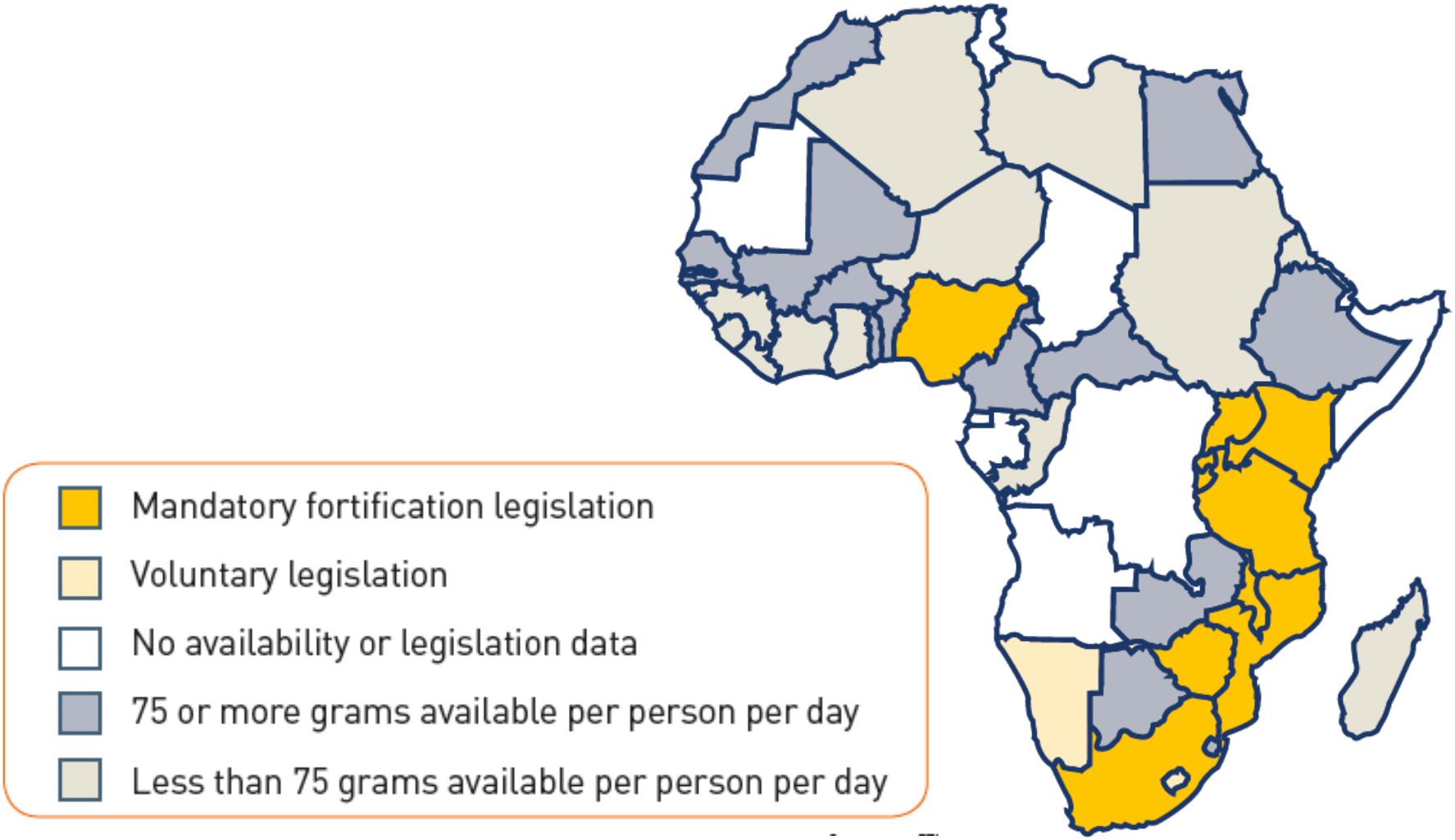


MAIZE FLOUR FORTIFICATION

Maize availability and Fortification Legislation



MAIZE STRATEGY MEETING, DAR ES SALAAM, OCT 2016

Dar es Salaam, Tanzania
Maize strategy meeting

Stakeholders: millers, governement involved from maize producing and consuming countries: 71 participants (incl. facilitators)

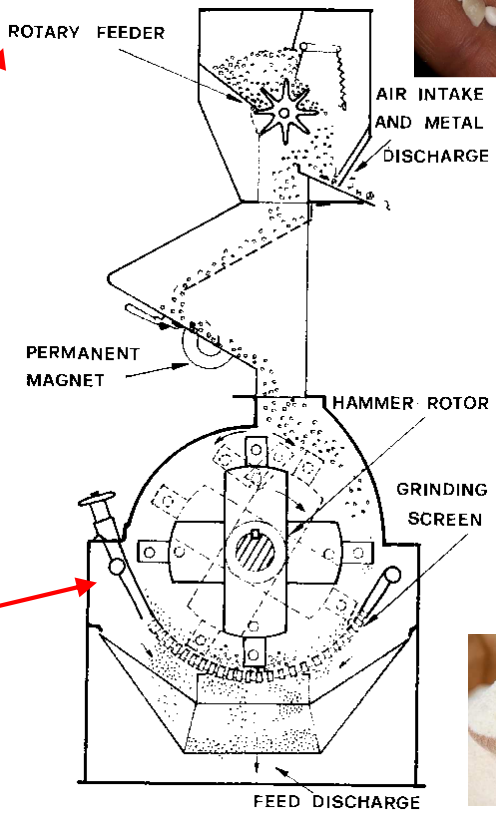
Knowledge: maize processing structure overview throughout Africa

Maize fortification technology + field trips to maize mills (large and small)

Declaration of Dar on maize fortification

SMALL SCALE HAMMER MILLS

->1 step size-reduction of dehulled maize



SMALL SCALE HAMMER MILLS

- Fortifiable?

CHALLENGES: SOUTH AFRICA STORY

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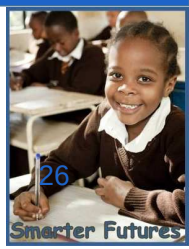


HISTORY

FOOD FORTIFICATION BECOMES A REALITY IN SOUTH AFRICA

On 7 April 2003 regulations pertaining to the mandatory fortification of all maize meal and wheat flour were printed in the *Government Gazette*. Published under Act No 54 of 1972 Foodstuffs, Cosmetics and Disinfectants. These regulations will become legally applicable and implementable 6 months later, on 7 October 2003.

The regulations apply to any person or company which manufactures, imports, or sells maize meal and wheat flour, and foodstuffs which contain 90% of either maize meal or wheat flour such as bread.

The fortification cocktail and addition rates were scientifically calculated based on the research and data from the SAVACG Study as well as the South African National Food Consumption Survey concluded in 2000. Tables I and II list the Fortification Standards for wheat flour and bread, and maize meal respectively.

An official fortification logo (monochromatic or in colour) with an allowed health claim has been developed which may be used voluntarily on the packaging and advertising materials of fortified maize meal and wheat flour.

TABLE I. FORTIFICATION STANDARDS – WHEAT FLOUR AND BREAD

Micronutrient	Unit	WHEAT FLOUR		WHEAT BREAD	
		White	Brown	White	Brown
Vitamin A*	µRE/kg	1610	1415	800	700
Thiamine	mg/kg	3.91	3.79	2.49	2.54
Riboflavin	mg/kg	2.05	1.95	1.41	1.39
Niacin	mg/kg	38.42	54.76	27.91	41.59
Pyridoxine	mg/kg	2.82	3.07	2.13	2.67
Folic acid	mg/kg	1.36	1.24	0.74	0.74
Iron	mg/kg	43.65	47.97	32.26	34.69
Zinc	mg/kg	20.70	26.73	15.30	20.07

* Retinol equivalents (RE) = 1 µg retinol = 3.33 IU (International units) vitamin A.

TABLE II. FORTIFICATION STANDARDS - MAIZE MEAL

Micronutrient	Unit	MAIZE MEAL			
		Super	Special	Sifted	Unsifted
Vitamin A*	µRE/kg	1877	1877	1877	1877
Thiamine	mg/kg	3.09	3.86	4.76	5.57
Riboflavin	mg/kg	1.79	1.88	1.97	2.06
Niacin	mg/kg	29.70	31.86	34.65	38.25
Pyridoxine	mg/kg	3.89	4.25	4.79	5.42
Folic acid	mg/kg	1.89	1.90	1.92	1.94
Iron	mg/kg	37.35	40.14	44.28	50.40+
Zinc	mg/kg	18.90	22.55	26.60	30.20

*Retinol equivalents (RE) = 1 µg retinol = 3.33 IU (International units) vitamin A.

+Where special permission was granted in terms of regulation 10, a lower iron content of 34.65 mg/kg is allowed.

framework of a balanced meal, as well as to influence people's choice and selection towards fortified food products.

The key messages of the communication programme are as follows:

- Vitamins and minerals are essential for everyone's good health.

Revision of regulations since 2015

Food fortification working group

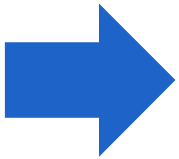
IDENTIFIED SHORTCOMINGS

- Bread vs cake flour

- Applied nutrients:
  - Fe: electrolytic Fe (40 ppm): shift to NaFeEDTA (15ppm Fe)
  - Zn: too low concentration: 15 -> 30 ppm (WHO)

CONDITIONS OF A SUCCESFUL NATIONAL FORTIFICATION PROGRAM

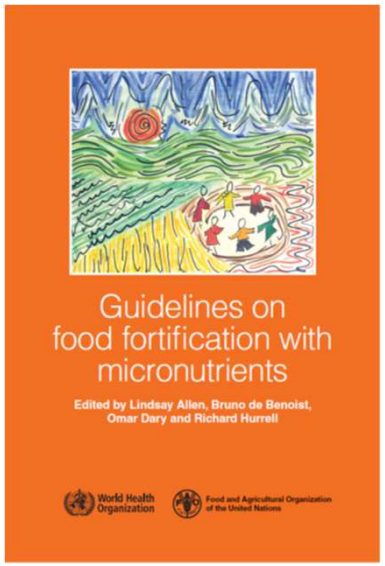
- *Political support
- ***Industry support**
- ***Consumer acceptance**
- Mandatory legislation
- National implementation
- No cultural or other objection
- Availability of micronutrient premix
- Low cost economically sustainable



No organoleptic changes of the cooked product

* Requires a private-public-civic partnership

PROBLEM STATEMENT



Factors that may limit the amount of fortificants that can be added to a single food vehicle

Nutrient	Technological/sensory	Safety	Cost
Vitamin A	X	XXX	XXX[a]
Vitamin D	–	X	X
Vitamin E	–	X	XXX
Vitamin C	XX	X	XXX[b]
Thiamine (vitamin B_1)	–	–	–
Riboflavin (vitamin B_2)	XX	–	–
Niacin (vitamin B_3)	–	XXX[c]	X
Vitamin B_6	–	X	–
Folic acid	–	XXX[d]	–
Vitamin B_{12}	–	–	X
Iron[e]	XXX	XX	X
Zinc	XX	XXX	X
Calcium	X	XX	XXX[f]
Selenium	–	X	X
Iodine	X	XXX	–

–, no constraint; X, a minor constraint; XX, moderate constraint; XXX, major constraint.

[a] If an oil-based form is used to fortify oils or fats, costs can be reduced.

[b] Cost constraints are mainly a consequence of losses during manufacturing, storage, distribution and cooking which mean that a considerable overage is required.

[c] Much less of a concern if niacinamide, as opposed to nicotinic acid, is used as the fortificant.

[d] The risk of adverse effects is minimized by the co-addition of vitamin B_{12}.

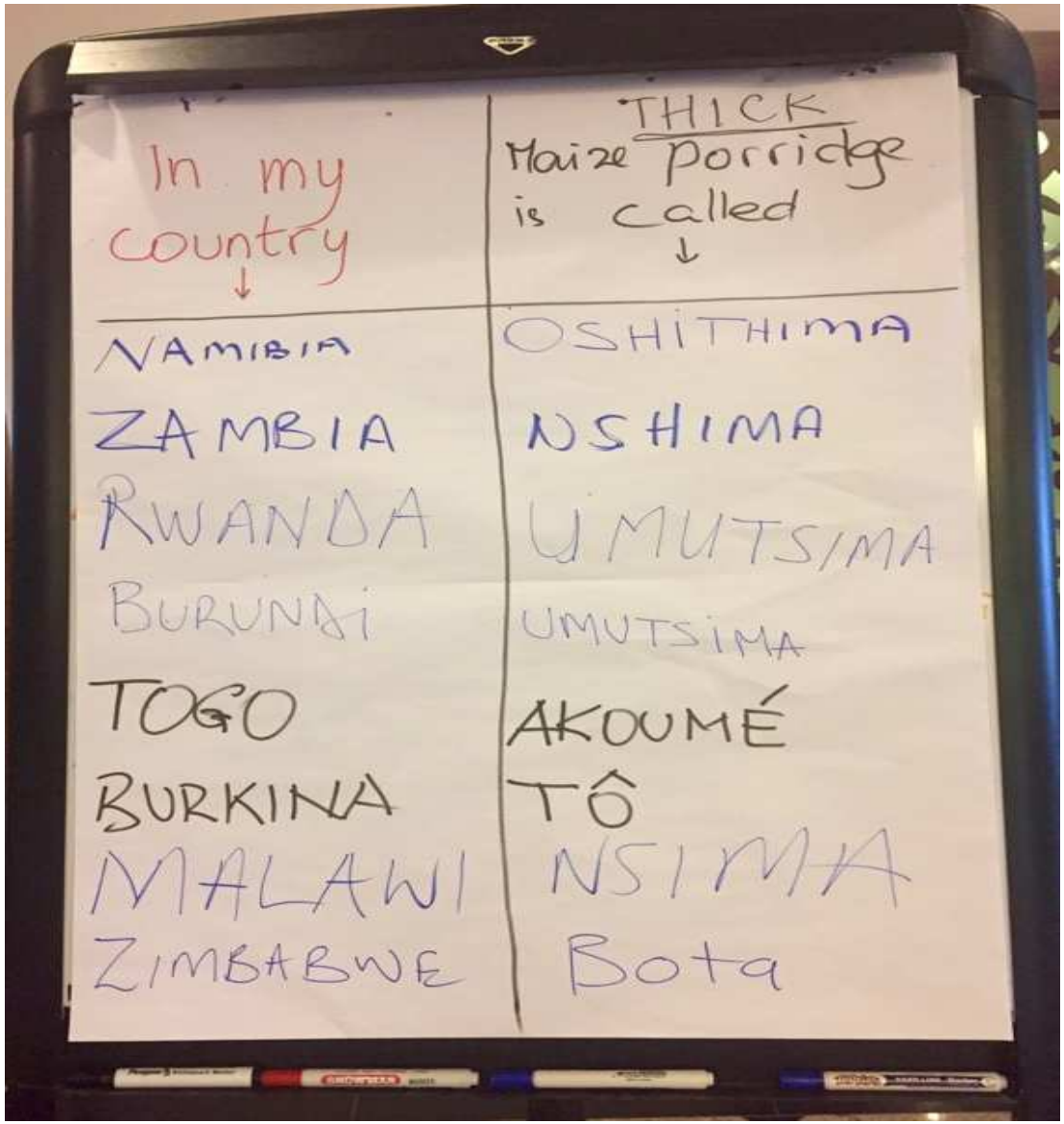
[e] Refers to the more bioavailable forms.

[f] Cost constraints are mainly a consequence of the need to add such large amounts.

PORRIDGE PRODUCTION

Ingredients → Processing → End product

Water/maize ratio
Water quality
Stirring
Cooking time
Cooking pot



In my country ↓	THICK Maize Porridge is called ↓
NAMIBIA	OSHITHIMA
ZAMBIA	NSHIMA
RWANDA	UMUTSIMA
BURUNDI	UMUTSIMA
TOGO	AKOUMÉ
BURKINA	TÔ
MALAWI	NSIMA
ZIMBABWE	Bota

In my Country ↓	Thick maize porridge is Called ↓
MALAWI	NSIMA
ZIMBABWE	1) SADZA 2) ISTHWALA
TANZANIA	UGALI
South Africa	1) PAP 2) Putu 3) Liphalishi
Kenya	Ugali/Sima

Sasco

FVB1

IMPACT OF FORTIFICATION ON MAIZE PORRIDGE

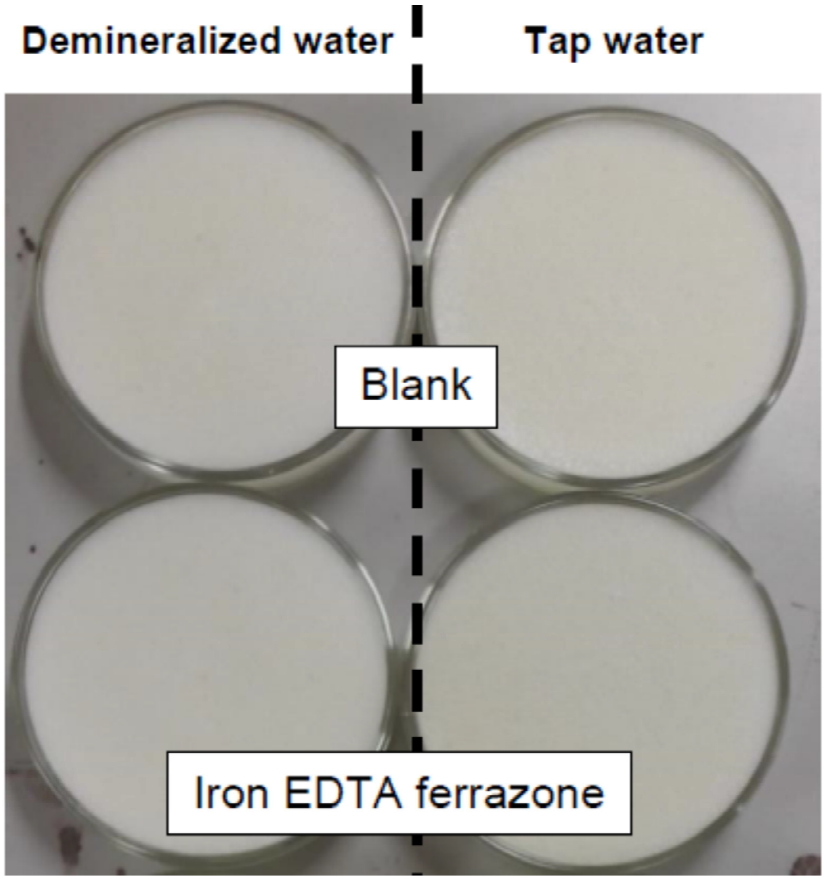
– Impact of different iron sources on maize meal functionality (Master thesis Lien Bierens)

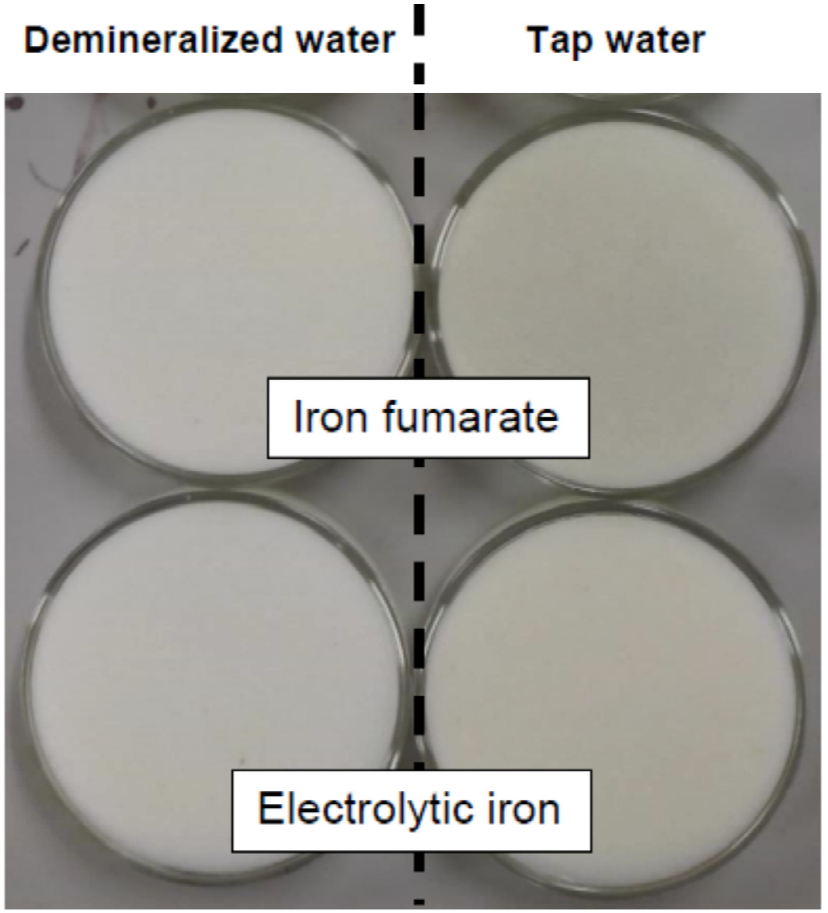
‘Pap’

Dia 33

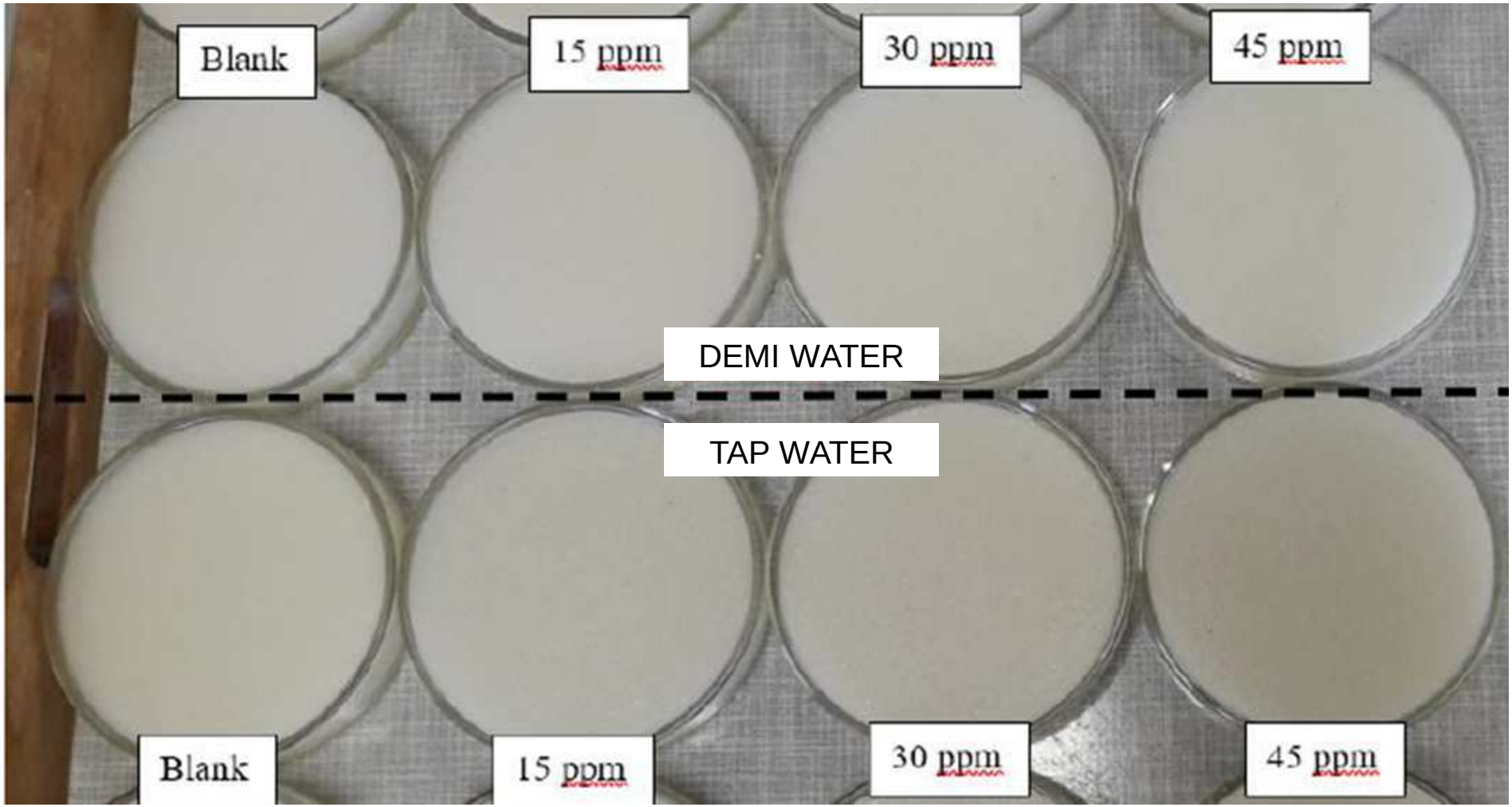
FVB1 Filip Van Bockstaele; 15/12/2017

IMPACT OF FE-SOURCE ON MAIZE PORRIDGE

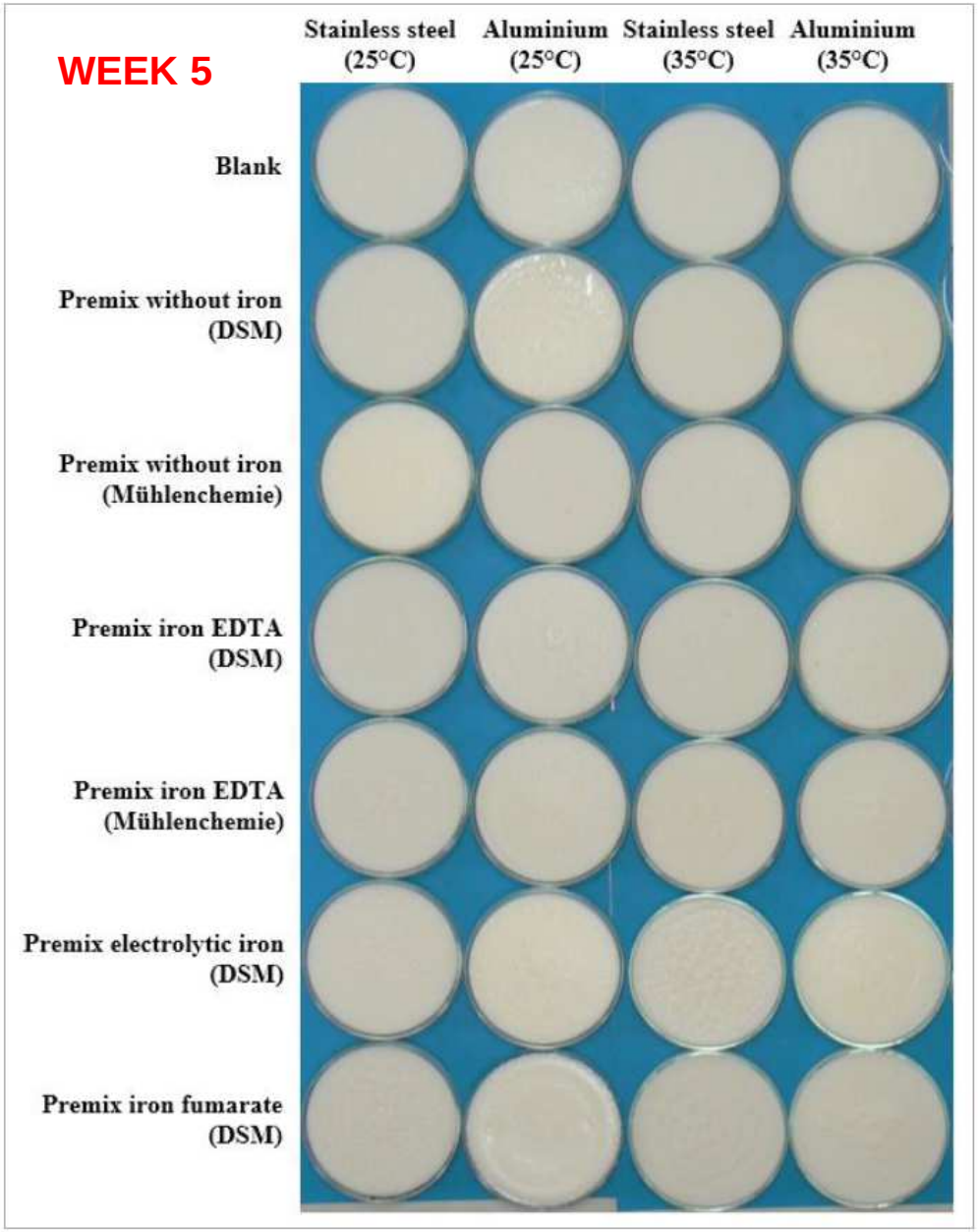




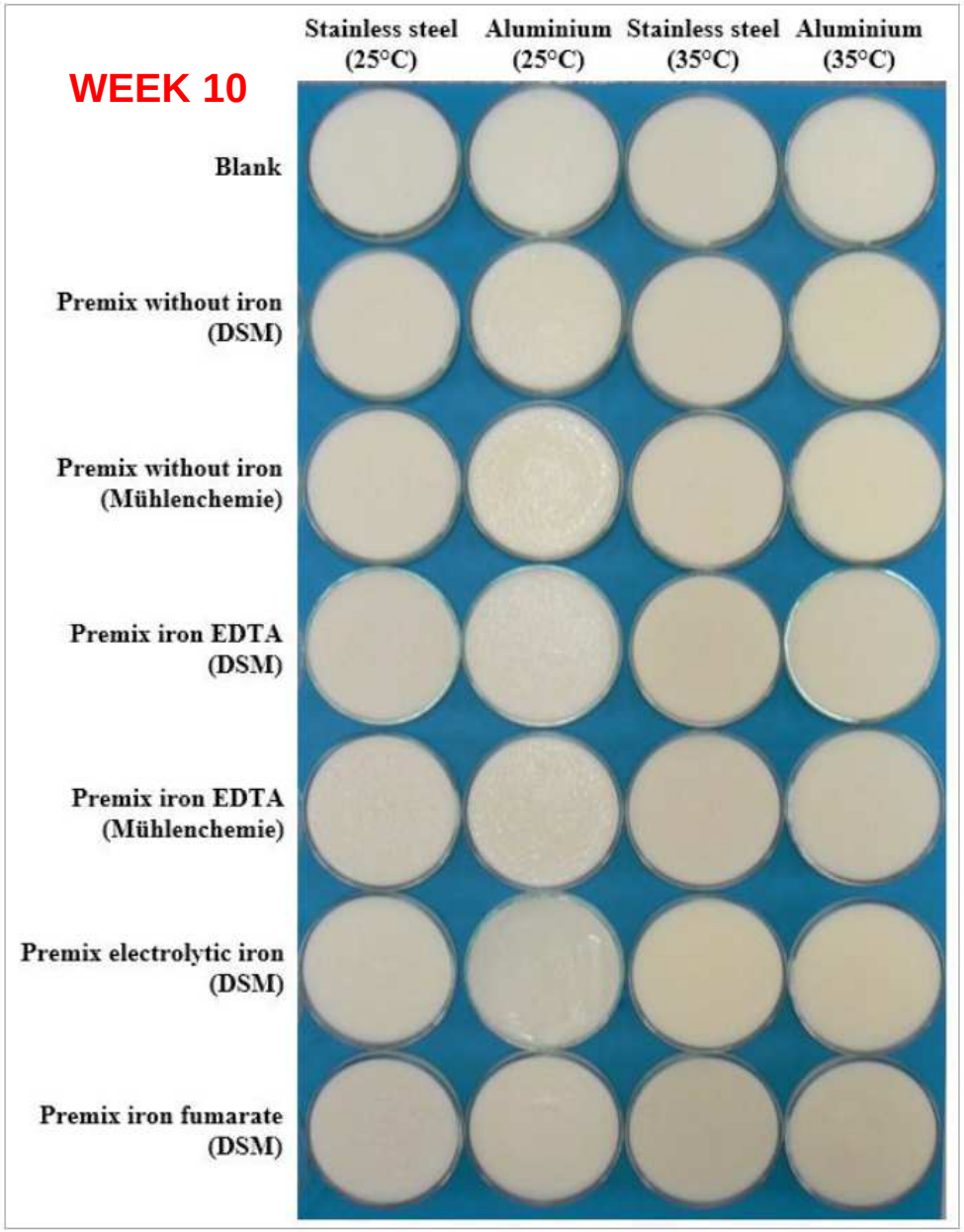
IMPACT OF NAFE-EDTA ON MAIZE PORRIDGE



WEEK 5



WEEK 10



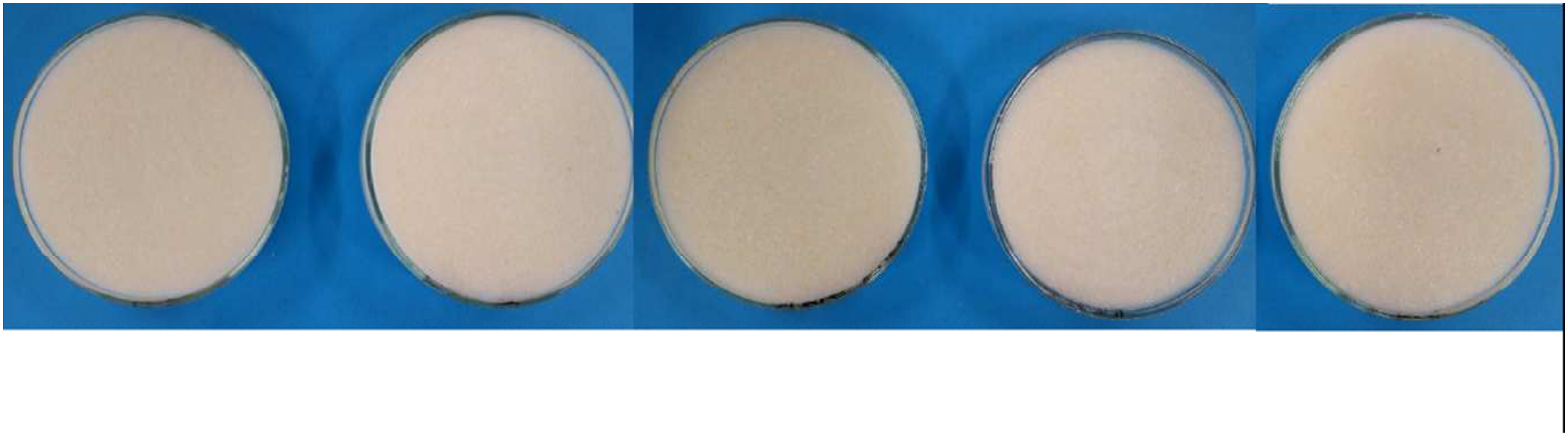
SENSORY TRIAL AT MAIZE FORTIFICATION MEETING, DAR ES SALAAM, TANZANIA

- Q1: Do any of these samples differ? If yes, which one?
- Q2: Which one did you like most?
- Q3: Why?

Around 1/3 of the participants indicated no difference among the samples was present. Of the other 2/3, preference to fortified/unfortified was 50:50

QUIZ: WHICH ONE IS FORTIFIED?

1 2 3 4 5



CHALLENGES: QUALITY CONTROL

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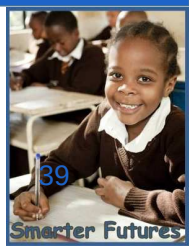
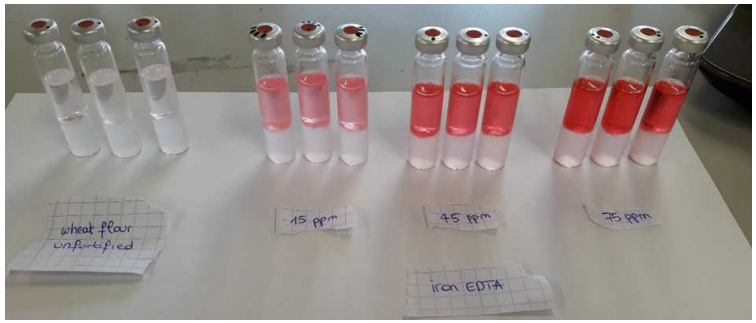
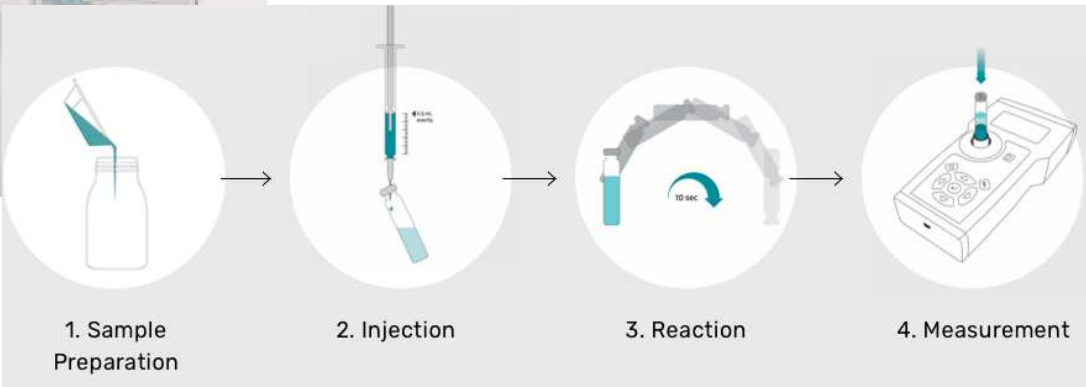


QUALITY CONTROL

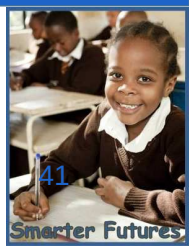
- Lack of in country quantitative methods: AAS, ICP
- Fast measuring techniques for fortificants: Fe, VitA, I

- Fully prepared reagent vials
- Off-line
- No expensive lab equipment needed
- Standardized protocols
- Quantitative





TAKE HOME MESSAGES



- Flour fortification = easy
- Africa made huge progress since 2004
- Challenges
  - Programs need monitoring and revision
  - Maize meal fortification needs attention
    - -> focus on small scale mills
  - Fast and reliable methods for quality control

ACKNOWLEDGEMENTS

- Research Group Cereal and Feed Technology

  Lien Bierens, Nele Vandevelde, Tom Hellemans

- Smarter Futures & partners

  Anna Verster, Lieven Bauwens, Margo Vandenbroucke, Quentin Johnson, Philip Randall, Ronald Afidra, …

- VLIR-UOS
  - STI 2016
  - Global Minds Fund: Capacity Building 2017-2018

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