# Analysis and justification of the possibility of harmonizing standards for wheat flour fortification in CAR, Afghanistan and Pakistan

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## Technical Meeting - Regional Expert Group on Harmonization of Wheat Flour Fortification Standards

**Central Asian Republics, Afghanistan, Pakistan**

**Almaty, 14-15 March, 2016**

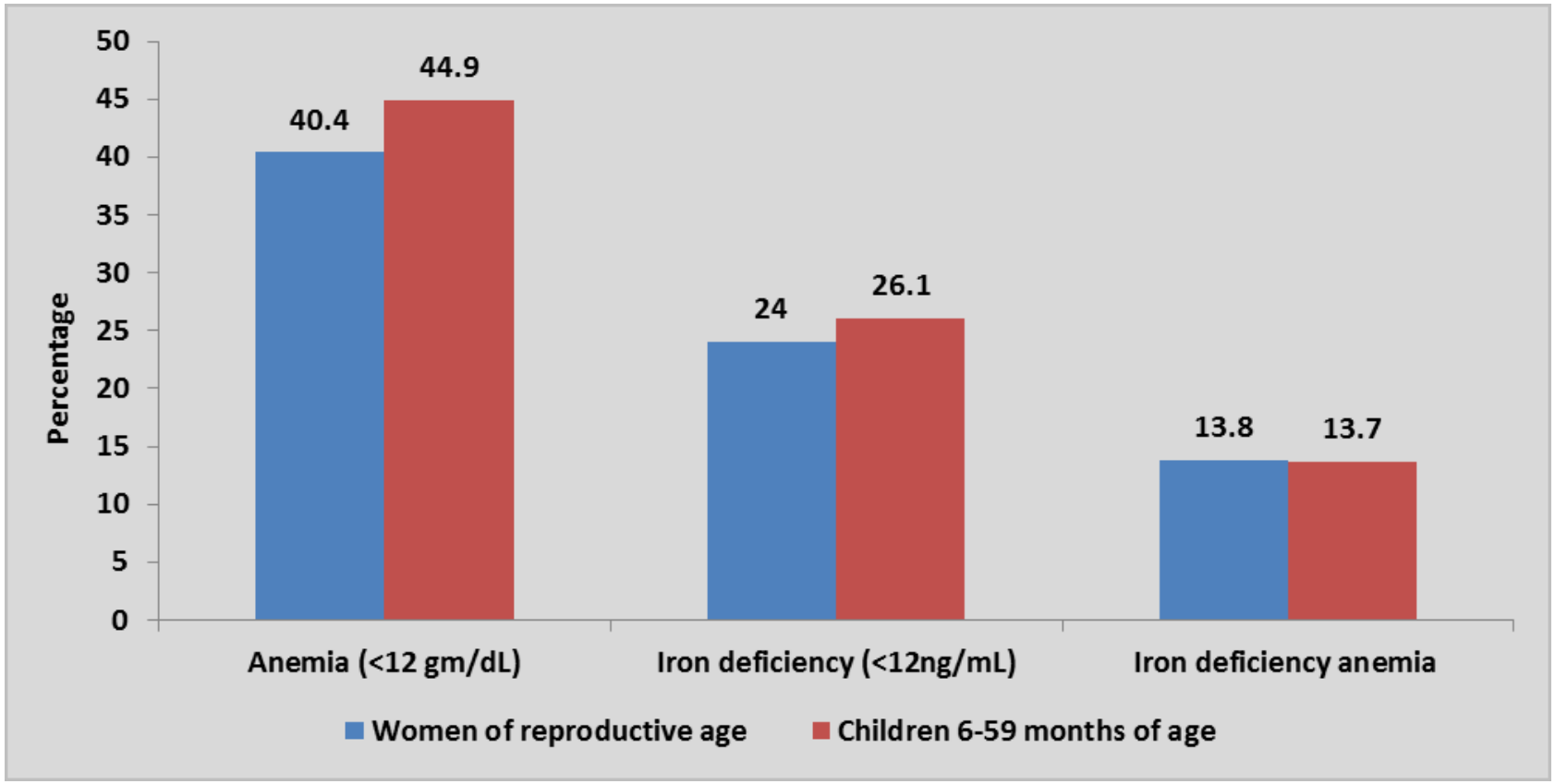
# **Scope** (1)

- **The prevalence of micronutrient deficiency** (MN) in the region
- **Rationale for fortification** of wheat flour fortification (WFF**)**
- **Methodology**
- **WHO Recommendations on** WFF
- **Used standards** for WFF in the region
- **Suggestions on** WFF
- **Determining the levels of bioavailability** of iron and zinc in the region
- **Basic parameters of premix** for low extraction WFF
- **The main production and regulatory parameters** for low extraction WFF
- **Terms and sex and age groups** for comparison with **EAR and RNI** for MN
- **Minimum and maximum daily intake levels of MN** in the composition of low extraction WFF by population groups in the participating countries**, in% RNI/day**:
  - vitamins of B group
  - iron and zinc

# **Scope** (2)

- **Costs** for low extraction WFF by:
  - **7 micronutrients** (iron as EDTA and ferrous sulfate)
  - **7 micronutrients** (iron as EDTA, without ferrous sulfate)
  - **6 micronutrients** (without vitamin B-12, iron as EDTA)
  - **6 micronutrients** (without vitamin B-12, iron electrolytic)
  - **comparison of costs** with different composition of the premix and WFF
- **Basic parameters of premix** for high extraction WFF
- **The main production and regulatory parameters** for high extraction WFF

# Prevalence of anemia, iron deficiency and iron deficiency anemia among women of reproductive age and children 6-59 months of age - **Afghanistan**



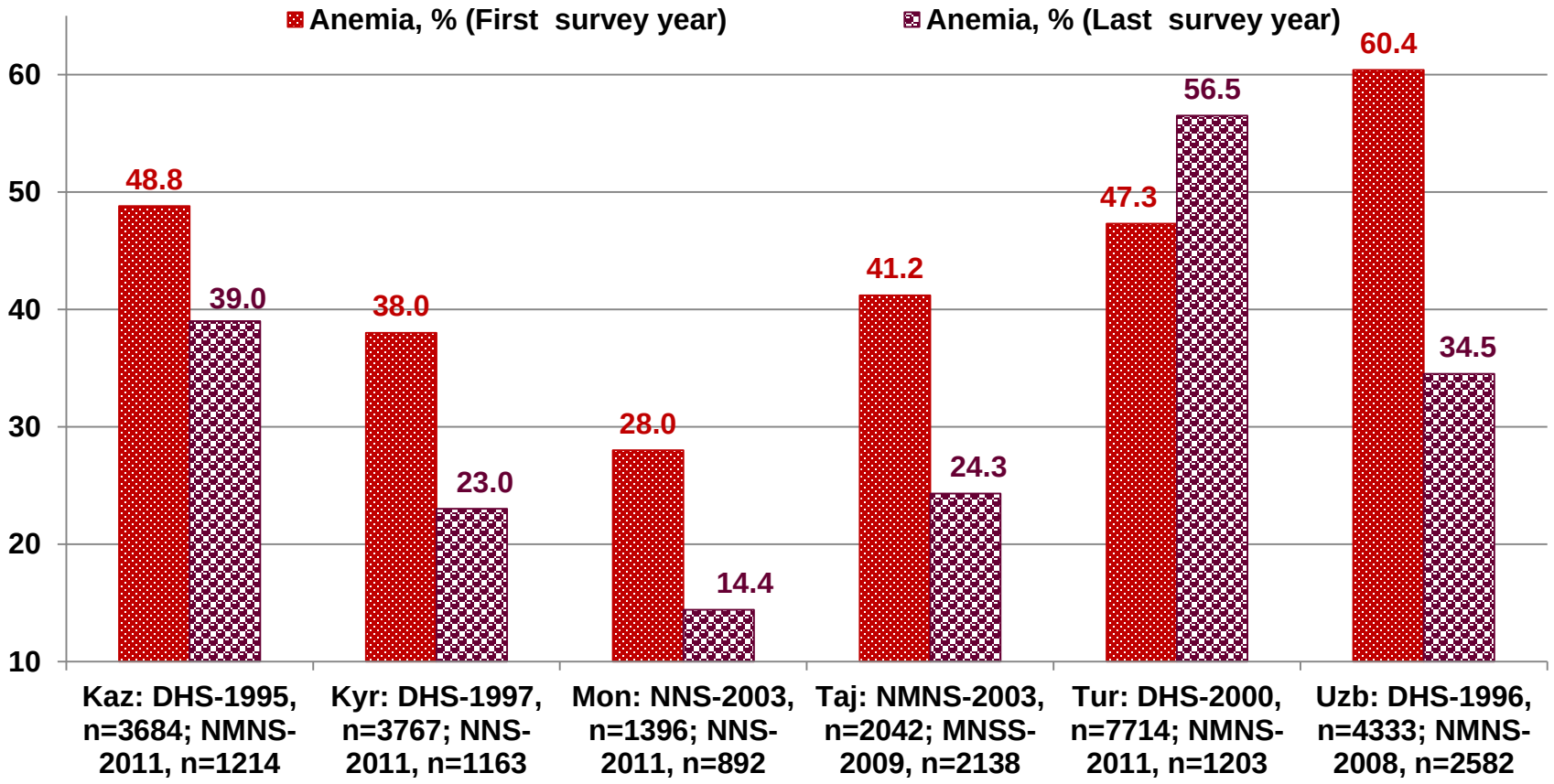

**Source:** National Nutrition Survey Afghanistan, **2013**

# Nutrition Indicators - **Pakistan**

| | Indicator | NNS 2001-02 | NNS 2011 |
|---|---|---|---|
| **1.** | Wasting % (Low Weight for Height) | 12% | 15% |
| **2.** | Stunting% (Low Height for Age) | 31% | 44% |
| **3.** | Under Weight% (Low Weight for Age) | 42% | 32% |
| **4.** | Anemia (Children) | 51% | 63% |
| **5.** | Anemia (Pregnant women) | 29% | 51% |
| **6.** | Iodine Deficiency (Children) | 63% | 36% |
| **7.** | Iodine Deficiency (Women) | 76% | 36% |
| **8.** | Vitamin A Def (Children) | 13% | 54% |
| **9.** | Vitamin A Def (Non-pregnant women) | 6% | 42% |
| **10.** | Zinc Def (Mothers) | 41% | 47% |
| **11.** | Zinc Def (Children) | 37% | 39% |

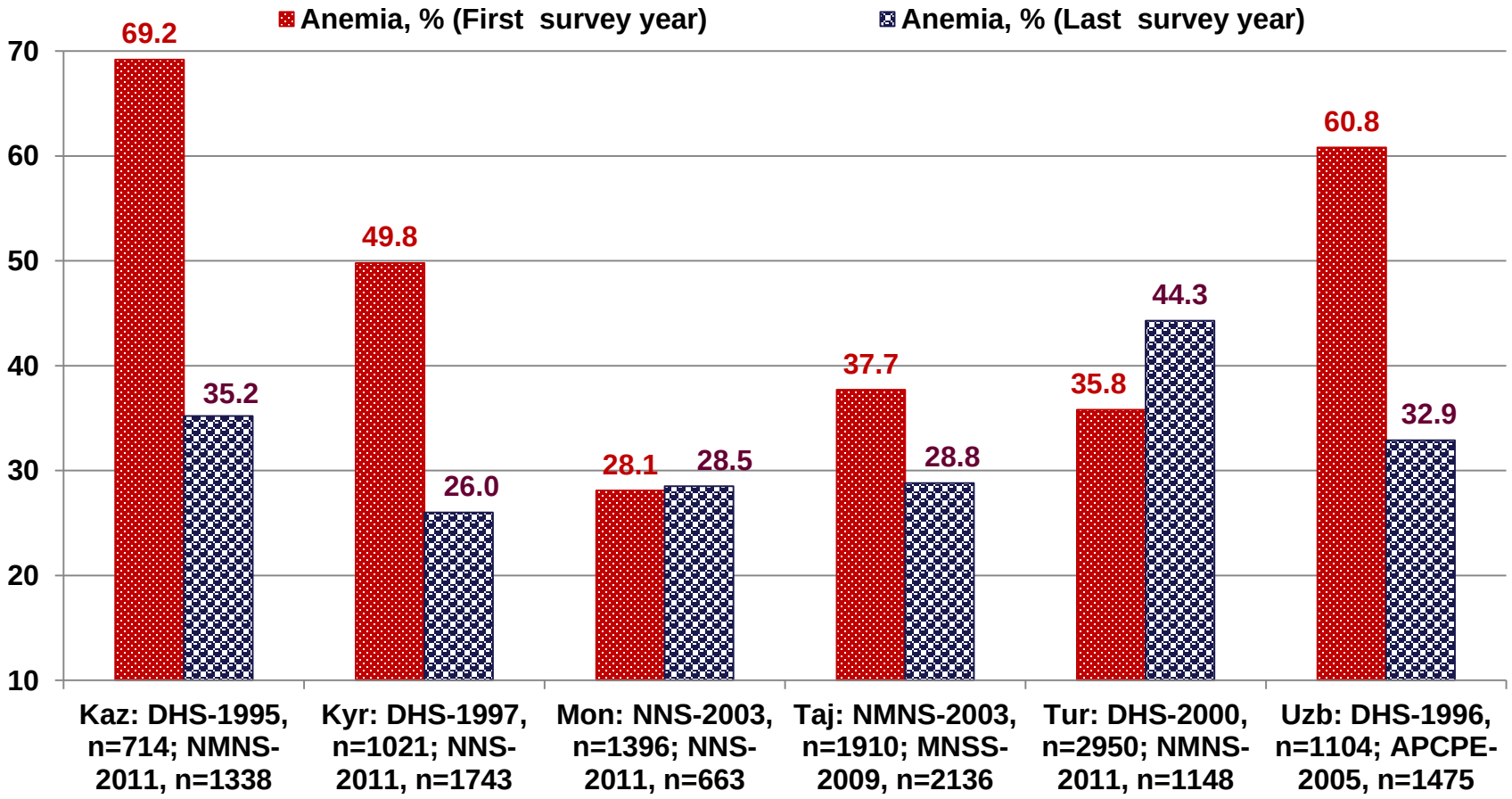
**Source:** Dr. Baseer Khan Achakzai (Director Nutrition/ Secretary NFA Ministry of National Health Services, Regulations & Coordination), **2015**

# Percent of anemic women of 15-49 years in some Asian Countries according to the results of first and last National representative surveys



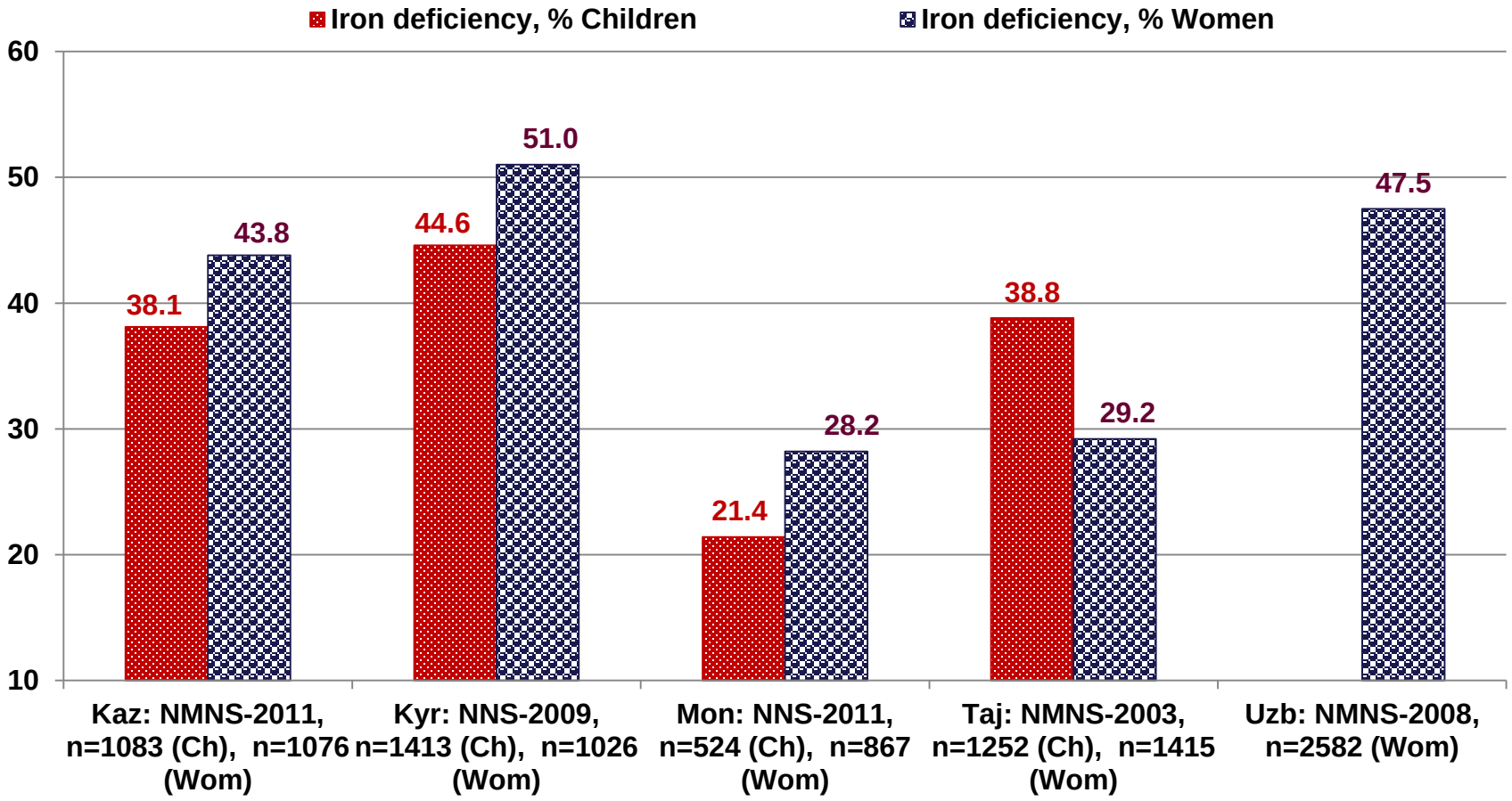

NMNS – National Micronutrient Survey
NNS – National Nutrition Study
DHS – Demographic and Health Survey

# Percent of anemic children under five years in some Asian Countries according to the results of first and last National representative surveys



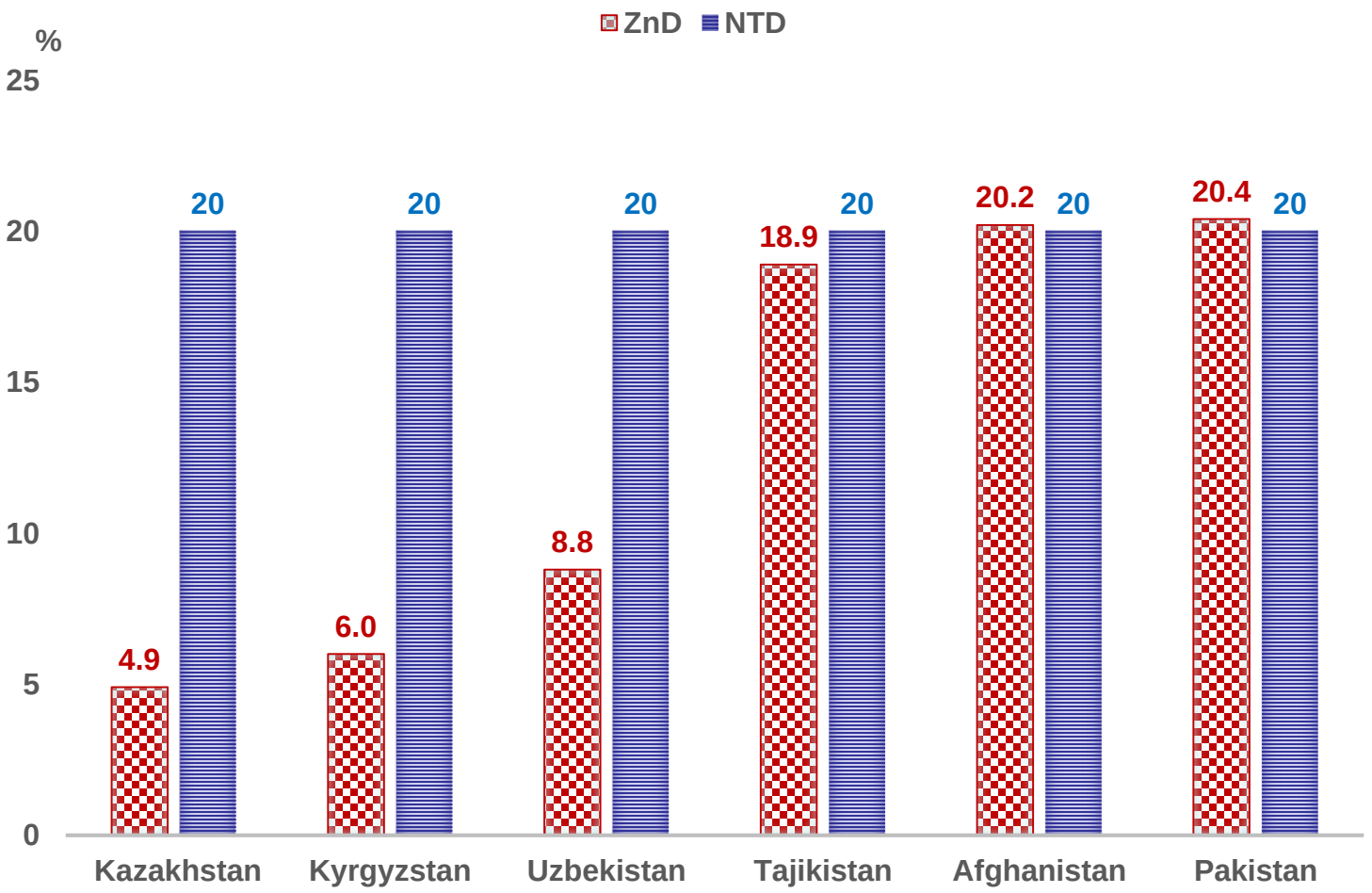

NMNS – National Micronutrient Survey
NNS – National Nutrition Study
DHS – Demographic and Health Survey
APCPE – Anemia Prevention and Control Program Evaluation

# Prevalence of iron deficiency (in percent) in children aged 6-59 months and women of reproductive age, by low serum ferritin levels with CRP≤5 mg/L in some Asian countries




NMNS – National Micronutrient Survey
NNS – National Nutrition Study

**Population at risk of inadequate zinc intake (ZnD, %) and neural tube defects (NTD, per 10,000 births)** in CAR, Afghanistan and Pakistan, http://www.ffinetwork.org/country_profiles/



# **Rationale** for wheat flour fortification (1)

- **The high prevalence of micronutrient deficiencies** and diseases caused by them (anemia, of neural tube defects, and others) in the region.
- There are four **main benefits of flour fortification:**
  - Prevention of nutritional anemia
  - Prevention birth defects of neural tube
  - Productivity increase
  - Economic progress
- Based on the analysis of **185 randomized controlled trials** flour fortification reduces the incidence of*:
  - Anemia by **41%**, and
  - Iron deficiency by **52%**

* Tarun Gera, Harshpal Singh Sachdev, and Erick Boy. Effect of iron fortified foods on hematologic and biological outcomes: systematic review of randomized controlled trials. Am J Clin Nutr August **2012** vol. 96 no. 2 309-324

# **Rationale** for wheat flour fortification (2)

- **As a result of a systematic meta-analysis of 201 studies** on the effectiveness of flour fortification the anemia prevalence was decreased by*:
  - **45%** in children ,and
  - **32%** in women

* Jai K Das, Rehana A Salam, Rohail Kumar and Zulfiqar A Bhutta. Micronutrient fortification of food and its impact on woman and child health: a systematic review. Systematic Reviews **2013**, 2:67

- A systematic **meta-analysis of 18 randomized studies involving 5142 children** under 10 years of age who received iron-fortified foods from 6 to 12 months, revealed **an increase in the concentration of hemoglobin in the blood to 5.09 g/L** **

** Ramesh Athe M Vishnu Vardhana Rao, and K Madhavan Nair. Impact of iron-fortified foods on Hb concentration in children (,10 years): a systematic review and meta-analysis of randomized controlled trials. Review. Public Health Nutrition, **2013**, 17(3), 579–586.

- **Flour fortification with folic acid** is effective way in the prevention of neural tube defects and folate deficiency (there are many evidences)

# **Methodology** of analysis and justification the possibility of harmonizing standards for refined wheat flour fortification in CAR, Afghanistan and Pakistan

- **Fully based on the WHO recommendations** on fortification of food products, was taken into account:
  - Current levels of flour consumption per capita in the region
  - Levels of flour extraction
  - Composition of fortificants
- By use of the **Formulator, elaborated by Omar Dary и Michael Hainsworth*,** were determined the following indicators:
  - the levels of MH consumption in the composition of FWF by different age and gender groups of population;
  - the basic parameters of the premix for low and high extraction WFF;
  - the main production and regulatory parameters for low and high extraction WFF;
  - premixes costs with different composition for low and high extraction WFF
- **The calculated levels of consumption of MN** in the composition of low and high extraction WFF by different age and gender groups were compared with internationally accepted levels of **EAR and RNI**

* Omar Dary and Michael Hainsworth. The Food Fortification Formulator. Technical Determination of Fortification Levels and Standards for Mass Fortification. USAID, April **2008**

**WHO interim consensus statement about recommendations for fortified flours, 2009:** Average levels of nutrients to consider adding to fortified wheat flour based on extraction, fortificant compound, and estimated per capita flour availability

| Nutrient | Flour extraction rate | Compound | Level of nutrient to be added in parts per million (ppm) by estimated average per capita wheat flour availability (g/day) | | | |
|---|---|---|---|---|---|---|
| | | | <75g/day | 75-149 g/day | 150-300 g/day | >300g/day |
| **Iron** | Low | NaFeEDTA | 40 | 40 | 20 | 15 |
| | | Ferrous sulphate | 60 | 60 | 30 | 20 |
| | | Ferrous fumarate | 60 | 60 | 30 | 20 |
| | | Electrolytic iron | NR[d] | NR[d] | 60 | 40 |
| | High | NaFeEDTA | 40 | 40 | 20 | 15 |
| **Folic acid** | Low or high | Folic acid | 5.0 | 2.6 | 1.3 | 1.0 |
| **Vitamin $B_{12}$** | Low or high | Cyanocobalamin | 0.04 | 0.02 | 0.01 | 0.008 |
| **Vitamin A** | Low or high | Vit A palmitate | 5.9 | 3 | 1.5 | 1,0 |
| **Zinc[e]** | Low | Zinc oxide | 95 | 55 | 40 | 30 |
| | High | Zinc oxide | 100 | 100 | 80 | 70 |

# Summary data on the levels of micronutrients to be added in parts per million (ppm) to fortified wheat flour **according to standards in Central Asian Republics, Afghanistan and Pakistan**

| Items | Kazakhstan | Kyrgyzstan | Tajikistan | Uzbekistan | Pakistan | Afghanistan |
|---|---|---|---|---|---|---|
| | premium & 1st grade | premium & 1st grade | premium & 1st grade | 1st grade | Atta | Atta |
| Vitamin $B_1$ | 2.0 & 1.6 | 2,0 | 2.0 & 1.6 | 1,6 | n/f | n/f |
| Vitamin $B_2$ | 3.0 & 2.4 | 3,0 | 3.0 & 2.4 | 2,4 | n/f | n/f |
| Vitamin $B_3$ | 10.0 & 8.0 | 10,0 | 10.0 & 8.0 | 8,0 | n/f | n/f |
| Vitamin $B_9$ | 1.5 & 1.2 | 1,0 | 1.5 & 1.2 | 1,2 | 1,5 | 1,0 |
| WHO, 2009 | **1,3** | **1,0** | **1,0** | **1,0** | **1,0** | **1,0** |
| Vitamin $B_{12}$ | n/f | n/f | n/f | n/f | n/f | 0,008 |
| WHO, 2009 | **0,01** | **0,008** | **0,008** | **0,008** | **0,008** | **0,008** |
| Iron | 50.0 & 40.0 | 15,0 | 50.0 &40.0 | 40,0 | 10,0 | 15,0 |
| WHO, 2009 | **60,0** | **15,0** | **40,0** | **40,0** | **15,0** | **15,0** |
| | Electrolytic | Sodium Iron EDTA | Electrolytic | Electrolytic | Sodium Iron EDTA | Sodium Iron EDTA |
| Zinc | 22.0 & 17.6 | 30,0 | 22.0 &17.6 | 17,6 | n/a | 30,0 |
| WHO, 2009 | **40,0** | **30,0** | **30,0** | **30,0** | **30,0** | **30,0** |

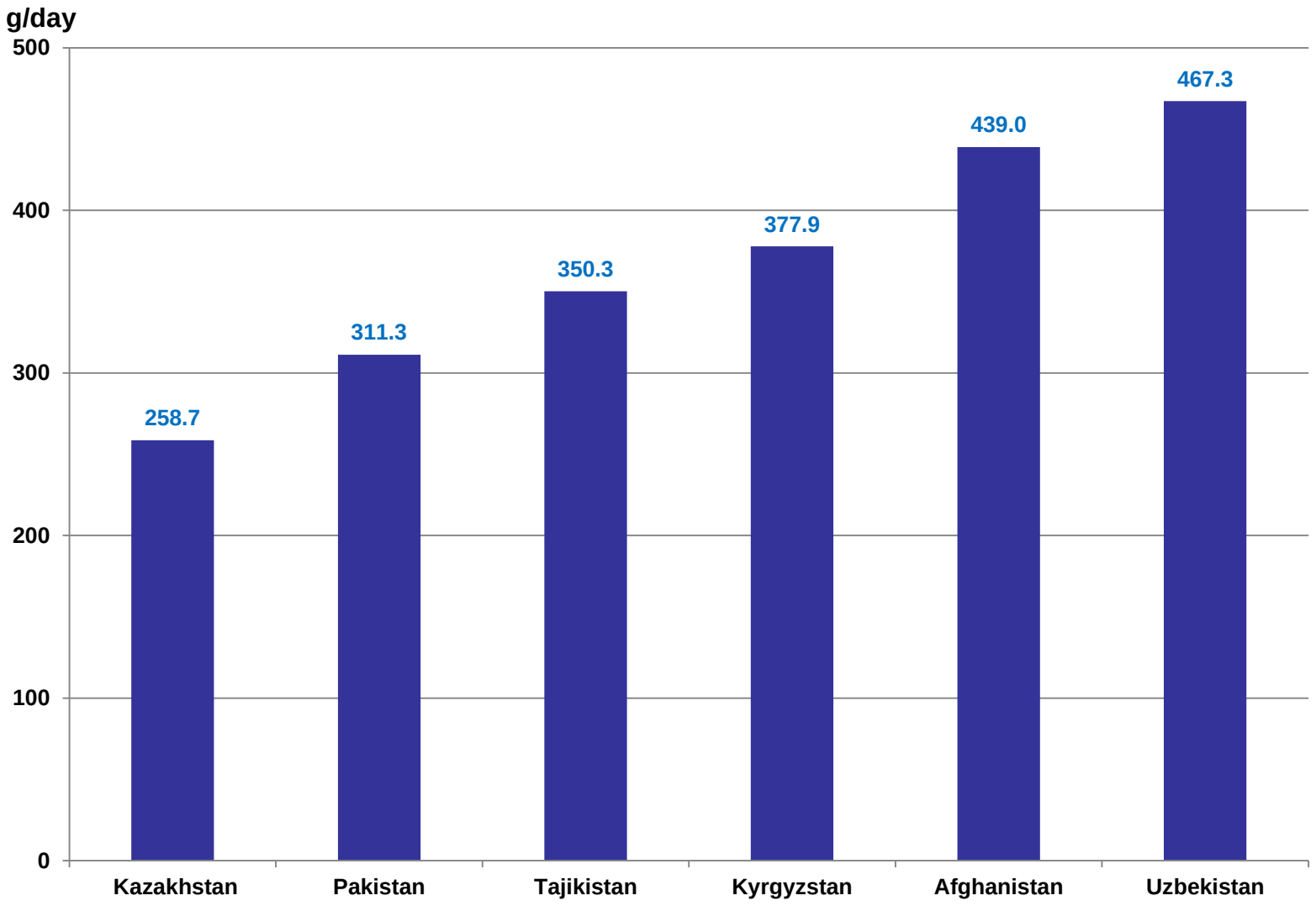
## Suggestions for wheat flour fortification

- Mandatory fortification of flour with micronutrients endorsed by the World Health Organization, namely:
  - by vitamins $B_9$ and $B_{12}$, iron and zinc **for all types of flour**,
  - plus $B_1$, $B_2$ and $B_3$ **for low extraction (low extraction) flour**;
  - as the **high-extraction wheat flour** contains good amounts of the latter vitamins ($B_1$, $B_2$ and $B_3$); those would not be added to this type of flour;
- **Carry out studies** of vitamin A and vitamin D deficiencies in all the countries in order to establish if the addition of these other micronutrients would be appropriate for the whole region.

## **Setting the levels of bioavailability of minerals** in Afghanistan, Kazakhstan, Kyrgyzstan, Pakistan, Tajikistan and Uzbekistan

- **FAO and WHO** set iron bioavailability at:
  - **5%** for a strict vegetarian diet,
  - **10%** when some meat and ascorbic acid was added, and
  - **15%** for diets rich in meat and fruits
- Kazakhstan can be attributed to the group with a high bioavailability of **iron (15%) and zinc (30%)** where:
  - mainly intake **low-extraction wheat flour**, the average per capita intake is about 250 g/day, and
  - generous contribution of meat/poultry and vegetables/fruits.
- Kyrgyzstan, Tajikistan and Uzbekistan can be attributed to the group with a moderate bioavailability of **iron (10%) and zinc (15%)** where:
  - mainly intake **low-extraction wheat flour**, the average per capita intake is more than 300 g/day
- Afghanistan and Pakistan can be attributed to the group with a low bioavailability of **iron (5%)** and moderate bioavailability of **zinc (15%)** where:
  - mainly intake **high-extraction wheat flour**, the average per capita intake is more than 300 g/day

# Per capita intake (g/day) of wheat flour
in CAR, Afghanistan and Pakistan, http://faostat3.fao.org/



# The main parameters of the premix for fortification **of low-extraction wheat flour**

| Nutrient | Fortificant compound | Selected FL (mg/kg flour) | Amount of fortificant (mg/kg flour) | Premix Formulation | | | |
|---|---|---|---|---|---|---|---|
| | | | | Fortifi-cant (g/kg premix) | Nutrient (g/kg premix) | Cost (US$/kg) | % Cost |
| Vit. B-1 | Thiamin mononitrate | 2,0 | 2,5 | 9,9 | 8 | $0,25 | 2,5 |
| Vit. B-2 | Riboflavin | 3,0 | 3,0 | 12,0 | 12 | $0,72 | 7,5 |
| Vit. B-3 | Niacinamide | 10,0 | 10,1 | 40,4 | 40 | $0,40 | 4,2 |
| Vit. B-9 | Folic Acid | 1,0 | 1,1 | 4,4 | 4 | $0,49 | 5,1 |
| Vit. B-12 | **Vit. B-12 0.1% WS** | 0,008 | 8,0 | 32,0 | 0,03 | **$1,28** | **13,4** |
| Iron | Ferrous sulfate dried | 10 | 31,3 | 125,0 | 40 | $0,34 | 4,0 |
| Iron | **NaFeEDTA** | 15 | 115,4 | 461,5 | 60 | **$3,00** | **31,4** |
| Zinc | Zinc oxide | 30 | 37,5 | 150,0 | 120 | $0,88 | 9,2 |
| | Filling material | | 31,3 | 164,7 | | $0,16 | 1,7 |
| | | **TOTAL** | 240,1 | **1000,0** | | | |
| | Estimated cost of manufacturing, quality control and delivery | | | | | **$2,00** | **20,9** |
| **Estimated cost of micronutrient premix per metric ton of fortified product:** | | | | | | **$2,39** | |
| | | | | | | **0,48 % of the Price** | |

| | |
|---|---|
| Minimum Amount (grams per MT) | **240** |
| Selected Amount (grams per MT) | **250** |

| | |
|---|---|
| Maximum Dilution Factor = 1/ | **4164** |
| Selected Dilution Factor = 1/ | **4000** |

# The main production and regulatory parameters for fortification **of low extraction wheat flour**

| Nutrient | Fortificant compound | Selected FL (mg/kg flour) | Production Parameters | | | Regulatory Parameters | |
|---|---|---|---|---|---|---|---|
| | | | mFL (1) (mg/kg flour) | Average (2) (mg/kg flour) | MFL (3) (mg/kg flour) | LmL (4) (mg/kg flour) | MTL (5) (mg/kg flour) |
| Vit. B-1 | Thiamin mononitrate | 2,0 | 1,5 | 2,8 | 4,1 | 1,3 | 4,1 |
| Vit. B-2 | Riboflavin | 3,0 | 2,0 | 3,6 | 5,2 | 1,8 | 5,2 |
| Vit. B-3 | Niacinamide | 10,0 | 11,0 | 20,0 | 29,0 | 9,9 | 29,0 |
| Vit. B-9 | Folic Acid | 1,0 | 0,7 | 1,3 | 1,9 | 0,6 | 1,9 |
| Vit. B-12 | Vit. B-12 0.1% WS | 0,008 | 0,004 | 0,008 | 0,012 | 0,004 | 0,012 |
| Iron | Ferrous sulfate dried **(6)** | 10,0 | 13,0 | 19,0 | 25,0 | 13,0 | 25,0 |
| Iron | NaFeEDTA **(7)** | 15,0 | 16,0 | 24,0 | 32,0 | 16,0 | 32,0 |
| Zinc | Zinc oxide | 30,0 | 26,0 | 38,0 | 50,0 | 26,0 | 50,0 |

**(1) mFL** = Minimum Fortification Level, using equation 2.
**(2) Average** = Selected Fortification Level + Intrinsic content of micronutrient in unfortified food.
**(3) MFL** = Maximum Fortification Level, using equation 3.
**(4) LmL**= Legal Minimum Level, using equation 4.
**(5) MTL** = Maximum Tolerable Level, equivalent to MFL but only for those micronutrients with safety concerns, and rounded.
**(6)** As the iron from ferrous sulfate is very difficult to measure independently from intrinsic iron, as well as from NafeEDTA, because the usual analytical methods require ashing of the sample, the expected total iron amount is presented here (i.e. intrinsic iron + iron from NaFeEDTA + iron from ferrous sulfate).
**(7)** As the iron from NaFeEDTA can be determined separated of the intrinsic iron (and perhaps the iron from ferrous sulfate), these values are only expressing the variation of the content of iron coming from NaFeEDTA

# **Terms and sex and age groups**
## for comparison with EAR and RNI

- **EAR** = Estimated Average Requirement is the daily intake which meets the nutrient requirements of **50%** apparently healthy individuals in an age- and sex-specific population.
- **RNI** = Recommended nutrient intake is the daily intake which meets the nutrient requirements of almost all (**97.5%**) apparently healthy individuals in an age- and sex-specific population.
- The following **age-sex groups** were used for comparison the consumption of micronutrients in the composition of fortified wheat flour with the levels of EAR and RNI:
  - **Children**: 1-3 years; 4-6 years; 7-9 years
  - **Male**: 10-18 years; 19-50 years; 51-65 years; +65 years
  - **Female**: 10-18 years; 19-50 years; 51-65 years; +65 year

Minimum and maximum daily intake levels of **Vitamins of B group** in the composition of low extraction FWF in population groups in the participating countries, **in % RNI/day**

| Countries | Minimum and maximum daily intake levels of Vitamins of B group: in % RNI/day | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Vitamin B-1 | | Vitamin B-2 | | Vitamin B-3 | | Folate | | Vitamin B-12 | |
| | Mini-mum | Maxi-mumм | Mini-mum | Maxi-mumм | Mini-mum | Maxi-mumм | Mini-mum | Maxi-mumм | Mini-mum | Maxi-mumм |
| Kazakhstan | 22 | 29 | 42 | 52 | 11 | 14 | 64 | 91 | 51 | 73 |
| Pakistan | 28 | 35 | 50 | 62 | 13 | 17 | 76 | 109 | 62 | 88 |
| Tajikistan | 30 | 39 | 56 | 70 | 14 | 19 | 86 | 123 | 70 | 99 |
| Kyrgyzstan | 33 | 43 | 61 | 76 | 16 | 20 | 93 | 133 | 75 | 107 |
| Afghanistan | 38 | 49 | 71 | 88 | 18 | 23 | 108 | 156 | 87 | 124 |
| Uzbekistan | 40 | 53 | 75 | 94 | 19 | 25 | 115 | 164 | 93 | 132 |

Minimum and maximum daily intake levels of **iron and zinc** in the composition of low extraction FWF in population groups in the participating countries, **in % RNI/day**

| Countries | Minimum and maximum daily intake levels of iron and zinc: in % RNI/day | | | |
|---|---|---|---|---|
| | Iron | | Zinc | |
| | Minimum | Maximum | Minimum | Maximum |
| Pakistan | 15 | 46 | 41 | 75 |
| Afghanistan | 21 | 66 | 59 | 106 |
| Tajikistan | 27 | 85 | 95 | 169 |
| Kyrgyzstan | 30 | 92 | 102 | 183 |
| Kazakhstan | 30 | 94 | 70 | 125 |
| Uzbekistan | 37 | 113 | 127 | 226 |

Minimum and maximum daily intake levels of **железа** in the composition of low extraction FWF in population groups in the participating countries, сравнительные данные у женщин в возрасте 10-50 лет и в других половозрастных группах населения **in % RNI/day**

| Countries | Minimum and maximum daily intake levels of iron and Zinca: in % RNI/day | | | |
|---|---|---|---|---|
| | Женщины в возрасте 10-50 лет | | Другие половозрастные группы населения | |
| | Minimum | Maximum | Minimum | Maximum |
| Pakistan | 15 | 17 | 33 | 46 |
| Afghanistan | 21 | 24 | 46 | 66 |
| Tajikistan | 27 | 31 | 58 | 85 |
| Kyrgyzstan | 30 | 33 | 63 | 92 |
| Kazakhstan | 30 | 34 | 66 | 94 |
| Uzbekistan | 37 | 41 | 78 | 113 |

**The costs** of low extraction wheat flour fortification **by 7 micronutrients** (Iron as EDTA and Ferrous sulfate dried)

| Nutrient | Fortification levels, ppm | Costs | |
|---|---|---|---|
| | | US$/кг | % |
| Vit. B-1 (thiamin) | 2,0 | 0,25 | 2,5 |
| Vit. B-2 (riboflavin) | 3,0 | 0,72 | 7,5 |
| Vit. B-3 (niacin) | 10,0 | 0,40 | 4,2 |
| Vit. B-9 (Folate) | 1,0 | 0,49 | 5,1 |
| Vit. B-12 | 0,008 | **1,28** | **13,4** |
| Iron, sulphate | 10 | 0,34 | 4,0 |
| Iron, EDTA | 15 | **3,00** | **31,4** |
| Zinc | 30 | 0,88 | 9,2 |
| Filling material (at least 25%) | | 0,16 | 1,7 |
| Total cost for the premix | | **7,56** | **79,1** |
| Manufacturing, quality control and delivery cost | | **2,00** | **20,9** |
| Total cost | | **9,56** | **100,0** |
| Cost of premix per metric ton of fortified product | **$2,39** | **0,48 % of the Price** | |

## **The costs** of low extraction wheat flour fortification **by 7 micronutrients (without ferrous sulphate)**

| Nutrient | Fortification levels, ppm | Costs | |
|---|---|---|---|
| | | US$/кг | % |
| Vit. B-1 (thiamin) | 2,0 | 0,25 | 2,7 |
| Vit. B-2 (riboflavin) | 3,0 | 0,72 | 7,7 |
| Vit. B-3 (niacin) | 10,0 | 0,40 | 4,23 |
| Vit. B-9 (Folate) | 1,0 | 0,49 | 5,3 |
| Vit. B-12 | 0,008 | **1,28** | **13,8** |
| Iron, EDTA | 15 | **3,00** | **32,2** |
| Zinc | 30 | 0,88 | 9,4 |
| Filling material (at least 25%) | | 0,29 | 3,1 |
| Total cost for the premix | | **7,31** | **78,5** |
| Manufacturing, quality control and delivery cost | | **2,00** | **21,5** |
| Total cost | | **9,31** | **100,0** |
| Cost of premix per metric ton of fortified product | **$2,33** | **0,47 % of the Price** | |

**The costs** of low extraction wheat flour fortification **by 6 micronutrients (without Vit. B-12, Iron as EDTA)**

| Nutrient | Fortification levels, ppm | Costs | |
|---|---|---|---|
| | | US$/кг | % |
| Vit. B-1 (thiamin) | 2,0 | 0,25 | 3,1 |
| Vit. B-2 (riboflavin) | 3,0 | 0,72 | 8,9 |
| Vit. B-3 (niacin) | 10,0 | 0,40 | 5,0 |
| Vit. B-9 (Folate) | 1,0 | 0,49 | 6,1 |
| Iron, EDTA | 15 | **3,00** | **37,2** |
| Zinc | 30 | 0,88 | 10,9 |
| Filling material (at least 25%) | | 0,32 | 4,0 |
| **Total cost for the premix** | | **6,06** | **75,2** |
| **Manufacturing, quality control and delivery cost** | | **2,00** | **24,8** |
| **Total cost** | | **8,06** | **100,0** |
| **Cost of premix per metric ton of fortified product** | **$2,02** | **0,40 % of the Price** | |

**The costs** of low extraction wheat flour fortification **by 7 micronutrients (without Vit. B-12, Iron as electrolytic)**

| Nutrient | Fortification levels, ppm | Costs | |
|---|---|---|---|
| | | US$/кг | % |
| Vit. B-1 (thiamin) | 2,0 | 0,25 | 4,1 |
| Vit. B-2 (riboflavin) | 3,0 | 0,72 | 12,0 |
| Vit. B-3 (niacin) | 10,0 | 0,40 | 6,8 |
| Vit. B-9 (Folate) | 1,0 | 0,49 | 8,2 |
| Iron, electrolytic | 40 | **0,62** | **10,4** |
| Zinc | 30 | 0,88 | 14,7 |
| Filling material (at least 25%) | | 0,62 | 10,3 |
| Total cost for the premix | | **3,98** | **66,5** |
| Manufacturing, quality control and delivery cost | | **2,00** | **33,5** |
| Total cost | | **5,98** | **100,0** |
| Cost of premix per metric ton of fortified product | **$1,49** | **0,30 % of the Price** | |

## **The comparative costs** of low extraction wheat flour fortification **depending on micronutrients (MN) composition in the premix**

| Micronutrients and costs | 7 MN (Iron as EDTA & sulphate) | 7 MN (only EDTA Iron) | 6 MN (EDTA Iron, without Vit. B-12) | 6 MN (electrolytic Iron, without Vit. B-12) |
|---|---|---|---|---|
| Vit. B-1 (thiamin) | + | + | + | + |
| Vit. B-2 (riboflavin) | + | + | + | + |
| Vit. B-3 (niacin) | + | + | + | + |
| Vit. B-9 (Folate) | + | + | + | + |
| Vit. B-12 | + | + | - | - |
| Iron, sulphate | + | - | - | - |
| Iron, EDTA | + | + | + | - |
| Iron, electrolytic | - | - | - | + |
| Zinc | + | + | + | + |
| Total cost for the premix, US$/кг | 7,56 | 7,31 | 6,06 | 3,98 |
| Manufacturing, quality control and delivery cost, US$/kg | 2,00 | 2,00 | 2,00 | 2,00 |
| Total cost фортификации, US$/кг | 9,56 | 9,31 | 8,06 | 5,98 |
| Cost of premix per metric ton of fortified product | | | | |
| US$/MT | 2,39 | 2,33 | 2,02 | 1,49 |
| % of the Price | 0,48 | 0,47 | 0,40 | 0,30 |

## **The main parameters of the premix** for fortification of **high-extraction wheat flour**

| Nutrient | Fortificant compound | Selected FL (mg/kg flour) | Amount, fortificant (mg/kg flour) | Premix Formulation | | | |
|---|---|---|---|---|---|---|---|
| | | | | Fortificant (g/kg premix) | Nutrient (g/kg premix) | Cost (US$/kg) | % Cost |
| Vit. B-9 | Folic Acid | 1,0 | 1,1 | 2,8 | 3,0 | $0,54 | 7,8 |
| Vit. B-12 | Vit. B-12 0.1% WS | 0,008 | 8,0 | 20,0 | 0,02 | $0,84 | 12,1 |
| Iron | NaFeEDTA | 15,0 | 115,4 | 288,5 | 38,0 | $2,02 | 29,2 |
| Zinc | Zinc oxide | 30,0 | 37,5 | 93,8 | 75,0 | $0,63 | 9,1 |
| | Filling material | | 40,5 | 595,0 | | $0,89 | 12,9 |
| | | TOTAL | 202,5 | 1000,0 | | | |
| | Estimated cost of manufacturing, quality control and delivery | | | | | $2,00 | 28,9 |
| | | | | | Approximate Cost per kg = | $6,93 | 100,0 |
| | | | | | | $2,77 | |
| | | | | | Estimated cost of micronutrient premix per metric ton of fortified product*: | 0,55 % of the Price | |

| | | | |
|---|---|---|---|
| Minimum Amount (grams per MT) | 202 | Maximum Dilution Factor = 1/ | 4938 |
| Selected Amount (grams per MT) | 400** | Selected Dilution Factor = 1/ | 2500 |

## The main production and regulatory parameters
for fortification of **high-extraction wheat flour**

| Nutrient | Fortificant compound | Selected FL (mg/kg flour) | Production parameters | | | Regulatory Parameters | |
|---|---|---|---|---|---|---|---|
| | | | mFL (1) (mg/kg flour) | Average (2) (mg/kg flour) | MFL (3) (mg/kg flour) | LmL (4) (mg/kg flour) | MTL (5) (mg/kg flour) |
| **Vit. B-9 (Folate)** | Folic Acid | 1,0 | 0,8 | 1,4 | 2,0 | 0,7 | 2,0 |
| **Vit. B-12** | Vit. B-12 0.1% WS | 0,008 | 0,004 | 0,008 | 0,012 | 0,004 | 0,012 |
| **Iron** | NaFeEDTA | 15,0 | 36,0 | 53,0 | 70,0 | 36,0 | 70,0 |
| **Zinc** | Zinc oxide | 30,0 | 40,0 | 59,0 | 78,0 | 40,0 | 78,0 |

(1) mFL = Minimum Fortification Level
(2) Average = Selected Fortification Level + Intrinsic content of micronutrient in unfortified food.
(3) MFL = Maximum Fortification Level, using equation 3.
(4) LmL= Legal Minimum Level, using equation 4.
(5) MTL = Maximum Tolerable Level, equivalent to MFL but only for those micronutrients with safety concerns, and rounded

## **Further steps** to harmonize standards for flour fortification in the region

1. **The consensus of the Working Group** on Harmonization of Standards: March 2016
2. **Development and coordination of National standards** on wheat flour fortification of based on the consensus reached by the Working Group on the harmonization of standards: March-June 2016
3. **Presentation of National standards** on wheat flour fortification at a conference in Almaty within the GAIN project: July 2016
4. **Recommendations/suggestions of the Conference in Almaty** for the National standardization body on the need for approval of National Standards for Wheat Flour Fortification: July 2016
5. **Adoption of National standards** for flour fortification by National standardization body: 2017-2018
6. **Implementation of National** standards for flour fortification into practice: 2017-2020
7. **Analysis the results of implementation** of National standards for flour fortification into practice: 2020-2021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***Thanks for attention!***