REPORT ON ANALYSIS OF ECONOMIC LOSSES DUE TO IRON & FOLIC ACID DEFICIENCIES IN KAZAKHSTAN

FOOD FORTIFICATION AS A COST-EFFECTIVE STRATEGY FOR ECONOMIC GROWTH

Cost Benefit Analysis and Report by Kalimuddin Ghauri

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CONTENTS

EXECUTIVE SUMMARY

Micronutrient malnutrition is a major public health problem in Kazakhstan, with devastating, often lifelong consequences for the health, mental development, and productivity of its people, as well as the nation's economic progress. Women and children are especially vulnerable. Children with micronutrient malnutrition are more susceptible to illnesses that prevent them from regularly attending school. They find it more difficult to learn, with deficits equivalent to a 2 to 3-year loss in education[1]. As adults, they are more likely to be overweight and in danger of contracting diseases such heart problems and diabetes[2]. They will earn as much as 22 per cent less[3], causing challenges in raising and feeding their own families, perpetuating a cycle of poverty.

Poor maternal and infant nutrition affects the well-being of communities and the economic performance of entire nations across generations[4]. Losses due to lower productivity, poor cognitive development, reduced schooling and the heavy burden on already stretched health care systems, hamper a nation's economic advancement through reductions of as much as 3 per cent in GDP[5]. Making sure that children and women of reproductive age have the essential vitamins and minerals they need for life, learning and health can break the cycle of poverty in which they have been trapped, enriching their lives, their communities, and ultimately their nations.

Tackling the problem of micronutrient malnutrition is also one of the best investments a nation can make in its future. The Copenhagen Consensus, a group of economists who calculate the most cost-efficient ways of improving the lives of populations, has said that even in very poor countries and using very conservative assumptions, every dollar spent reducing chronic malnutrition has a payoff of at least 23 USD. The economists have also found that delivering micronutrients through fortification of food staples is a top public health priority, with cost benefit ratios of up to 24:1 for flour fortification.

In January 2009, with the objective of improving population nutritional status, the Government of Kazakhstan passed guidelines on fortification procedures and specified that certain food products, including premium and first-grade wheat flour as well as baking yeast, bread, baked goods and pastries, could be fortified.

Findings of a Fortification Assessment Coverage Tool (FACT) carried out by the Kazakh Academy of Nutrition (KAN) indicate 40.9% of households in Kazakhstan consume fortified flour, up from 27% in 2011. However, only 25.2% of households consume flour that is fortified to national standards and only 3.1% consume bread made from fortified wheat flour. While 88.5% of households consume iodized salt, 80.5% of it is adequately iodized. Fortified wheat flour currently provides 5-25% of daily iron requirements among children 9-59 months and 9% for women of reproductive age. Fortified salt provides 74-138% of daily iodine requirements among children and 170% among women of

[1] Hoddinott J, Maluccio JA, Behrman JR, Flores R, Martorell R. Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. Lancet. 2008;371:411–16. doi:10.1016/S0140- 6736(08)60205-6.

[2] Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al.; the Maternal and Child Nutrition Study Group. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 2013;371:243–60. doi:10.1016/S0140-6736(13)60937-X

[3] Victora C., et al. 2008. Maternal and Child Undernutrition: Consequences for Adult Health and Human Capital. The Lancet 2008 (Maternal and Child Undernutrition Series).

[4] Walker, S. P., T. D. Wachs, S. Grantham-McGregor, et al., 2011, "Inequality in early childhood: risk and protective factors for early child development," *The Lancet* - 8 October, 378(9799): 1325-1338.

[5] Repositioning nutrition as central to development: a strategy for largescale action. Washington DC: The World Bank; 2006 (http://siteresources. worldbank.org/NUTRITION/Resources/281846-1131636806329/ NutritionStrategy.pdf, accessed 21 October 2014).

reproductive age. The findings demonstrate recent progress made in wheat flour fortification, while highlighting the need for improvements in monitoring and enforcement to increase availability of adequately fortified flour.

As a result of this CBA, the government can understand the cost of inaction. Data from the CBA show that if current circumstances prevail this would **lead to economic losses of USD5,651 million over the next decade.**

CONSEQUENCES OF VITAMIN AND MINERAL DEFICIENCY	USD MILLION
Neural tube defects	53.678
Neonatal deaths	142.784
Maternal mortality	14.033
Iron deficiency anemia in children	3,303.902
Iron deficiency anemia in adults	2,136.852
Accumulated economic loss over 10 years	**5,651.248**

The CBA looked at the cost-effectiveness of **a single intervention**, wheat flour fortification, in addressing micronutrient malnutrition. Analysis revealed that over a ten-year period, a successful fortification program would reduce these losses by USD1,753.97 million.

Lastly, the CBA estimated the cost of such a ten-year wheat flour fortification program in Kazakhstan at USD74.36 million, with the potential to generate 24 times more benefit than cost. The minimal direct cost to the consumer would be just 1.37 per cent of the current average retail price of wheat flour in Kazakhstan – an increase of 81 Kazakhstan Tenge on a 50kg bag. Now, there is a clear economic case for moving forward to fortify flour in Kazakhstan with essential micronutrients.

IRON AND FOLIC ACID DEFICIENCY IN KAZAKHSTAN

Iron deficiency anemia is a major cause of maternal deaths and of cognitive deficits in young children. It can permanently affect school performance and has a negative impact on the economic well-being of individuals, families and national economies. In adults, anemia also affects productivity. In Kazakhstan in 2011, anemia prevalence in pregnant women was 44% and in women of fertile age was 39%[6]. **Folate** is a vitamin that is essential for development of the brain, spinal cord and skull. Ensuring sufficient levels of folate in women prior to conception can reduce neural tube defects. An estimated 92 children in Kazakhstan are born each year with neural tube defects such as spina bifida[7].

In Kazakhstan, wheat flour is an ideal vehicle for fortification with iron and folic acid. Bread is consumed by most in Kazakhstan, usually at every meal, with an estimated per capita consumption of 260 grams per day[8]. Since 2015, GAIN, with financial support from USAID, has been working with the Government of Kazakhstan to build an enabling environment for fortification and improve enforcement of mandatory fortification legislation. The Government of Kazakhstan and other stakeholders have

[6] National Micronutrient Survey, Kazakh Academy of Nutrition (KAN) 2011

[7] The National Genetic Register of the Republic of Kazakhstan (RoK), 2015 (according to the National Genetic Register of the Republic of Kazakhstan - the Republican medical-genetic consultation of the Scientific Center for Obstetrics, Gynecology and Perinatology, Ministry of Health and Social Development (MHSD) of the Republic of Kazakhstan

[8] Estimated average, as per expert assessments of the Kazakh Academy of Nutrition

supported this initiative to conduct a robust analysis of flour fortification to determine its cost effectiveness in addressing iron and folic acid deficiencies.

While flour fortification is mandatory for wheat flour sold on the domestic market in Kazakhstan, only 25-30 per cent of the wheat flour sold is fortified. While most millers have access to adequate equipment, there are price competition issues and a need for increased controls and monitoring. And since Kazakhstan is a major exporter of flour to Afghanistan, ensuring adequate fortification has the potential to improve the health of both populations[9]. Understanding the economic impact of fortification can help move the agenda forward.

Applying scientific and economic methods to national health, demographic, labor and economic data, the CBA can quantify health and economic losses due to iron and folic acid deficiencies in Kazakhstan.

METHODOLOGY

The CBA is an analysis for the 10-year period from 2017 to 2026 using a model with three major components: assumption data sets; a spreadsheet based model; and an analysis of results. Key parameters / assumptions used for this analysis are presented in data sets (Annex A). These data sets were presented and discussed at a workshop at which related public sector, development sector and private representatives were present. Participants at the workshop discussed and agreed upon the findings set out in this report.

Economic consequences are measured via four distinct pathways:

1. Mortality and disability in children and consequent forgone income from future employment;
2. Economic deficits due to poorer child cognition, inferior school performance and depressed future productivity;
3. Depressed productivity in working but anemic adults; and
4. Additional health care costs due to micronutrient malnutrition.

Monetizing health risks and deficits is based on a range of national demographic, labor and health statistics, as well as some key assumptions in cases where data are not available. The general algorithm (coefficients of loss) for projecting the magnitude of economic losses is set out in the diagram below.

GENERAL ALGORITHM FOR PROJECTION OF ECONOMIC LOSSES

Risk Group Population		Prevalence of Condition		Population with Deficit		Economically Active Population[10]		Average Annual Wage[11]		Coefficient Of Deficit or Loss		Lost Productive Activity
National statistics	X	% from National Survey	=	By Indicator and Risk Group	X	**67%** 73% Male 61% Female	X	USD4,845 Per Year	X	% or RR (Relative Risk)[12]	=	USD/year

The benefits shown by this analysis are mainly in the form of enhanced human productivity and reduction in costs to treat health conditions related to malnutrition. The economic loss use Net Present Value (NPV) of losses calculated over the 10-year period at 2.5% annual inflation rate in US dollars.

[9] Industry Assessment in Kazakhstan (Wheat Flour) and Pakistan (Wheat Flour and Edible oil), Altai consulting, 2015, GAIN, USAID.
[10] Labor Force
[11] IBID
[12] From global literature

Since deficits are applied only to individuals projected to be economically active, with Kazakhstan's 67% labor participation rate the impacts of iron and folic acid deficiencies are applied to male and female labor participation rates of 72.7% and 60.8% respectively[13]. Childhood productivity deficits are not felt until children enter the workforce, as much as 15 years in the future, and earnings stretch out for another 40-50 years. Therefore, an NPV of future economic losses is calculated with a 2.5% discount rate to account for the time the child is not in the workforce.

Converting indicators of malnutrition to economic activity and attaching a monetary value to that economic activity involves factors beyond human potential and performance. Workplace incentives, technology and opportunity all affect how increased potential translates into improved productivity and earnings. Additionally, the effects of iron and folic acid deficiency extend beyond the workplace to parenting, household work, education, entrepreneurial pursuits and community participation.

ECONOMIC IMPACTS OF ANEMIA AND FOLIC ACID DEFICIENCY

ANEMIA IN CHILDREN

ANNUAL NPV OF FUTURE EARNINGS LOSS FROM IDA IN CHILDREN

Children w/ IDA		Average Annual Wage		Labor Force Participation		Coefficient of Loss		NPV for 39 years' earnings after 12.5-year delay[14]		NPV loss (12.5 years to workforce entry)
1.021million	x	USD4,845	x	67%	x	2.5%	x	2.5%	=	USD324.633m

Some 18.2% of children under 5 years of age in Kazakhstan suffer from iron deficiency anemia[15]. A range of evidence links iron status in children to cognitive development and productivity deficits as adults. A *Journal of Nutrition* review documents the positive impact of iron intervention on cognitive scores, ranging from 0.5 to 1 Standard Deviation (SD), concluding that "available evidence satisfies all of the conditions needed to conclude that iron deficiency causes cognitive deficits and developmental delays."[16]

A recent review of child psychology, nutrition and economic knowledge concluded that developmental problems related to iron status in children under 5 years is associated with a 4% reduction in lifetime earnings.[17] This led us to correct the 4% deficit by a factor of 0.62 to arrive at a 2.5% decrease in lifetime earnings for children under five who are iron deficient.[18]Our estimates are based on a 39-year work life, with a 2.5% discount rate to account for the time the child is not in the workforce.

Over 1 million children (total children under 5 years multiplied by 38% of applicable iron deficiency rate) in Kazakhstan may not live up to their full cognitive potential, will perform less well in school and will suffer associated earnings deficits as adults. Even with modest 2.5% productivity deficits, this accumulated loss will have a significant impact on national GDP. The NPV of Kazakhstan's lost earnings

[13] Estimated by the Committee of Statistics of the Ministry of National Economy of the Republic of Kazakhstan, 2014
[14] Average number of years before entering workforce
[15] National Micronutrient Survey, Kazakh Academy of Nutrition (KAN) 2011
[16] Haas, J. and Brownlie T., Iron Deficiency and Reduced Work Capacity: A Critical Review of the Research *Journal of Nutrition.* 2001;131
[17] Horton & Ross The Economics of Iron Deficiency Food Policy 28 (2003) 51–75
[18] Horton & Ross The Economics of Iron Deficiency Food Policy 28 (2003) 51–75

totals USD324.633 million per year. Adding an annual birth growth rate of 0.5, increases that figure to about USD3,303.901 million over a 10-year period.

ANEMIA IN ADULT WORKERS

ANNUAL ECONOMIC LOSSES IN ADULT MANUAL LABOR AS A CONSEQUENCE OF IDA

IDA prevalence Adults 15-65		Manual labor wage		10% Manual Labor Deficit		12% Loss Heavy Labor[19]		Annual Loss
Women: 19.9%x3.405m	X	USD1,405/yr	X	USD95.209	+	17.137m	=	USD112.346m/yr
Men: 8.3%x3.816m		USD2,132/yr		USD67.650		20.295i		USD87.945m/yr

Weakness, fatigue and lethargy brought on by anemia in adults results in measurable productivity losses across the manual labor sector, including agriculture, manufacturing, construction, mining and defense. There is substantial documented evidence demonstrating the negative impact of anemia on indicators of work performance.

The general annual NPV of economic losses (diagram above) projects an annual productivity deficit of USD324.6 million. Separate calculations for male and female workers have been made to account for significant variances in anemia prevalence, wage levels and labor participation. Productivity deficits are applied only to those engaged in manual labor where aerobic capacity, endurance and strength play a role in work performance. While doubtless anemia has consequences in non-manual "white collar jobs", the 10% work deficit is not applied to education and social sectors where women represent a significant share of the workforce.

ANEMIA IN MOTHERS

ANNUAL MATERNAL DEATHS DUE TO ANEMIA

Calculated Deficit in Mean Hb		Relative Risk Mortality		Population Attributable Risk		Annual Maternal Deaths (live births x MMR)		Annual Maternal Deaths due to Anemia[20]
0.87 g/dL	X	0.71	=	26%	X	103	=	26

During pregnancy, iron requirements increase significantly and the risk of anemia rises in parallel, threatening the health and survival of mother and child. Prevalence of maternal iron deficiency anemia in Kazakhstan in 2011 was 24.2%[21]. A recent meta-analysis with WHO Global Burden of Disease estimates suggest that perinatal mortality decreases by 16% for each 1 gram per deciliter (1g/dL) increase in hemoglobin, with a relative risk of 0.84.[22] Based on IDA prevalence of 24.2% and over-all anemia rate of 44%, mean hemoglobin is calculated at 12.08 grams per deciliter and mean hemoglobin in the absence of iron deficiency, is projected at 12.92 grams per deciliter.[23]

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[19] Estimated at 12%(From Horton et al 2003)

[20] Committee of Statistics, Ministry of National Economy of the Republic of Kazakhstan (maternal mortality per annum)

[21] National Micronutrient Survey, Kazakh Academy of Nutrition (KAN) 2011

[22] Stoltzfus R, Mullany, L, Black R. Iron Deficiency Anaemia, in Global Burden of Disease, WHO 2004

[23] Presuming normal Hb distribution from Stoltzfus above.

The annual maternal deaths are calculated by multiplying the total annual births of 412,406 multiplied by maternal mortality rate of 25 per 100,000 births. Since there is no reliable data available for maternal deaths due to IDA we have used the statistic for maternal deaths due to anemia. While the human loss is immeasurable, in economic terms these 26 annual deaths due to anemia simply represent the NPV of a lost future workforce, valued at about USD1.378 million/yr.

ESTIMATE FOR NPV OF LOST WAGES DUE TO MATERNAL DEATH

Attributed Deaths		Average Annual Wage (All Sectors)		Labor Participation Rate		Average Years in Workforce		Discount Rate for NPV[24]		Lost Productive Activity
26	X	USD3,193/yr.	X	60.8%	X	57	X	2.5%	=	USD1.378 million

Due to a 26% prevalence of IDA in pregnant women[25] and a relative mortality risk of 1.45, the population attributable to risk is 10.4%. As per national statistics the annual deaths of infants of less than 1 month of age is 2,326 [26].Kazakhstan's Ministry of National Economy places this number at 5.64 per thousand. Accordingly, the estimate of number of child deaths attributed to IDA in mothers is 242.

PROJECTION OF PERINATAL DEATHS DUE TO MOTHERS' IDA

Prevalence of IDA in pregnant women		Decreased Relative Risk Mortality		Population Attributable Risk		Annual Deaths of infants<1month		Number of Child Deaths Attributed to IDA in Mother
26%	X	1.45	=	10.4%	X	2,326	=	242

Presuming 30 years of age is the average age of maternal death, suggesting 22 years of additional work lost, we estimate an NPV of average USD14.029 million.

ESTIMATE OF LOST WAGES DUE TO PERINATAL DEATH

Attributed Deaths		Average Annual Wage		Labor Participation Rate		Average Years in Workforce		Discount Rate For NPV		NPV Lost Productive Activity[27]
242	X	USD4,845/ year	X	67%	X	57	X	2.5%	=	USD14.029 million/year

[24]After 15 years' delay
[25] National Micronutrient Survey, Kazakh Academy of Nutritiion (KAN), 2011
[26] Ministry of Healthcare and Social Development of the Republic of Kazakhstan
[27]Assuming 15 years to workforce entry

FOLIC ACID-RELATED NEURAL BIRTH DEFECTS

PROJECTED NTD-ASSOCIATED MORTALITY

Annual Births		Average Annual NTD Rate/1000 Births x Folic Acid Associated/Preventable NTDs		Projected Annual Folic Acid Associated NTDs		Assumed Mortality Rate		Total Projected Annual Folic Acid Associated Deaths from NTDs
0.412 million	X	0.32x72%=0.25	=	95	X	90%	=	86

Neural Tube Defects (NTDs), are a significant cause of death and disability. Without available nationally representative statistics for incidence of spina bifida and anencephaly in Kazakhstan, we used The March of Dimes Global Report which estimates almost 11,000 cases annually – a rate of 2/1,000 births, about the global average.[28] We conservatively assumed that the annual NTD rate per 1000 births is 0.2 out of which around 85% are Folic Acid Associated/Preventable NTDs. Applying this assumption to total annual births of 412,416, the approximate annual folic acid associated NTDs are in the range of 86. Annual births are calculated by applying annual birth rate of 2.2% over estimated population of 18,213,312 for 2017.

PROJECTION OF ECONOMIC LOSSES FROM NTD MORTALITY

Attributed Deaths		Average Annual Wage		Labor Participation Rate		Average Years in Workforce		Discount Rate For NPV after 15 years delay		NPV of Annual Economic Loss[29]
86	X	USD4,845/yr	X	67%	X	57	X	2.5%	=	USD4,948m/yr

PROJECTION OF NPV OF LOST PRODUCTIVITY DUE TO NTD CASES

Number of Survivors		Average Annual Wage		Labor Participation Rate		Average Years in Workforce		Discount Rate For NPV after 15 years' delay		NPV Annual Lost Productivity[30]
9	X		X		X		X		=	
Severe Disability 1		USD4,845/yr		68%		43		2.5%		100% Loss USD0.90m/yr
Moderate Disability2		USD4,845/yr		68%		43		2.5%		50% Loss USD0.181m/yr

The 86 children projected annually with folic acid associated NTDs face a lifetime of moderate or severe disability. Infants born with NTDs require surgery at birth and will require specialist care throughout life. The associated lost productivity and health care costs are estimated very roughly as follows:

- Presuming appropriate facilities are available in 1/5 of birth cases and that cost of surgery is USD4,500 this suggests about USD42,758 costs to the health system – both public and private.
- USD1,800 per year for rehabilitation and medicines along with USD1,100 estimated Annual Cost per Case of Ongoing Rehabilitation and Care for individuals with Moderately Disabled NTDs.

[28] March of Dimes Global Report on Birth Defects, Appendix B, 2011
[29] Assuming 15 years to workforce entry
[30] Assuming 15 years to workforce entry

SUMMARY OF ANNUAL NATIONAL ECONOMIC LOSSES

TABLE 1: SUMMARY ECONOMIC CONSEQUENCES FOR ALL INDICATORS

Year	Baseline Loss	Country GDP[31]	Loss as % of GDP
	USD millions		
2017	545.608	184,359	0.296%
2018	549.819	189,890	0.290%
2019	554.076	195,587	0.283%
2020	558.380	201,454	0.277%
2021	562.732	207,498	0.271%
2022	567.131	213,723	0.265%
2023	571.579	220,135	0.260%
2024	576.077	226,739	0.254%
2025	580.624	233,541	0.249%
2026	585.222	240,547	0.243%
TOTAL	**5,651.248**		

Based on the analysis above, the best available global evidence applied to national health, labor and demographic data suggests depressed national economic activity of nearly USD5,651 million over a ten-year period which could be attributed to current rates of IDA and folic acid related NTDs.

COST OF LARGE SCALE WHEAT FLOUR FORTIFICATION

This calculation covers premix, industry and government costs associated with fortification of wheat flour by mills in Kazakhstan, using GAIN's supply chain study as a basis[32]. While the cost of fortification will be passed on to the consumer as part of the current wheat flour fortification program, this analysis uses these costs as opportunity costs in undertaking fortification activities. The tables below present costs of fortification clustered by premix, industry and government costs along with related assumptions:

TABLE 2: COST OF LARGE SCALE WHEAT FLOUR FORTIFICATION OVER A 10-YEAR PERIOD

	Premix	Industrial	Government	Total
		Costs in USD millions		
2017	1,387,823	7,037,027	2,185,000	10,609,851
2018	1,840,920	1,989,961	335,000	4,165,881
2019	2,344,266	2,072,066	535,000	4,951,332
2020	2,902,314	2,158,614	1,985,000	7,045,927
2021	3,519,873	2,249,897	535,000	6,304,770
2022	4,202,137	2,346,227	485,000	7,033,364
2023	4,706,976	2,435,553	2,185,000	9,327,529
2024	4,994,968	2,515,958	335,000	7,845,926
2025	5,300,580	2,599,225	535,000	8,434,806
2026	5,624,891	2,685,467	335,000	8,645,358
	36,824,749	**28,089,994**	**9,450,000**	**74,364,744**

[31] GDP is sourced from Committee of Statistics of the Ministry of National Economy of the Republic of Kazakhstan and increased for each year using 3% average growth rate

[32] Afghanistan/Central Asia Regional Food Fortification Program: Industry Assessment in Kazakhstan (wheat flour) and Pakistan (wheat flour and edible oil), October 2015, Altai Consulting.

TABLE 3: PREMIX COST

Premix costs are projected using population growth rate and proportion of premium and first grade white flour, as only these are required to be fortified. Per capita consumption of wheat flour and associated products, and is assumed at 0.5% per year compared to other food items. The columns are multiplied to give the cost of premix.

	Total Population	Consumption kg/yr	Proportion Population Consuming Flour	% Flour Fortified	Target/Scale Fortified Production MT/yr	Cost of Premix $ millions
	A	B	C	D	E	
2017	18,175,655	95	90.0%	40%	621,607	1.388
2018	18,448,290	96	90.5%	50%	800,534	1.841
2019	18,725,015	97	90.9%	60%	989,725	2.344
2020	19,005,890	98	91.4%	70%	1,189,638	2.902
2021	19,290,978	99	91.8%	80%	1,400,748	3.520
2022	19,580,343	100	92.3%	90%	1,623,552	4.202
2023	19,874,048	101	92.7%	95%	1,765,634	4.707
2024	20,172,159	102	93.2%	95%	1,819,090	4.995
2025	20,474,741	103	93.7%	95%	1,874,164	5.301
2026	20,781,862	104	94.1%	95%	1,930,906	5.625
					14,015,597	**36.825**

TABLE 4: INDUSTRIAL COST (USD MILLIONS)

Industrial cost includes provision of micro feeders to 250 flour mills and establishment of 15 new labs for quality assurance. Equipment maintenance includes costs associated with labor, maintenance and quality assurance spot testing. Other operational costs are 5% of the premix cost.

	Equipment - Capex	Equipment Maintenance	Operational Costs	Total $ million
2017	5,125,000	1,842,636	69,391	7.037
2018	-	1,897,915	92,046	1.990
2019	-	1,954,853	117,213	2.072
2020	-	2,013,498	145,116	2.159
2021	-	2,073,903	175,994	2.250
2022	-	2,136,120	210,107	2.346
2023	-	2,200,204	235,349	2.436
2024	-	2,266,210	249,748	2.516
2025	-	2,334,196	265,029	2.599
2026	-	2,404,222	281,245	2.685
	5,125,000	**21,123,757**	**1,841,237**	**28.090**

TABLE 5: GOVERNMENT COST (USD MILLIONS)

Government costs mainly represent two flour mill inspections a year, including lab costs; project costs associated with monitoring, and one-time capacity building and social advocacy costs.

	Ongoing Food Control	Additional Monitoring	One time startup cost	Total $ million
2017	335,000	200,000	1,650,000	2.185
2018	335,000	-	-	0.335
2019	335,000	200,000	-	0.535
2020	335,000	-	1,650,000	1.985
2021	335,000	200,000	-	0.535
2022	335,000	150,000	-	0.485
2023	335,000	200,000	1,650,000	2.185
2024	335,000	-	-	0.335
2025	335,000	200,000	-	0.535
2026	335,000	-	-	0.335
	3,350,000	**1,150,000**	**4,950,000**	**9.450**

PROJECTING THE BENEFITS OF FORTIFICATION

Large scale wheat flour fortification could generate material economic value through reductions in economic losses due to malnutrition to the extent of $6,873 million over a 10-year period. To calculate economic benefit, coverage used is of fortification of flour produced by mills in Kazakhstan and the effectiveness of this intervention in the context of five areas of economic loss from international studies. This benefit analysis is only for a wheat flour fortification-related intervention.

TABLE 6: SUMMARY CALCULATIONS OF INTERVENTION BENEFITS

	Neonatal Mortality	Maternal Mortality	NTD	IDA Children	IDA Adults	Total	Coverage (1)
	Base economic losses in USD millions						
2017	14.030	1.379	5.274	324.633	200.292	545.608	36%
2018	14.084	1.384	5.295	325.899	203.157	549.819	45%
2019	14.139	1.390	5.315	327.170	206.062	554.076	55%
2020	14.194	1.395	5.336	328.446	209.008	558.380	64%
2021	14.250	1.401	5.357	329.727	211.997	562.732	73%
2022	14.305	1.406	5.378	331.013	215.029	567.131	83%
2023	14.361	1.411	5.399	332.304	218.104	571.579	88%
2024	14.417	1.417	5.420	333.600	221.223	576.077	89%
2025	14.473	1.422	5.441	334.901	224.386	580.624	89%
2026	14.530	1.428	5.462	336.207	227.595	585.222	89%
Total	142.784	14.033	53.678	3,303.902	2,136.852	5,651.248	
EFFECTIVENESS (2)	15%	15%	70%	40%	50%		
2017	0.758	0.074	1.329	46.747	36.053	84.961	
2018	0.955	0.094	1.676	58.955	45.939	107.620	
2019	1.157	0.114	2.029	71.377	56.194	130.871	
2020	1.362	0.134	2.389	84.016	66.830	154.730	
2021	1.570	0.154	2.754	96.875	77.857	179.210	
2022	1.782	0.175	3.126	109.956	89.286	204.325	
2023	1.898	0.187	3.329	117.100	96.072	218.586	
2024	1.915	0.188	3.359	118.145	97.933	221.540	
2025	1.932	0.190	3.389	119.199	99.830	224.539	
2026	1.949	0.192	3.419	120.262	101.764	227.585	
Total	15.277	1.501	26.801	942.633	767.756	1,753.968	

1. As per level of fortification stipulated as part of flour fortification intervention.
2. As per international studies.

COST AND BENEFIT RATIO FOR FLOUR FORTIFICATION

TABLE 7: COST AND BENEFIT RATIO FOR FLOUR FORTIFICATION (USD MILLIONS)

A CBA for a large-scale food fortification program is presented below. By spending $74.36 million over a ten-year period, economic benefits equal to $1,753 million could be generated,23.59 times the costs expected to be incurred in the implementation of a large-scale wheat flour fortification program in Kazakhstan. The table shows the 10-year cost of fortification and related economic value benefits that could be generated through large scale wheat flour fortification and ratio of cost over benefits.

	Cost	Benefit	Cost Benefit Ratio
2017	$10.61	$84.96	8.01
2018	$4.17	$107.62	25.83
2019	$4.95	$130.87	26.43
2020	$7.05	$154.73	21.96
2021	$6.30	$179.21	28.42
2022	$7.03	$204.33	29.05
2023	$9.33	$218.59	23.43
2024	$7.85	$221.54	28.24
2025	$8.43	$224.54	26.62
2026	$8.65	$227.59	26.32
	$74.36	**$1,753.97**	**23.59**

RETAIL PRICE IMPACT OF WHEAT FLOUR FORTIFICATION

The CBA shows that the overall percentage of the fortification cost of current average retail price of wheat flour is 1.40%. Accordingly, we are looking at a potential increase of 83.29Kazakhstan Tenge on 50kg bag or 1,665.82Kazakhstan Tenge in 1MT of wheat flour based on the current average retail price of wheat flour. While it is apparent from the analysis that the impact of cost of fortification on the end user retail price seems minimal, millers are concerned that they don't have the resources up front to initiate the process of fortifying flour. This is a problem that will need to be addressed moving forward.

TABLE 8: POTENTIAL IMPACT OF FORTIFICATION ON RETAIL WHEAT FLOUR PRICE (USD)

Exchange Rate - USD to Kazakhstan Tenge	340
Current average per kg price of Wheat Flour in USD	0.35
Cost of fortification per kg in USD	0.0048
Projected average per kg price of Fortified Wheat Flour in USD	0.3548

	Premix Cost	Industrial Cost - Recurring	Industrial Cost -Capital Cost Allocated	Industrial Cost - Total	Total	Expected Production of Fortified Wheat Flour (MT)
2017	1,387,823	1,912,027	512,500	2,424,527	3,812,351	621,607
2018	1,840,920	1,989,961	512,500	2,502,461	4,343,381	800,534
2019	2,344,266	2,072,066	512,500	2,584,566	4,928,832	989,725
2020	2,902,314	2,158,614	512,500	2,671,114	5,573,427	1,189,638
2021	3,519,873	2,249,897	512,500	2,762,397	6,282,270	1,400,748
2022	4,202,137	2,346,227	512,500	2,858,727	7,060,864	1,623,552
2023	4,706,976	2,435,553	512,500	2,948,053	7,655,029	1,765,634
2024	4,994,968	2,515,958	512,500	3,028,458	8,023,426	1,819,090
2025	5,300,580	2,599,225	512,500	3,111,725	8,412,306	1,874,164
2026	5,624,891	2,685,467	512,500	3,197,967	8,822,858	1,930,906
	36,824,749	22,964,994	5,125,000	28,089,994	64,914,744	14,015,597

	Fortification Cost Per MT	Fortification Cost Per KG	% of Current Retail Price
2017	6.33	0.0063	1.81%
2018	5.59	0.0056	1.60%
2019	5.11	0.0051	1.46%
2020	4.80	0.0048	1.37%
2021	4.58	0.0046	1.31%
2022	4.44	0.0044	1.27%
2023	4.42	0.0044	1.26%
2024	4.49	0.0045	1.28%
2025	4.57	0.0046	1.31%
2026	4.65	0.0047	1.33%
	4.90	0	0.013998559
	Overall Average		**1.40%**

CONCLUSION

Stakeholders on this issue participated in a roundtable meeting to discuss the findings of the CBA. The roundtable meeting was preceded by a series of advocacy meetings with an overall goal to identify actions and possible mechanisms for improving implementation of food fortification agenda in the country. The dissemination roundtable meeting became a discussion platform for all stakeholders and policy-makers to develop informed recommendations based on the CBA findings in the country. These stakeholders recommended the following actions:

- To discuss recommendations with Kazakhstan's National Coordination Council on Healthcare
- To present research findings at the Parliament committee meetings and engage representatives of key government ministries/agencies in these discussions
- To initiate and strengthen interagency coordination and co-operation among all key partners
- To discuss measures to further develop fortified wheat flour production jointly with all key government agencies/ministries and other stakeholders
- To support further harmonization of wheat flour fortification standards
- To promote harmonization and application of regional wheat flour fortification standards in CAR, Afghanistan and Pakistan
- To establish adequate internal and external wheat flour fortification quality control and assurance and to conduct training workshops for flour millers on quality control and assurance
- To strengthen routine monitoring and assessment of production and sale of wheat flour fortification for domestic consumption and export
- To include wheat flour fortification production volumes into state statistical systems
- To ensure proper monitoring and assessment of wheat flour fortification coverage at household level as well as on the prevalence of anemia, iron and folic acid deficiencies and associated diseases
- To create educational/information materials on the health benefits of wheat flour fortification.

Following the CBA, we know that failing to tackle the problem of micronutrient malnutrition will lead to economic losses of USD 5,651 million over the next decade. We know that over a ten-year period, one single intervention, a successful wheat flour fortification program, would reduce these losses by USD 1,753 million. We also know that the cost of this fortification program is USD 74 million, with the potential to generate 24 times more benefit than cost.

Now, there is a clear economic case for moving forward to fortify flour in Kazakhstan with essential micronutrients. It is a common myth that cost of fortification is the key hurdle in sustainability of food fortification. This analysis shows that the cost of fortification as compared to the current retail price of wheat flour in Kazakhstan is insignificant and could easily be absorbed in the retail price of final fortified product under good price control processes.

Beyond that, this wheat flour fortification program can be the cornerstone upon which other nutrition interventions can be built, with positive consequences for the health and wealth of the people of Kazakhstan and the future of its children.

ANNEX A: LIST OF DATA SETS

Data Class 1	Data Title	Value Set	Values	Year
Demographic / Health	Total Population	No.	18,213,312	2015
Demographic / Health	Proportion of Male	%	48.30%	2015
Demographic / Health	Proportion of Female	%	51.70%	2015
Demographic / Health	Population Working Age Adults 15-65	No.	12,081,793	2015
Demographic / Health	Population Working Age Male Adults 15-65	No.	5,844,584	2015
Demographic / Health	Population Working Age Female Adults 15-65	No.	6,237,209	2015
Demographic / Health	Population Children < 15 years	No.	4,662,032	2015
Demographic / Health	Population Children < 5 years	No.	1,968,013	2015
Demographic / Health	Birth Rate	No. per 1000	22.69	2015
Demographic / Health	Annual Population Growth	%	1.43%	2015
Demographic / Health	Annual Birth Rate Growth	%	0.39%	2015
Demographic / Health	Under 5 Mortality/1000	No. per 1000	12	2015
Demographic / Health	Infant Mortality/1000	No. per 1000	10	2015
Demographic / Health	Neonatal < 1 month/1000	No. per 1000	9	2015
Demographic / Health	Maternal Mortality/100000	No. per 100,000	12	2015
Demographic / Health	Estimated ID in Children 6-59 months	%	50.0%	2011
Demographic / Health	Anemia in Pregnant Women	%	44.0%	2011
Demographic / Health	IDA in Pregnant Women	%	25.9%	2011
Demographic / Health	Anemia Adult Women	%	39%	2011
Demographic / Health	IDA Adult Women	%	19.9%	2011
Demographic / Health	Anemia Adult Men	%	28%	2011
Economics	Start year of Model	Year	2017	
Demographic / Health	Adult Labor Participation Rate (Male and Female Combined)	%	67.0%	2015
Demographic / Health	Adult Male Labor Participation Rate	%	72.7.0%	2015
Demographic / Health	Adult Female Labor Participation rate	%	65.9%	2015
Demographic / Health	Healthy Life Expectancy	Age in years	72	2015
Demographic / Health	Healthy Life Expectancy, Male	Age in years	67	2015
Demographic / Health	Healthy Life Expectancy, Female	Age in years	76	2015
Demographic / Health	Average Maternal Age at Birth of First Child	Age in years	28	2015
Demographic / Health	Age at Work Force Entry		15	2015
Economics	GDP (current US$)	USD	$184,359,217,065	2015
Economics	Individual Wage/Labor Share GDP	%	32%	2015
Economics	Per Capita Manual Wage as % Average Wages	%	44%	2015
Economics	Female Manual Wage as % Male Manual Wage	%	79%	2015
Economics	Discount Rate	%	2.50%	
Demographic / Health	Relative Risk of Neonatal Death Due IDA in Mother		1.45	
Demographic / Health	Average Annual NTD Rate/1000 Births	No. / 1000	0.35	2015
Demographic / Health	Folic Acid Associated/Preventable NTDs	%	72%	2015
Demographic / Health	Proportion of Survivors with Severe Disability	%	33%	2015
Demographic / Health	Proportion of Survivors with Moderate Disability	%	67%	2015
Demographic / Health	% Births with Access to Special Care or Pediatric Surgery for NTD Cases	%	10%	2015
Demographic / Health	Estimate of Cost per Case for Pediatric Surgery for NTD Cases	$	$4,500	2015
Demographic / Health	Estimated Annual Cost per Case of Ongoing Rehabilitation and Care for Severely Disabled	$	$1,400	2015
Demographic / Health	Estimated Annual Cost per Case of Ongoing Rehabilitation and Care for Moderately Disabled	$	$1,100	2015
Demographic / Health	Annual Social Security, Welfare or Other Special Programs	$	$400	2015

Data Class 1	Data Title	Value Set	Values	Year
Demographic / Health	RR of Maternal Mortality Associated with a 1 g/dL Increase in Hemoglobin:		0.71	
Demographic / Health	Reduction in Future Productivity in All Sectors due to Anemia	%	2.50%	
Cost of Fortification	Feeders and Start-Up	Total units	250	2016
Cost of Fortification	Cost per unit of Micro feeder	$	$4,500	2016
Cost of Fortification	Feeders for Expansion into Private Sector	$	$3,500	2016
Cost of Fortification	Installation and Training	Per Unit $	$2,500	2016
Cost of Fortification	Lab and Other Capital Improvement Costs	No. Units	15	2016
Cost of Fortification	Lab and Other Capital Improvement Costs per unit cost	$	$300,000	2016
Cost of Fortification	Per Capita Consumption in kg/yr Among Consumers	Kgs	95.0	2016
Cost of Fortification	Current Percent Population Consuming Flour	%	90%	2016
Cost of Fortification	Growth Population Rate	%	1.5%	2016
Cost of Fortification	Growth in Population of Consumers	%	0.5%	2016
Cost of Fortification	Growth in Average per Person Flour Consumption	%	0.5%	2016
Cost of Fortification	Proportion of Consumption of Wheat Flour - Premium	%	60%	2016
Cost of Fortification	Proportion of Consumption of Wheat Flour - 1st Grade	%	40%	2016
Cost of Fortification	Proportion of Consumption of Wheat Flour - 2nd Grade	%	0%	2016
Cost of Fortification	Training Food Control Agency	$ for 3 years	$300,000	2016
Cost of Fortification	Training Program Monitors	$ for 3 years	$100,000	2016
Cost of Fortification	Advocacy/Social Marketing	$ for 3 years	$1,000,000	2016
Cost of Fortification	Capital Improvement	$ for 3 years	$250,000	2016
Cost of Fortification	Inspections/Yr	Number of inspections/yr	2	2016
Cost of Fortification	Estimated Total Cost/Inspection	$	$500	2016
Cost of Fortification	Lab Costs/Inspection-per Sample	$	$160	2016
Cost of Fortification	Lump Sum Bi Annual	$	$200,000	2016