Government of the Federal Democratic Republic of Ethiopia

Assessment of Feasibility and Potential Benefits of Food Fortification in Ethiopia

Federal Ministry of Health

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Acknowledgments

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Foreword

The Ethiopian Government developed the National Nutrition Strategy (NNS) in 2008 to overcome the burden of under- nutrition. For this purpose, the National Nutrition Program (NNP) was designed to implement this strategy. The primary aim of the NNP is to improve the nutritional status of the population, especially children, pregnant and lactating women and PLHIV, through cost effective, sustainable and harmonised interventions primarily at the community level.

The NNP, under its service delivery strengthening component, puts strong emphasis in combating micronutrient deficiencies (through interventions such as supplementation Vitamin A for children 6-59 months and iron foliate tablets for pregnant and lactating women). At the same time, food fortification and other feasible food-based interventions play vital roles in reducing under-nutrition and micronutrient deficiencies. In this context, Ethiopia has already taken significant steps in this direction with the enactment of mandatory universal salt iodization, which came into force in April 2011.

However, cognizant of the potential positive impact of more widespread food fortification on micronutrient deficiencies within the Ethiopian context, the Ethiopian Federal Ministry of Health in partnership with Concern Worldwide, the World Bank through the Japanese Social Development Fund, commissioned this report with the overall aim of assessing the appropriateness of various food vehicles for the implementation of a national fortification programme in Ethiopia. Furthermore, the study also recommends a series of methods and an achievable timetable to enable the development of an effective national food fortification program.

This report is a very positive step towards expanding food fortification efforts in the country and I am delighted to see that the study has found flour fortification with iron and folic acid, and oil fortification with vitamin A to be viable options. This report also sets out feasible methods and a timetable to fortify flour and oil in Ethiopia. Therefore, I would like to take this opportunity to encourage all partners and stakeholders to work closely with Government sectors to bring this initiative into fruition, which in turn will contribute towards meeting the NNP targets for reducing micronutrient deficiencies in particular and under-nutrition in general.

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List of Acronyms

BCR	Benefit Cost Ratio
CHD	Community Health Day
CSA	Central Statistical Agency
CSB	Corn Soy Blend
DACA	Drug Administration and Control Authority
EAR	Estimated Average Requirement
EEOS	Extended Enhanced Outreach Strategy
EHNRI	Ethiopian Health and Nutrition Research Institute
EMA	Ethiopian Millers Association
EOS	Enhanced Outreach Strategy
EQSA	Ethiopian Quality and Standards Authority
ESDA	Ethiopian Sugar Development Agency
FAO	Food and Agricultural Organization
FMHCA	Food, Medicine and Healthcare Administration and Control Authority of Ethiopia
GAIN	Global Alliance for Improved Nutrition
GTP	Growth and Transformation Plan
HAZ	Height-for-Age Z Score (stunting)
HEW	Health Extension Worker
HICE	Household Income, Consumption and Expenditure Survey
HSDP	Health Sector Development Programme
HEP	Health Extension Programme
IDA	Iron Deficiency Anaemia
IFPRI	International Food Policy Research Institute
MDG	Millennium Development Goal
MMP	Multiple Micronutrient Powder
MOH	Ministry of Health
MOST	Ministry of Science and Technology
MOTI	Ministry of Trade and Industry
MT	Metric Tonne
NGO	Non-Governmental Organization
NNP	National Nutrition Programme
NNS	National Nutrition Strategy
NPV	Net Present Value
PLHIV	People Living with HIV
QSAE	Quality and Standards Authority of Ethiopia
RNI	Recommended Nutrition Intake
SD	Standard Deviation
USAID	United States Agency for International Development
VAC	Vitamin A Capsule
VAD	Vitamin A Deficiency
VAT	Value Added Tax
WAZ	Weight-for-Age Z Score (underweight)
WFP	World Food Programme
WHO	World Health Organization
WHZ	Weight-for-Height Z Score (wasting)

Executive Summary

Malnutrition erodes the foundation of economic growth - people's strength, energy, creative and analytical capacity, initiative and entrepreneurial drive. Widespread poor health, lower learning capacity, diminished physical activity and depressed work performance place a heavy burden on prospects for national economic development. Vitamin and mineral deficiencies, also known as micronutrient malnutrition, represent a severe public health problem in Ethiopia. More than half of children and a quarter of adult women are anaemic.[1] Nearly 40% of children are vitamin A deficient.[2] As a consequence, the nation's GDP is depressed by nearly half a billion dollars annually and each year more than 50 thousand children die as a consequence of vitamin A, iron and folic acid deficiencies. These losses limit capacity to meet national objectives for reducing mortality, poverty and malnutrition as well as economic development.

The National Nutrition Program (NNP) presents an opportunity to build on the current portfolio of affordable and effective micronutrient interventions and bring them to full scale. Food fortification can play a key role within the context of comprehensive multiple strategies to reduce micronutrient deficiencies. Wheat flour, edible oil and sugar are three traditionally proven food fortification vehicles with high consumption, wide distribution and centralized processing required by fortification. This report assesses the feasibility of a national fortification program including these three food vehicles.

The key parameters of the assessment, summarized in the table below, suggest that flour fortification with iron and folic acid, and oil fortification with vitamin A are affordable and feasible options which offer significant nutrition protection to large populations. While current data suggests more urban and affluent groups consume more of these foods than the rural and poor, evidence shows a high prevalence of anaemia and vitamin A deficiency among all socio economic segments. Sugar fortification with vitamin A is not recommended at this time based on relatively low coverage, skewed distribution and high cost.

Summary of Findings for Cost and Coverage for 3 Potential Fortification Vehicles

	Nutrition Protection	Feasible Industrial Coverage		Estimated Cost	Cost Per Person
	% WHO Standard	% Share	000,000 Consumers	USD Million/Yr	$/yr
Flour	26% EAR[3] Iron; 64% EAR Folic Acid	28%	22	$2.28	$0.10
Oil	~ 37% RNI Vitamin A[4]	48%	38	$0.95	$0.02
Sugar	~ 36% RNI Vitamin A	20%	16	$5.98	$ 0.38

Available data suggests about 53% of wheat flour consumption can be fortified at the nation's 208 registered mills, reaching > 22 million people. Based on estimated per capita consumption of 130 g/d, fortification is sufficient to deliver more than one-fourth WHO Estimated Average Requirements for iron and around two-thirds WHO Estimated Average Requirements for folic acid. These benefits can be achieved in the short term with annualized 10-year costs of about $2.3 million, about $0.10 per beneficiary per year. We recommend initiating a process to develop mandatory regulations and capacity building to enable fortification of all wheat flour with at least iron and folic acid (2.6 ppm).

[1] Ethiopia Demographic and Health Survey (EDHS), 2005, Central Statistical Agency, MEASURE DHS, ICF Macro
[2] Ethiopian Health and Nutrition Research Institute (EHNRI), 2010
[3] WHO Estimated Average Requirement (mid bioavailability)
[4] WHO Recommended Nutrition Intake

Analysis of available data suggests it is feasible to fortify about 87% of edible oil consumption, mainly imported palm oil from large industries in Asia. We estimate 55% of the population purchases commercial edible oil with average per capita consumption at about 15 grams per day. If fortified with vitamin A this is sufficient to supply 47% of RNI for an adult woman and 10-35% of RNI for young children. These benefits can be achieved within the short to medium term with annualized 10-year costs of $9.46 million, about $0.02 per beneficiary annually. We recommend initiating a process to include fortification with vitamin A at 20 ppm into the current mandatory standards for edible oil.

Based on estimated coverage and suggested effectiveness, we venture to estimate reductions in the prevalence of micronutrient malnutrition including: more than 1 million cases prevented, 4600 saved lives and a reduction in economic losses by about $37 million annually. Ten Year Projected Budgets, including start-up, capacity building, capital investment and all recurring and operating expenses for public and private sectors are estimated at $36 million. This $36 million includes > 25% in duties, VAT and customs service fees on imported premix, as well as a 12.5% margin and in-kind costs of producers. Presuming these "soft costs" are substantially reduced, incremental costs of the program are about $30 million. Depending on whether we take full costs or assume reduced duties and margins, the Benefit Cost Ratio (BCR) is very positive – a BCR of 10 for full costs and BCR of 13 when government and industry charges are reduced.

We believe achieving fortification at national scale, defined as 28% population coverage with fortified flour and 48% coverage with fortified oil is possible within 2-4 years and will require the following:

- *Further developing NNP capacity to mobilize stakeholders to initiate, support and coordinate fortification.* This includes creation of a multi-sectoral fortification work group within NNP or Ministry of Health (MOH), developing a 5 Year National Fortification Strategy and possibly undertaking additional data gathering and/or operational research.

- *Creating public and private stakeholder awareness and support for fortification.* This includes creating government support for mandatory regulations as well as developing a package of incentives for industry. We recommend that food aid donors process and mill their oil and wheat flour with domestic industries capable of fortification.

- *Revising Ethiopian National Standards for flour and oil to include mandatory fortification.* The Standards Council of Ethiopia should convene appropriate technical subcommittees and charge them with reforming current product standards for oil and flour to include fortification. In parallel, NNP should work with stakeholders to clarify roles and responsibilities for regulation and enforcement among Ministry of Health (MOH), Ministry of Science and Technology (MOST) and Ministry of Trade and Industry (MOTI) agencies (Food, Medicine and Healthcare Administration and Control Authority of Ethiopia (FMHCA), Ethiopian Health and Nutrition Research Institute (EHNRI), Ethiopian Quality and Standards Authority (EQSA) and appropriate MOTI agencies).

- *Resource mobilization for program development, capacity building and initial operations*. Currently there are limited budgets for development and implementation of a national fortification program. NNP should work with stakeholders to determine resources needs and identify financing from within current NNP as well as open discussions with Global Alliance for Improved Nutrition (GAIN) for support beginning in 2011.

We suggest a rough timetable as follows:

- Continued policy and program development as well as resource mobilization (2011)
- Operational Research and Policy and Standards Development (2011-2012)
- Capacity Building and Initial Operations (2012-2013)
- Program launch and mandatory national operations (2014-2015)

While the situation may change in the coming decades, the reach of classic fortification approaches may be limited to about half the population. However, recent innovations bring opportunities to reach the most at-risk rural segment including: small scale fortification (particularly maize meal) and in-home fortification (sprinkles). Developing these non-traditional approaches will require operational research to define scale, cost and effectiveness. In addition, there may be opportunities to expand substantial domestic capacity for the production of complementary foods in Ethiopia.

1. Background

1.1 Nutrition Policy and Economic Development

Ensuring food security and optimizing human capital are the twin challenges for nutrition and economic policy in Ethiopia. Still among the world's highest recipients of food aid, Ethiopia is also among "the top performing economies in the Sub-Saharan Africa" with real GDP growth projected at 11.2%.[5] The service sector expanded 17 %, agriculture 7.5% and industry 10.4%.[6] As the national *Growth and Transformation Plan* (GTP) aims to double national GDP and wean reliance off food aid in five years, one in ten Ethiopians continues to rely on international food aid.[7] The GTP targets increasing agricultural production, processing and exports as a pathway to economic development and a future where "we will feed ourselves."[8]

Malnutrition erodes the foundation of economic growth - people's strength, energy, creative and analytical capacity, initiative and entrepreneurial drive. Widespread poor health, lower learning capacity, diminished physical activity and depressed work performance place a heavy burden on prospects for national economic development. Lifting that economic burden along with optimizing Ethiopia's human and economic potential, can enhance prospects for achieving the GTP's ambitious goal for economic development.

The Health Sector Development Programme (HSDP) recognizes Ethiopia's parallel food security and economic development challenges. The HSDP works to strengthen emergency preparedness and capacity to deliver humanitarian aid but also recognizes that "better nutrition is key to economic growth and socio-economic development by increasing labour productivity as well as through its effect on the cognitive achievements and abilities of children."[9] Malnutrition creates and reinforces poverty – but improved nutrition is a pathway to escape it.

Recognizing that "malnutrition has been a serious obstacle to economic development in Ethiopia," the National Nutrition Program (NNP) works simultaneously to "strengthen nutrition in emergencies" as well as to "undertake appropriate and coordinated nutrition actions to enable the creation of a healthy and productive labour force, which is vital to ensuring rapid social and economic development."[10] The "continuing human costs for the many malnourished people are enormous – shortened lives filled with illness and reduced physical capabilities and compromised mental performance."[11] Nutrition interventions act both as humanitarian efforts to save lives as well as economic development tools to optimize human productive potential.

1.2 Micronutrient Deficiencies

According to NNP "micronutrient deficiencies have a devastating effect on the physical and mental well-being of people."[12] Vitamin and mineral deficiencies represent a severe public health problem. More

[5] National Bank of Ethiopia Annual Report, 2009/10
[6] Ibid
[7] Reports from Reuters, August 12-16, 2010
[8] President quoted in Reuters, August 12-16, 2010
[9] Health Sector Strategic Plan (HSDP-III) 2005/6 – 2009/10, Planning and Programming Department, Federal Ministry of Health, Ethiopia, 2005
[10] Program Implementation Manual of National Nutrition Programme (NNP) – I July 2008 – June 2013, Federal Ministry of Health, April 15, 2008, Addis Ababa, Ethiopia
[11] National Nutrition Strategy (NNS), Federal Ministry of Health, January 2008, Ethiopia
[12] NNP

than half of children and a quarter of adult women are anaemic.[13] Nearly 40% are of children are vitamin A deficient.[14]

The mission developed a "Micronutrient Damage Assessment Report," (DAR) which concludes Ethiopia's GDP is depressed by 1.42% due to current levels of anaemia, vitamin A and folic acid deficiencies.[15] The full analysis, attached as Annex I, finds economic losses of nearly half a billion dollars annually, including:

- *Lost Workforce:* More than 50 thousand annual infant and child deaths attributed to vitamin A, iron and folic acid deficiencies.
- *Lost Future Productivity:* Net Present Value of productivity deficits from > 8 million children suffering developmental, cognitive and schooling deficits due to iron deficiency anaemia.
- *Lost Current Productivity:* Depressed work performance from nearly 2.5 million anaemic adults engaged in manual and heavy manual labour.

Table 1: Damage Assessment Report: Economic Losses Due Iron Deficiency Anaemia, Vitamin A Deficiency and Folic Acid Deficiency

	Lost Workforce Child Mortality		Lost Future Productivity	Lost Current Productivity	Total
	# Deaths	NPV 000,000	NPV 000,000	000,000	000,000
Perinatal Mortality due to Maternal Anaemia	6,333	$30.97			$30.97
Infant Mortality due to Folic Acid related Birth Defects	4,215	$20.61	$0.08		$20.70
Child Mortality due to Vitamin A Deficiency	38,842	$167.18			$167.18
NPV of Lost Production due to **Anaemia in < 5 years olds**			$121.46		$121.46
Current Lost Productivity due to **Anaemia in**				$114.01	$114.01
Total Annual Losses		$218.77	$121.54	$114.01	$454.32

The DAR attributes almost half the economic losses to child mortality due to mothers' anaemia, folic acid-related birth defects or vitamin A deficiency. Iron deficiency anaemia in children under 15 years of age and in adult manual labourers each contribute about one-quarter of the annual lost economic activity. These micronutrient deficiencies limit capacity of national programs to reach MDG targets for reducing mortality, poverty and malnutrition. They also are a barrier to achieving the GTP's annual 11% growth objectives. In fact, annual 1.4% loss to GDP from these three micronutrient deficiencies represents 10-15% of the GTP's growth targets for the national economy.

The National Nutrition Strategy (NNS), along with the National Micronutrient Guidelines developed by the MOH, outline a comprehensive set of strategies to reduce the burden of micronutrient deficiencies including:

- Provision of iron-folic supplements to pregnant women
- Vitamin A capsules for children 6-59 months and mothers within first 45 days of delivery
- Nutrition education and dietary diversification
- Hygiene, de-worming and other public health measures
- Food fortification

[13] EDHS, 2005
[14] EHNRI, 2010
[15] See Annex 1: Bagriansky, Jack Ethiopia National Damage Assessment Report

These strategies have been demonstrated feasible, effective and affordable in many developing countries. However, national data provided by the EDHS 2005 suggests the scale of these programs has not yet met the enormous need across Ethiopia:

- About one-fourth of children and one-third of mothers consumed vitamin A rich foods.
- 10% of children and 14% of mothers consumed iron rich foods.
- Less than 3% of children consumed fortified baby foods.
- 10% of women took iron folic acid supplements during pregnancy.
- About half of children and 20% of post-partum mothers were provided vitamin A supplements.
- Less than 20% of families had access to adequately iodized salt.
- No major staple foods are fortified.[16]

The NNP presents an opportunity to build on the portfolio of affordable and effective micronutrient intervention programs and bring them to scale. Food fortification can play a key role within the context of NNS's multiple strategies to reduce micronutrient deficiencies.

[16] EDHS, 2005

2. Food Fortification Situation Analysis

Among NNP stakeholders there has been a commonly held perception that "unfortunately, it is difficult to fortify foods in Ethiopia because no staple food has been identified as widely consumed in the entire country and the foods that are relatively common are not processed in factories." [17] The NNS proposes that "although food fortification with micronutrients has not yet been developed due to the low-levels of industrial foods processing, special attention will be given to expanding this sector and encouraging the population to utilize industrially-processed micronutrient fortified foods."[18] This report is a step towards defining the potential contribution of food fortification towards national health and development goals along with NNP objectives.

Opportunities for public health improvements via fortification with micronutrients are defined (and limited) by existing market, distribution and consumption patterns for commercially processed foods. These market patterns define fortification's "reach" (to all consumers) and "coverage" (to at-risk consumers). Often, modern food production and market systems capable of cost effective fortification are preferentially accessed by the urban and the affluent, while micronutrient deficiencies are most severe among rural populations and lower income groups. Therefore, three key questions in assessing food vehicles are:

- Do market and consumption patterns include significant segments of groups at risk of micronutrient deficiencies?
- Do at-risk groups purchase, consume and prepare the food in sufficient quantities to deliver a significant level of nutrition protection?
- Are food processors sufficiently large and centralized to cost-efficiently incorporate technology, sustain quality, assure fortification and be effectively regulated by government agencies?

In Ethiopia, three processed commercial foods have this requisite wide distribution, high consumption, and centralized processing: edible oils, wheat flour and sugar.

2.1 Distribution of Consumption by Income Level

While the distribution is skewed towards the most affluent, these three food products can cover a substantial proportion of the population. HICE 2000 found that 28% of consumers purchase flour and flour products, 21% purchase sugar, and 55% purchase cooking oils. Purchasing is most concentrated among the highest income segments. Still, flour and edible oil are purchased by one-quarter of the middle-income consumers – a bit less for sugar (economic quintiles 2-4 in the attached graph). Among the poorest income quintile, wheat flour is purchased by 21%, edible oil by 18% and sugar by 12%.[19] Based on this data we estimate sugar reaches about 17 million Ethiopians while wheat flour and edible oil each reach about 22 million.

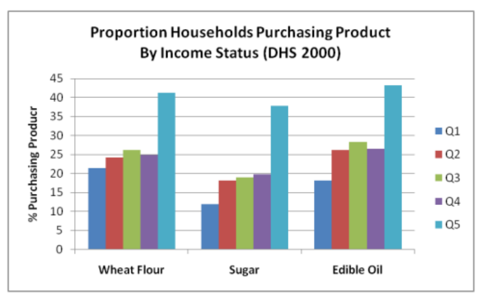

Figure 1 Proportion of households purchasing product by income status (HICE, 2000).

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[17] National Guideline for Control and Prevention of Micronutrient Deficiencies, Federal Ministry of Health Family Health Department, June 2004
[18] NNS
[19] Fiedler, Analysis of HICE 2000, Unpublished

Distribution of consumption skewed toward the affluent is not a barrier to public health impact of fortification in Ethiopia. While the situation is more severe among the lowest income, micronutrient deficiencies represent a significant public threat across all socio-economic segments. As shown in table 2 below, there are about 5.4 million anaemia cases among the poorest 20% of Ethiopians. But there are also 18 million cases among those in higher income groups. Even among families with the highest income quintile (20%) in Ethiopia, half of the children under 5 years of age suffer anaemia, representing nearly 4 million cases.[20] Therefore, significant nation-wide reductions in micronutrient deficiencies require coverage of all income quintiles.

Table 2 Distribution of Anaemia by Income Quintile (DHS 2005)

	Anaemia in Children		Anaemia in Women		Total Anaemia in Women & Children
	%	# Cases	%	# Cases	Total Cases
Q1	60%	4,138,766	32%	1,246,703	5,385,469
Q2	56%	3,848,569	30%	1,187,896	5,036,465
Q3	53%	3,648,194	27%	1,046,760	4,694,955
Q4	49%	3,392,545	27%	1,038,919	4,431,464
Q5	48%	3,302,722	17%	682,158	3,984,880
		18,330,796		5,202,436	23,533,233

2.2 Geographic Distribution of Potential Food Vehicles

Nationally, more than half of households purchase cooking oil, about one-quarter purchase wheat flour and about one-fifth consume sugar. However, easier access to food markets stocked with processed foods means the urban population tends to purchase more flour products, sugar and cooking oil. Wheat flour, sugar and oils are purchased by about 90% of urban populations but less than 20% of rural households.[21] As indicated in table 3 below, given the much larger rural population, on a national basis, commercially processed foods can reach at least 25 million people - fairly equally distributed among rural and urban populations and suggesting both would benefit.

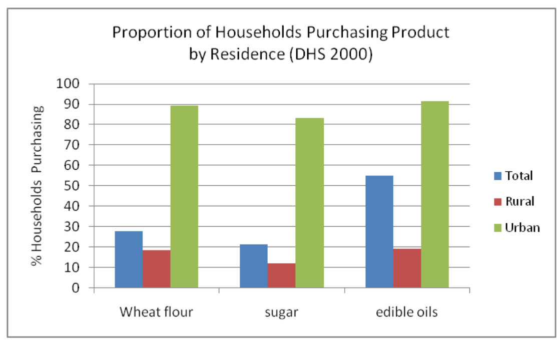

Figure 2: Proportion of households purchasing product by residence (HICE, 2000).

Table 3 Consumers of Potentially Fortified Items Consumption (HICE, 2000) and Population (CSA 2009)

	Total	Rural	Urban
Population	79,455,634	66,265,999	13,189,635
Wheat flour	28% 22,247,578	18% 12,270,056	89% 11,688,648
Sugar	21% 16,925,629	12% 8,048,997	83% 10,910,702
Edible oils	55% 43,700,599	19% 12,696,626	92% 12,005,662

Moreover, the evidence indicates urban populations have high levels of micronutrient malnutrition. A recent IFPRI report noted "the high degree of under-nourishment in urban centres relative to rural areas."[22] In fact, DHS and other sources suggest that the nutrition status of the urban population is not

[20] EDHS, 2005
[21] Fiedler, Analysis of HICE 2000, Unpublished
[22] Schmidt et al A Sub-National Hunger Index for Ethiopia, IFPRI Discussion Paper No. ESSP2 005 October 2009

much better than the rural. Rates of anaemia, vitamin A deficiency and iodine deficiency are 87-99% that of rural children, as suggested by the attached graph. A recent survey of vitamin A deficiency found higher prevalence among urban children than rural. [23] While the anaemia burden is higher in rural areas with an estimated 9.3 million anaemic children and women, still more than 6.7 million urban women and children also suffer from anaemia.[24]

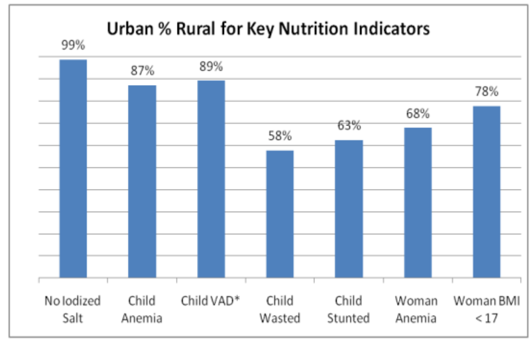

Figure 3 Urban % rural of key nutritional indicators (EDHS, 2005).

In 2010 WFP undertook a series of surveys to assess the nutrition risks faced by urban populations and found a "deterioration of all the three pillars of food security."[25] The reports conclude food security was "seriously impacted due to several factors:"[26]

- Below-acceptable level of consumption by about one-third of the surveyed population.
- Food utilization affected by the poor basic infrastructure and the deterioration of basic services.
- Maladaptive coping strategies that include shifting to less expensive and less nutritious foods.
- High expenditures on food by the majority of households (about 60% of total income).
- More than 70% of households were below the national absolute poverty line.

Better distribution and higher levels of consumption of flour products, oil and sugar in urban areas should not be considered a limitation to improving micronutrient status.

2.3 Future Trends in the Reach of Potential Fortified Foods

While the trend is not as pronounced as in many developing countries, Ethiopia's population is becoming more urban. The urban population was estimated at about 16.6% in 2009 and projections are for 20% by 2015.[27] Current investments to expand and improve the nation's road network will not only bring a wider range of products to the market place, but will also create easier market access for a wider range of consumers who may not be strictly defined as "urban." A recent analysis suggested that 45% of the population currently live within a five hour walk of a town of five thousand people - and access to markets with a range of processed food products.[28] As the population continues to urbanize and food markets become more accessible, it stands to reason that within a medium-term time frame, one-third to one-half of Ethiopians could have easy and regular access to commercial foods which are potentially fortified, including flour products, edible oil and sugar.

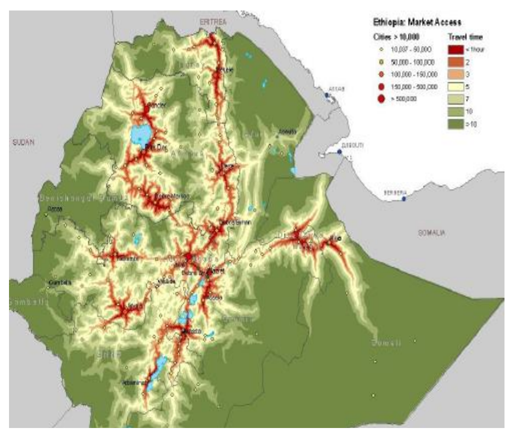
Figure 4 Ethiopia market access

[23] Tsegaye Demissie, Ahmed Ali, Yared Mekonnen, Jemal Haider, and Melaku Umeta, Demographic and Health-related Risk Factors of Subclinical Vitamin A Deficiency in Ethiopia, J HEALTH POPUL NUTR 2009 Oct;27(5):666-673
[24] Authors calculations based on EDHS, 2005
[25] WFP, UNICEF, Addis Ababa Government, Urban Food Security and Vulnerability in Selected Towns, Ethiopia 15/06/2010
[26] Ibid
[27] Paul Dorosh, Food Prices, Consumption and Nutrition in Ethiopia: Implications of Recent Price Shocks, Institute of Medicine Workshop on Mitigating the Nutritional Impacts of the Global Food Crisis July 14, 2009
[28] Schmidt et al A Sub-National Hunger Index for Ethiopia, IFPRI Discussion Paper No. ESSP2 005 October 2009

In summary, wheat flour, edible oil and sugar can protect at least 25 million Ethiopians in the near-term and possibly twice that number in the not-too-distant future. In the near-term, substantial national reductions in the burden of micronutrient malnutrition can be achieved by improving micronutrient protection of urban populations. Sections 3-5 will individually consider the industrial and market environment for these potential food fortification vehicles.

2.4 Food Standards and Food Control Systems

Fortification is implemented primarily by industry and financed by the market place, but government plays a central role by promulgating policies that enable the industry and market. Global experience illustrates that mandatory standards along with consistent monitoring and transparent enforcement are key elements of successful and sustainable food fortification programs. In Ethiopia, key government food regulatory agencies include:

- The Quality and Standards Authority of Ethiopia (QSAE) is a semi-autonomous body that reports to the Ministry of Science and Technology. The QSAE is responsible for preparation of all national standards, including food quality and safety standards. The QSAE's National Quality Standard Strategy emphasizes developing key economic sectors including food and agro-processing. Currently, QSAE has published mandatory standards for edible oil and iodized salt along with voluntary standards for wheat flour and wheat flour products such as pasta.

- While QSAE is the implementation body, the Standards Council of Ethiopia is a multi-agency institution that develops and approves new standards. The Standards Council of Ethiopia includes technical committees convened to address specific standards and issues. For food and nutrition, technical committees include participation of the Codex Committee of Ethiopia, Ministry of Trade, Ministry of Science and Technology, Ministry of Industry and other stakeholders. The QSAE as a secretariat to the Standards Council develops the written standards once the technical committee has approved the standard. Food standards are developed following Codex Alimentarius guidelines and reference documents. The time to establish a new standard or to modify an existing one is estimated to take between 6 to 18 months.
- The Ministry of Trade and Industry (MOTI) is responsible for business registration and is responsible, along with other agencies, for inspection of products and industries. With responsibility over business licenses, MOTI is a major player in enforcement of standards.
- The MOH is represented on the technical committees for the development of food standards. Development of food fortification standards and specifications are led by the MOH on the relevant technical committees.

The food control and enforcement system is undergoing a re-organization. Within MOH, the former Drug Administration and Control Authority (DACA) is being reorganized into the Food, Medicine, Healthcare and Control Authority (FMHCA). While FMHCA's capacity is limited at the moment, there are plans to increase the number of inspectors as well as build laboratory and analytical capacity. The agency is in the process of moving to a new building and will be equipped with laboratory testing capacity for foods and drugs. Currently, FMHCA as well as QSAE and MOTI have limited analytical capacity and rely on the food testing capacity at the Ethiopian Health and Nutrition Research Institute (EHNRI). Significant NNP stakeholder investments are being made to further develop EHNRI's laboratory and food analysis capacity. While the processes and systems to implement a national food fortification program are generally in place, including the global best practice of mandatory fortification standards and regulation, NNP stakeholders will need to support continued capacity building as well as a planning process to develop clear and cost effective coordination of roles and responsibilities for inspection, analysis and enforcement among these various agencies.

3. Assessment of Wheat Flour as Fortification Vehicle

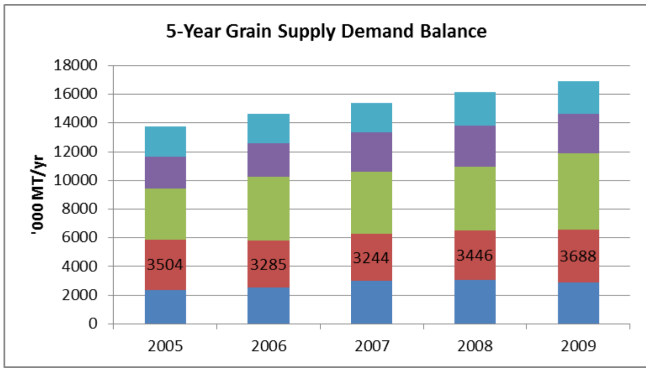

Figure 5 Five year grain supply demand balance

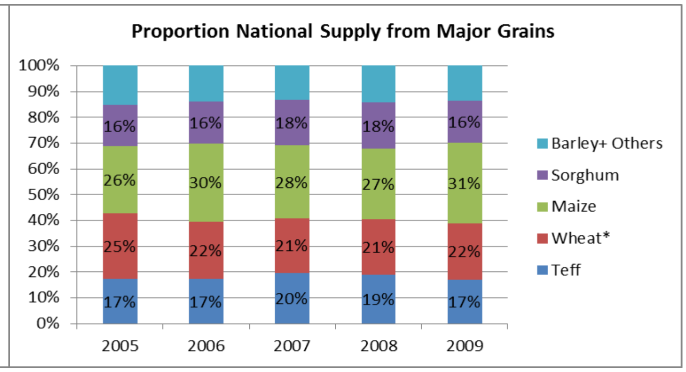

Figure 6 Proportion national supply from major grains

A rough picture of national cereal grain consumption and trends was compiled from Central Statistical Agency (CSA) data, FAO national estimates, reports of imports from UN and CSA and some records of food aid wheat distributed by USAID and WFP. From 2005 to 2009, national cereal gain consumption grew from about 14 million MT to nearly 17 million MT – more than 20% growth. This includes a diverse range of staple cereals including traditional small grains like teff, millet and barley along with sorghum, wheat and maize. Maize is the largest and fastest growing segment, representing just under one-third of consumption. Wheat has a consistent 20-25% share of national consumption, 10-20% of which has been in the form of food aid over the past 5 years.

3.1 How Much Wheat Flour Can be Fortified?

Most staple grains in Ethiopia are milled at thousands of small scale stone or hammer mills with capacities of 2-10 MT/d. These mills operate intermittently during the year and are often homes or informal and non-registered businesses, which are not appropriate for traditional fortification technology and business models. However, a significant share of wheat is milled at 208 mills registered with Ministry of Trade and Industry and/or the Ethiopian Millers Association. Most of these mills, with a capacity of 25 to > 200 MT/d, can easily and inexpensively adapt fortification technology.

Varying and incomplete data from numerous sources suggests that one-third to one-half of national wheat consumption is milled in these 202 facilities. The calculation shown in the table below, concludes about 1 to 1.57 million metric tons of wheat is milled at these 20 mills. The wide variation comes from differing reports of capacity utilization of mills from the Central Statistical Authority (36.4%) and estimates from the Ethiopian Milling Association (60%). This represents the wheat that is technically available for fortification. While recognizing this wide error band, in order not to underestimate costs of flour fortification, this report will use the middle figure of 1.566 MT.

Table 4 Calculation for Proportion of Milling from 202 Registered Mills

Estimated Annual Capacity (EMA)	2,611,409 MT
Capacity Utilization at Mills @ 60% (EMA)	1,566,845 MT
Capacity Utilization at Mills @ 36.4% (CSA)	949,508 MT
Mixed Capacity Utilization by Size (estimated by consultants[29])	1,620,000 MT
Total Annual Wheat Consumption Estimate	2,969,295 (FAO 2009)

[29] See Table 7

Estimated % of Consumption Estimated from 202 Mills	53% (EMA) 32% (CSA) 55% (Author Estimate)

3.2 How Many People Consume How Much Flour?

In the absence of concrete individual data such as a food consumption survey, our general estimate for flour consumption is based on the following reasoning, data triangulation and assumptions:

- The 2000 Household Income, Consumption and Expenditure Survey found 28% of Ethiopians purchase wheat flour, bread, pasta or other flour products, 22.3 million consumers who rely on the processing from commercial mills. This is plausible even though wheat represents only 20-25% of national consumption by volume because Ethiopians consume multiple staples and mix wheat products with other grains and flours in their diets. We speculate 58% are consumers as follows:
    - In addition to HICE findings of flour purchase by 28%, the survey found another 15% who purchase wheat as grain.
    - We might presume another 15% grow their own wheat on-farm, are paid with wheat in-kind as wheat or in some way consume wheat which is not purchased.
    - Adding these three segments suggests 58% of Ethiopians consume wheat and wheat flour products (as opposed to the 20-25% share of national consumption).

- FAO found 2.9 million MT of wheat was consumed in Ethiopia as food in 2009, suggesting an average per capita consumption of 37.4 kg per person per year.[30] However, since many Ethiopians are not regular wheat consumers, this national average does not reflect real consumption. If we assume only 58% (as we speculate above) actually consume wheat, then the average intake of actual consumers is 64 kg per person per year.

- The 28% who purchase wheat flour, pasta and other flour products consume flour milled at an average 74% extraction. Therefore, we adjust average per capita consumption of 64 kg/yr wheat by 74% to estimate 48 kg/yr per capita consumption of wheat flour.

To summarize this line of reasoning, we estimate more than 22 million people purchase wheat flour products which they consume at an average of 48 kg/yr – suggesting a national market of about 1.06 million metric tons annually. This is reasonably close to our previous estimate of registered mills milling 1.57 million MT of wheat, which at 74% extraction is some 1.16 million MT of flour. It is also reasonably close to our assumptions that wheat flour is consumed throughout the urban areas – about 17-20% - as well as in extended peri-urban population along Ethiopia's expanding roads and market infrastructure.

We should emphasize that these are speculative planning scenarios and are based on incomplete data and a number of assumptions. Additional data, from an in depth re-analysis of the 2007 HICE or undertaking additional surveys with simple tools like the MI's Fortification Rapid Assessment Tool, would doubtless contribute to the accuracy of this estimate.

[30] Food use is distinct from the overall demand shown in earlier graphs. Calculation based on 79.5 million population.

3.3 Fortification Profile: How Much to Add

WHO has published flour fortification recommendations that define effective and safe levels of key micronutrients that can be added to flour based on four categories of average consumption, ranging from < 75 g/d to more than 300 g/d.[31] Our estimate of 130 grams/d for Ethiopian consumers falls within the 75-149 g/d category. This is comfortably within the 75 – 149 gram per day range. Therefore, while additional data on consumption and distribution will doubtless shed light, unless additional data suggests consumption is more than 149 grams a day or less than 75 grams per day, this would have little bearing on the development and implementation of a flour fortification program.

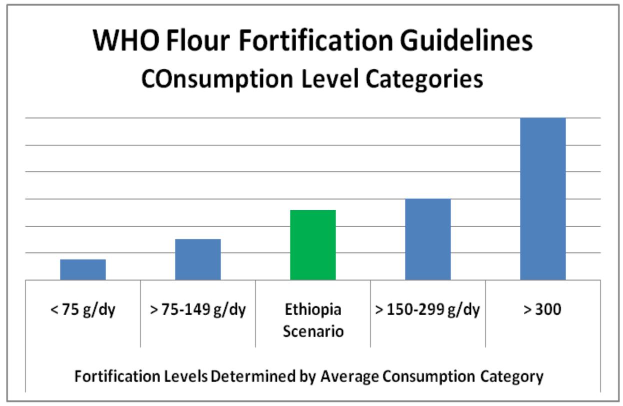

Figure 7 WHO flour fortification guidelines

Based on WHO recommendations, 130 g/d average consumption indicates the use of the fortification profile or added level of fortification shown in table 5 below. Applying WHO's mid-bioavailability thresholds for mineral absorption, fortification at the WHO recommended levels would offer the average adult female consumer an additional 144% of WHO Recommended Nutrition Intake (RNI) for zinc and 26% for iron. After accounting for estimated losses during processing, distribution and baking, nutrition protection for the average female consumer is projected at 64% for folic acid, 61% for vitamin A and 81% for vitamin B_{12}. In addition to these 5 micronutrients, B vitamins lost during milling, riboflavin, thiamine and niacin might be considered at "restoration levels," i.e. to return the nutrition of the milled flour to levels found in whole wheat.

Table 5 Potential Nutrition Protection for 5 Micronutrients in Proposed Fortification Profile

	Added Level	Retention to Consumer	Added Units/ Day	WHO RNI	% RNI Delivered
	Ppm	%	Unit/d	Unit/d	%
Ferrous Fumarate	60	99%	7.7 mg	29.4	26%
Folic Acid	2.6	75%	254 ug	400	64%
Vitamin A	3	65%	254 ug	500	51%
Vitamin B12	0.02	75%	1.95 ug	2.4	81%
Zinc Oxide	55	99%	7.08 mg	4.9	144%

[31] Recommendations on Wheat and Maize Flour Fortification, WHO, 2009

While teff is a traditional grain that is widely consumed along with wheat flour, it has not been recommended for fortification for a number of reasons including:

- High nutrition values, with iron content possibly 10 times the level of wheat.
- Fermentation of *injera* improves bioavailability of minerals like iron and zinc.
- Prices for mixed teff in recent years averaged 35% higher than wheat.
- Consumption pattern is heavily skewed towards urban and upper income populations.
- Teff is milled in small scale environments not appropriate or cost-effective for fortification.

Table 6: Calories from Teff vs Wheat[32]

	Teff	Wheat
By Residence		
National	248	266
Urban	588	181
Rural	192	280
By Income		
Q1	173	215
Q2	224	259
Q3	225	275
Q4	273	304
Q5	349	280

3.4 Industry Overview and Requirements

The state of the flour milling industry in Ethiopia was discussed with the President, Mr. Tadesse Genna, and the Program Officer, Mr. Buruk Tetemke of the Ethiopia Millers Association, EMA.

- Of 208 mills registered with MOTI, 106 mills are members of the EMA. The top 26 mills, based on rated capacity, are considered to operate at 60-80% of the rated capacity while the remaining smaller mills operate at less than 60% of rated capacity.

- In the past decade, several new mills have been constructed in the capacity range of 100 to 240 MT per day. In many cases these mills have been built in conjunction with downstream food processing facilities such as bread bakeries, biscuit factories or pasta plants.

The larger mills operate at a higher utilization rate than the smaller sized mills because the economies of scale and production mean that it is inefficient to run the larger mills at lower utilization rates. The smaller mills will tend to run longer (i.e. higher utilization rates) at the time of harvest for about 2-3 months and then stop running for the balance of the year or run at significantly reduced capacity. The mills with the smaller rated capacity are typically inexpensive Chinese mills with rated capacities less than 50 MT per day. Based on this information the roller mills can be classified according to size and an estimate can be made for the milling utilization rate for each classification. Table 7 shows the classification of the roller mills in Ethiopia based on the information supplied by the EMA.

Table 7 Industrial Segmentation

Mill Rated Capacity MT/d	Number Of mills	Estimated Utilization Rate %	Estimated Flour production MT /yr	Estimated Production Share %
> 100	11	60-80	410,250	25
50-100	22	35-60	481,750	30
<50	175	10-35	728,000	45
Total	208		1.62 million MT	100

Industrial Requirements:

<u>*Micro-Feeders*</u>

Based on the industry segmentation in table 7 above and using the experience of other countries that have implemented or are implementing flour fortification, microfeeders to "dose" flour with accurate rates of micronutrients will need to be procured and installed as follows:

[32] From Dorosh, Calculated from Ethiopia Central Statistical Agency (CSA) Household Income, Consumption and Expenditure Survey (HICE) 2004/05 data

- Mills with capacity of 100 MT per day and above require feeders with electronic controls appropriate for automated or computer controlled mills. These can be either volumetric feeders or loss-in-weight feeders. Typical costs for these types of feeders range from $8,000 - $15,000 and are supplied by European or North American suppliers.

- Mills with a 50-100 MT capacity require manual control volumetric type feeders that are suitable for this capacity range. Typical costs for these types of feeders range from $2,000 - $4,000 and are supplied by Turkish suppliers.

- For the mills with less than 50 MT capacity, the feeders should be manual control, volumetric type feeders that are suitable for this capacity range. Typical costs for these types of feeders are approximately $2000.

Premix Options

Based on the recent WHO recommendations for flour fortification as well as the experience of other countries with the implementation of flour fortification programs, there are three different options which can be considered for premix in Ethiopia. The following tables provide a summary of the levels of compounds to be added, the premix cost FOB factory, the addition rate and the fortification cost for addition at levels consistent with consumption of 75-150 grams of flour per person per day.

- Core Package: Iron, Folic Acid. This core package has been used in many countries in the Middle East, North and West Africa specifically to address iron and folic acid deficiencies. This is the least costly premix.

Table 8 Core Package Premix

Premix Composition	Active Ingredient
Ferrous Fumarate	60 ppm as Iron
Folic Acid	2.6 ppm
Addition Rate g/MT flour	200
Cost of premix $ per kg	$6.58
Fortification cost $ per MT flour	$1.32

- Restoration Package: Iron, folic acid, vitamins B1, B2, B3. This package has been used in North and South America by the flour milling industry. The restoration package is so called because the milling process removes B group vitamins from the flour and restoration adds these back to restore the levels to the naturally occurring level in the whole wheat grain.

Table 9 Restoration Package Premix

Premix Composition	Active Ingredient
Ferrous Fumarate	60 ppm as Iron
Folic Acid	2.6 ppm
Vitamin B1, Thiamine Mononitrate	6.0 ppm
Vitamin B2, Riboflavin	5.0 ppm
Vitamin B3, Niacin	45 ppm
Addition Rate g/MT flour	300
Cost of premix $ per kg	$8.34
Fortification cost $ per MT flour	$2.50

- WHO Package: Vitamin A, folic acid, iron, zinc, B12. Following an international meeting of experts in 2008, the WHO endorsed guidelines that included vitamin A, folic acid, vitamin B12, iron and zinc. This package includes all five micronutrients reviewed in the WHO recommendations.

Table 10 WHO Package Premix

Premix Composition	Active Ingredient
Ferrous Fumarate	60 ppm as Iron
Folic Acid	2.6 ppm
Vitamin A	3.0 ppm
Vitamin B12	0.02 ppm
Zinc Oxide	55 ppm as Zinc
Addition Rate g/MT flour	320
Cost of premix $ per kg	$12.48
Fortification cost $ per MT flour	$3.99

Table 11 summarizes the addition rates and costs for each of the three options listed above.
In view of the issues surrounding the implementation of salt iodization, the fortification of wheat flour with iodine in the form of potassium iodide may provide an alternative vehicle for iodine.

Table 11 Summary Premix Options and Costs			
Premix	Core Package	Restoration	WHO guidelines
Micronutrients	Iron, Folic Acid	Core + Vit B1, B2, B3	Core + Vit A, B12, Zinc
Addition rate g/MT	200	300	320
Premix cost $/kg	$6.58	$8.34	$12.48
Fortification Cost $/MT	$1.32	$2.50	$3.99

Premix Standards and Supply

There are no standards for premixes to be used in flour fortification, which means that there is potential for problems and confusion with competing premix companies. In addition, due to the large number of smaller mills (208), the cost of the premix to supply these mills on an individual basis will be much higher than if there was some sort of centralized purchasing system. This will allow the mills to take advantage of economies of scale. In addition, the country can take advantage of the GAIN premix facility to ensure quality standards for premix that can be met at a fair market price.

ES1052:2005 Wheat Flour – Specification

There is official voluntary Ethiopian standard for wheat flour.[33] This standard has been prepared under the direction of the Agricultural and Food Technology Standards Committee and is published by the Quality and Standards Authority of Ethiopia (QSAE). The wheat flour standard section 4.4 refers to "enriched flour" permitting the addition of vitamins and minerals which includes "riboflavin, niacin, folic acid, iron, calcium, zinc, iodine, etc." In section 6.3 the levels for vitamins B1, B2, B3, and D are specified as follows:

- Thiamine 4.5 to 5.5 ppm
- Riboflavin 2.7 to 3.3 ppm
- Niacin 35.5 to 44.4 ppm
- Vitamin D 250 to 1000 IU

Folic acid, vitamin B12 and vitamin A levels are not specified in section 6.3 but are permitted under the general provisions of section 4.4. In section 6.6 the following minerals are permitted but no levels are prescribed: iron, calcium, zinc and iodine.

Issues:

The Ethiopian Millers Association (EMA) Executive Committee is very interested and committed in principle to the introduction of flour fortification in Ethiopia. The EMA recognizes that the Government of Ethiopia has introduced a NNS and NNP, where food fortification is included as one of the actions. However the EMA has expressed the following concerns:

- The low level of awareness of the importance of flour fortification at the highest levels of the government as well as industry. NNP stakeholders should continue advocacy of fortification as a key component of a comprehensive approach to improve nutrition in Ethiopia.

- The high burden of import duties and VAT on premixes, about 25%. NNP stakeholders should develop policies to lessen this burden on companies, including developing incentive tax packages for mills producing fortified flour as part of the NNP.

- The inconsistent supply of domestic wheat reduces the running time, efficiency and profitability. NNP should mobilize stakeholders involved in wheat procurement, (including the Government of

[33] ES1052:2005 Wheat Flour – Specification, First edition 2005-03-12

Ethiopia which periodically mitigates price increases by importing wheat along with WFP and USAID and associated NGOs) to ensure that as much of their domestic distribution as possible is milled – and fortified – in local facilities.

Food aid comprised a modest 11-26% of total wheat consumption over the four years 2006-9. However, based on our limited data, it represents as much as one-fourth to one-half of estimated volume of milling at the nation's registered mills. Access to this additional wheat supply means higher capacity utilization, more efficiency and profitability for millers – and therefore a key incentive. For the aid agencies, government and other NNP stakeholders this means an opportunity to supply a fortified product to the most at-risk populations in Ethiopia. However, there are concerns about limited shelf-life of fortified flour (about three months) versus the up to two year storage needs of agencies like WFP. We recommend that these barriers to local milling fortification of grains from aid agencies be studied further.

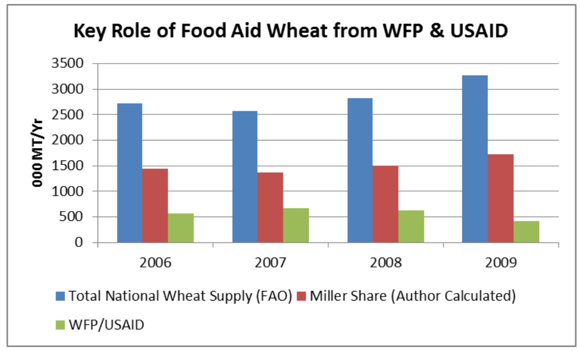

Figure 8 Key role of food aid wheat from WFP and USAID

3.5 Summary of 10 Year Costs (Line Item Budget in Annexes)

Table 12 Flour Fortification Implementation 10 Year Summary

Option #1: Core Package Iron and Folic Acid											
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Production											
Capital & Start-Up	$316	$316	$0	$0	$0	$0	$0	$0	$0	$0	$632
Recurring incl premix	$1,168	$1,168	$2,335	$2,335	$2,335	$2,335	$2,335	$2,335	$2,335	$2,335	$21,016
Regulatory											
Start up	$89	$0	$0	$0	$0	$0	$0	$0	$0	$0	$89
Mill inspection		$114	$114	$114	$114	$114	$114	$114	$114	$114	$1,026
TOTAL	$1,573	$1,598	$2,449	$2,449	$2,449	$2,449	$2,449	$2,449	$2,449	$2,449	**$22,763**
Option #2: Core and Restoration Package with Iron, Folic Acid, Zinc and 3 B Vitamins											
Production											
Capital & Start-Up	$316	$316	$0	$0	$0	$0	$0	$0	$0	$0	$632
Recurring incl premix	$2,211	$2,211	$4,423	$4,423	$4,423	$4,423	$4,423	$4,423	$4,423	$4,423	$39,806
Regulatory											
Start up	$89	$0	$0	$0	$0	$0	$0	$0	$0	$0	$89
Mill inspection	$0	$114	$114	$114	$114	$114	$114	$114	$114	$114	$1,026
TOTAL	$2,616	$2,641	$4,537	$4,537	$4,537	$4,537	$4,537	$4,537	$4,537	$4,537	**$41,553**
Option # 3: Full Package of Core, Restoration and WHO Recommended Micronutrients, Including Vitamin A											
Production											
Capital & Start-Up	$316	$316	$0	$0	$0	$0	$0	$0	$0	$0	$632
Recurring incl premix	$3,404	$3,404	$6,809	$6,809	$6,809	$6,809	$6,809	$6,809	$6,809	$6,809	$61,280
Regulatory											
Start up	$89	$0	$0	$0	$0	$0	$0	$0	$0	$0	$89
Mill inspection	$0	$114	$114	$114	$114	$114	$114	$114	$114	$114	$1,026
TOTAL	$3,809	$3,834	$6,923	$6,923	$6,923	$6,923	$6,923	$6,923	$6,923	$6,923	**$63,027**

In summary, the speculative scenario above suggests that wheat flour is a promising food fortification vehicle:

- > 22 million people purchase wheat flour products which they consume at an average of 47.3 kg/year or 130 grams per day.

- We estimate this consumption is sufficient to deliver more than one-fourth WHO estimated average requirements for bio-available iron and two-thirds WHO estimated average requirements of folic acid adult women.

- About one-quarter of Ethiopians regularly consume wheat flour products with about 53% of national consumption supplied by 208 mills capable of fortification.

We provisionally estimate that significant nutrition protection can be provided to 22 million people, about 28% of the population, via wheat flour fortification. These benefits can be achieved within the short to medium term with annualized 10-year industrial costs of about $2 million, about $0.10 per beneficiary per year.

We recommend the NNP consider initiating the process of opening communication channels with all necessary stakeholders including the private sector, defining the optimal premix package for Ethiopia (Core, Restoration or WHO), developing mandatory standards for flour fortification and mobilizing resources for further program planning, development and capacity building.

4. Assessment of Edible Oil as a Fortification Vehicle

Vitamin A deficiency is a major public health problem in Ethiopia, associated with annual deaths of nearly 40 thousand children. Vegetable oils are an ideal vehicle for fortification with vitamin A, technically simple, inexpensive and effective. We estimate cooking oil fortification can provide one-third to one-half of WHO recommended nutrition intakes (RNI) for average women and child consumers.

Available statistics indicate that edible oil consumption in Ethiopia is rising dramatically, more than doubling from 2000 to 2007 according to the FAO, and according to several sources possibly doubling again since 2007. Imports, traditionally the dominant source of supply, are rising steeply and averaged 82% of supply from 2000-2007.[34] This high proportion of imports represents an opportunity for fortification.

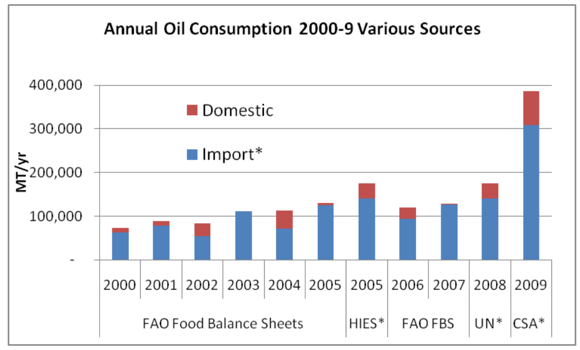

Figure 9 Annual oil consumption 2000-9 (FAO Balance Sheet, HICE 2005, UN, CSA).

4.1 How Much Oil Can Be Fortified?

Despite widespread agricultural production and consumption of oil seeds, most refined edible oil in Ethiopia has been imported for many years, with import share of national consumption ranging from 65% to more than 90% over the past decade.[35] Imports have grown dramatically throughout Africa as a result of improving distribution networks and the low price of palm oil. Large scale producers in Malaysia and Indonesia are well equipped and can fortify on demand. Some Malaysian palm oil fortified with vitamin A is already sold into Ethiopia. Indonesia is currently considering national oil fortification standards with vitamin A. Today, these imports are mainly palm oil from large and well organized industrial and marketing organizations in Malaysia and Indonesia.

The Ethiopian government, concerned about food security and the population's regular access to this strategic food commodity, has exempted duties and VAT from imported oil. This government policy has essentially reduced the cost of imported palm oil by about 25%. Consequently, the volume of imports may have doubled in 2009 to more than 300 thousand metric tons. While the lower price enabled by the government intervention will spur demand, we presume this huge increase in imports is a temporary distortion and does not represent a sustainable level of import or national consumption. However, even if there is some correction with lower imports in 2010, the growth trend should continue or even steepen. Consumers in countries with growing economies, like Ethiopia, historically increase edible oil consumption over time.

In this environment dominated by imports, domestic industrial production is limited – and supplies represent only about 20% of edible oil consumption. Ethiopian Oil Millers Association, as well as market studies sponsored by the Dutch Embassy indicates that 26 medium and large scale facilities produce more than one-third of national production.[36] The rest is from small-scale producers that are not technically oil refiners but rather "crushers." These small-scale producers are not considered capable of fortification. In fact, most cannot satisfy the current national mandatory edible oil standard and therefore the safety of edible oil consumption is a relatively high visibility concern.[37] In 2008 a survey by the QSAE found only 23 of 320 factories surveyed met national recognized standards for safety and

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[34] Ethiopia Food Balance Sheet, 2007, Food and Agricultural Organization (FAO)
[35] Ibid
[36] Wijnands et al Oilseeds Business Opportunities in Ethiopian 2009. Wageningen University & Research Center
[37] Abbay Media "The Ethiopian Information Bank" June 2008 http://abbaymedia.com/News/?p=1238

quality. Even most of the 26 medium and large scale producers will require significant capacity building to enable fortification.

For the approximately 20% consumption from domestic producers, we estimate about 35% of domestic production – representing about 7% of national consumption - is from medium and large scale producers capable of fortification.[38] Although the feasibility of a national oil fortification program is based on capacity of oil importers, a sustainable national fortification policy should include efforts to build the domestic oil industry. [39]

Table 13 Estimate for Market Shares of Domestic Edible Oil Producers by Size of Plant[40]

	Large	Medium	Small	
Number of Establishments	7	19	Others < 1000	Total
Gross Value of Production (1,000 Birr)	60688	49122	202935	312745
Calculated Share	19%	16%	65%	100%

To summarize, the technical and business conditions are in place to enable fortification of about 80% of consumption from imported palm and soybean oil produced by large modern refineries and imported by large distributors. With 7% potential fortification of production from large and medium domestic companies, it is not unreasonable to target fortification of 85% of the market for refined oil.

4.2 How Many People Consume How Much Oil?

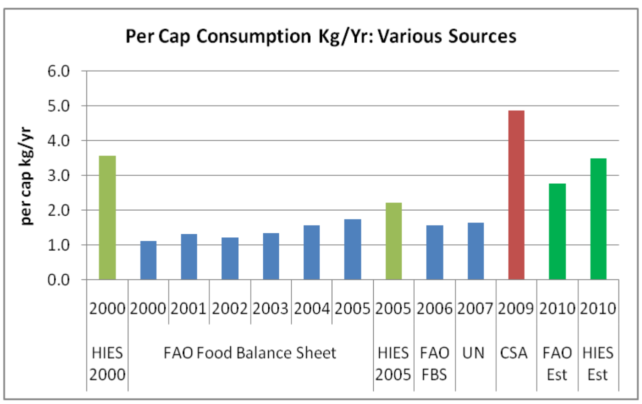

Figure 10 Per capita consumption kg/yr (HICE 2000, FAO Food Balance Sheet, HICE 2005, UN, CSA).

The consumption environment is complex. Large volumes of oilseeds are harvested throughout Ethiopia supplying export markets, a small number of domestic vegetable oil refiners and a large undocumented number of small local oil crushers. Often oilseeds are consumed without major processing in the form of "oil cakes" and other preparations that may not be classified as oil by statistic-keeping agencies. Despite the ambiguities and gaps in the data, the following consumption data was collected suggesting a range of per capita annual consumption from less than 2 kg/yr to nearly 5 kg/yr.

- FAO Food Balance Sheets for 10 years 1998-2007 suggest average per capita consumption rose from about 0.9 kg/yr to about 1.7 kg/yr – an increase of about 90%.
- Analysis of the 2000 HICE found about 55% of the population purchased an average 6.5 kg/year of edible oil - which suggests average consumption of 3.6 kg/per capita/year.[41]
- HICE 2005 provides more recent data on average calories per capita supplied by edible oil consumption. We recalculate this to estimate per capita oil consumption of 2.21 kg/yr.

[38] Wijnands et al Oilseeds Business Opportunities in Ethiopian 2009. Wageningen University & Research Center
[39] Ibid
[40] Ibid
[41] Fiedler, Analysis of HICE 2000, Unpublished

- Combined CSA data of imports in 2009 along with industry reports of domestic production suggest consumption of 4.86 kg/yr.[42] We consider that this is a one-year aberration in the business cycle driven with a huge increase in imports.

For planning purposes, we estimate 3.12 kg per person per year as a plausible figure. This is based on the five year growth rates 2000-2005 found by FAO (58%) applied to 2005 estimates by FAO and HICE to derive 2.8 to 3.5 kg/yr respectively – and averaging 3.12 kg/yr. This level of individual consumption suggests national consumption of 248 thousand MT/yr. This continues the growth trend of the past decade but is significantly lower than what we presume is the temporary spike to 400 thousand metric tons in 2009.

The average 3.12 kg per person per year means roughly 8.6 grams per person per day. However, if we assume only 55% of households purchase edible oils, as found in HICE 2000, then this suggests that consumption is much higher among the roughly half of Ethiopians which purchase commercially processed edible oil, an average of about 15.6 grams per day. We use this speculative figure for planning purposes, but additional consumption data will be important to validate this estimate.

Socio Economic Distribution of Oil Consumption

Available data underscores that purchase of edible oil is skewed toward the urban and affluent. In the 2000 HICE, 92% of urban but only 19% of rural households purchased edible oil.[43] Likewise, the 2000 HICE found that only 15-25% of lower income Ethiopians purchased edible oil as opposed to about half of the highest income. In 2005, HICE reports that calories consumed from edible oil were five times higher in urban than rural populations. The HICE also reported per capita expenditure of oil of about 15% among the poorest to nearly 65% for the most affluent. Given evidence that micronutrient deficiencies remain at severe levels across all income and geographic segments – and one study finding higher VAD in urban than rural areas - this skew in consumption across income and residence should be not be considered a major barrier to fortification oil with vitamin A.

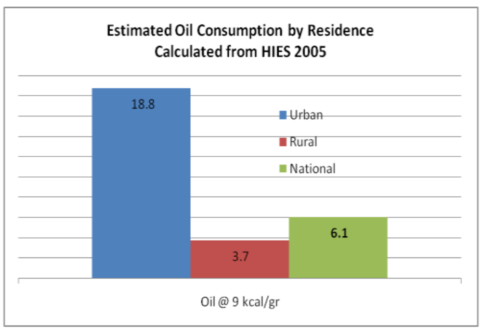

Figure 11 Estimated oil consumption by residence (HICE, 2005).

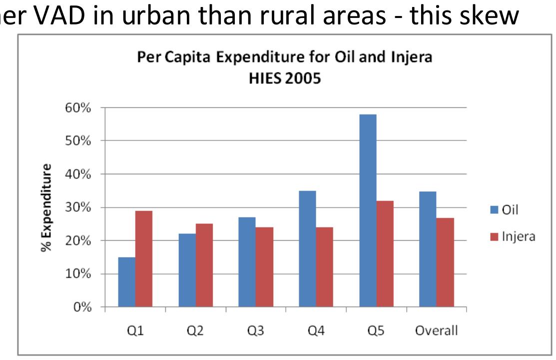

Figure 12 Per Capita expenditure for oil and injera (HICE 2005).

4.3 Fortification Profile: How Much to Add

Significant levels of vitamin A can be lost due to heat, light and air encountered both in shipping and distribution. However, the largest losses are during cooking – mainly high heat frying. Losses after multiple frying are often more than 50%.[44] However, in Ethiopia cooking oil is used less in high heat frying and more in boiling, light frying and sauce-making where vitamin A losses are considerably less. While a more in-depth review and even some retention studies in Ethiopian conditions may be appropriate, for planning purposes retention of vitamin A in vegetable oil will be conservatively set at about 75% (although this will vary widely

[42] Dutch Report, Modjo, Malaysian Association
[43] Fiedler, Analysis of HICE 2000, Unpublished
[44] Abraham, Guelph, University Studies

depending on exposure to light, intensity of heat in cooking, length of cooking, and amount of re-use of the same oil). Overages of vitamin A must be added to the oil during fortification process to compensate for these losses.

There are no global guidelines for fortification of edible oils with vitamin A. However, more than 30 countries have established regulations for oil or margarine fortification at levels ranging from 10 to 20 parts per million (ppm) of vitamin A.[45] Oil distributed by WFP or USAID associated NGOs, is fortified at 20ppm. As shown in table 14 below, assuming 15.6 grams per day consumption, oil fortified at 20 ppm can deliver about 47% of daily vitamin A needs for an adult woman of reproductive age. We speculate that at one-third and two-thirds of adult consumption respectively, younger children would benefit from an additional 20-35% of WHO RNI for vitamin A. We provisionally recommend the 20 ppm level.

Table 14 Estimated Nutrition Protection for Women of Reproductive Age Based on Average Consumption of Fortified Oil

	Consumption	Added Level Vitamin A	Retained after Cooking	Added to Daily Diet	WHO RNI	Via Fortification
	g/d	µg/g	%	µg/d	µg/d	% RNI
Adult Woman	**15.6**	20	75%	234	500	47%
3-5 Year Old @ 2/3rd	10.4	20	75%	156	450	35%
1-3 Year Old @ 1/3rd	5.2	20	75%	78	400	20%

In summary, the speculative scenario above suggests that edible oil is a promising food fortification vehicle:

- Presuming the huge jump in imports during 2009 is an aberration in the business cycle (in reaction to new government tax holidays), we estimate the sustained and expanding demand for edible oil in Ethiopia at about 248 metric tons of which an estimated 87% is technically available for fortification.
    - About 80% of edible oil is imported from major processors and business, mainly in Malaysia and Indonesia.
    - Of the approximately 20% of edible oil manufactured domestically, about one-third is processed at medium and large scale plants where fortification is appropriate, although some significant capacity building may be required.

- We estimate average per capita consumption of purchased refined edible oils at around 15 grams per day among 55% of the population.

- Adding vitamin A at 20 ppm (or µg/g) and allowing for loss of 25% of the vitamin during storage and cooking, average consumption of vitamin A fortified cooking oil can supply 47% of RNI for an adult woman and 10-35% of RNI for young children.

- Fortifying 87% of the edible oil supply which purchased by 55% of the population suggests coverage of about 48% with an average 47% of RNI for women and 10-35% for children.

4.4 Industry Overview and Requirements

The oilseed processing industry in Ethiopia is considered to be fragmented because it is made up of three distinct registered oilseed processing sectors with neither sector having a dominant position in the marketplace. The first sector can be classified as the large scale sector, equipped with both oilseed crushing and refining capacity. There are 8 companies that fall into the large size capacity above 20 MT

[45] NutriView, Special Issue, 2003, Roche Vitamins Europe Ltd, Basel, Switzerland

capacity per day. The second sector is made up of 18 medium sized oilseed crushing and partial refining plants with a rated capacity between 10-20 MT/d. The third sector is made up of oilseed crushing mills with rated capacity less than 10 MT per day producing unrefined oils.

Segmentation by Size/Capacity

Based on discussions with the Oilseeds Millers Association of Ethiopia Executive Committee and information from the Ministry of Industry and Trade and CSA, the actual oilseed mill utilization rates are considered to be very low, ranging between 35% and 45%. However it is estimated that only 1 or possibly 2 larger size oilseed milling and refining plants will operate at a higher utilization rate than the smaller sized oilseed mills and processing plants. The smaller sized oilseed mills will tend to run longer (i.e. higher utilization rates) at the time of harvest for about 2-3 months and then stop running for the balance of the year, or run at significantly reduced capacity.

Based on this information the oilseed mills can be classified according to size and an estimate can be made for the milling utilization rate for each classification. The following table shows the classification of the formal sector of the industry in Ethiopia, based on the information supplied by the Oilseeds Millers Association of Ethiopia.

Table 15 Oilseed Mill Classification and Utilization

Oilseed Mill Rated Capacity MT/d	Number Of oilseed Mills	Estimated Utilization Rate %	Estimated oil production MT /yr	Estimated Production Share %
> 50	3	40-50	27,900	45
20-50	23	25-40	34,100	55
Total	26		62,000 MT	100

Based on the Oilseeds Business Opportunities in Ethiopia 2009 Report, there are 834 small scale producers who produce unrefined oil. The estimated market share of this sector is considered to be about 10% of the local production. Since this oil is unrefined it is considered to be suitable for oil fortification.

Oil Fortification Requirements: Blenders and Mixers

Based on the information in the table above and using the experience of other countries that have or are implementing oil fortification, there are two options for the equipment and system required for vegetable oil fortification.

The first option, which is designed to be used in larger scale refineries (greater than 50 MT/d capacity), uses a system consisting of the following:

- A vitamin concentrate and oil mixing tank, equipped with a stirrer blender to produce a diluted vitamin premix,
- Two metering pumps to deliver the diluted vitamin premix and,
- An on-line blending system.

Typical costs for these types of system are $30,000. The metering pumps and electronic control systems are supplied by European or North American suppliers. The rest of the blending tanks and pipes etc. can be manufactured locally using food grade stainless steel.

The second option which is designed to be used in the medium sized operations (20 – 50 MT/d capacity) uses the following system:

- A vitamin concentrate and oil mixing tank, equipped with a stirrer blender to produce a diluted vitamin premix,
- Another blending tank, to blend the diluted premix with the oil on a batch blending basis.

Typical costs for these types of systems are $5,000 assuming they can be manufactured locally in Ethiopia.

Premix

The type of premix to be used in a national oil fortification program will be predicated upon two main factors. The first is the degree and types of micronutrient malnutrition problems that the MOH considers to be a public health problem. The current NNP for Ethiopia includes a statement that food fortification is part of the national strategy and the action plan, but it does not specify what the level of micronutrient malnutrition is in the country.

The WHO and other international agencies have determined that there are five main micronutrient deficiencies that affect public health in many countries at the global level. Based on this, the options for vegetable oil fortification in Ethiopia can cover vitamin A and D. It should be noted that many countries in Africa use both vitamin A and D in vegetable oil fortification.

Premix Options

Based on the experience of other countries with the implementation of vegetable oil fortification programs, the option for Ethiopia can be considered as follows:

- Vitamin A and D. This core package has been used in many countries in the Middle East, North and West Africa. The following table provides a summary of the levels to be added; the compounds used; the premix cost FOB factory; the addition rate; and the fortification cost.

Table 16 Oil Fortification Premix Option

Premix Composition	**Active Ingredient**
Vitamin A as Retinol Palmitate	60 IU
Vitamin D	6 IU
Addition Rate g/MT oil	93
Cost of premix $ per kg	$11.32
Fortification cost $ per MT oil	$1.05

Government Standards, Regulation and Enforcement

Premix Standards and Supply

There are no standards for premix to be used in oil fortification, which means that there is potential for problems and confusion with competing premix companies in supplying the market in Ethiopia. In addition, due to the large number of smaller oilseed mills (23), the cost of the premix to supply these oilseed mills on an individual basis will be much higher than if there was some sort of centralized purchasing system. This will allow the oilseed mills to take advantage of economies of scale. In addition, the country can take advantage of the GAIN premix facility to ensure quality standards for premix can be met at a fair market price.

Standards and Regulations for Edible Oil

There is an official Ethiopian standard for edible oils. The standard covers oils derived from many different oilseeds that are grown in the country. In addition, there are standard specifications for additives and contaminants, which were made mandatory in 2008. This was due to a number of serious illnesses and injuries caused by the consumption of contaminated oils. In addition, the Government of Ethiopia has announced new standards (not yet officially published at the time of the mission) covering Niger (noug) and sunflower oils, which are pressed and filtered. Fortified vegetable oil may be produced and sold in Ethiopia, provided that the containers are labelled as containing the added micronutrients and levels.

State of the Industry

The state of the oilseed processing industry in Ethiopia was discussed with Mr. Getachew Desta, the Plant Manager at Mulate Edible Oil Factory, other members of the Oilseeds Millers Association and Mr. Omer Abdi, Acting Executive Director, Addis-Modjo Edible Oil Complex. The following major issues affect the members of the Oilseeds Millers Association:

- The inconsistent supply of oilseeds for local processing in the country, which is due to the significant exports of unprocessed oilseeds to Europe and North America. Ethiopia exports large quantities of niger seed (noug), sunflower seed and other oilseeds as bird feed. The lack of oilseed supply reduces the running time of the crushing and refining sectors and their production efficiencies.
- The estimates of the operating capacity of the industry range from 35% to 60% of the total rated capacity.
- The number of members in the Oilseeds Millers Association is 22 with an additional 4 who are not in the association. The 26 oilseed processing plants, based on rated capacity, are considered to operate at 35-45% of capacity.
- Based on the oilseeds availability after export, the local oilseeds processing industry is estimated to produce 62,000 MT of refined oil per year.
- In the past decade, there have been significant imports of refined oils, mainly palm oil and soybean oil. Refined packaged palm oil is imported from Malaysia and Indonesia. The current estimates of imported oils are 310,000 MT annually.
- Currently there are no duties or taxes levied by the Government of Ethiopia on imported oils; whereas the locally produced oil is subject to 15% VAT.
- Vegetable oil production by the informal sector, mostly illegal operations with poor manufacturing conditions and contamination with inedible oils (such as castor oil) represents about 10% of the national market.

Attitude toward Fortification

The Executive Committee of the Oilseeds Millers Association of Ethiopia is interested and appears committed, in principle, to the introduction of vegetable oil fortification to Ethiopia. The Oilseeds Millers Association of Ethiopia recognizes that the Government of Ethiopia has introduced a NNS and NNP where food fortification is included as one of the actions. However the EMA has expressed the following concerns about vegetable oil fortification:

- The low level of awareness of the importance of food fortification in general, and vegetable oil in particular, at the highest levels of the government.
- The low level of awareness of the importance of vegetable oil fortification by members of the Oilseeds Millers Association of Ethiopia and those oilseed millers who are not members of the association.
- The low level of technical expertise within the industry to implement oil fortification at the factory level.
- The high burden of import duties and VAT on both the blending equipment and the premixes, which is at 25%.

All these issues raised by the EMA Executive Committee will need to be addressed by both the Government of Ethiopia and development partners.

4.5 Summary of 10 Year Oil Fortification Costs

Table 17 Oil Fortification Implementation 10 year Summary

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Production											
Capital & Start-Up	$113	$113	$0	$0	$0	$0	$0	$0	$0	$0	$226
Recurring including premix	$165	$331	$331	$331	$331	$331	$331	$331	$331	$331	$3,144
Regulatory											
Start up	$89	$0	$0	$0	$0	$0	$0	$0	$0	$0	$89
Mill inspection	$0	$12	$12	$12	$12	$12	$12	$12	$12	$12	$108
Subtotal Domestic	$367	$456	$343	$343	$343	$343	$343	$343	$343	$343	$3,567
Imported Oils @ $2/MT increment	$310	$620	$620	$620	$620	$620	$620	$620	$620	$620	$5,890
Total	**$677**	**$1,076**	**$963**	**$963**	**$963**	**$963**	**$963**	**$963**	**$963**	**$963**	**$9,457**

In summary, the speculative scenario above suggests that edible oil is a promising food fortification vehicle:

- Presuming the huge jump in imports during 2009 is an aberration in the business cycle (in reaction to new government tax holidays), we estimate the sustained and expanding demand for edible oil in Ethiopia at about 248 metric tons of which an estimated 87% is technically available for fortification.
    - About 80% of edible oil is imported from major processors and business, mainly in Malaysia and Indonesia.
    - Of the approximately 20% of edible oil manufactured domestically, about one-third is processed at medium and large scale plants where fortification is appropriate, although some significant capacity building may be required.
- We estimate average per capita consumption of purchased refined edible oils at around 15 grams per day among 55% of the population.
- Adding vitamin A at 20 ppm (or μg/g) and allowing for loss of 25% of the vitamin due during storage and cooking, average consumption of vitamin A fortified cooking oil can supply 47% of RNI for an adult woman and 10-35% of RNI for young children.
- Fortifying 87% of the edible oil supply which purchased by 55% of the population suggests coverage of about 48% with an average 47% of RNI for women and 10-35% for children.

We estimate these benefits can be achieved within the short to medium term with annualized 10-year costs of $9.46 million, about $0.02 per beneficiary per year.

5. Assessment of Sugar as a Fortification Vehicle

Sugar fortification with vitamin A has been implemented in Latin America for several decades and more recently has been implemented in Zambia, Malawi and Nigeria. National evaluations in Latin America have confirmed the effectiveness of sugar fortification as a single intervention and also in tandem with vitamin A supplementation of 6-59 month old children.

5.1 Market and Consumption Overview

More than 400 thousand MT of sugar are consumed in Ethiopia annually. About three-quarters is produced by several large plants operated by the Ethiopian Sugar Development Agency. The remainder is imported. Data from ESDA and CSA as well as FAO Food Balance Sheets indicate average per capita sugar consumption of about 5.5 kg/yr or about 15 grams per day. If fortified at 20 ppm vitamin A, with an average 60% retention (similar to that found in Latin America) fortification could provide an average female consumer with an added 181 micrograms of vitamin A daily – more than one-third of daily needs. Moreover, the domestic industry is centrally managed by ESDA with production via a handful of large sugar refineries. While this suggests feasibility from a technical perspective, the situation is complicated by a number of factors:

- 5% of sugar production is used in ethanol production and an unknown amount of sugar is used in processing soft drinks and other value added foods where much of the vitamin A, though not all, is lost (in cola drinks all added vitamin A is lost). Therefore, average consumption of table sugar in households may be considerably less than 5.5 kg/yr.

- Data from HICE 2000 suggests 20% of households purchase sugar, 16 million consumers. However, flour reaches one-third more families and oil more than 2.5 times wider coverage compared to sugar.

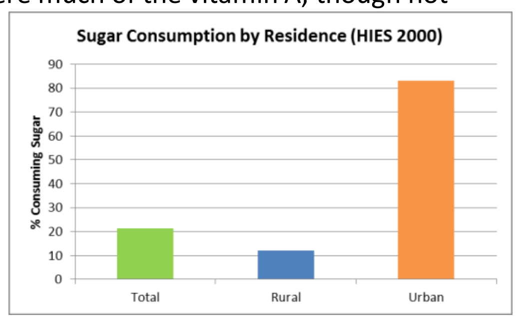

Figure 13 Sugar consumption by residence (HICE, 2000).

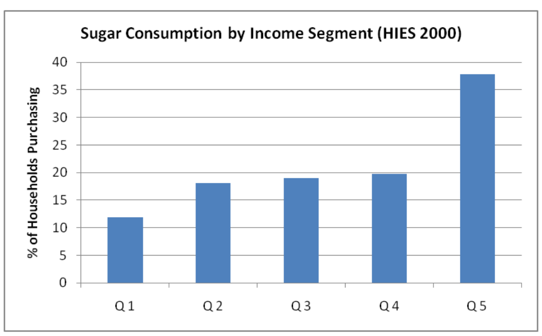

Figure 14 Sugar consumption by income segment (HICE 2000).

- Sugar coverage in rural areas is only about 12%. The coverage of edible oil and flour is about 50% higher.[46] Sugar consumption amongst the lowest quintiles is 12%, compared with 18% for edible oils and 21% for wheat flour.[47]

- Average consumption may be deceiving. Unlike oil and flour where very high consumption is limited by organoleptic issues, some consumers may consume very high levels of sugar. This has implications for both our estimates of coverage as well as consumer safety.

- On a global basis, capacity to fortify an imported supply is very limited. Until and unless ESDA's plans for national sugar self-sufficiency are realized, suppliers for imported sugar would be

[46] Fiedler, analysis of HIES 2000
[47] Ibid

limited to Zambia (which exports about 100,000 MT/yr) or the large sugar producers of Central America. This may disrupt trade and food security arrangements.

Consequently there are questions about feasibility, effectiveness and safety. In addition, fortification of sugar with vitamin A is the most expensive option amongst oil, flour and sugar.

5.2 Industry Overview and Requirements

The sugar processing industry in Ethiopia is highly centralized because there are only five large scale sugar refineries in the country. All five of the sugar refineries produce an estimated 300,000 MT of sugar annually. All of the sugar refineries are state owned within the Ethiopian Sugar Development Agency (ESDA).

State of the Industry

The state of the sugar processing industry in Ethiopia was discussed with Mr. Shimelis Kebede, Director, Project Development & Monitoring, ESDA. The following major issues were discussed:

- The current annual supply of 300,000 MT of sugar in the country is grown on 30,000 hectares. However, this is insufficient to meet the domestic demand for sugar.
- Ethiopia currently imports through the ESDA (who controls imports) an additional 100,000 to 150,000 MT of sugar per year to fill the domestic production short-fall.
- The ESDA has developed and implemented a new five year plan to increase the planned sugar production in the country to 1.3 million MT per year. The additional domestic production of sugar will be produced by the installation of expanded capacity in the existing mills and the construction of three new mills.
- A new private sector sugar mill, Al Habeesh Sugar, is currently being built in the country. The owners of this plant are based in Pakistan.
- The main markets for sugar in the country are: domestic consumption; baking and confectionary foods; and soft drinks. In the case of soft drinks, the multinational companies have import licenses for sugar from ESDA.
- 5% of the local sugar crop is used for ethanol production (annual estimate of 8 million litres per year) and used in gasoline for cars.
- The current estimated per capita sugar consumption is 5-6kg per person per year. The distribution of sugar is tightly controlled by ESDA and distributed mainly though consumer cooperatives in the country. Sugar is distributed in 100kg bags (woven polypropylene) and sold in the markets. Typically sugar is not pre-packaged in small bags (i.e. 2 -5 kg).
- The retail price for sugar is currently 13.5 birr/kg.

Attitude toward Fortification

There is little knowledge about the fortification of sugar within Ethiopia, although the personnel at ESDA were aware of sugar fortification taking place in Zambia. The staffs at EDSA were aware that the Government of Ethiopia has introduced a NNS and NNP where food fortification is included as one of the actions. However, they were not aware that sugar could be included as a potential food vehicle for vitamin A fortification in the NNP. Mr. Shimelis Kebede, raised the following issues about sugar fortification:

- The low level of awareness of the importance of food fortification in general, and sugar in particular, at the highest levels of the government.
- The low level of awareness of the importance of sugar fortification within the ESDA staff members.

- The low level of technical expertise within the industry to implement sugar fortification at the factory level.

All these issues raised by the ESDA representative executive will need to be addressed by both the Government of Ethiopia and development partners.

Segmentation by Size/Capacity

Based on discussions with ESDA staff, the actual sugar mill and refinery utilization rates are considered to be constrained by the current sugar cane supply. The following table shows the classification of the sugar processing sector based on the information supplied by ESDA.

Table 18 Sugar Mill Classification

Sugar Mill and Refinery Rated Capacity MT/yr	Number Of sugar Mills and refineries	Estimated sugar production MT /yr	Estimated market Share %
70,000 – 100,000	5	300,000	67
Imports		150,000	33
Total	5	450,000 MT	100

Sugar Fortification Requirements

For any country embarking on a national sugar fortification program, there are requirements that need to be in place for the successful implementation of the program. Based on the information in the table above and using the experience of other countries that have or are implementing sugar fortification, there are two parts for the equipment and system required for sugar fortification.

The first requirement is the construction of a sugar premix production facility. This facility is required to be able to supply a vitamin A fortified sugar premix, which can then be added at the individual sugar factories. Typically, this sugar premix plant is installed at an existing sugar mill and refinery, rather than a free standing production facility. The system consists of the following:

- A vitamin concentrate, oil, sugar and anti-oxidant blending system to produce the sugar premix concentrate.
- A bagging system usually in 50 kg bags to supply the other factories.

Typical costs for these types of system are $350,000. This cost covers the installation of a building and the equipment to produce the premix.

The second requirement for the system, which is designed to be used in the sugar factories, is a vibratory feeder which can be controlled and interlocked with the sugar production line to accurately add the premix to the sugar flow stream. Typical costs for these types of systems are $10,000 because the vibratory feeders have to be imported from Europe or North America.

Premix

The type of premix to be used in a national sugar fortification program will be predicated upon two main factors. The first is the degree and types of micronutrient malnutrition problems that the MOH considers to be a public health problem. The current NNP for Ethiopia includes a statement that food fortification is part of the national strategy and the action plan, but it does not specify what the level of micronutrient malnutrition is in the country.

The WHO and other international agencies have determined that there are five main micronutrient deficiencies that affect public health in many countries at the global level. Based on this, the options for sugar fortification in Ethiopia can cover vitamin A. It should be noted that many countries in Central America and Zambia use vitamin A in sugar fortification.

Premix Options

Based on the experience of other countries with the implementation of sugar fortification programs, the option for Ethiopia can be considered as follows:

Table 19 Sugar Fortification Premix Option

Premix Composition	Active Ingredient
Vitamin A as Retinol Palmitate	60 IU
Addition Rate g/MT sugar	1000
Cost of premix $ per kg	$11.40
Fortification cost $ per MT sugar	$11.40

Premix Standards and Supply

There are no standards for premix to be used in sugar fortification, which means that there is potential for problems and confusion with competing ingredient companies in supplying the market in Ethiopia. Because there is a centralized sugar processing system in Ethiopia, this will allow the ESDA and the sugar industry to take advantage of economies of scale. In addition, the country can take advantage of the GAIN premix facility to ensure quality standards for premix that can be met at a fair market price.

ES Sugar Standards

There is an in-house ESDA sugar standard for sugar, but no current ES sugar standard. In the past when Ethiopia had a sugar surplus available for export, the sugar industry would use the importing country standards to meet their requirements. Fortified sugar may be produced and sold in Ethiopia provided that the containers are labelled as containing the added micronutrient and level.

5.3 Summary of 10 Year Sugar Fortification Costs

Table 20 Sugar Fortification Implementation 10 Year Summary

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Production											
Capital& Start-Up	$440	$0	$0	$0	$0	$0	$0	$0	$0	$0	$440
Recurring including premix	$0	$4,777	$4,777	$4,777	$4,777	$4,777	$4,777	$4,777	$4,777	$4,777	$42,993
Regulatory											
Start up	$89	$0	$0	$0	$0	$0	$0	$0	$0	$0	$89
Mill inspection	$0	$8	$8	$8	$8	$8	$8	$8	$8	$8	$72
Subtotal	$529	$4,785	$4,785	$4,785	$4,785	$4,785	$4,785	$4,785	$4,785	$4,785	$43,594
Imports @ $12/MT	$0	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$16,200
Total	$529	$6,585	$6,585	$6,585	$6,585	$6,585	$6,585	$6,585	$6,585	$6,585	$59,794

In summary, sugar fortification is technically feasible. However, there are a number of questions about the relative advantage of sugar as a vehicle to delivery vitamin compared to oil and flour. These include:

- Possibly low individual consumption after accounting for sugar used in soft drinks and food industry.
- Limited reach into the population and coverage of the at-risk, based on HICE.
- Relatively high cost compared to alternative vehicles – particularly oil but also flour.
- Unknown political and institutional barriers. It is reported that sugar fortification was considered and ultimately rejected by the government during the past decade.

Therefore, prior to making a decision to move forward with sugar fortification, we suggest additional consideration. Ultimately, additional data is needed, either from a reanalysis of HICE 2005 or a special survey, to clarify whether distribution and consumption promises to be a safe and effective intervention. We believe sugar should be considered as a complementary and additive intervention to oil and flour. It should be considered only if further data suggests that:

- A significant additional at-risk population, not consuming either oil or flour, can be covered with sugar.
- Added vitamin A provided by oil (as a primary vehicle) and flour (as a secondary vehicle) is not sufficient.
- Other issues of feasibility include ESDA's modernization and expansion plan and the feasibility of relying on fortified sugar imports.

Our preliminary analysis suggests that with vitamin A fortification of oil along with flour as a potential additional vitamin A vehicle, there may be no significant benefit to also fortifying sugar with vitamin A. Additional data may clarify these points.

6. Non Traditional Fortification Approaches

Traditional fortification of industrially processed foods is a classic approach with proven technologies, commercial experience, market sustainability and public health effectiveness and safety. However, while the situation may change in the coming decades, currently the reach of classic fortification approaches may be limited to about half the population for edible oil and 20-30% of the population for sugar and flour. While the reach of these traditional fortification approaches suggests a positive public health impact, non-traditional fortification approaches could be explored to address the widespread micronutrient deficiencies in populations that do not regularly purchase industrially processed foods that are potential fortification vehicles.

The reach of traditional food fortification is limited by the distribution infrastructure for processed commercial foods, reaching perhaps 50-60% of the population for oil and less for flour. Likewise, primary health services are also less accessible to remote rural families – as recently as 2005, coverage of urban children with vitamin A capsules was about 40% higher than rural children.[48] However, recent developments bring opportunities to reach this most at-risk rural segment. Developing these non-traditional approaches will require either basic and/or operational research to define scale, cost and effectiveness.

6.1 Small Scale Milling

One of the main features of the manufacturing sector in Ethiopia is the existence of a countrywide small scale manufacturing sector. The Central Statistics Agency of Ethiopia published a study of this sector called "Small Scale Manufacturing Industries Survey"[49] in 2010 covering data collected in 2007-2008. As in most countries in Africa, the small scale manufacturing sector is an important source of processed and semi-processed foods in the country. This sector is characterized by the following components:

- Widespread across the country
- Found in all geographical settings, rural, peri-urban and urban
- Mostly in the informal sector and unregistered
- Family owned businesses with "unpaid" family members as employees
- Little knowledge of good manufacturing and business practices
- A large proportion of the population use small scale mills to process cereals into cereal flours. In many cases the total output of cereal flours from small mills exceeds the available output from large scale mills.

There were 43,338 small scale manufacturing establishments in the Ethiopian fiscal year (E.F.Y) 2000 (2007/08). The largest in number, 23 thousand, were grain mills as seen in table 21. It provides the largest number of jobs, 70,023 (50.4%), however only 53.5% were permanent jobs. The small scale milling industry generated an estimated value added contribution to the economy of $35.6 million. The small scale grain milling enterprises use small stone mills or hammer mills to grind all types of grain including teff, sorghum, maize, millet and wheat. The services are provided on a toll milling basis i.e. a fee for service paid either in cash or in kind i.e. a portion of the grain provided by the customer.

Table 21 Small Scale Manufacturing

Type of Industry	Number	%
Grain Milling	23,000	53.2
Furniture	8,600	19.8
Metal	4,400	10.1
Other	7,338	16.9
Total	43,338	100

[48] EDHS, 2005
[49] Report on Small Scale Manufacturing Industries Survey, Central Statistical Agency, Addis Ababa, April 2010

One of the biggest challenges for flour fortification in Africa is the implementation of fortification at the small scale milling sector because of the number of mills in a country, the type of milling service provided (toll milling), and the geographical spread of the mills into the remotest areas in a country. Small scale fortification has been shown to be technically feasible but requires the intervention of a NGO to be able to implement it and control the process to ensure that it is carried out properly. Notable examples of small scale fortification projects include Malawi (World Vision), Tanzania (World Vision and UNICEF) and Nepal (MI and Project Healthy Children). All of these have demonstrated technical feasibility at the mill level but the biggest challenges are the programming and implementation level including the high cost of premix distribution, equipment maintenance, quality control and social marketing. In addition, the added cost of the premix is high compared to the toll milling (conversion) charge. The issues of feasibility and cost of scale up along with long term sustainability remain some of the biggest obstacles to implementation on a large scale within a country.

One approach that could be considered for the small scale milling sector would be the inclusion of small scale fortification as part of a NGO's existing development program or project, so that it gets included as part of other nutritional interventions such as supplementation, dietary diversification, and food security. In this way the additional programming costs can be spread out over the total cost of the NGO's program. In the context of national food fortification for Ethiopia, these challenges will not lead to a rapid introduction of small scale fortification in the country.

6.2 Multiple Micronutrient Powders (MMPs/Sprinkles)

MMPs, often known as "sprinkles," are sachets containing 5 to 15 or more micronutrients. These single and multiple serving vitamin sachets essentially enable "in-home fortification" of porridges, complementary foods and family meals during preparation in the home. MMPs have been extensively evaluated for efficacy and effectiveness. Thousands of children have been studied in more than 20 countries, finding anaemia "cure rates" ranging up to 90%, as well as some impacts on linear growth. MMPs can address the "window of opportunity" to improve nutrition in children 6-24 months. They are highly accepted by children and mothers, and they are easily delivered with a paraprofessional and volunteer network.

The Health Extension Programme (HEP), including the extensive Health Extension Worker (HEW) network, Community Health Days (CHD), and other outreach efforts, represent new and expanding channels and infrastructure reaching remote areas and malnutrition "hotspots." When the HEP is fully in place there will be one health post in every rural kebele, two HEWs at every health post and a trained volunteer for every 50 households.[50] These programmes offer opportunities to extend the reach of nutritional supplements, fortified products and related education. In fact, nutrition is one component of the multi-module training program for HEWs. However, nutrition interventions in the HEP portfolio are mainly therapeutic - targeting children with severe acute malnutrition. But in Ethiopia, the high prevalence of micronutrient deficiencies suggest that virtually all children are at risk – an environment requiring a population-wide preventative approach such as mass administration of vitamin A capsules, de-worming pills or vaccinations.

The current HEP offers numerous opportunities to "piggy-back" programming of MMPs onto a range of routine services as well as mass campaigns delivering vaccinations, or vitamin A/mebandazole. An analysis of EOS/EEOS and CHDs noted cost efficiencies in "piggy-backing" additional services and that

[50] John L Fiedler and Tesfaye Chuko, The cost of Child Health Days: a case study of Ethiopia's Enhanced Outreach Strategy (EOS) Health Policy and Planning 2008;23:222–233

“the provision of additional different types of services results in reductions in the average cost of the services that were already being provided.” [51] Since the infrastructure for training, mobilization and delivery is substantially in place, the incremental cost of added products and services is comparatively low. Procurement, logistics, training and management can be theoretically integrated into pre-existing modules for HEWs and cascaded to the cadre of volunteers. However, educational messages, delivery protocols and compliance issues for delivery of MMP interventions would need thorough testing and evaluation.

Unlike these other universal preventive interventions which can be administered bi-annually (vitamin A or de-worming) or even once in-a-life-time (vaccines), most nutrition interventions must be consumed daily or at least weekly to be effective. Therefore, while HEP delivery is feasible and appropriate human capacity and supply management infrastructure may be largely in place, nutrition interventions still represent a special challenge and require some large scale operational research including:

- While six monthly VAC campaigns offer a convenient existing infrastructure of delivery, what are the compliance implications of delivering MMPs on a six monthly basis?

- What is the capacity of HEWs to add MMPs as an additional product and service to their already full portfolio of health services?

- Can capacity be built to sustainably reach children with MMPs in shorter intervals as part of home visits?

- What is the most cost effective protocol for MMPs in the Ethiopian environment? The literature offers evaluations of daily, weekly and flexible (90 sachets per six months) use of MMPs.

- What is the optimal and most cost-effective composition for Ethiopian children? MMP costs range from USD 2-3 cents/sachet for 5 micronutrients to USD 5-6 cents/sachet for 15 micronutrients.

Once these operational questions are clarified, delivery of MMPs via mass campaigns may be the least expensive approach. Still, the cost of MMPs is relatively high compared to vitamin A or mebandazole, where one inexpensive capsule offers six months of protection. At $0.04/per sachet the MMP cost for the various delivery protocols ranges from about $2 per child for weekly (52 sachets/yr) to about $12 per child for daily (300 sachets/yr) consumption. This cost per child is relatively high compared to current investments in CHDs. Fiedler et al found the full costs of vitamin A, de-worming, measles vaccine, nutrition screening and IEC including procurement, logistics, training and delivery was $0.90-1.30 per child – $1.80-2.60 per year. [52] Even the least expensive weekly approach to MMPs would more than double the per child cost.

On a national basis, costs will vary depending on the target age group. Assuming a midrange MMP cost of $0.04 per sachet and incremental annual program costs of $0.25 per child, the cost of the various delivery options, shown in table 28 below, ranges from $8 million per year to cover 3.48 million 6-24

[51] Ibid
[52] Ibid

month olds on the least expensive weekly basis to $128 million per year to cover all 6-59 month olds with 300 sachets annually.

Table 22 Cost of Three "Universal" Delivery Scenarios: MMPs @ $0.04 each and Delivery Costs @ $0.50/child per year				
Age	**Estimated # Children**	**Weekly 52 Sachets per year : $2.08**	**Flexible: 90 Sachets for 6 month: $7.20**	**Daily: 300 Sachets Per Year: $12.00**
6-24 months	3,480,000	$8,108,400	$25,926,000	$42,630,000
6-36 months	5,800,000	$13,514,000	$43,210,000	$71,050,000
6-59 months	10,440,000	$24,325,200	$77,778,000	$127,890,000

Operational research may also clarify strategic targeting approaches that could significantly increase efficiency and lower cost of these programs. Some options include:

- Targeting by Age: Targeting only the youngest 6-24 month children makes sense from an epidemiological point of view since this cohort is at highest risk of deteriorating nutrition status as well as mortality. This is considered feasible within the vitamin A campaign context since children of younger age groups already receive slightly different interventions: blue vs orange vitamin A capsule, different mebandazole doses, or younger children get vaccines and older ones do not. The cost savings of targeting by age are illustrated in table 22 above.

- Targeting by Nutrition Status: In districts where growth monitoring is operational, MMPs can be targeted by the individual child's nutrition status. For example, distribution might be limited to children less than minus 2 SD for any given growth indicator. Based on DHS statistics for stunting, wasting and underweight, this approach could cut over-all costs by 10-50% depending on the indicator selected. Success of targeting depends on capacity to continuously monitor. However, with the threshold for action at < 2 SD, this cannot be considered a full "preventative measure."

Table 23 % of Children Below 2 SD for Key Growth & Nutrition Indicators[53]

Indicator	% < 2 SD
WHZ	10.50%
WAZ	38.40%
HAZ	46.50%

- Targeting by District or Kebele: Finally, within the same kebele and within the same campaign environment, it may not be feasible to provide supplements for some children and withhold it from others. Therefore, targeting would have to be by high risk kebele or districts rather than by individual at-risk children. Based on aggregate health, mortality, nutrition, economic or other welfare data, higher risk districts or kebeles could be identified for blanket universal coverage or coverage by age. This is considered easier to implement than segmenting children for different treatments during CHDs.

For the short term we recommend three to five large scale pilot MMP interventions delivered in conjunction with CHDs and HEW activities on at least a district-wide scale to test optional delivery strategies, MMP protocols, client compliance and effectiveness. Each should test a different approach to targeting and distribution for possible scale-up. We believe these pilots should target maize eating areas because these are most at-risk of micronutrient malnutrition for a number of reasons: they tend to be poor, maize itself is deficient in a number of nutrients relative to other staple cereals, and because wheat-eating areas will have some access to fortified flour. Based on these pilots, recommendations for targeting and cost-effective scale-up strategies can be developed. Presuming 3 year pilots with 6 distributions targeting an average of 10-12 thousand children per district, MMP costs will run about

[53] EDHS, 2005

$225,000. While proposals remain to be developed, full implementation and evaluation along with recommendations and policy development will require $1 million or more.

6.3 Blended Fortified Foods and Complementary Foods

In the past Ethiopia has been a major beneficiary of international support for fortified blended foods from donors which have been imported.

State of the Industry – Fortified Blended Foods

In the past several years there has been the development and establishment of food companies to produce fortified blended foods. With the support of WFP Ethiopia and other international partners, a local complementary foods industry in Ethiopia has been developed.

The following key points cover the complementary foods sector of the food industry in Ethiopia:

- WFP Ethiopia supported the development of corn soy blend (CSB) manufacturing in the country. Today there are seven CSB manufacturers, mostly in and around Addis Ababa.

- The total requirement for locally produced CSB for WFP is 60,000 MT annually which represents about 60-70% of the rated capacity of the seven manufacturers. In 2010 WFP planned to procure 100% of its needs within Ethiopia. The majority of the production is shipped to Southern Sudan.

- Of the seven manufacturers of CSB registered with WFP, there are two major manufacturers. The first is Faffa Food Share Company and the second is Hilina Enriched Foods.

- Faffa Foods was originally set up by the Ethiopian government as a public sector company. The company is now privately owned. The equipment is produced by Buhler, Uzwil, Switzerland. It has a capacity of 100 MT of CSB per day, mainly under the Famix name for WFP. In addition it can produce 6 MT of wheat flour per day (using hammermill technology). It imports micronutrient premix from European suppliers such as DSM, Fortitech, Muhlenchemie. The premix is subject to 25% import duties and VAT.

- The company is accredited (by SABS) for HACCP under ISO 22000:2005

- Faffa Foods is trying to introduce fortified blended foods as a commercial product particularly for the urban areas. However, traditional baby food, called *mitten,* in Ethiopia is produced in the home by mothers of infants.

- WFP represents more than 50% of Faffa Food's sales.

- Hilina Enriched Foods has been established as a joint venture between Nutriset and local Ethiopian business interests. The company produces RUTFs under the "Plumpynut" brand name and is licensed by Nutriset to produce their product line for distribution in East Africa. The capacity of the plant is 1,200 MT per month. In addition they have a sister company called Healthcare Foods producing CSB for WFP. Other products include soybean oil crushing and refining producing 5 MT of oil per day and a salt iodization plant set up after the Eritrean war closed Ethiopia's access to iodized salt. The main business strategy of the company is to focus on exports where the Ethiopian tax system favours exports over local distribution.

- The challenges affecting the complementary food industry in Ethiopia include the following: Lack of consumer awareness of the benefits of fortified blended foods; the price of the products targeted to babies compared to the home prepared foods; distribution problems in Ethiopia due to the rural/urban population split (high rural population); and taxes and VAT applied on foods for local consumption.

In summary, based on industrial development to primarily meet supply needs of aid agencies there is substantial capacity for commercial/industrial fortification of complementary foods in Ethiopia. However, there are few market incentives to expand this capacity to include a domestic market. We recommend that:

- International agencies and partners provide support to the industry to lobby the Government of Ethiopia for a more equitable tax regime for the production, distribution and sale of locally produced foods by the elimination of VAT and other import duties for raw materials, particularly micronutrient premix.

- International agencies such as the World Bank provide technical support to the industry for raising consumer awareness of the benefits of locally produced complementary foods.

7. Conclusions

Food fortification can make a significant contribution towards achieving the objectives of the NNP.

7.1 Selection of Food Fortification Vehicles:

Fortification of flour, oil and sugar are feasible strategies to contribute to the reduction of micronutrient deficiencies in Ethiopia. Flour is a vehicle for multiple micronutrients including vitamin A, whilst oil and sugar are limited to fortification with vitamin A and possibly other oily vitamins. We provisionally recommend the following:

- Wheat Flour: Fortification of flour with at least a "core package" of iron and folic acid. Zinc, thiamin, riboflavin, niacin and vitamins B_{12} might also be considered. At this time we do not recommend addition of vitamin A to flour since coverage of industrially produced flour is relatively limited, vitamin A is expensive to add in flour and other vehicles are available.

- Edible Oil: Fortification of oil with vitamins A (and D) offers the least cost, lowest technology and widest coverage option for providing significant population-wide nutrition protection.

- Sugar: Sugar fortification is not recommended at this time given the high cost, limited coverage and less expensive alternatives in oil and flour which can deliver multiple micronutrients.

Table 24 below summarizes the key criteria and assumptions in making the above conclusions. Coverage of recommended vehicles is not perfect, the projected coverage population promises to have significant public health impact providing vitamin A protection to 38 million people and enhanced iron and folic acid nutrition to 12 million Ethiopians. Based on our analysis this coverage is affordable, feasible and sustainable and comes with few opportunity costs to the NNP. The fortification of flour and oil can make a significant contribution to the overall effort to reduce micronutrient deficiencies with a budget of about $3 million annually. This is a fraction of the NNP budget – and will be largely financed by the market rather than government.

Table 24 Summary Cost and Impact for Estimated Feasible Fortification Coverage

	% RNI	Feasible Industrial Coverage		Estimated Cost	Cost Per Person
		% Consumers	Million Consumers	USD Million/Yr	$/yr
Flour	26% Iron; 64% Folic Acid	28%	22	$2.28	$0.10
Oil	~ 37% Vit A	48%	38	$0.95	$0.02
Sugar	~ 36% Vit A	20%	16	$5.98	$ 0.38

A major question remaining to be clarified is the optimal mix of fortification vehicles for vitamin A. All three foods considered are potential vehicles for vitamin A. Since oil offers the lowest cost and widest coverage it is not clear whether there is any advantage to including sugar fortification or adding vitamin A to the flour fortification mix. Question to consider include:

- Are the potential distribution patterns for vitamin A fortified oil, flour and sugar additive or duplicative? In other words, will fortification of sugar or flour with vitamin A expand protection from the 48% projected for oil to possibly 60-70% of the population or will these additional vehicles essentially cover the same consumers leaving coverage at around 50%?

- Will fortified oil on its own deliver enough vitamin A to consumers to make a difference? Projections of RNI delivered suggest this is the case. However, if the “dose” of vitamin A is not sufficient there are there several approaches with very different costs:
    - Doubling the vitamin A level in oil to address this shortfall is estimated to cost less than $900 thousand annually.
    - Adding vitamin A compounds to the flour premix may cost more than $2 million annually.
    - Sugar fortification may cost nearly $6 million annually. More cost for about half narrower coverage.

Additional consumption research may help to more precisely define whether fortification of flour or sugar offers significantly expanded coverage or increased protection. However, based on currently available data we believe the recommendations above provide best balance of cost and effectiveness.

7.2 Projected Cost-Effectiveness of Flour and Oil Fortification

Estimated coverage and effectiveness yield a projection for the magnitude of improvements (See Annex 1 for a full discussion of this analysis and methodology). Our feasibility and market analysis provides the basis for our coverage estimate. Quantifying the effectiveness of national fortification is elusive. Based on the evidence from international program evaluations and the literature, along with our calculation that fortified oil and flour will provide an added 25% to more than 100% of RNI on a daily basis, we venture to quantify effectiveness in table 26 below.

Table 25 Projecting Reduction in Prevalence of Micronutrient Deficiencies and Associated Losses for Individual Nutrition Indicators

	Projected Coverage	Suggesting Effectiveness	Reasoning for Estimate of Effectiveness	Calculated Improvement
Perinatal Mortality Anaemia in Pregnancy	28%	10%	Women’s needs rise to more than 50 mg iron/d. Adding 8-10 mg iron daily promises only modest anaemia improvement.	2.8%
IDA Children 6 months to 15 years	28%	20%	While the youngest children will benefit less, children 5-15 yrs old consume sufficient quantities for impact like adults.[54]	5.6%
Folic Acid Related Birth Defects	28%	60%	Midpoint in evidence of NTD reductions from US, Canada, Chile and South Africa.[55]	16.8%
IDA in Adults in Manual Labour	28%	30%	DAR corrected anaemia prevalence by 61% to measure IDA only. Provision of added iron at WHO Recommended levels should reduce iron deficiency to levels found in industrial countries. [56]	8.4%
Vitamin A Deficiency Children 6-59 months	50%	20%	Recent trial in Indonesia reduced VAD by ~30%.[57] We estimate2/3rd of this improvement due to lower levels of oil consumption in Ethiopia.	9.6%

Reduced prevalence of micronutrient deficiencies mean parallel reductions in losses found in the DAR. Using the Damage Assessment Report presented in Section 1.2 as a “baseline”, we project a scenario estimating the benefits as well as cost effectiveness of the proposed oil and flour fortification program. The improvements calculated above suggest more than 4600 saved lives annually. [58] We project that baseline losses ($454 million per year found in the DAR) will be reduced 8% - for a net annual “savings” of about $37 million in reduced burden of anaemia, folic acid and vitamin A deficiency.

[54] Scrimshaw et al, Venezuela Evaluation, MI, 1999
[55] Bell KN, Oakley GP. Update on prevention of folic acid-preventable spina bifida and anencephaly. Birth Defects Research Part A: Clin Mol Teratol. 2009 Jan;85(1):102–107.
[56] WHO/CDC Atlanta Meeting Report, 2008
[57] Bagriansky J., JFPR 9065: Enriching Lives of the Urban Poor Through Food Fortification Indonesia, Japan Fund for Poverty Reduction Report to Asian Development Bank 2009
[58] See Annex 1: Bagriansky, Economic Analysis of Flour and Oil Fortification in Ethiopia.

Table 26 Projected Reductions in Economic Losses from Flour and Oil Fortification at Scale			
	Status Quo Losses	Projected Improvement	Projected Benefit
	000,000		000,000
Perinatal Mortality	$30.97	2.8%	$ 0.87
IDA in Children 6 months to 15 years	$121.46	5.6%	$ 6.80
Folic Acid Related Birth Defects	$20.70	16.8%	$ 3.48
IDA in Women and Men Manual Labour	$114.01	8.4%	$ 9.58
Vitamin A Deficiency Children 6-59 months	$167.18	9.6%	$ 16.05
Overall	$454.32	**8.1%**	**$ 36.78**

Ten Year Projected Budgets for industry fortification and government regulation, along with an additional $4 million estimated for management and social marketing, totals about $36 million. However, this includes > 25% in duties, VAT and customs service fees on imported premix, as well as 12.5% margin and in-kind costs of producers. Presuming these "soft costs" are substantially reduced, the more realistic incremental costs of the program are a bit less than $30 million over 10 years.

Since we have no scale-up schedule for fortification or its impact, we calculate only a very rough simple benefit cost ratio based on cost and impact at program scale (defined as 15% coverage of flour and 48% coverage of oil). Whether we take full costs or assume reduced duties and margins, the benefit cost ratio is very positive – a BCR of 10 for full costs and BCR of 13 for reduced government and industry charges. For every dollar invested in fortification, annual return will be $10-13 in reduced losses from iron deficiency anaemia, folic acid deficiency and vitamin A deficiency. For more details please see full analysis in Annex 1.

Table 27 Calculation of Benefit Cost Ratio at Scale for Oil and Flour Fortification
Based on 10 Year Estimated Start-Up and Recurring Costs for Government and Private Sector

	Full Costs with Duties, VAT and Millers Margin	Costs with Reduced Duties, VAT and Millers Margin (25%)
Annualized Cost(on 10 yr basis)	$3,622	$2,717
Annual Benefit	$36,773	$36,773
Benefit Cost Ratio	10	13

8. Recommendations and Next Steps

Fortified flour with multiple micronutrients and oil with vitamin A can be made widely available in the marketplace within 2 years and national scale achieved with 4-5 years. We venture the following rough conceptual timetable.

Table 28 Conceptual Timetable for Achievement of National Mandatory Fortification Program

	2011				2012				2013				2014				2015			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
NNP Policy Development	■	■	■																	
Standards Revision			■	■	■	■	■	■	■	■	■	■								
Capacity Building					■	■	■	■	■	■	■	■								
Initial Sub national Implementation							■	■	■	■	■	■								
National Mandatory Implementation													■	■	■	■	■	■	■	■

Achieving fortification at the national scale described in this report will require the following:

1. Further developing NNP capacity to mobilize stakeholders to initiate, support and coordinate.
2. Creating public and private stakeholder awareness and support for fortification.
3. Revising Ethiopian National Standards for flour and oil to include mandatory fortification.
4. Mobilizing sufficient financing for the development and initial implementation phases.

1. Further developing NNP capacity to mobilize stakeholders to initiate, support and coordinate.
The MOH should develop terms of reference and mandate a multi-sectoral public-private work group to fast-track an action plan for national food fortification. This includes defining the best organizational "nesting place" for this work-group within the NNP structure in order to maximize participation and effectiveness. Consideration should be given to defining appropriate channels for expanded private sector inputs within this organizational structure.

While the mandate may be long term, this NNP work group should be charged with a 4-6 month task of developing a 5-Year National Fortification Strategy and work plan to implement flour and oil fortification as well as potentially consider sugar and other fortification strategies. Further program development, capacity building and resource mobilization should be built specifically on this 5-Year Strategy. We believe work group participation should be focused on the concrete needs of the action plan and need not include all stakeholders, but focus on agencies with specific operational and monitoring responsibilities in the fortification program. This includes representatives of FMHCA, EHNRI and Ethiopian Quality and Standards Authority (EQSA) as well as appropriate agencies of MOTI and Ethiopian Customs Authority.

In parallel with strategy development, the NNP may request additional short-term research, study and technical assistance to address key issues including:

- Further data on consumption patterns based on re-analysis of 2005 HICE or a new rapid consumption survey (such as Micronutrient Initiatives Fortification Rapid Assessment Tool).

- Develop potential for milling and processing of fortified food aid in domestic industries. WFP and USAID might undertake a study to better understand how distribution of fortified flour as opposed to whole grain would impact their operations.
- Additional needs assessment to consider a range of institutional and technical capacity building development needed by public agencies to monitor and enforce fortification programs.
- Operational research to further develop non-traditional fortification approaches such as sprinkles and small scale fortification.

2. Creating public and private stakeholder awareness and support for fortification.

Government Stakeholders: Based on an approved 5-Year NNP Fortification Strategy, we recommend that NNP develop a series of communications and advocacy activities aiming to ensure government support for mandatory fortification. This report, including the feasibility analysis and the economic and human impact scenarios, may provide the basis for a coordinated communications program describing the benefits, costs and immediate opportunities for mandatory flour and oil fortification program. In some countries undertaking this type of analysis as a capacity and consensus-building process including a range of stakeholders and the media has proven effective.

Food Industry Stakeholders: NNP should open channels and develop programs to motivate private sector participation including a package of public marketing, company recognition and tax incentives to attract private food company investment and support. Examples from other countries involve consumer awareness raising campaigns, awarding logos and offering tax holidays on inputs to fortification. We recommend that flour, oil and other relevant food industries are officially defined as important components of the NNS and that the relevant industries be granted incentives similar to those provided to companies focusing on export markets including temporary or permanent exemption or partial relief from taxes and duties on inputs to fortification and on corporate taxes

International Stakeholders: We recommend that WFP and USAID NGOs distributing wheat or fortified oil make every effort to process and mill these commodities with domestic industries. This is in-line with donor regional procurement objectives, as well as an incentive to the private sector for developing fortification capacity.

3. Revising Ethiopian National Standards for flour and oil to include mandatory fortification.
Based on 5-Year NNP Strategy, the MOH along with the EQSA and other appropriate agencies should convene technical subcommittees, charged with reforming current product standards. These should initiate appropriate consultations to make official technical recommendations on fortification profiles for oil and flour including:

- Revise current voluntary flour fortification standard to include mandatory fortification. Fortification profile should include at least “Core Premix” (iron and folic acid) and consider appropriate elements of the “Restoration Premix” and “WHO Premix” described in this report.
- Revise current mandatory edible oil standards to include vitamin A at 20ppm based on public health need as well as sufficient flexibility to ensure no barriers to imported supplies.

We also suggest that NNP stakeholders initiate consultations to clarify the framework for mandating and enforcing food fortification.

- It is unclear whether each individual food vehicle will require distinct legislation and "gazetting" as seems to be the case with salt;[59] or whether a blanket omnibus food law can authorize MOH and Ethiopian Standards Authority to move forward to define vehicles for mandatory fortification on a purely "administrative" level once there is consensus from the health and technical agencies involved.

- Within the ongoing reorganization of government food control, consultants believe there may be overlapping and unclear demarcation of roles and responsibilities among MOH, MOST and MOTI agencies (FMHCA, EHNRI, EQSA and appropriate MOTI agencies). Insofar as this impacts regulation and enforcement of fortification as well as potential investments in capacity building, NNP should initiate a dialogue to clarify food control activities and determine the most coordinated, affordable, effective strategies to inspect, analyze and enforce.

4. Mobilizing sufficient financing for the development and initial implementation phases.
Currently there are limited budgets for implementation of a national fortification program. NNP should work with stakeholders to determine resources needs for:

- Short term continued policy and program development (2011)
- Operational Research (2011-2012)
- Policy and standards development (2011-12)
- Capacity Building (2012-2013)
- Program launch and initial operations (2013-2015)

Resource needs should be relatively modest until the capacity building and operations phases. Based on a 5-Year strategy, discussions should be opened with the Global Alliance for Improved Nutrition (GAIN) for support beginning in 2011. GAIN guidelines and our experience suggest support will be directed towards programs which:

- Launch within 1-2 years
- Achieve scale within 2-4 years
- Achieve sustained domestic financing with 3-5 years.

[59] (Currently the FMHCA Gazette document specifies mandatory salt legislation. Do all foods need to be specifically mentioned in Gazette, or is an administrative decision by the Minister of Health sufficient?).

References

Abraham, G., University Studies

Bagriansky J., JFPR 9065: Enriching lives of the urban poor through food fortification Indonesia, Japan Fund for Poverty Reduction Report to Asian Development Bank 2009

Bell KN, Oakley GP. Update on prevention of folic acid-preventable spina bifida and anencephaly. Birth Defects Research Part A: Clin Mol Teratol. 2009 Jan;85(1):102–107.

Demissie T., Ali A., Mekonnen Y., Haider J., and Umeta M., Demographic and Health-related Risk Factors of Subclinical Vitamin A Deficiency in Ethiopia, J HEALTH POPUL NUTR 2009 Oct;27(5):666-673

Dorosh, P., Food Prices, Consumption and Nutrition in Ethiopia: Implications of Recent Price Shocks, Institute of Medicine Workshop on Mitigating the Nutritional Impacts of the Global Food Crisis July 14, 2009

Dorosh, Calculated from Ethiopia Central Statistics Agency (CSA) Household Income, Consumption and Expenditure Survey (HICE) 2004/05 data

Dutch Report, Modjo, Malaysian Association

Ethiopia Demographics and Health Survey (EDHS), Central Statistical Agency, MEASURE DHS, ICF Macro, 2005

Ethiopia Food Balance Sheet, Food and Agricultural Organization (FAO), 2007

Ethiopian Health and Nutrition Research Institute (EHNRI), 2010

ES1052:2005 Wheat Flour – Specification, First edition 2005-03-12

Fiedler, Analysis of HICE 2000, Unpublished

Fiedler, JL and Chuko, T, The cost of Child Health Days: a case study of Ethiopia's Enhanced Outreach Strategy (EOS) Health Policy and Planning 2008;23:222–233

Health Sector Strategic Plan (HSDP-III) 2005/6 – 2009/10, Planning and Programming Department, Federal Ministry of Health, Ethiopia, 2005

Household Income, Consumption and Expenditure Survey (HICE), Central Statistical Agency, Ethiopia, 2000 and 2005

National Bank of Ethiopia Annual Report, 2009/10

National Guidelines for Control and Prevention of Micronutrient Deficiencies, Federal Ministry of Health Family Health Department, Ethiopia, June 2004

National Nutrition Strategy (NNS), Federal Ministry of Health, Ethiopia, January 2008

NutriView, Special Issue, Roche Vitamins Europe Ltd, Basel, Switzerland, 2003

Program Implementation Manual of National Nutrition Program (NNP) – I July 2008 – June 2013, Federal Ministry of Health, Addis Ababa, Ethiopia, April 12, 2008

Report on Small Scale Manufacturing Industries Survey, Central Statistical Agency, Addis Ababa, Ethiopia, April 2010

Reports from Reuters, Aug 12-16, 2010

Schmidt et al A Sub-National Hunger Index for Ethiopia, IFPRI Discussion Paper No. ESSP2 005 October 2009

Scrimshaw et al, Venezuela Evaluation, MI, 1999

WFP, UNICEF, Addis Ababa Government, Urban Food Security and Vulnerability in Selected Towns, Ethiopia 15/06/2010

Wijnands et al, Oilseeds Business Opportunities in Ethiopia, Wageningen University & Research Center, 2009

ANNEX 1:

An Economic Analysis of Flour and Oil Fortification in Ethiopia: Damage Assessment Report and Benefit Cost Calculation

I. Background

Rationale
Micronutrient malnutrition as a result of inadequate intake and absorption of vitamins and minerals is a serious public health problem threat in Ethiopia. "The enormous impact of micronutrient deficiency is largely invisible. Silently, micronutrient deficiencies trap people, communities and entire countries in a cycle of poor health, poor educability, poor productivity and consequent poverty, often without the victims ever knowing the cause.[60]" Because micronutrient deficiencies are a "hidden hunger," policy makers do not generally view these deficiencies in vitamins and minerals as impediments to economic growth. For selected indicators, this analysis makes a general estimate of the magnitude of human and economic consequences emerging from current prevalence rates of vitamin A, iron and folic acid deficiencies in Ethiopia.

Pathways to Economic Consequences
Micronutrient malnutrition erodes the foundation of economic growth - people's strength and energy, creative and analytical capacity, initiative and entrepreneurial drive. The scientific literature has developed "coefficients of loss," evidence-based estimates of health risks and functional deficits associated with iron and folic acid deficiency. This paper ventures to quantify the health and economic consequences of iron and folic acid deficiencies by applying this best evidence from the scientific and economic literature to national health, demographic, labour and economic environment in Ethiopia. Economic consequences of these micronutrient deficiencies are measured via three distinct pathways.

- Mortality and disability in children and consequent forgone income from future employment. This analysis is applied to iron, vitamin A and folic acid deficiencies.

- Deficits in children's cognitive development resulting in inferior school performance and depressed future productivity. This applies to iron deficiency anaemia only.

- Depressed productivity in working adults with anaemia. This applies to anaemia only.

Excess Health Care Costs related to Iron, Folic Acid and Vitamin A Deficiency
The Ghana VAST Survival Trials randomized placebo controlled trials involving 21,906 children, found vitamin A supplemented children had significantly lower clinic attendance and hospitalization (Rate Ratio of 0.88 for clinic attendances and 0.62 of hospital admissions).[61] However, this was not replicated and the evidence is mixed. In Ethiopia a recent study of impacts of vitamin A supplementation found a "significant reduction of the following morbidity incidences: fever ($p <0.01$), diarrhoea ($p < 0.05$), measles ($p < 0.05$) and conjunctivitis ($p < 0.01$). However, reduction in the proportion of cases of cough ($p > 0.5$) was not statistically significant."[62] Although "there is evidence that sufficient iron is essential for immune function… the evidence from experimental trials does not suggest that iron supplementation reduces morbidity." [63] While birth defects related to folic acid deficiency do result in expenses to the health care system or family, health care costs are difficult to estimate in Ethiopia. Therefore, given the mixed evidence, this analysis will not address the excess health and welfare expenses associated with micronutrient deficiencies.

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[60] Vitamin and Mineral Deficiency Global Progress Report, UNICEF, 2004
[61] Ghana VAST Study Team, Vitamin A Supplementation in Northern Ghana: Effects on Clinic Attendances, Hospital Admissions, and Child Mortality. The Lancet, 1993 342, 7-12
[62] J. Haidar, Tsegaye D et al Vitamin A Supplementation and Child Morbidity, East African Medical Journal Vol. 80 No. 1 January 2003
[63] Stoltzfus et al, Iron Deficiency Anaemia, in Global Burden of Disease, WHO 2004

II. General Methodology

The general algorithm for defining the economic losses is provided in the graphic below.

Table 1 Calculation for Projection of Economic Losses												
Risk Group Population	X	Prevalence of Condition	=	**Population with Deficit**	X	Economically Active Population	X	Average Annual Wage	x	Coefficient Of Loss	=	**Lost Productive Activity**
#		%		**#**		**# or %**		$/yr		% Or Rel Risk		**$/yr**

Monetizing the productive potential of individuals is based on a range of national demographic, labour and health statistics – as well as some key assumptions in cases where data is not available. These, along with coefficients of loss, will be reviewed in the individual sections that follow. Key national statistics are reviewed below.

Population of Risk Groups:

- Annual Births: 2,218,457 from the 2007 Census supplied by Central Statistics Authority of Ethiopia (CSA). This is substantially less than the birth rate reported by UNICEF for 2008.
- Population of children less than 15 years of age: 35.738 million. Calculated from total population reported by CSA in 2010 and adjusted by proportion of population in this age group found during the last full Census of 2007.
- Population of children less than 5 years of age: 11.593 million. Calculated from total population reported by CSA in 2010 adjusted by proportion of population in this age group found during the last full Census of 2007.
- Adult Population 15-55 years. 19.6 million women and 19 million men. Calculated from total population reported by CSA in 2010 adjusted by proportion of population in this age group found during the last full Census of 2007. UNICEF and US government report higher populations.

Table 2 Demographic Indicators

	Source	Used in Analysis
Total Population	2010 CSA	79,455,634
Females: 15-55 years	2010 CSA x 24.67% from 2007 Census	19,602,252
Males: 15-55 years	2010 CSA x 23.91% from 2007 Census	19,001,181
Adult Working Age		38,603,433
Children < 15 years	2010 CSA x 44.98% from 2007 Census	35,738,582
Children < 5 yrs	2010 CSA x 14.59% from 2007 Census	11,593,000
Elderly		5,113,618
Births	Births 2007 Census	2,218,457

Labour and Income Statistics

Average value of individual productivity is difficult to estimate for a country like Ethiopia, where many workers are not paid in cash or have a formal wage. We presume wage share or value of individual worker output at 40% of 2009 GDP of $32.044 billion.[64] The resulting $12.8 billion wage share is divided

[64] Wage share estimate based on Horton et al Copenhagen Consensus methodology

among the estimated number of economically active adults to arrive at $411.30 as the annual value of individual work output. Based on a study in the Global Economic Review, women are presumed to earn 95% of male rates.

Table 3 Calculation for Estimated Value of Individual Work Output	
Ethiopia GDP 2009 (Nominal)	$32,033,000,000
Wage Share GDP at	40%
Adjusted Wage Share GDP	$12,813,200,000
Annual Value from Economically Active Population	$411.30
Female vs Male Average Wage	95%[65]

Childhood productivity deficits are not felt until children enter the work force, as much as 15 years in the future – and earnings stretch out for another 40-50 years into the future. Therefore a Net Present Value (NPV) is calculated based on a discount rate of 3%, the rate recommended by the World Bank for projecting the value of social investments.[66] The social discount rate is not related to inflation, but merely reflects the subjective time preference for current consumption or savings over future consumption or savings.[67] Other key statistics include both years of economic activity and labour participation rates for males and females, as seen below.

Table 4 Key Labour Statistics Used in Analysis		
National Labour Part Rate	80.70%	Labour Survey 2007, CSA
Male Labour Participation Rate	86.80%	Labour Survey 2007, CSA
Female Labour Participation rate	74.90%	Labour Survey 2007, CSA
Work Life Women	42.0	Labour Survey 2007, CSA
Work Life Men	39.0	Labour Survey 2007, CSA
Work Life Average	40.5	Labour Survey 2007, CSA
Discount Rate	3%	World Bank, 1993

Caveats:

Converting indicators of malnutrition to economic activity and attaching a monetary value to that economic activity travels a long and winding road. Many factors beyond human potential determine earnings or work performance. Work place incentives, available technology and sense of opportunity all affect how increased potential translates into improved productivity and earnings.

Benefits of improved iron and folic acid nutrition extend beyond the workplace to a range of "voluntary" activities, including parenting and household activities, educational improvement, entrepreneurial pursuits and community participation. In a world where improvement in nutrition, health and subsequent productivity will emerge mainly from individual choices and behaviours, the significance of these "voluntary" activities cannot be overstated. Because of these limitations as well as in some cases the lack of up-to-date comprehensive national data, conclusions drawn in this analysis do not capture the full human, social and economic impact of anaemia and folic acid deficiency in Ethiopia. It paints only a general picture on an order of magnitude.

[65] Tilahun Temesgen Decomposing Gender Wage Differentials in Urban Ethiopia: Evidence from Linked Employer-Employee (LEE) Manufacturing Survey Data Global Economic Review, Volume 35, Issue 1 March 2006 , pages 43 - 66

[66] World Bank, Development Report 1993: Investing in Health. Oxford University Press World Bank. (1993)

[67] Ross et all, Calculating the Consequences of Micronutrient Malnutrition on Economic Productivity, Health and Survival, AED 2003

III. Human and Economic Impact of VAD

Risk of Death in Children Associated with Vitamin A Deficiency

A widely accepted meta-analysis by Beaton, Martorell and Aronson reviewing a number of vitamin A interventions and trials, concluded that children ages 6-59 months living in vitamin A deficient (VAD) areas receiving vitamin A supplements were, on average, 23% less likely to die than children not receiving supplements.[68] This has also been interpreted as increased risk of death with a Relative Risk (RR) of 1.75.[69]

Prevalence of Vitamin A Deficiency (VAD)

Inadequate intake of vitamin A compromises the immune system, leading to risks of common illnesses progressing to more severe forms, including death. The risks are especially high during periods of rapid physical growth, and consequent increases in nutritional requirements, as in pregnancy and early childhood. Over the past decade, surveys of vitamin A deficiency among children 6-59 months have often found prevalence of greater than 60%.[70] However, we will use a more recent survey of more than 23 thousand children who were examined for clinical signs, with blood samples collected from 1,200 for serum retinol analysis.[71] This study found prevalence of 37.7%, significantly lower than the rate found at the beginning of the decade. Nevertheless, this means more than 4 million children with vitamin A deficiency and a higher risk of death before their fifth birthday. The projection for the associated number of deaths is shown in the graphic below.

Table 5 Calculation for Projection of Economic Losses

Prevalence of Condition		Relative Risk Mortality		Population Attributable Risk		Annual Deaths of Children 6-59 months[72]		Annual Deaths attributed to VAD
37.7%	X	1.75	=	**22%**	X	176,214	=	38,842

- Based on 37.7% prevalence of vitamin A deficiency and the related 1.75 Relative Risk of mortality, a Population Attributable Risk (or Fraction) of 22% is calculated.

- Since vitamin A intervention will not be proposed for children less than 6 months of age, a 6-59 month mortality rate is estimated. While the < 5 mortality rate found in DHS is 132/1000, after accounting for neonatal mortality (< 1 month) and presuming % of post-neonatal deaths occur before the 6th month of life, a rate of 76/1000 is projected for the analysis (this defines a pool of child deaths of about 176 thousand as opposed to more than 300 thousand that is derived from the full under 5 year figure).

- Population Attributable Risk (PAR) 22% is applied to the number of child deaths in the 6-59 month range projecting 38,340 deaths annually attributable to VAD.

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[68] Beaton GH, Martorell R. Aronson KA et al. Effectiveness of vitamin A supplementation in the control of young child morbidity and mortality in developing countries. Toronto, Canada: University of Toronto, 1993.

[69] Ross et al, 1995

[70] West, KP, Extent of Vitamin A Deficiency among Preschool Children and Women, Proceedings of the XX International Vitamin A Consultative Group Meeting, , 2002 published in Journal of Nutrition Journal of Nutrition

[71] Demissie T, Ali A, Mekonen Y, Haider J, Umeta M., Magnitude and distribution of vitamin A deficiency in Ethiopia, Food Nutr Bull. 2010 Jun;31(2):234-41.

[72] Based on DHS 2005. 6-59 month morality rate based of 76/1000. Estimated at child mortality rate of (56/1000) plus 50% of post neonatal death (40/1000). Does not include neonatal (41/1000) plus 50% of post neonatal (40.1000).

Economic Losses Associated with Vitamin A Deficiency in Children 6-59 months

While the loss of life is an immeasurable value, in cold economic terms these deaths simply represent a lost future workforce. While gross potential lifetime earnings are projected at about $17 thousand per child, the discounted foregone wages, or lost productivity, is calculated at a mere $4,302. This is the impact of discounting earnings 53 years into the future, to account for an average of 12.5 years until the beginning of the earnings stream and another slow increment on annual income over another 40.5 working years. Further, we assume the current labour participation rate will continue and therefore attribute only 80.7% of the potential lifetime earnings. While the gross earnings losses total more than half a billion dollars, the Net Present Value discounted at 3% totals only $167 million. It should be recognized that this methodology which measures losses in hard currency clearly undervalues life.

Table 6 Calculation for Projection of Economic Losses

Attributed Deaths	X	Average Annual Wage	X	Labour Participation Rate	X	Average Years in Workforce	X	Discount Rate For NPV	-	Average Years Until Work Force Entry	=	**Lost Productive Activity**
38,842		$411.3		80.7%		40.5		3%		12.5		**$167.2 million/yr**

IV. Economic Impact of Iron Deficiency Anaemia in Children:

Productivity Losses Associated with Anaemia in Children:

A range of evidence links anaemia in children to future productivity deficits as adults. The evidence shows a direct link of anaemia-related cognitive development deficits with future earnings, as well as an indirect relationship mediated by educational opportunity:

- Anaemia and Cognitive Development: A review of observational studies concluded anaemic children score 0.5 to 1.5 standard deviations lower on intelligence tests.[73] A parallel body of literature documents the positive impact of iron intervention on cognitive scores, generally ranging from 0.5 to 1 SD.[74] The *Journal of Nutrition* found, "available evidence satisfies all of the conditions needed to conclude that iron deficiency causes cognitive deficits and developmental delays.[75]"

- Anaemia and School Performance: Substantial literature links anaemia and the ability of children to capitalize on educational opportunities. In addition to diminished cognitive ability, lack of energy undermines an anaemic child's ability to concentrate and participate in learning experiences. A recent study linked anaemia with significantly reduced school attendance.[76]

- Cognitive Scores and Future Earnings or Productivity: The association of childhood cognitive scores and productivity has been extensively documented. A recent review of the global literature by Galal et al linking cognitive test scores and earnings, concludes that a "0.25 SD increase in IQ… would lead to a 5%-10% increase in wages."[77]

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[73] Pollitt, Ernesto Relationship Between Undernutrition and Behavioral Development in Children, Journal of Nutrition, August, 1995 Volume 125 Number 8s

[74] Annex 7 provides descriptions and sources for a number of individual studies

[75] Haas, J. and Brownlie T., Iron Deficiency and Reduced Work Capacity: A Critical Review of the Research to Determine a Causal Relationship[1] *Journal of Nutrition.* 2001;131:676S-690S

[76] Bobonis et al, Anemia and School Participation, Journal of Human Resources, Feb 2006

[77] Osman M. Galal et al *Proceedings of the International Workshop on Articulating the Impact of Nutritional Deficits on the Education for All Agenda*, Food & Nutrition Bulletin Vol. 26, no. 2 (Supplement 2), June 2005

Based on a comprehensive review of the literature from child psychology, nutrition and economic science, Ross and Horton concluded that IDA related development deficits in less than 5 years old children can be associated a 4% drop in earnings.[78] The authors suggest that nutrition related improvements in cognitive measures persist into adolescence and calculate a correlation coefficient 0.62–0.65 from young children ages 6 to 8 with teenagers 17 years.[79] Therefore, the original 4% deficit is corrected by a factor of 0.62 to arrive at a 2.5% decrease in wages for children less than 15 years of age.[80] This 2.5% coefficient of loss, which recognizes the diminishing but still significant impact of anaemia on cognitive development and school performance of older children, is used in this analysis.[81]

Prevalence of Anaemia in Children:
The DHS 2005 found average anaemia prevalence of 53.5% among children less than 5 years of age. However, this average includes rates of more than 70% for children less than 2 years of age which decline through age 5. Since this analysis is applied to the cohort of children up to 15 years of age, we will apply the lower rate of rate of 38.2% found by the DHS in 5 year olds.

The causation of anaemia is multi-factorial and includes malaria, hookworm and HIV as well as lack of dietary iron and other micronutrient deficiencies (such as folic acid and vitamin A deficiencies). Globally, WHO estimates about 60% of anaemia is from iron deficiency.[82] A large 2005 study including more than 27,000 subjects in Ethiopia by Haidar et al found a remarkably similar proportion, with iron deficiency anaemia representing 61% of all anaemia.[83] Since only iron deficiency anaemia (IDA) will be responsive to nutrition interventions with added dietary iron such as supplements or fortified foods, therefore this analysis will only measure productivity losses from iron deficiency anaemia, estimated at about 24% of children under 15 years of age.

Calculating For Earnings Lost Due to Cognitive Deficits of Children
Based on the estimated 24% prevalence of IDA, more than 8 million children under 15 years of age suffer IDA. Modest 2.5%/yr productivity deficits estimated at $15 per child, accumulate with a significant impact on the national GDP. Gross earnings deficit over a 40.5 year work life totals more than $670 million. However, the NPV discounted at 3% projects with an average 7.5 year lag until entry into the workforce, totals about $121 million per year.

Table 7 Calculation of Net Present Value of Future Earnings Loss from Today's Anaemic Children

Children Iron Deficiency Anaemia	X	Average Annual Wage All Sectors	X	Labour Force Participation Rate	X	Coefficient of Loss	X	Discount for 40.5 years earnings after 7.5 year delay	=	Net Present Value of Losses
34,547,296		$411.30		81%		2.5%		3%		$121,458,290/yr

[78] Horton & Ross The Economics of Iron Deficiency Food Policy 28 (2003) 51–75
[79] Pollitt et al. 1995 and Jensen, 1980 in Horton & Ross The Economics of Iron Deficiency Food Policy 28 (2003) 51–75
[80] Horton & Ross The Economics of Iron Deficiency Food Policy 28 (2003) 51–75
[81] It should be noted that these deficits apply to all anemia and takes into account differences in severity of the anemia.
[82] Global Burden of Disease Update, WHO, 2004
[83] Jemal A Haidar Rebecca S Pobocik, Iron deficiency anemia is not a rare problem among women of reproductive ages in Ethiopia: a community based cross sectional study. *BMC Blood Disorders* 2009, **9**:7

V. Anaemia in Adult Workers

Global Evidence and Coefficient of Loss

Weakness, fatigue and lethargy brought on by anaemia result in measurable productivity deficits in the manual labour sector. This depressed work performance will be concentrated in Ethiopia's agriculture, mining, manufacturing and electricity sectors. A substantial literature shows the negative impact of anaemia on indicators of work performance. Ability to sustain moderate-to-heavy physical labour involving strength, endurance and aerobic capacity, is compromised 10-75%.[84] Studies in the real workplace support these laboratory findings. In Indonesia, the output of iron supplemented rubber tree tappers involved in heavy manual labour was 17% higher than non-supplemented co-workers.[85] There is also evidence that anaemia impairs less physically demanding work in "blue collar labour" or manufacturing jobs.[86] Three studies measuring productivity of supplemented female cotton mill workers in China, jute mill workers in Indonesia and cigarette rollers in Indonesia, found 5% improvement in work output.[87] [88] [89] Deficits of 5% for manual labour and 17% for heavy manual labour will be used in the analysis.

Prevalence of Anaemia in Working Adults:

In DHS 2005, anaemia prevalence among women was found to be 26.6%.[90] With no available data on anaemia in adult men, the model assumes prevalence of one-fourth the rate in women or 6.7%. As indicated earlier, although the data is thin, iron deficiency anaemia is presumed to be 61% of all anaemia based on WHO projections and findings of Haider et al. Therefore, the analysis will apply a 16% IDA rate for women and 4% for men.

Segmenting the Workforce to Include only Manual Labour

A strict interpretation of the evidence indicates that productivity deficits are applied only to those engaged in manual labour – where aerobic capacity, endurance and strength play a role in work performance. White collar administrative, intellectual and other employment requiring no physical exertion, is expressly excluded from the analysis. The analysis shown in the following table, based on data from CSA labour survey of 2007, suggests that 86% of male workers and 78% of female workers are engaged in manual labour – mainly agriculture and elementary occupations which "which mainly require the use of handheld tools and in some cases considerable physical effort."[91]

Table 8 Parameters and Assumptions for Defining Proportion of Population in Manual Labour

	CSA Survey 2007	Calculated % Total	Estimated Manual by Sector %	Projected % Manual Labour
Male Workforce				
1 Legislators, senior officials and managers	80.439	0.47%	0%	0%
2 Professionals	113.016	0.65%	0%	0%
3 Technicians and associate professionals	216.388	1.25%	0%	0%

[84] Celsing F., Blomstrand E., Werner B., Pihlstedt P., Ekblom B. Effects of iron deficiency on endurance and muscle enzyme activity in man. Med. Sci. Sports Exerc. 1986;18:156-161
[85] Basta S. S., Soekirman D. S., Karyadi D., Scrimshaw N. S. Iron deficiency anemia and the productivity of adult males in Indonesia. Am. J. Clin. Nutr. 1979;32:916-925
[86] Li R., Chen X., Yan H., Deurenberg P., Garby L., Hautvast J.G.A.J. Functional consequences of iron supplementation in iron-deficient female cotton workers in Beijing, China. Am. J. Clin. Nutr. 1994;59:908-913
[87] IBID
[88] Scholz B. D., Gross R., Schultink W., Sastroamidjojo S. Anaemia is associated with reduced productivity of women workers in even less-physically-strenuous tasks. Br. J. Nutr. 1997;77:47-57
[89] Unturo J., Gross R., Schultink W., Sediaoetama D. The association between BMI and haemoglobin and work productivity among Indonesian female factory workers. Eur. J. Clin. Nutr. 1998;52:131-135
[90] DHS 2005
[91] http://www.ilo.org/public/english/bureau/stat/isco/isco88/9.htm

4 Clerks	82.958	0.48%	0%	0%
5 Service workers and shop and market sales workers	674.489	3.90%	10%	0%
6 Skilled agricultural and fishery workers	9375.515	54.23%	95%	52%
7 Craft and related trade workers	693.633	4.01%	80%	3%
8 Plant and machine operators and assemblers	137.15	0.79%	80%	1%
9 Elementary occupations	5476.857	31.68%	95%	30%
X Not classifiable by occupation	437.734	2.53%	10%	0%
Total Male				86%
Female Workforce				
1 Legislators, senior officials and managers	20.227	0%	0%	0%
2 Professionals	45.652	0%	0%	0%
3 Technicians and associate professionals	94.309	1%	0%	0%
4 Clerks	99.441	1%	0%	0%
5 Service workers and shop and market sales workers	1427.804	9%	10%	1%
6 Skilled agricultural and fishery workers	3349.399	21%	95%	20%
7 Craft and related trade workers	1504.987	10%	80%	8%
8 Plant and machine operators and assemblers	41.775	0%	80%	0%
9 Elementary occupations**	7987.353	51%	95%	48%
X Not classifiable by occupation	1229.667	8%	10%	1%
Total Female				78%

Calculating For Earnings Lost Due to IDA in Adult Workers

This anaemia prevalence rate, together with economic activity rates of 75% for women and 87% for men, indicate that more than 3 million workers are currently suffering iron deficiency anaemia. However, a strict interpretation of the evidence indicates that productivity deficits only apply to those engaged in manual labour – where aerobic capacity, endurance and strength play a role in work performance. White collar administrative, intellectual and other employment requiring no physical exertion is expressly excluded from the analysis. The analysis shown the Annex suggests that 86% of male workers and 78% of female workers are engaged in manual labour in Ethiopia. Since there is no data to allow segmentation of heavy manual labour from light manual labour, the analysis will assume that 33% of manual labour is heavy in Ethiopia, where agriculture accounts for 85 percent of employment nationally and 96 percent of employment in rural areas (World Bank 2005). The coefficients of productivity deficit – 5% for manual labour and 17% for heavy manual labour will only be applied to these workers.

The calculations for productivity deficits from iron deficiency anaemia are summarized in the table below – applying separate rates of anaemia, economic activity, manual labour activity and average wages for each. 2.44 million manual workers suffer productivity deficits due to IDA, resulting in depressed economic activity of $48 million annually. When the added losses from heavy manual labour are included, this deficit totals more than $100 million annually.

Table 9: Losses from Iron Deficiency Anaemia Among Adult Workers			
	Women	**Men**	**Totals**
Health Data Background			
Prevalence of anaemia	26.6%	6.7%	Men at 25% Women
% Anaemia from IDA	61%	61%	
Iron Deficiency Anaemia	16%	4%	
Demographic & Labour Data Background			
Economic activity rate,	75%	87%	
Population 15-65 yrs	19,602,252	19,001,181	
Employed Population	14,682,087	16,493,025	31,175,112
Manual Labour Share	78%	86%	
Working in Manual Labour	11,404,260	14,200,953	25,605,212
Heavy Manual Labour Share of Manual Labour	33%	33%	
Workers in Heavy Manual Labour	3,975,961	4,950,995	$8,926,956
Average Wage Sector	$390.73	$411.30	
Economic Productivity Loss Projections			
Anaemic Workers in Manual Labour	1,857,265.14	578,181.65	2,435,447
Productivity Deficit	5%	5%	
Manual Labour Loss Subtotal	$36,284,877	$11,890,290	$48,175,167
Anaemic Workers in Heavy Manual Labour	1,057,606	329,241	$1,386,847
Additional Deficit	12%	12%	
Additional Loss for Heavy Manual Labour Subtotal	$49,589,162	$16,250,007	$65,839,169
Grand Total			$114,014,336

VI. Perinatal Maternal Mortality Due to Mother's Anaemia:

Global Evidence and Coefficient of Loss

Improving maternal iron status is generally recognized as an essential component to improving birth outcomes. During pregnancy the need for iron increases significantly and prevalence of anaemia rises in parallel, threatening the health and survival of both mother and child. Worldwide anaemia is associated with 115,000 maternal deaths and 591,000 perinatal deaths annually.[92] A recent meta-analysis quantified the association of anaemia during pregnancy with perinatal death (mortality in the weeks just prior or after birth), concluding that where malaria is not a significant threat, perinatal mortality decreases 16% for every 1 gram per decilitre increase in haemoglobin - a relative risk of 0.84 used in this analysis.[93] [94]

Prevalence of Anaemia in Pregnancy and Attributable Perinatal Deaths

Maternal anaemia is one cause of the nearly 83 thousand annual perinatal deaths estimated by ORC Macro in 2007. While no comprehensive data on anaemia in pregnancy has been identified, DHS 2005 shows 37.3% anaemic – and we correct this by 61% to arrive at 22.8% suffering from iron deficiency.

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[92] Stoltzfus et al, Iron Deficiency Anaemia, in Global Burden of Disease, WHO 2004

[93] Ibid

[94] A similar risk for maternal death (RR .8) has been found and is projected within the analysis. However, this is not monetized, but for a number of reasons will not be calculated as part of an economic analysis.

This suggests more than half a million infants are born annually to women suffering from iron deficiency anaemia, with risks to health and survival of both mother and child.
Based on anaemia prevalence of 37.3% and iron deficiency anaemia rate of 61% among pregnant women, mean haemoglobin is calculated at 12.9 gram per decilitre and mean haemoglobin in the absence of iron deficiency, is calculated at 13.3 grams per decilitre. [95] The resulting 0.46 gram per decilitre deficit is applied to relative risk of 0.84 for each added gram per decilitre, yielding a 7.7% Population Attributable (PAR). The PAR is applied to 83 thousand annual perinatal deaths, to attribute about 6,333 annual perinatal deaths to the mother's anaemia. While the loss is immeasurable, in economic terms these 6333 annual deaths simply represent a lost future workforce valued at about $28.6 million/yr.

Table 10 Calculation for Projection of Economic Losses

Prevalence of Condition (IDA)		Relative Risk Mortality		Population Attributable Risk		Annual Perinatal Deaths		Annual Deaths Attributed
	X		=		**X**		=	
22.8% IDA 1.21 g/Dl Hb Deficit		.84		**7.7%**		82,748/yr		6,333 Deaths/yr

Table 11 Calculation for Projection of Economic Losses

Attributed Deaths	**X**	Average Annual Wage	X	Labour Participation Rate	**X**	Average Years in Workforce	**X**	Discount Rate For NPV	-	Average Years Until Work Force Entry	=	Lost Productive Activity
5855		$411.3		80.7%		40.5		3%		15		$30,971,973/yr

VII. Folic Acid Related Neural Birth Defects

Global Evidence and Coefficient of Loss

Neural Tube Defects (NTD), spina bifida and anencephaly, are a significant cause of death and disability throughout the world. The March of Dimes Global Burden of Birth Defects estimated almost 324,000 yearly NTD births worldwide. Using these estimates, a recent review calculated that more than 200,000 are likely preventable with folic acid.[96]

Incidence of NTDs

No nationally representative figures exist for the incidence of spina bifida and anencephaly in Ethiopia. The March of Dimes global report shows incidence of NTDs ranging from 1/1000 to more than 4/1000 births. Using a mid-point of 2/1000 births with NTDs such as spina bifida and anencephaly, suggests more than 44 hundred cases annually. With limited access to sophisticated medical care, these infants face high probability of death. With about 95% of births outside a health care facility, we will presume at 95% of NTDs result in death to the infant within the first year. The NPV of the lost workforce from these projected 4215 deaths is nearly $20 million annually.

Table 12 Calculation for Projected Mortality from NTDs

Annual Births		NTD Rate		Annual Cases		Assumed Mortality Rate		Annual Deaths attributed to VAD
	X		=		**X**		=	
2,218,457		2/1000		4437		95%		4215 Deaths/yr

Table 13 Calculation for Projected Economic Losses from NTD Mortality

Attributed	**X**	Average	X	Labour	**X**	Average	**X**	Discount	-	Average Years		**Lost**

[95] Presuming normal distribution in the population. Bae of Stoltzfus above
[96] Bell KN, Oakley GP, Jr. Tracking the prevention of folic acid-preventable spina bifida and anencephaly. Birth Defects Res A Clin Mol Teratol 2006;76:654-7.

Deaths		Annual Wage		Participation Rate		Years in Workforce		Rate For NPV		Until Work Force Entry	=	**Productive Activity**
4215		$411.3		80.7%		40.5		3%		15		**$** 20,614,423

VIII. Summary of Annual National Economic Losses

Based on the analysis above, the best available global evidence applied to national health, labour and demographic data suggests depressed national economic activity of nearly half a billion dollars annually can be attributed to current rates of vitamin A deficiency, iron deficiency anaemia and folic acid related NTDs. Almost half these losses are from nearly 50 thousand annual child deaths – mainly from vitamin A deficiency. About a quarter of these losses are the NPV of earnings deficits due to anaemia related cognitive deficits in today's children. Another quarter can be attributed to iron deficiency anaemia is adult workers in agriculture and other manual jobs.

Table 14: Summary National Economic Losses

	Lost Workforce	Lost Future Potential	Lost Current Productivity	Total	%
	000,000	**000,000**	**000,000**	**000,000**	
Maternal & Child Malnutrition					
Perinatal Mortality	$30.97			$30.97	7%
Anaemia 6 mo - 5 Years		$121.46		$121.46	27%
NTD	$20.61	$0.08		$20.70	5%
VAD Mortality	$167.18			$167.18	37%
Anaemia in Adults			$114.01	$114.01	25%
	$218.77	$121.54	$114.01	$454.32	
	48%	27%	25%		

IX. Projecting the Benefits of Fortification

Based on the original Damage Assessment Report above estimating annual economic losses at 1.42% of GDP, along with projections of coverage and added nutrition protection for various vitamins and minerals offered by oil and flour fortification, we might project the benefits of the proposed two-food-vehicle fortification program. A simple projection method to arrive at a rough benefit- cost ratio is outlined below.

Table 15 Overview of the Benefit Cost Analysis Process

Baseline Economic Loss		Projected Effectiveness		Projected Coverage		Projected Improvement		Cost of fortification		Benefit Cost Ratio
$/yr	X	%	X	%	=	$/yr	/	$/yr	=	#

We have established objectives for 28% coverage of flour, 20% for sugar and 50% for oil in previous sections. Quantifying the effectiveness of national fortification is elusive. Based on the evidence from program evaluations and the literature, and our calculation that fortification will provide an additional 25% to more than 100% of RNI, we venture to quantify effectiveness in the table below.

Table16 Assumptions and Parameters for Benefits of Fortification

	Projected Coverage	Suggesting Effectiveness	Reasoning for Estimate of Effectiveness	Calculated Improvement
Flour: Multiple Micronutrients				
Perinatal Mortality Anaemia in Pregnancy	28%	10%	Woman's needs rise to more than 50 mg iron/dy. Added 8-10 mg iron daily promises only modest anaemia improvement.	3%
IDA Children 6 months to 15 years	28%	20%	While the youngest children will benefit less, children 5-15 yrs old consume sufficient quantities for impact like adults.[97]	6%
Folic Acid Related Birth Defects	28%	60%	Midpoint in evidence of NTD reductions from US, Canada, Chile and South Africa.[98]	17%
IDA in Adults in **Manual Labour**	28%	30%	DAR corrected anaemia prevalence by 61% to measure IDA only. Provision of added iron at WHO Recommended levels should reduce iron deficiency to levels found in industrial countries. [99]	8%
Oil with Vitamin A				8%
Vitamin A Deficiency Children 6-59 months	50%	20%	Recent trial in Indonesia reduced VAD by ~30%.[100] We estimate2/3rd of this improvement due to lower levels of oil consumption in Ethiopia.	10%

Projecting Improvements in National Prevalence of Micronutrient Deficiencies

Based on the projected coverage and presumed effectiveness parameters above, fortification promises modest 3-8% reductions in national prevalence of iron deficiency anaemia, 17% reduction in folic acid related birth defects and 10% reduction in Vitamin A deficiency. Applying these projected improvements to current populations suffering from micronutrient deficiencies suggests the fortification programs will prevent more than 1 million cases annually.

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[97] Scrimshaw et al, Venezuela; WHO Background Docs

[98] Bell et al

[99] WHO Background docs

[100] Bagriansky J., JFPR 9065: Enriching Lives of the Urban Poor Through Food Fortification Indonesia, Japan Fund for Poverty Reduction Report to Asian Development Bank 2009

Table 17 Projected Reduced Prevalence and Cases						
			Status Quo		Projected At Scale	
	Risk Group	Prevalence	Cases	New Prevalence	Current	Saved
Perinatal Mortality Anaemia in Pregnancy	2,218,457	23.0%	510,245	22.4%	495,958	14,287
IDA Children 6 months to 15 years	34,547,296	23 .4%	8,079,837	22.1%	7,627,366	452,471
Folic Acid Related Birth Defects	2,218,457	0.2%	4,437	0.166%	3,692	745
IDA in Women Manual Labour	11,404,260	16.3%	1,857,265	14.9%	1,701,255	156,010
IDA in Male Manual Labour	14,200,953	4.1%	578,182	3.7%	529,614	48,567
Vitamin A Deficiency Children 6-59 months	11,593,000	37.7%	4,370,561	34.1%	3,950,987	419,574
Total Cases			15,400,527		14,308,872	1,091,655

Projecting Reductions in Mortality Attributable to Oil and Flour Fortification

These improvements in prevalence yield significant savings of life and human potential. The reduced prevalence calculated above suggests more than 4500 saved lives annually from: reduced maternal and perinatal morality; fewer fatal cases of spina bifida and anencephaly; and, most significantly, more than 3800 deaths of children 6-59 months attributed to their vitamin A deficiency. While about 900 lives annually can be saved via impact of flour fortification on anaemia and folic acid deficiency, the impact of oil fortification with vitamin A is the most significant investment in terms of saving lives.

Table 18 Projected Reductions in Mortality Attributed to Oil and Flour Fortification Programs Based on Estimates of Reduced Prevalence

	Status Quo Mortality	Projected Improvement	Projected Lives Saved
Perinatal Mortality	6,333	3%	177
VAD	38,842	10%	3,729
NTD	4,215	17%	708
Maternal Mortality	2,062	3%	58
Total Annual Deaths	51,452		4,672

Projecting Reductions in Economic Burden of Micronutrient Deficiencies

Several years will be required before the proposed fortification program reaches scale and an additional 9-12 months will be required before annual benefits and reduced losses begin to be realized via daily consumption of fortified foods. Since the speed of scale-up is not clear at this point, we will not attempt describe the scale-up of impact on nutrition status but project annual benefits after fortification reaches scale (which we define as 28% flour and 50% oil coverage). Our calculations project that baseline losses of $454 million annually will be reduced about 8.1%. This is a net annual “savings” of about $37 million in reduced burden of anaemia, folic acid and vitamin A deficiency.

Table 19 Projected Economic Benefit from Flour and Oil Fortification at Scale			
	Status Quo Losses 000,000	Projected Improvement	Projected Benefit 000,000
Perinatal Mortality	$30.97	2.8%	$ 0.87
IDA in Children 6 months to 15 years	$121.46	5.6%	$ 6.80
Folic Acid Related Birth Defects	$20.70	16.8%	$ 3.48
IDA in Women and Men Manual Labour	$114.01	8.4%	$ 9.58
Vitamin A Deficiency Children 6-59 months	$167.18	9.6%	$ 16.05
	$454.32	**8.1%**	**$ 36.77**

Rough Benefit Cost Ratio for Oil and Flour Fortification

10 Year Projected Budgets for industry fortification and government regulation, along with an additional $4 million estimated for management and social marketing, totals about $36 million. However, this includes > 25% in duties, VAT and customs service fees on imported premix, as well as 12.5% margin and in-kind costs of producers. Presuming these “soft costs” are substantially reduced, the more realistic incremental costs of the program are a bit less than $30 million over 10 years.

Again, since we have not ventured a scale-up schedule for fortification or its impact, we will calculate a very rough simple benefit cost ratio based on cost and impact at program scale. Whether we take full costs or assume reduced duties and margins, the Benefit Cost Ratio is very positive – a BCR of 10 for full costs and BCR of 13 for reduced government and industry charges. For every dollar invested in fortification, annual return will be $10-13 in reduced losses from iron deficiency anaemia, folic acid deficiency and vitamin A deficiency.

Table 20 Calculation of Benefit Cost Ratio at Scale for Oil and Flour Fortification
Based on 10 Year Estimated Start-Up and Recurring Costs for Government and Private Sector

	Full Costs with Duties, VAT and Millers Margin	Costs with Reduced Duties, VAT and Millers Margin (25%)
Flour Cost (Core Premix)	$22,761	$17,071
Oil Cost	$9,461	$7,096
Sugar Cost	$59,790	
Social Marketing	$3,000	$3,000
Management	$1,000	$1,000
Total 10 Year Costs	$36,222	$27,167
Annualized Cost	$3,622	$2,717
Annual Benefit	$36,773	$36,773
Benefit Cost Ratio	10	13

ANNEX 2: Line Item Budget for Flour Fortification

WHEAT FLOUR FORTIFICATION	Flour production MT	1,159,000	Assumptions: Core + restoration micros
208 mills producing MT flour/yr	Premix addition rate g/MT	300	2 inspections per mill/yr ; 2,000 market samples from 50 markets/yr

Mill fortification cost	Unit	Number	Cost/unit	Total	Capital start-up	Annual recurring	Hard cash costs	Soft costs in-kind/absorbable
Large mill start-up > 100 MT								
Feeders for expansion into private sector	# private mills/production lines	11	$10,000	$110,000	$110,000		$110,000	
Installation & training	# private mills/production lines	11	$2,000	$22,000	$22,000		$22,000	
Medium mills start-up 50-100 MT								
Feeders for expansion into private sector	# private mills/production lines	22	$3,000	$66,000	$66,000		$66,000	
Installation & training	# private mills/production lines	22	$600	$13,200	$13,200		$13,200	
Small-medium mills start-up < 50 MT								
Feeders for expansion into private sector	# private mills/production lines	175	$2,000	$350,000	$350,000		$350,000	
Installation & training	# private mills/production lines	175	$400	$70,000	$70,000		$70,000	
Premix procurement								
Premix cost to major distribution point	kg for 16,200,000 MT based on 300 g/MT	347,700	$8.34	$2,899,818		$2,899,818	$2,899,818	
Domestic storage & distribution to mills	MT x average 100 km	348	$5.00	$1,739		$1,739	$1,739	
Taxes & duties	% value	2,899,818	25%	$724,955		$724,955		$724,955
Processing & certification costs	% value	2,899,818	0.50%	$14,499		$14,499		$14,499
Mill process								
Process labour	2 employees per mill @ 10% annual salary	20	$1,000	$2,000		$2,000		$2,000
Maintenance (new feeders & spare parts)	5% feeder value av $5,000	526,000	5%	$26,300		$26,300	$26,300	
Quality assurance: spot tests, reagents & labour	$5 per mill per operating day (200 d/yr)	3,000	$5.00	$15,000		$15,000	$7,500	$7,500
Incremental packaging cost	50 kg bags	32,400,000	$0.01	$324,000		$324,000	$324,000	
Management, overhead, administration	3% of costs above	$324,000	3.0%	$9,720		$9,720	$4,860	$4,860
Miller's margin	12.5% of costs above (excluding taxes)	$3,238,818	12.5%	$404,852		$404,652		$404,652
subtotal				$5,053,883	$631,200	$4,422,683	$3,895,417	$1,158,466

Regulatory & food control	Unit	Number	Cost/unit	Total	Capital start-up	Annual recurring	Hard cash costs	Soft costs in-kind/absorbable
Capacity building & training								
Establish sampling, testing and enforcement protocols	Technical consultations	2	$2,000	$4,000	$4,000			
Inspector training*	Inspectors	30	$500	$15,000	$15,000			
Initial lab technician training*	Workshop	2	$5,000	$10,000	$10,000			
Added lab equipment	Specify if necessary	2	$25,000	$50,000	$50,000			
Added lab renovations	Specify if necessary	Lump sum		$10,000	$10,000			
*Ongoing training integrated into routine								
Mill inspection & sampling								
Inspector salaries	Days for 2 inspections/mill/yr @ 1/4 d/mill	50	$5.00	$250		$250		
Sampling visit transport	km @ 40 for 2 inspections/mill/yr	18,840	$0.25	$4,150		$4,150		
Spot test materials	Tests or samples	416	$0.25	$104		$104		

Shipping to lab	25% of tests	104	$25	$2,600		$2,600
Management	10% of costs above	$7,114	10%	$711		$711
Monitoring in market						
Inspector salaries	Inspector days - 2,000 samples 40 markets	50	$5	$250		$250
Sampling visit transport	km @ 40 sweeps @ 40 km	2,000	$1	$1,000		$1,000
Spot test materials	Tests or samples	2,000	$0.25	$500		$500
Shipping to lab	25% of tests	500	$15	$7,500		$7,500
Management	10% of costs above	$9,250	10%	$925		$925
Laboratory analysis: expendables						
Laboratory labour	Total 804 samples @ 1/2 d/sample	804	$5	$3,020		$3,020
Laboratory analysis: expendables	Sample	804	$5	$3,020		$3,020
Laboratory overhead & management	10% of costs above	$8,040	10%	$604		$604
subtotal				$113,634	$89,000	$24,634
TOTAL				$5,167,517	$720,200	$4,447,317

ANNEX 3: Line Item Budget for Oil Fortification

VEGETABLE OIL FORTIFICATION		*Assumptions: Vitamin A 60 IU/g of oil*
Oil production	*49,500 MT*	*3 refineries using metering systems*
Oil imports	*198,400 MT*	*26 refineries using batch system*
Premix addition rate	*200 g/MT*	*EHNRI lab*

Unit	*Number*	*Cost/unit*	*Total*	*Capital start-up*	*Annual recurring*	*Hard cash costs*	*Soft costs in-kind absorbable*
Production & distribution equipment							
# private refineries - metering system	*3*	*$30,000*	*$90,000*	*$90,000*		*$90,000*	
Installation costs - 10% of capital	*3*	*$3,000*	*$9,000*	*$9,000*		*$9,000*	
# private refineries - batch system	*23*	*$5,000*	*$115,000*	*$115,000*		*$115,000*	
Installation costs - batch system	*23*	*$500*	*$11,500*	*$11,500*		*$11,500*	
Premix							
kg for 105,000 MT based on g/MT	*9,920*	*$19*	*$188,480*		*$188,480*	*$188,480*	
MT x avg 50 km	*9,920*	*$5*	*$50*		*$50*	*$50*	
Premix taxes	*188,480*	*25%*	*$47,120*		*$47,120*		*$47,120*
Customs service fee	*188,480*	*0.50%*	*$942*		*$942*		*$942*
QA/QC							
2 employees per refinery @10% annual salary	*20*	*$1,000*	*$2,000*		*$2,000*		*$2,000*
Maintenance 10% closing system value	*205,000*	*10%*	*$20,500*		*$20,500*	*$20,500*	
QA/QC $5/mill/operating day (200 d/yr)	*5,200*	*$5*	*$26,000*		*$26,000*	*$13,000*	*$13,000*
Packaging, labels, bottles	*1,500,000*	*0.01*	*$15,000*		*$15,000*	*$15,000*	
Management overhead 3% of costs above	*$63,500*	*3%*	*$1,905*		*$1,905*	*$953*	*$952*
Refining margins 12.5% of costs above (excl taxes)	*$231,480*	*12.50%*	*$28,935*		*$28,935*		*$28,935*
subtotal			*$556,432*	*$225,500*	*$330,932*	*$463,483*	*$92,949*
Regulatory control							
Food control costs							
Technical consultations	*2*	*$2,000*	*$4,000*	*$4,000*			
Inspectors	*30*	*$500*	*$15,000*	*$15,000*			
Workshop	*2*	*$5,000*	*$10,000*	*$10,000*			
Spectrophotometer	*2*	*$25,000*	*$50,000*	*$50,000*			
Lab repairs/upgrade	*Lump sum*		*$10,000*	*$10,000*			
subtotal			*$89,000*	*$89,000*			
Inspection costs - national production							
Days for 4 inspection/refinery/yr @ 1/2 day/refinery	*30*	*$5*	*$150*		*$150*		
km@40 for 4 inspections/refinery/yr	*2,400*	*$0.25*	*$600*		*$600*		
2 samples per refinery inspection	*208*	*$0.25*	*$52*		*$52*		
tests sent for qualitative lab tests	*208*	*$25*	*$5,200*		*$5,200*		
10% of costs above	*$6,002*	*10%*	*$600*		*$600*		
Inspection costs - imports							
Inspector days for 1,000 samples from 20 border sweeps	*40*	*$5*	*$200*		*$200*		
km@20 sweeps @40 km	*800*	*$0.50*	*$400*		*$400*		

Tests or samples	*1,000*	*$3.50*	*$3,500*		*$3,500*
10% of costs above	*$4,100*	*10%*	*$410*		*$410*
Inspection costs - market					
Inspector days for 200 samples from 20 market sweeps	*30*	*$5*	*$150*		*$150*
km @20 sweeps @40 km	*800*	*$0.5*	*$400*		*$400*
Tests or samples	*200*	*$3.50*	*$700*		*$700*
10% of costs above	*$1,250*	*10%*	*$125*		*$125*
subtotal			*$12,487*		*$12,487*
TOTAL			*$657,919*	*$314,500*	*$343,419*

ANNEX 4: Line Item Budget for Sugar Fortification

SUGAR FORTIFICATION			*Assumptions: Vitamin A 60 IU/g of sugar*				
Sugar production estimate	*300,000 MT*		*ESDA data, EHNRI lab*				
Sugar imports	*150,000 MT*		*1 premix plant to be installed at existing plant*				
Premix addition rate	*1,000 g/MT*		*Colorimetric method*				
Unit	*Number*	*Cost/unit*	*Total*	*Capital start-up*	*Annual recurring*	*Hard cash costs*	*Soft costs in-kind absorbable*
Production & distribution equipment							
Sugar premix plant building	*1*	*$200,000*	*$200,000*	*$200,000*		*$200,000*	
Sugar premix plant equipment	*1*	*$150,000*	*$150,000*	*$150,000*		*$150,000*	
Installation costs - 10% of capital	*1*	*$35,000*	*$35,000*	*$35,000*		*$35,000*	
# sugar refineries feeder system	*5*	*$10,000*	*$50,000*	*$50,000*		*$50,000*	
Installation cost feeder system- 10% of capital	*5*	*$1,000*	*$5,000*	*$5,000*		*$5,000*	
Premix							
kg for 300,000MT based on g/MT	*300,000*	*$11.40*	*$3,420,000*		*$3,420,000*	*$3,420,000*	
MT x avg 50km	*300,000*	*$5*	*$1,500*		*$1,500*	*$1,500*	
Premix taxes	*3,249,000*	*25%*	*$812,250*		*$812,250*		*$812,250*
Customs	*3,249,000*	*0.50%*	*$16,245*		*$16,245*		*$16,245*
QA/QC							
2 employees per refinery @10% annual salary	*2*	*$1,000*	*$2,000*		*$2,000*		*$2,000*
Maintenance 10% dosing system value	*200,000*	*10%*	*$20,000*		*$20,000*	*$20,000*	
QA/QC $5/mill/operating day (200 d/yr)	*1,200*	*$5*	*$6,000*		*$6,000*	*$3,000*	*$3,000*
Packaging, labels, bags (50kg bags)	*6,000,000*	*0.01*	*$60,000*		*$60,000*	*$60,000*	
Management overhead 3% of costs above	*$88,000*	*3%*	*$2,640*		*$2,640*	*$1,320*	*$1,320*
Refining margins 12.5% of costs above (excl taxes)	*$3488,000*	*12.50%*	*$436,000*		*$436,000*		*$436,000*
subtotal			*$5,216,635*	*$440,000*	*$4,776,635*	*$3,945,820*	*$1,270,815*
Regulatory control							
Food control costs							
Technical consultations	*2*	*$2,000*	*$4,000*	*$4,000*			
Inspectors	*30*	*$500*	*$15,000*	*$15,000*			
Workshop	*2*	*$5,000*	*$10,000*	*$10,000*			
Specrophotometer	*2*	*$25,000*	*$50,000*	*$50,000*			
Lab repairs/upgrade	*Lump sum*		*$10,000*	*$10,000*			
subtotal			*$89,000*	*$89,000*			
Inspection costs - national production							
Days for 4 inspection/refinery/yr @1/2 d/refinery	*6*	*$5*	*$30*		*$30*		
km @40 for 4 inspections/refinery/yr	*2,400*	*$0.25*	*$600*		*$600*		
2 samples per refinery inspection	*6*	*$0.25*	*$2*		*$2*		
Tests sent for quantitative lab tests	*48*	*$25*	*$1,200*		*$1,200*		
Overhead 10% of costs above	*1832%*	*10%*	*$183*		*$183*		
Inspection costs - imports							
Inspector days for 1,000 samples from 20 border sweeps	*40*	*$5*	*$200*		*$200*		

km @20 sweeps @40 km	*800*	*$0.50*	*$400*		*$400*
Tests or samples	*1,000*	*$3.50*	*$3,500*		*$3,500*
10% of costs above	*$4,100*	*10%*	*$410*		*$410*
Inspection costs - market					
Inspector days for 200 samples from 20 market sweeps	*30*	*$5*	*$150*		*$150*
km @20 sweeps @40 km	*800*	*$0.50*	*$400*		*$400*
Tests or samples	*200*	*$3.50*	*$700*		*$700*
10% of costs above	*$1,250*	*10%*	*$125*		*$125*
subtotal			*$7,900*		*$7,900*
TOTAL			*$5,313,535*	*$529,000*	*$4,784,535*

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