Nutriview

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A quarterly newsletter on the role of micronutrients in nutrition and health for health-care professionals and science communicators

Editorial:
Paying the price

Considerable increases in the price of food in recent months are forcing poor people (who already spend a large proportion of their income on food) to eliminate important nutritious foods from their diet. Although there is plenty of food on the market, they simply cannot afford it. In many parts of the world, the high price of basic foods has already caused violent protests against governments, and is becoming a serious threat to peace.

Stories about rising food prices are hitting the headlines everywhere, as the UN, the World Bank, the International Monetary Fund, the International Food Policy Research Institute and many governments express their concern about its political impact. Even the World Food Programme (WFP), the UN agency responsible for relieving hunger, is finding it hard to finance its activities budgeted for 2008. It now costs twice as much to fill a child's cup with food as it did last year. WFP Executive Director Josette Sheeran has taken every opportunity to inform possible donors and government representatives about the problems caused by soaring food prices, and suggested possible ways to approach the challenge, which she calls the "new face of hunger".

According to expert opinion, there are four reasons for the present situation: increasing energy costs, increasing demand for food following to the economic boom in emerging nations, climate changes (the growing frequency and severity of hurricanes, floods and droughts) and increasing use of food crops for biofuel. A particular question is whether higher food prices at least benefit ordinary farmers in developing countries? Ms Sheeran is skeptical. Many of them do not produce enough food to sell, but still have to spend more on fuel and fertilizer. Even those who do have food to sell often do not earn more, because others who are closer to the market absorb the profits.

We cannot accept that a considerable part of the world's population has to pay the price for these developments with a lower work capacity, lower school attendance, poorer health, poverty aggravation and loss of even more valuable lives. We must find a way to solve the problem urgently. For this, it is particularly important that we increase collaboration between partners, raise the level of political dialogue, and create adequate strategies. At the same time, we must continue efforts to achieve sustainable improvements in the overall quality of the diet.

Coping with rising food prices

According to the WFP Issue Brief published in May 2008 [1], economically disadvantaged households are trying to cope with increasing food prices mainly by eating less and/or by buying foods of lower quality. These dietary changes increase the prevalence and severity of micronutrient deficiencies, and so severely affect the health and nutritional status of hundreds of millions of people (especially young children, pregnant and lactating women, the chronically ill, and the very poor).

Children aged 6–23 months are the most vulnerable; to avoid irreversible effects of deficiency, they must be fed a nutritionally complete complementary food. Other priority measures should aim at ensuring adequate micronutrient intakes and restoring food security. Surveillance systems need to be established to monitor coping strategies used, impacts on food consumption and changes in the nutritional status and health of population groups.

1. *Bloem MW, de Pee S, Thorne-Lyman A, van den Briel T. Rising Food Prices – Interventions required to prevent deterioration of health and nutritional status. Issue Brief, WFP, May 2008.*

Photo on title page shows WFP Executive Director Josette Sheeran with poor children at a Nairobi school

A. Bowley

Conference report:
Experts address challenges of hidden hunger

On March 12, 2008, Dr Lester Packer, (University of Southern California) and Dr Klaus Kraemer (Sight and Life, Basel, Switzerland) convened a one-day meeting, entitled "Hidden Hunger: Socioeconomic and Scientific Challenges: A Round-Table Discussion", in the Ronald Reagan Room of the Fess Parker's Double Tree Resort on the shoreline of Santa Barbara, California. Subtitled "The Impact of the Micronutrient Nutrition Economic and Social Development in the

Industrial and Developing World", the gathering was sponsored by Sight and Life, the University of Southern California School of Pharmacy, the Oxygen Club of California Davis and the Linus Pauling Institute, Corvallis, Oregon. Dr Alfred Sommer, Dean Emeritus of the Johns Hopkins University Bloomberg School of Public Health in Baltimore, Maryland, acted as moderator. With seven principal speakers, and about forty invited professionals and students in nutrition and economics, including two Nobel Laureates, the meeting primed for interaction among concepts and participants.

Nutrition and economic development exert a mutual interaction

The Program is best seen in terms of specific thematic areas. The keynote speaker was Nobel Laureate Dr Daniel McFadden (University of California Berkeley), who received the Nobel Prize in Economics in 2000 for his pioneering work in econometrics. This uses economic models to address policy issues such as the interaction of health, income and national wealth. For this presentation, entitled "Nutrition, Health and Wealth", he substituted "micronutrient status" for "health" in his econometric models, and projected a series of scenarios in which direct, primary investment in better micronutrient nutrition could be an agent for economic and social development in low-income societies.

Three speeches covered issues of specific nutrients. Dr Alok Bhargava, an economist at the University of Houston, Texas, addressed the topic of "Diet Quality, Iron Status and Economic Development". Iron deficiency is conventionally recognized as a global problem, and there is a basic skepticism concerning whether the world's poor could afford diets that provide sufficient biologically available iron. This led him to suggest that targeted interventions at the most vulnerable ages could improve iron status in infants, school performance in juveniles, reproductive outcomes in women and labor productivity in adolescents and adults.

Two internationally renowned nutrition experts focused their talks on choline and omega-3 fatty acids, respectively, topics that are not commonly considered in a public health context. Dr Steve Zeisel (University of North Carolina) spoke on "Choline and Brain Development", while Dr Ricardo Uauy (London School of Hygiene and Tropical Medicine, and the Chilean Institute of Nutrition and Food Technology) covered "Essential Lipids in Brain Development and Aging". Both speakers stressed the importance of the respective nutrients for early cognitive development. Choline and omega-3 fatty acids act in complex, and often interacting, manners to foster the anatomical and functional development of brain cells. As a result, social and economic functioning throughout life depends on the adequacy of choline and essential fatty acid nutrition.

Support for action in supplementation, fortification and functional foods

The remaining three speakers presented applications of micronutrients in public health. Mr M.G. Venkatesh Mannar, President of the Micronutrient Initiative in Ottawa, Canada, spoke on "Addressing Global Hidden Hunger". He asked what it would really take to eliminate malnutrition by 2015 in relation to the Millennium Goals, and highlighted the distances remaining to eliminate deficiencies of iodine, iron, zinc and vitamin A. He called for persistent advocacy, national investment strategies and public-private partnerships as components

Panelists and organizers (from left to right) Ricardo Uauy, Alok Bhargava, Venkatesh Prakash, Lester Packer, Klaus Kraemer, Venkatesh Mannar, Alfred Sommer, Steven Zeisel, Bruce Ames, Daniel McFadden, Noel Solomons

of the way forward to improve the public health dimension of hidden hunger.

Dr Venkatesh Prakash, Director of the Central Food Technological Research Institute in Mysore, India, spoke about "Micronutrient Kinks in the Food Chain in Driving the Vehicle of Food Technology for Better Nutrition". His summary extolled the strides and advances that have been made in food technology, and pointed to virtually unlimited possibilities to create functional foods with bioactive ingredients aimed at reducing the risk of acute and chronic illness.

Dr Bruce Ames (Children's Hospital Oakland Research Institute, Oakland, California) addressed "Micronutrient Nutrition: Keeping the Elderly Brain Young". The reality of extended longevity in developed countries came to the fore with this topic. Based on a premise that free radicals cause loss of memory and intellectual abilities with advancing age, he advocated personal supplementation with multiple antioxidant nutrients as a way to preserve cognitive function throughout life.

Reaching across the divide of richer and poorer countries in a common format is a novel and innovative endeavor. The whole range of biological variation and programmatic options come into the conversation. It proves, however, to be very complex to assign priorities for inquiry and action with the very broadest of considerations of micronutrients in human health. Finally, it seemed to be the consensus of the organizers, speakers and discussants that neither the time allotted nor the number of themes explored could do full justice neither to the unaddressed micronutrient problems in public health and their negative impacts, nor to the potential solutions and their costs, efficacy and safety.

Noel Solomons, CeSSIAM

Feature:

Developing a commercial process for tortilla fortification

Corn tortillas are the traditional staple food for many Mexicans. In some groups, intakes account for more than 120 kg annually (nearly 50% of energy). However, corn tortillas are deficient in two essential amino acids (lysine and tryptophan) and several key micronutrients. In 1999, the National Nutrition Survey of the National Institute of Public Health of Mexico found micronutrient deficiencies in 52% (iron) and 33% (zinc) of children less than five years of age. Figures for children aged between five and twelve were 36% (iron), 20% (zinc) and 10% (folate), and for women aged 12–49 were 41% (iron) and 39% (zinc). Severe growth retardation was also a serious public health issue.

In the preparation of corn for tortillas, the grains are cooked and soaked in an alkaline solution such as lime to produce *nixtamal* (name derived from the Aztec language for the soaked and softened maize kernels). The purpose of this is to improve the flavor and aroma of the product, and make grinding easier. It also increases levels of calcium, iron, copper and zinc, reduces the content of mycotoxins (poisons from molds that commonly infect maize), and possibly liberates niacin. Fresh *nixtamal* is milled in small neighborhood mills throughout Mexico on a daily basis to produce *masa* (corn dough). This dough is rolled, molded into thin patties, and baked on a clay or metal grill. *Nixtamal* can also be dried to produce corn masa flour, a convenience product that is rehydrated for use in commercial and home-based tortilla production. These two manufacturing methods each account for roughly half of the commercial tortilla market in Mexico (although estimates of market shares vary). Until recently only the flour, but not the fresh *nixtamal* dough, could be successfully fortified with essential micronutrients.

The challenge

In its efforts to improve the nutritional status of the population, the Mexican government proposed a federal regulation allowing voluntary fortification of wheat and corn flour, with the expectation that mandatory requirements would follow. However, implementation has not been as successful as hoped. At this time, only about one third of industrially

Rolling and shaping fresh masa into tortillas ready for baking

made tortillas are fortified. This is largely because technologies for enriching fresh *nixtamal* have not been available. While corn *masa* flour producers have long had the technical capacity to fortify their product, they became reluctant to invest in fortification unless their competitors using fresh *nixtamal* dough were required (and able) to do so as well.

To "level the playing field" a fortification system that meets the following requirements was needed for Mexico's *nixtamal* millers:

1. It must fit into the existing milling process without significant changes.
2. The process for incorporating the micronutrient premix must be relatively straightforward, reproducible, and easy to learn.
3. Fortification should not significantly increase manufacturing or product costs.
4. The added micronutrients must be distributed homogenously in the *masa*.
5. After baking, nutrient levels must still be adequate.
6. The fortified tortillas must be acceptable to consumers.

Aware of this need, the non-profit organization SUSTAIN, based in Washington, DC, took on the initiative in 2004 to develop a commercially viable, industrial process for fresh *nixtamal* fortification to extend the benefits of micronutrient enrichment to a much larger segment of the population. Probably the two biggest hurdles to overcome were the nature of the nixtamalization process itself and the limited resources of the numerous small operators (up to 15,000 mills nationwide). The success of the project so far shows the importance of collaboration between all of the stakeholders.

Initial testing showed that a dry premix is more suitable than a liquid one. Liquid premixes were unstable, more expensive, and caused undesirable interactions that affected the appearance and taste of the tortillas. Nevertheless, several reformulations of the dry premix were needed. The iron sources defined in the original regulation caused an unwanted discoloration. The final premix was made with electrolytic iron, in addition to zinc, folic acid, niacin, riboflavin and thiamin. Electrolytic iron was preferred due to its low cost and minimal impact on the food vehicle. It was also the form favored by the industry. Because it is about half as bioavailable as ferrous sulfate, it was added at twice the level recommended for ferrous sulfate.

Considerable work went into identifying and adapting the premix dosifier. Involved millers agreed that it should not cost more than 1,500 US$, a tenth of the price of conventional equipment. After evaluating the potential alternatives, it was decided that the best solution would be to feed the dry premix into the auger (a device for transporting material by means of a rotating helical screw) that conveys the *nixtamal* to the grinding stones for milling. This semi-continuous mechanized approach would not unduly impede production throughput. Tests indicated that the method yields consistent levels of iron (used as a marker because of its stability and ease of analysis) in consecutive production runs.

Excellent collaboration: the key to success

- SUSTAIN initiated, organized and managed the project.
- The Bill & Melinda Gates Foundation, the General Mills Foundation, GAIN, as well as public and private donors in Mexico, generously supported the project.
- Researchers at the National Institute of Public Health of Mexico, Brigham Young University and the Monterrey Institute of Technology evaluated the potential technical approaches, and provided training manuals and technical support for educating millers participating in extended trials.
- A working group with representatives from the tortilla industries, ingredient suppliers, premix manufacturers, food scientists, nutritionists, and government officials provided valuable input and review during development of the research. Ultimately, it endorsed the evaluation of dosifiers for incorporation of micronutrient premixes into the process. Two mills (one in Mexico City, the other in Guadalajara) set up and tested the dosifier, and helped to make it more suitable for commercial use. Probst SA de CV, a supplier of additives for the food industry in Mexico, designed the unit chosen for dosing the dry premix.
- DSM Nutritional Products, Mexico, developed suitable dry and liquid premixes based on the government's fortification objectives. DSM and Brigham Young University analyzed the micronutrient content of fortified and unfortified tortillas.
- The 'Salvador Zubirán' National Institute of Medical and Nutritional Science in Mexico City tested consumer acceptance of tortillas fortified with various premixes.

The results

The enriched tortillas produced by this procedure had comparable sensory properties to unfortified tortillas. Consumers who evaluated the tortillas in side-by-side comparisons rated the fortified tortillas as being the same as those that were not fortified.

The chosen method is cost effective, easy to use and has a minimal impact on the manufacturing process. It dramatically improves the nutritional value of the tortillas without changing their appearance and taste. An extended trial in selected mills has confirmed that the procedure is commercially viable, and that consumers who know about the nutritional benefits provided by fortified tortillas become loyal customers. The participating millers have expressed a great interest in this technology, and are enthusiastic about the prospect of benefiting the health of their customers.

We thank SUSTAIN for permission to publish this summary of their tortilla fortification project. Information was derived in part from an article in Cereal Foods World 2007 (52: 240–248) and in Cereal Chemistry 2008 (85: 70–75). For more information on this project, please contact SUSTAIN at www.sustaintech.org.

Feature:

Vitamin A and zinc potentially beneficial in malaria

Malaria imposes a substantial economic and social burden on approximately two billion people (a third of the global population) living in countries where the disease is endemic. Though precise data are lacking, most estimates agree that malaria causes up to a million deaths every year. Child mortality due to malaria has increased over the last three decades.

Most of the countries where malaria is endemic are also burdened by high rates of micronutrient deficiency (especially of vitamin A and zinc). Current evidence indicates that these deficiencies might increase the severity of malaria in young children. Researchers are therefore interested to establish whether improving micronutrient status can reduce malaria-related morbidity and mortality. Results so far suggest that supplementation with vitamin A and zinc, as an adjunct to malaria therapy, is potentially beneficial. However, they do not provide definitive proof, and further studies are needed. Given the major implications of this simple and inexpensive intervention for public health, it is vitally important to conduct well designed and adequately powered studies to overcome the limitations of previous research and to provide a convincing answer to the question.

Recently, Sazawal et al. found that children (mainly not iron deficient) supplemented with iron and folic acid in Pemba, Zanzibar, had an increased risk for serious adverse events due to clinical malaria [1]. The reason for this was unclear, although there are two potential explanations. First, increased malaria infections have been previously described in children supplemented with iron alone. Second, there is now clinical evidence that folic acid may interfere with the activity of anti-folate malaria drugs.

Vitamin A and zinc important for immunity

Vitamin A and zinc are essential for normal immune function. Vitamin A influences antibody response and cell-mediated immunity, while zinc plays a critical role in lymphocyte development and function. Even a marginal vitamin A deficiency increases all-cause mortality in children, and might also affect morbidity associated with malaria. Vitamin A supplementation along with vaccinations improves lymphocyte responses and IgG antibody titers (a measurement of the activity of the most abundant immunoglobulin in humans).

Cross-sectional studies from sub-Saharan Africa in children with malaria have shown an inverse association between serum retinol level and both the clinical severity of an attack and the proliferation of the parasites in the blood. Since malaria treatment increases plasma levels of retinol and carotenoids, reduced retinol levels might not only be due to the acute phase response to infection, but also to the increased metabolism and/or excretion of vitamin A during the infectious stage, so that malaria-affected individuals might need more retinol. An acute decline in retinol stores in children with marginal vitamin A status may provoke a clinical deficiency. If malaria contributes to depletion of already compromised vitamin A stores, then it could indirectly increase the risk of morbidity or mortality from other infections. In such populations, supplementation with vitamin A could have a protective effect.

In humans, zinc deficiency is associated with reduced activity of thymulin (a hormone produced in the thymus that is involved in differentiation and enhancement of some immunoactive cells), levels of interleukin-2 (a signaling molecule that is instrumental in the body's natural response to infection) and total numbers of CD4 lymphocytes (CD4 = cluster of differentiation 4: an immunoglobulin that is expressed on the surface of various cells involved in cell-mediated immunity). In mouse models, it has been shown that CD4 lymphocytes are required for protection against asexual stages of malaria parasites. Given these findings, it is logical to ask whether zinc supplementation might also serve to prevent malaria, particularly in areas where zinc deficiency is common.

Vitamin A reduces malaria severity

Several in-vitro and animal studies have explored the role of vitamin A in malaria, and shown how supplementation might attenuate malaria-related morbidity. These studies paved the way for clinical studies in humans at risk of malaria to see if supplementation with vitamin A might be beneficial. In two randomized, placebo-controlled trials conducted in Ghana, and published in a single paper [2], vitamin A reduced the number of children with probable malaria (defined as a body temperature ≥37.5°C and blood parasite counts ≥4,000/μL) by 23% and 32%, but had no clear impact on parasitemia occurrence or parasite densities. However, the number of children studied was small, and the studies lacked adequate power to demonstrate an effect on confirmed malaria. They made only limited use of slide-confirmed longitudinal surveillance, relying instead on

EVENTS
Call for abstracts:

Micronutrients, Health and Development: Evidence–based Programs. Second Micronutrient Forum, May 12–19, 2009, Beijing, China.

The Micronutrient Forum serves as a stimulus for policy-relevant science and a catalyst for moving the global community towards consensus around evidence-based policies and programs that reduce micronutrient deficiencies. This meeting will focus primarily on lessons learned from large-scale programs that have, or have not, achieved their objectives. Other topics are: micronutrient interactions, micronutrients and the immune response, micronutrients and infectious disease, assessment of micronutrient status, early micronutrient deficiencies and their consequences over the life span, micronutrient research pertaining to maternal and child health.

Researchers and program implementers from a wide diversity of relevant disciplines are expected to attend. Representatives from international agencies, national ministries, educational and research institutions, food and chemical industries and non-governmental organizations are also welcome.

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reported fever as an indicator, which is known to be unreliable. Nevertheless, despite significant study limitations (small sample sizes, insensitive markers of disease), this work suggests that vitamin A might reduce the burden of clinical illness related to malaria.

A subsequent placebo-controlled study of vitamin A supplementation in 480 children in Papua New Guinea generated stronger clinical evidence that vitamin A is useful for preventing malaria [3]. Supplementation reduced symptomatic episodes of falciparum malaria by 30% (p=0.0013) with a trend towards lower rates of parasite density and splenomegaly (enlargement of the spleen). This benefit was most evident in supplemented children aged 12–36 months, who had 35% fewer episodes of slide-confirmed malaria and a 68% lower parasite density than those in the placebo group.

This evidence provides several plausible mechanisms for the beneficial effect of vitamin A on malaria, and consistently finds that supplementation reduces parasite density and clinical malaria symptoms. Given the detrimental effects of malaria on vitamin A status, the apparent benefits of vitamin A supplements in these trials, and the potential role of supplementation as a simple, cost-effective approach to malaria prevention, further research clarifying and confirming the role of vitamin A is worthwhile.

Zinc might be useful

A trial in The Gambia, designed principally to measure the effect of zinc supplementation on growth, found that children given zinc made 32% fewer visits to the health center because of malaria (confirmed microscopically) [4]. However, this difference was not statistically significant. While the finding is provocative, the study was not optimally designed for a malarial outcome, and had several important limitations (including a small sample size, a twice-weekly dose of zinc and no precise definition of malarial illness). Subsequent work from Papua New Guinea was more convincing [5]. In a community-based study, a 46-week period of daily zinc supplementation in preschool children significantly reduced health center attendance attributable to *P. falciparum* by 38% (p=0.037). Episodes accompanied by any level of parasitemia were also reduced by 38% (p=0.028) and episodes with blood parasite counts ≥100,000/μL were reduced by 69% (p=0.009).

In contrast, a community-based trial of zinc supplementation in Burkina Faso failed to demonstrate a protective effect of zinc in children aged 6–31 months on the incidence of febrile episodes of falciparum malaria, malaria severity or anemia [6]. Still, the cross-sectional prevalence of falciparum malaria and of parasitemia due to *P. falciparum*, *P. malariae* and *P. ovale* were all significantly lower in children supplemented with zinc. In addition, the mean density of *P. falciparum* increased significantly during the study in the placebo group relative to the supplemented group. Thus, zinc supplementation appeared to provide benefits in terms of several key measures. The study also noted other beneficial effects of zinc supplementation such as a significant reduction in the number of days with diarrhea and a trend towards reduced mortality.

It is not clear why the incidence of clinical episodes of malaria was not affected by zinc. One possibility is that the sample size was too small to measure this effect, since the proportion of febrile malaria episodes of all children with positive blood smears was relatively small. Another possibility is that the prevalence of significant impairment of zinc status in the population under study was too low. Using a cutoff point for zinc deficiency of 60 μg/dL, only a small proportion of these children would have been considered to be zinc deficient at baseline, as the mean zinc concentration was 76.5 μg/dL. Theoretically, zinc might have a greater effect on clinical malaria if used in a population where zinc deficiency is widespread.

A study in the Peruvian Amazon found that zinc, both alone and in combination with iron, was protective against *P. vivax* among children less than 5 years old [7]. There were too few episodes of falciparum malaria to evaluate the impact on *P. falciparum*. A protective effect of zinc was not found in older children.

Combined vitamin A+zinc has greater effect

A more recent trial in Burkina Faso, using the combination of a single large dose of vitamin A and a daily zinc supplement, found a significant reduction in clinical malaria episodes, a prolongation of time to first malaria episode and reduced episodes of fever [8]. Combining the two micronutrients might therefore explain the greater impact on malaria episodes in contrast to the earlier study of zinc alone in that country.

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[continued from page 6]

Participants wishing to make an oral or poster presentation describing new findings on the meeting topics are encouraged to submit abstracts before the August 2008 deadline. Presentations should relate to, but are not limited to, the micronutrient deficiencies of primary interest to the Micronutrient Forum (vitamin A, iron, folate, iodine, zinc).

Abstracts must reach the organizers by August 15, 2008. They can be submitted directly at: https://aed.conference-services.net/authorlogin.asp?conferenceID=1411&language=en-uk

For more information about this meeting, see the Micronutrient Forum website at: http://www.micronutrientforum.org/meeting2009/ or contact the Micronutrient Forum Secretariat, A2Z Project, AED, 1825 Connecticut Avenue NW, Washington DC, 20009; e-mail mnforum@aed.org.

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News in brief:

Making food fortification sustainable in Central Asia

At the third Almaty Forum on Food Fortification [1], participants* reviewed the progress achieved with the regional project 'Improving Nutrition for Poor Mothers and Children in Central Asia' which is being implemented in Azerbaijan, Kazakhstan, Kyrgyz Republic, Mongolia, Tajikistan and Uzbekistan. This project (funded by the Japan Fund for Poverty Reduction, and implemented by the Asian Development Bank (ADB), the United Nations Children's Fund (UNICEF), the Kazakh Academy of Nutrition (KAN), national governments, NGOs and private industries) aims at establishing mandatory fortification in the region, of salt with iodine, and of wheat flour with vitamins and minerals.

The Forum reaffirmed the commitments, made in 2004, that at least 90% of households should regularly consume iodized salt, and at least 33% of wheat flour should be fortified (60% in Kazakhstan). It also called upon all the countries to anchor food fortification strategies as an integral part of national development plans and budgets, to strengthen an effective national fortification alliance involving government, industry and academia, to complete legislation and regulations requiring flour fortification, to ensure that imported fortified foods meet national standards, to remove barriers to procurement of fortificants and fortification equipment, to educate consumers about the importance and safety of fortification, to strengthen communication and collaboration between countries, to establish a national surveillance system, and to set aside adequate funds for these measures. The Kyrgyz Republic, Tajikistan, and Uzbekistan will also establish an effective and high quality system for quality control and assurance.

* **Participants**: Key partners in food fortification in Central Asia, including the funding and implementing organizations, senior officials and leaders of the private sector and civil society, and representatives of the Global Alliance for Improved Nutrition (GAIN), the International Association of Operative Millers (IAOM) and the Flour Fortification Initiative (FFI).

1. *Third Almaty Forum 2007. Making food fortification sustainable. Almaty, Kazakhstan. Web address: http://www.adb.org/Projects/sustainable-food-fortification/default.asp*

Photos
Title page and page 2: WFP 2008/Peter Smerdon; page 3: Sight and Life; page 4: SUSTAIN

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