SCALING UP MICRONUTRIENT PROGRAMS: WHAT WORKS AND WHAT NEEDS MORE WORK?

The 2008 Innocenti Process

micronutrient forum

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This report is a **Micronutrient Forum publication**. The Micronutrient Forum serves as a stimulus for policy-relevant science and as an internationally-recognized catalyst for moving the global community toward consensus around evidence-based policies and programs that reduce micronutrient deficiencies around the globe. Established in 2006, the Forum consolidates and expands on more than thirty years of successful leadership by the International Vitamin A Consultative Group (IVACG) and the International Nutritional Anemia Consultative Group (INACG). The Micronutrient (MN) Forum focuses on the micronutrient deficiencies of public health significance, particularly vitamin A, iron, folate, iodine, and zinc.

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The 2008 Innocenti Process

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FOREWORD

The Micronutrient Forum has a history of examining policy-relevant scientific issues to catalyze evidence-based policies and programs that reduce micronutrient deficiencies in developing countries. The Micronutrient Forum initiated a process that critically examined knowledge related to program implementation in real world settings and culminated in a meeting at the UNICEF Innocenti Research Centre in Florence, Italy, in September 2008. A similar process was undertaken in 2005 to explore the biologic and clinical evidence underlying the policies these programs were designed to implement. The Micronutrient Forum recognizes the continuum from scientific discovery, through developing and testing tools and technologies, to, finally, implementing large-scale programs. The Forum seeks to support and strengthen on-going initiatives of global partners, researchers, and country program managers and implementers who are enhancing the health and development of the most vulnerable groups around the world.

The 2008 Innocenti Process involved three main features: (1) critically reviewing the evidence from real-world programs implemented at scale; (2) engaging and giving "center stage" to views of country-level program managers and implementers; and, (3) building consensus among key stakeholder groups on what programs have worked (strength of evidence), what makes those programs work, and what needs more work. The results, the basis of this report, reveal much about scaling up interventions; but they also reveal that large gaps remain in our understanding of the capabilities, resources, and strategies needed to implement programs effectively and to demonstrate measurable and meaningful impact.

Vital gaps in our understanding must still be addressed. Until they are, micronutrient deficiencies affecting more than a billion mothers and children in developing countries will continue to take their toll, leaving in their wake an unacceptable burden of preventable morbidity and mortality, and lost opportunities for human, social, and economic development. A solid foundation of scientific evidence has led to broad consensus on "what" to do—the challenge remains in identifying "how" to do it and translating basic research findings into large-scale, effective programs that contribute to achieving the Millennium Development Goals. This report provides concrete recommendations on how we can all begin to tackle this important challenge.

Alfred Sommer, MD MHSc
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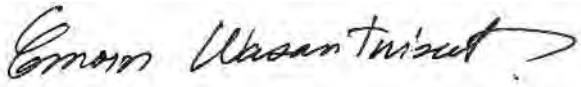

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EXECUTIVE SUMMARY

Background

The importance of micronutrient (MN) interventions to reduce mortality and morbidity in developing countries has been highlighted in recent high profile publications, and several ongoing global initiatives seek to accelerate Millennium Development Goals (MDG) achievement through MN and other nutrition interventions. Major challenges exist—not in knowing which interventions can produce the desired results—but in delivering these interventions at scale to populations deficient in essential micronutrients. Focusing on improving the effective delivery of MN programs, the Innocenti Micronutrient Program Meeting:

- Reviewed, discussed, and synthesized evidence on large-scale program implementation and impact;
- Assisted in moving global partners and country-level program managers toward a consensus on appropriate programming guidance; and,
- Recommended to the Micronutrient Forum priorities to improve the performance and effectiveness of scaled-up MN programs.

The Micronutrient Forum commissioned a process, which we refer to as the "2008 Innocenti Process," that involved three main features: (1) critically reviewing the evidence from real-world programs implemented at scale; (2) engaging and giving "center stage" to views of country-level program managers and implementers; and, (3) building consensus among key stakeholder groups on what programs have worked (strength of evidence), what makes those programs work, and what needs more work.

Methods

Four background papers were prepared for the meeting. These included (1) a framework for evaluating evidence on supplementation and fortification program implementation and impact in the unique policy and programming contexts of particular countries; (2) a review of evidence from selected case studies on large scale supplementation and fortification programs; (3) a review of evidence on the micronutrient impact of strategies that combine nutrition interventions that address immediate causes of MN deficiencies with poverty-alleviation and income-generating approaches, including conditional cash transfers, micro-credit and agriculture/home food production; and, lastly, (4) telephone survey results on barriers/enablers experienced by country-level micronutrient nutrition program implementers, many of whom participated in the meeting. This telephone survey engaged implementers early in preparing for the meeting and ensured their views were incorporated in the process. Representatives from three different stakeholder and expertise groups participated including country-level implementers, global-level partners, and program-oriented academics.

Results

Overarching Issues Affecting Micronutrient Program Implementation:

The following nine cross-cutting issues affecting the MN community's ability to accelerate scaling-up and documenting evidence-based, effective large-scale MN programs were identified:

- Key stakeholders share common MN goals but lack the leadership to coordinate priority-setting, advocacy, and action;

- Stakeholder groups within the MN community do not communicate effectively with one another;
- Stakeholders have misaligned and often competing priorities and approaches at both global and country levels. This has impeded coordinated actions and slowed progress in achieving common goals;
- The MN community has not adequately engaged with broader nutrition, health, or development initiatives;
- The MN community has not harnessed the full potential of private sector resources, expertise, and delivery mechanisms to improve MN products, services, and delivery platforms;
- Country teams lack guidance and are not empowered to assess needs systematically and facilitate evidence-based decision-making;
- Weak program monitoring, evaluation, and documentation of performance and impact of MN interventions hinders efforts to strengthen programs, advocacy, accountability, and guidance to country-level managers;
- Achieving MN goals is impeded by the overall paucity of nutrition funds; and,
- Limited funding for implementation research restricts our understanding of how best to strengthen the design, management, implementation, evaluation, and financing of MN programs at scale.

Intervention-specific Conclusions

Consensus on the strength of evidence on specific large-scale MN interventions resulted in the following categorization and conclusions:

Strong evidence of effective implementation and impact at large-scale:

- *Pre-school vitamin A supplementation:* Twice-annual vitamin A supplementation of children 6-59 months using a 'Child Health Day' delivery model has shown sustained success in maintaining high coverage (>80% twice-annually) in many countries. This intervention has likely contributed to mortality declines observed in some countries. Extending that coverage to all children, particularly the hard-to-reach and most vulnerable is expected to make an even greater contribution toward reaching the MDG4 goal of reducing under-five mortality.
- *Mass fortification programs:* Compelling evidence shows that, under the right conditions, mass fortification programs can be effectively implemented and achieve measurable impact on MN status and outcomes. Three examples include salt iodization, vitamin A-fortified sugar, and folic acid-fortified wheat flour. These programs produced population level impacts when the fortified food delivered sufficient amounts of a bioavailable nutrient to a large proportion of the at-risk population. Each program was deemed to be highly cost-effective.

Micronutrient interventions needing further confirmation of implementation effectiveness and impact:

- *Maternal iron and folic acid supplementation (IFA):* Descriptions of well implemented, national maternal IFA supplementation programs were found for only two countries even though evidence exists of iron supplementation programs for about 50 countries based on Demographic and Health Survey data. Substantial reductions in maternal anemia prevalence were documented in both countries, but given the multiple etiologies of anemia, secular trends, and concurrent interventions, the proportion of anemia reduction attributable to IFA supplementation could not be quantified. Evidence from well-designed and implemented IFA programs is needed to demonstrate program impact in real-world settings.

- *Iron fortification programs:* To date, many large-scale iron fortification programs have failed to demonstrate a measurable impact on anemia prevalence because they used iron fortificants with low bioavailability and/or because consumption by the at-risk population was low. More evidence is needed from iron fortification programs using bioavailable forms of iron.

Newly emerging micronutrient interventions that hold promise but lack implementation experience at large scale:

- *Home-based fortification:* Home fortification with MN powders provided free of charge has been implemented effectively at scale in a few contexts, and impact data has indicated promise. One study in Kenya established the feasibility, at least in the short term, of selling the powders through a community-based distribution system.
- *Zinc treatment for diarrhea:* Many countries have programs that include zinc treatment in managing diarrhea, but these are largely just starting. The program's major barrier is the overall poor performance of diarrhea programs. Finding locally or regionally manufactured high quality zinc products that are registered for use in each country is also a major barrier.
- *Poverty reduction strategies:* Poverty reduction programs such as conditional cash transfers, microcredit, and agricultural interventions that include nutrition components show limited evidence for improved MN impact. One exception is Mexico's well-documented *Oportunidades* program that has had positive impact on reducing iron deficiency anemia in young children. These broader programs hold great potential to improve MN malnutrition and strengthening the design and implementation of their nutrition components should be prioritized.

Call to Action

The following recommendations begin to address the overarching issues described above:

1. Advocate for a global leadership group or mechanism that will develop a unified voice on MN priorities and strategies, enhance global advocacy, and strengthen programming coordination;
2. Enhance communication among MN stakeholder groups;
3. Create mechanisms that promote and reward productive collaboration among stakeholders for effective, large-scale implementation of MN interventions;
4. Design and implement a proactive strategy to strengthen linkages between the MN community and the broader nutrition, health, and development initiatives;
5. Create new opportunities to advance regular public-private sector dialogue and collaboration to solve MN problems based on where public and private sector priorities merge, and a set of mutually agreed upon principles for interaction;
6. Develop guidance to help country teams systematically assess the nutrition situation and the effectiveness of existing programs in their countries to facilitate evidence-based decision-making;
7. Develop in-country capacity to design and implement strategic systems that monitor, evaluate, and document MN program performance and impact;
8. Mobilize funds for large-scale MN interventions; and,
9. Increase funds for implementation research to improve our understanding of the best ways to design, manage, implement, and finance MN programs at scale within different country or regional contexts.

BACKGROUND

The importance of micronutrient (MN) interventions to reduce mortality and morbidity in developing countries has been highlighted in recent major publications. The 2008 Lancet series on Maternal and Child Undernutrition reported that deficiencies of vitamin A and zinc were responsible for 0.6 million and 0.4 million child deaths, respectively, and iron deficiency, as one risk factor for maternal mortality, with an associated additional 115,000 maternal deaths.[1] Bhutta et al.[2] reviewed interventions that reduced morbidity and mortality resulting from undernutrition and recommended that 14 interventions be implemented in all high-need countries; 8 are direct and 3 are indirect MN interventions (Table 1). The Copenhagen Consensus 2008 identified vitamin A and zinc supplementation as the first priority, and iron fortification and salt iodization as the third priority, among 30 interventions for confronting ten great global challenges.[3] Several important ongoing initiatives directly or indirectly related to MN programming currently build on the momentum created by the Lancet Series. These include efforts to strengthen the 'global architecture' of nutrition, interagency efforts to reduce hunger and undernutrition (e.g. REACH),[4] the WHO Nutrition Landscape Analysis that seeks to assess readiness of countries to implement nutrition programs, a 10-year strategy to reduce vitamin and mineral deficiencies,[5] the Mainstreaming Nutrition Initiative (supported by the World Bank),[6] and calls for global partners to increase efforts to coordinate technical and financial support to governments interested in delivering proven and highly cost-effective MN interventions.[7]

Solid scientific evidence has led to broad consensus on the efficacy of MN interventions.

Recommended Direct and Indirect Micronutrient Interventions for Mothers, Newborns, Infants, and Children, Based on the 2008 Lancet Series.[1,2]

MATERNAL AND BIRTH OUTCOMES	TYPE OF MICRONUTRIENT INTERVENTION
Iron folate supplementation	Direct
Maternal supplements of multiple micronutrients	Direct
Maternal iodine through iodization of salt	Direct
Maternal calcium supplementation	Direct
NEWBORN BABIES	
Promotion of breastfeeding (individual and group counseling)	Indirect
INFANTS AND CHILDREN	
Promotion of breastfeeding (individual and group counseling)	Indirect
Behavior change communications for improved complementary feeding	Indirect
Zinc supplementation	Direct
Zinc in management of diarrhea	Direct
Vitamin A fortification or supplementation	Direct
Universal salt iodization	Direct

Table 1 - Recommended Direct and Indirect Micronutrient Interventions for Mothers, Newborns, Infants, and Children, Based on the 2008 Lancet Series.[1, 2]

The Innocenti Meeting on Micronutrient Research[8] conducted a systematic review of the biological effectiveness of improving MN status. However, translating scientific findings into national-scale policies and effective programs has proved challenging and was the focus of this second Micronutrient Forum Innocenti Consultation.

Limited evidence exists on "how" to transform interventions of known efficacy in controlled settings into programs delivered at scale in a variety of country-specific contexts. Addressing this gap would help use resources more effectively by bringing evidence into policy-making, program design, and subsequent program evaluation and refinement. The Micronutrient Forum initiated a process to review critically the evidence on programs that address vitamin and mineral deficiencies to determine (1) what interventions work at scale and how we know they work, and (2) gaps in evidence, experience, and documentation of MN program performance and effectiveness. Building a stronger knowledge and evidence base on effective implementation and MN program impact will assist the nutrition community to advocate for including these interventions in national programs, demonstrate to funders the excellent value of MN program investments, and strengthen global consensus on the most appropriate guidance for country-level MN program managers.

The "2008 Innocenti Process" was characterized by three main features: (1) critically reviewing the evidence from real-world programs implemented at scale; (2) engaging and giving "center stage" to views of country-level program managers and implementers; and, (3) building consensus among key stakeholder groups on what programs have worked, what makes those programs work, and what needs more work. The "process" culminated in a meeting at the UNICEF Innocenti Research Centre in Florence, Italy, in September 2008 that:

- Reviewed, discussed and synthesized evidence of large-scale program implementation and impact;
- Assisted in moving global partners and country-level program managers toward a consensus on appropriate programming guidance; and,
- Recommended to the Micronutrient Forum priorities to improve the performance and effectiveness of scaled-up MN programs.

The 2008 Innocenti Process

- Critically reviewed evidence from real-world programs implemented at scale
- Engaged and gave "center stage" to views of country-level program managers and implementers
- Built consensus among key stakeholder groups on what programs work, and what needs more work

Figure 1 - The 2008 Innocenti Process

METHODS

Preparation

Four background papers were prepared for the meeting:

- Houston and Pelletier[9] developed an "Assessment Tool" describing a framework for evaluating evidence on supplementation and fortification program implementation and impact in the unique policy and programming contexts of particular countries. This tool provided a methodology for systematically assessing key MN intervention program components, and evidence related to their implementation and impact. This tool was envisioned to provide a new framework for planning, implementing, scaling-up, and evaluating MN programs tailored to each country's specific context.
- Dary et al.[10] reviewed the evidence from selected case studies of large scale supplementation and fortification programs. Using the Assessment Tool described above, this review critically examined major MN interventions and delivery mechanisms implemented at scale.
- Leroy et al.[11] reviewed evidence on the MN impact of strategies that combine nutrition interventions that address the immediate causes of MN deficiencies with poverty-alleviation and income-generating approaches, including conditional cash transfers, microcredit, and agriculture/home food production.
- Faillace et al.[12] reported on a telephone survey on barriers/enablers experienced by country-level MN program implementers, many of whom participated in the meeting. Engaging participants in this survey grounded the meeting discussions in current realities of developing and implementing MN policies and programs.

Background Papers for the Innocenti Micronutrient Program Meeting

Figure 2 - Background Papers for the Innocenti Micronutrient Program Meeting

The Innocenti Consultation

The consultation took place at the UNICEF Innocenti Research Centre in Florence, Italy, 22-25 September, 2008. Representatives from three different stakeholder and expertise groups participated (see Appendix 1 for participant list):

- Country-level implementers from Ministries of Health in Africa, Asia, and Latin America;
- Global partners (A2Z, Bill & Melinda Gates Foundation, GAIN, Helen Keller International, IMMPaCt/CDC, Mainstreaming Nutrition Initiative, Micronutrient Initiative, REACH, UNICEF, USAID, World Bank, World Food Program, World Health Organization, World Vision);
- Program-oriented academics from universities and research centers;

The Innocenti meeting combined full-group presentations and discussions, and smaller group break-out sessions. Country-level implementers also attended a one-day pre-conference workshop that focused on finalizing the telephone survey results[12] and soliciting feedback on the draft MN program Assessment Tool.[9]

The meeting's expected output was a set of consensus statements addressing: (1) overarching issues affecting MN program implementation in general; (2) intervention-specific issues related to implementation performance, effective scale-up, and impact; (3) recommendations for improving program implementation, effectiveness, and documentation; and, (4) a call to action.

RESULTS

1. OVERARCHING ISSUES AFFECTING MICRONUTRIENT PROGRAM IMPLEMENTATION

This report presents two sets of results that emerged from the Innocenti discussions: (1) broad themes and issues extending across most, if not all, large-scale MN programs, which are termed "Overarching Issues"; and, (2) intervention-specific issues pertaining to a particular MN intervention (e.g. pre-school vitamin A supplementation) or class of interventions (e.g. fortification).

Participants identified the following nine cross-cutting issues affecting the MN community's ability to accelerate scaling-up and documenting evidence-based, effective large-scale MN programs.

Key stakeholders share MN common goals but lack the leadership needed to coordinate priority-setting, advocacy, and action.

Participants—global partners, universities and research centers, and country implementers—confirmed holding common goals. All seek to improve maternal health and birth outcomes, and child survival and child development, through implementing large-scale efficacious MN interventions. Participants agreed, however, that the MN community has not developed a unified voice on priorities and strategies and this has hampered its ability to create a sharp focus on key MN problems and solutions. The MN community lacks coordinated global leadership with a mandate and resources to develop a core strategy for

addressing MN problems. The MN community needs to strive for balanced stakeholder representation on governing bodies; adopt operating procedures and clearly define roles and responsibilities; practice partner-wide planning; establish systems for managing conflicts of interest; ensure that basic elements of transparency are observed; and practice mutual accountability.

Stakeholder groups within the micronutrient community do not communicate effectively with one another.

Stakeholder groups within the MN community are inter-dependent. Country implementers need to know they are implementing the correct interventions, have the capacity to design and manage interventions at scale, and operate in enabling technical and financial environments. Researchers and scientists need resources to advance knowledge about the causes of, risks of, consequences of, and solutions to MN deficiencies. Their findings must be effectively translated and used by policy makers and program implementers. Global partners and donors need to make sound investments in MN research and programming by documenting implementation and impact. Despite the clarity and inter-dependence of groups' needs, poor communication and other barriers within and among stakeholder groups have prevented effective collaboration. Meeting participants strongly expressed the need to enhance communication by increasing the frequency and quality of opportunities for interaction.

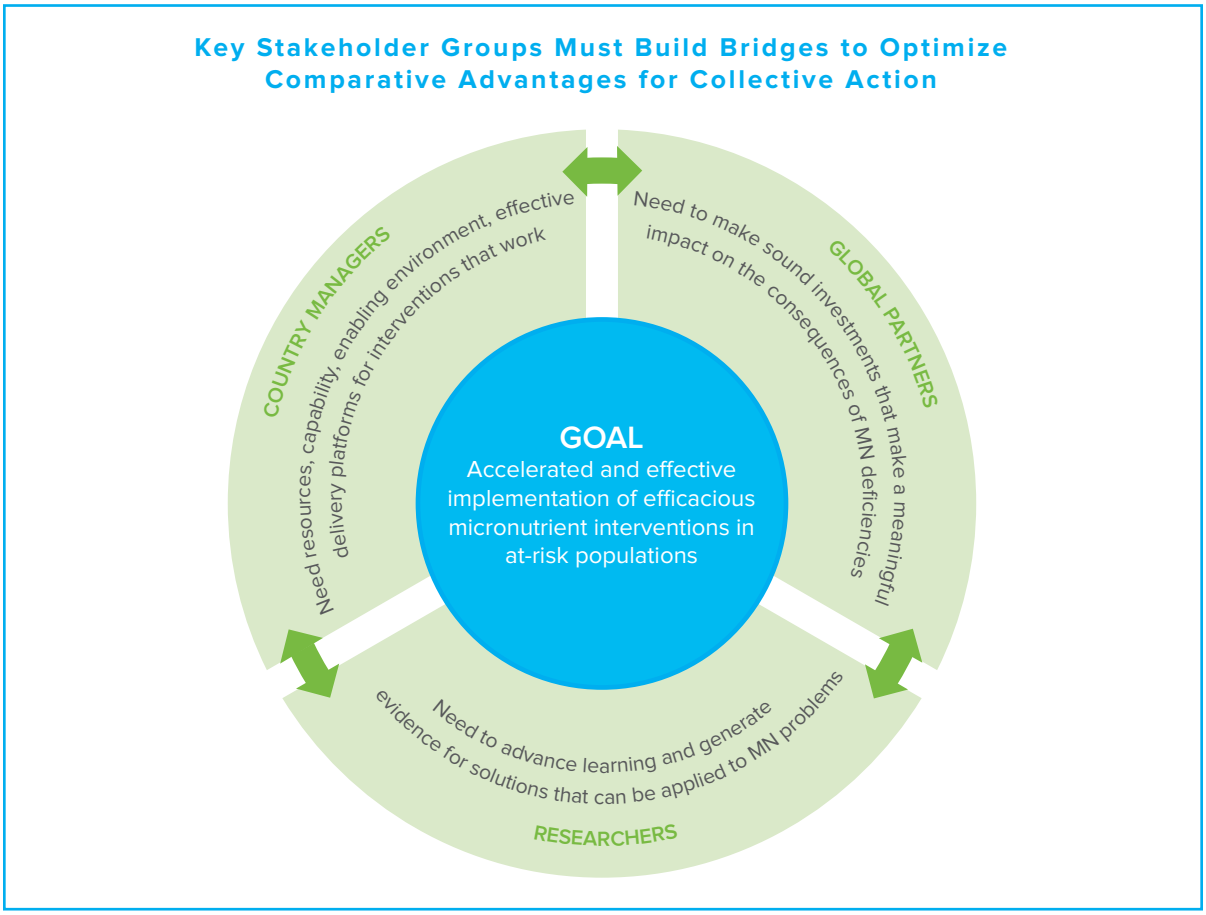

Figure 3 - Stakeholder Groups

Stakeholders have misaligned and often competing priorities and approaches at both global and country levels. This has impeded coordinated actions and slowed progress in achieving common goals.

This situation stems partly from "solutions-based" approaches that gave rise to different global stakeholder groups (e.g. supplementation, fortification, dietary diversification). It is made worse by the communication barriers noted above and the low priority and paucity of resources given to MN and nutrition at global and country levels. In some cases funding mechanisms encourage competition when cooperation would be more helpful. Furthermore, stakeholders advocate for different solutions and target policy makers with conflicting messages. This fosters uncoordinated and at times inconsistent guidance to country managers on policy development and program implementation.

"THERE WAS A COMMON BELIEF AMONG THE INNOCENTI MEETING PARTICIPANTS THAT THE MICRONUTRIENT COMMUNITY IS NOT YET ALIGNED AND WORKING TOGETHER, BUT THAT THE COLLECTIVE VISION WAS TO FIND WAYS TO WORK AND PARTNER TOGETHER IN MORE EFFICIENT WAYS WITHIN AND OUTSIDE THE MICRONUTRIENT COMMUNITY"

(Innocenti Meeting, Proceedings)

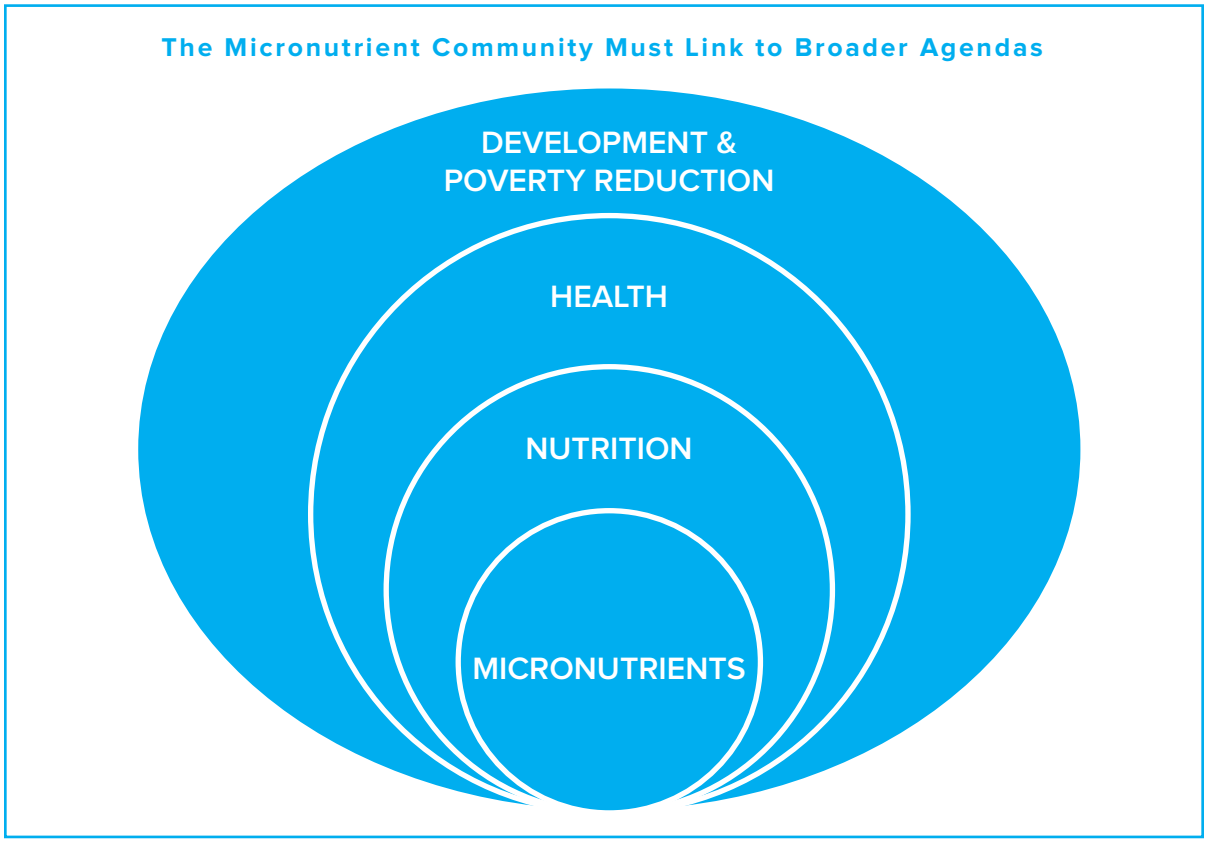

Figure 4 - Linking with Broader Agendas

The micronutrient community has not adequately engaged with the broader nutrition, health, or development initiatives.

The value of MN interventions has not been widely embraced outside the MN community. Innocenti participants recognized important opportunities to scale up MN interventions through stronger linkages with the broader nutrition, health, and development initiatives such as the International Health Partnership and the Global Fund to Fight HIV, Tuberculosis and Malaria. Unified, coherent agendas for MNs and nutrition in each country are pre-requisites for this engagement to be effective. In some instances MN interventions have been integrated into poverty reduction programs such as conditional cash transfers, micro-credit with education, and agricultural production.[11] While long promoted as essential for sustainable MN interventions, with the exception of Mexico's *Oportunidades* program, few well documented successes exist.

The micronutrient community has not harnessed the full potential of private sector resources, expertise, and delivery mechanisms to improve micronutrient products, services, and delivery platforms.

The private sector is vital in improving MN nutrition in deficient populations. However, real and perceived barriers between public and private sectors have hampered greater collaboration in developing, producing, and distributing MN commodities and behavioral messages. Effective public-private collaborations have contributed substantially to success with food fortification programs, product development (e.g. micronutrient powders, zinc tablets), and message distribution (e.g. educating physicians through commercial distribution networks). Both sectors are wary to collaborate when institutional missions are misunderstood, a clear common agenda is lacking, regulation and enforcement are weak, and/or partner leveraging is one-sided. As a result the public sector does not benefit from the experience and platforms of the private sector, and the private sector has limited opportunities to develop and market new products that address emerging public health issues.

Country teams lack guidance and are not empowered to assess needs systematically and facilitate evidence-based decision-making.

Participants identified the need for a structured approach to using available data to strengthen the assessment, design, implementation, and documentation of context-specific micronutrient policies and programs. Participants reviewed the assessment methodology developed for this meeting and concluded that if simplified and tested in several contexts, the methodology could systematically assess implementation problems, generate potential solutions, and document implementation performance and impact. Participants also agreed that further refining the methodology through facilitated, in-country workshops would create much-needed opportunities for constructive interaction between global- and country-level stakeholders to build trust and bridge communication barriers.

Weak program monitoring, evaluation, and documentation have hindered efforts to strengthen MN programs, advocacy, accountability, and guidance to country-level managers.

Participants recognized the critical evidence gaps in how to deliver effective MN interventions at scale and in different contexts. The capacity, resources, and commitment to fill these gaps are lacking. Bridging them will bring timely and useful information into policy-making, program design and management decisions, and assist advocacy to promote including MN interventions and resources in national programs and budgets. Governments and external funders will use the evidence to assess the soundness of their investment decisions. Major challenges in filling these gaps require designing strategic monitoring and evaluation systems that build rather than overwhelm current country capacity, and that are feasible, valid, and valued (i.e. the benefits of collecting, analyzing, and reporting the data outweigh the costs of collecting them). A key challenge for researchers is in balancing the need to build program design and evaluation capacity, and to maintain independence and objectivity in judging program success.

Achieving micronutrient goals is impeded by the overall paucity of nutrition funds.

The group agreed that far too little funding exists to implement MN interventions at scale. Donor spending for international nutrition, excluding food aid, presently totals about $250 million per year, one-tenth the amount spent on HIV/AIDS (Figure 6).[7] Global resources for nutrition programming are urgently needed. The REACH group calculated that nutrition programs globally require at least $4 billion annually.[13] Innocenti participants strongly agreed that much higher levels of funding for nutrition must be mobilized than are currently available. The "hidden face" and complex underlying causes of malnutrition may make resource mobilization more challenging compared with discrete disease-specific problems that have an effective single intervention. Nonetheless, the MN community must create a strategic unified advocacy

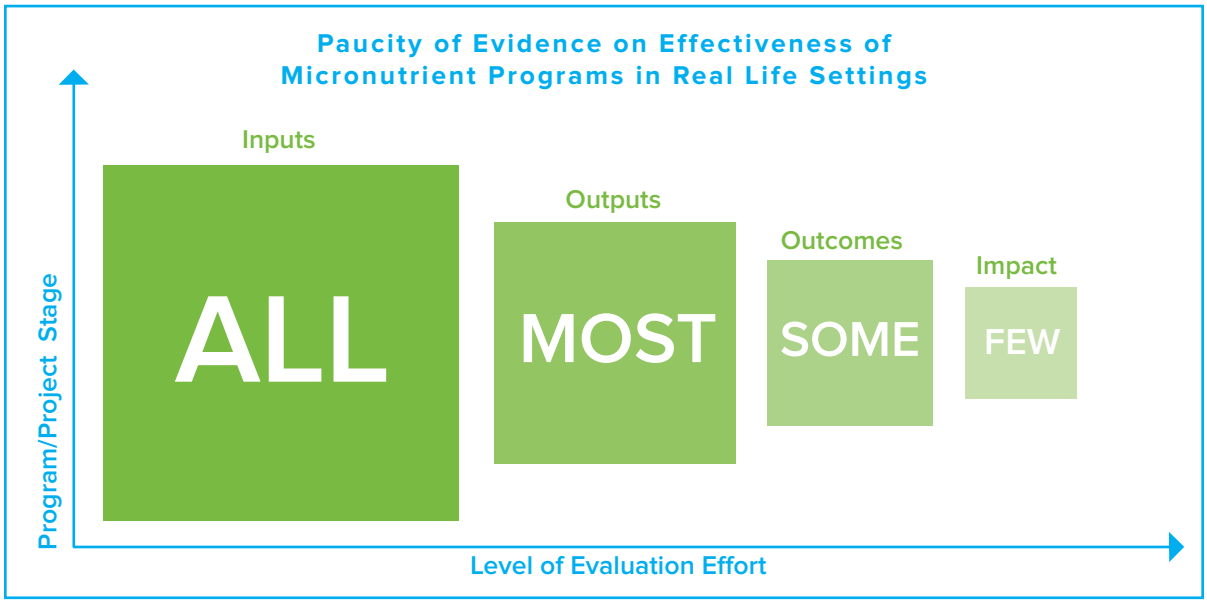

Figure 5 - Paucity of Evidence

platform to leverage opportunities to broaden its resource base. The role vitamins and minerals play in helping countries achieve the Millennium Development Goals established by the 2008 Lancet series will guide advocacy efforts. Further, top economists at the Copenhagen Consensus 2008 confirmed the cost-benefit of such investments.

Limited funding directed to implementation research restricts our understanding of how best to design, manage, implement, evaluate, and finance micronutrient programs at scale

Vital advances have been made by MN research investments and provide a strong evidence-base on causes and consequences of MN deficiencies and on the efficacy of MN interventions. Continued advances in such research are needed, particularly in valid and field-friendly MN assessment methodologies and testing new interventions. However, the paucity of research funds invested in implementation and delivery science impedes effective scale-up efforts. More research funds are needed to address how best to deliver, use, and sustain proven MN interventions (i.e. 'how' to do it rather than 'what' to do).

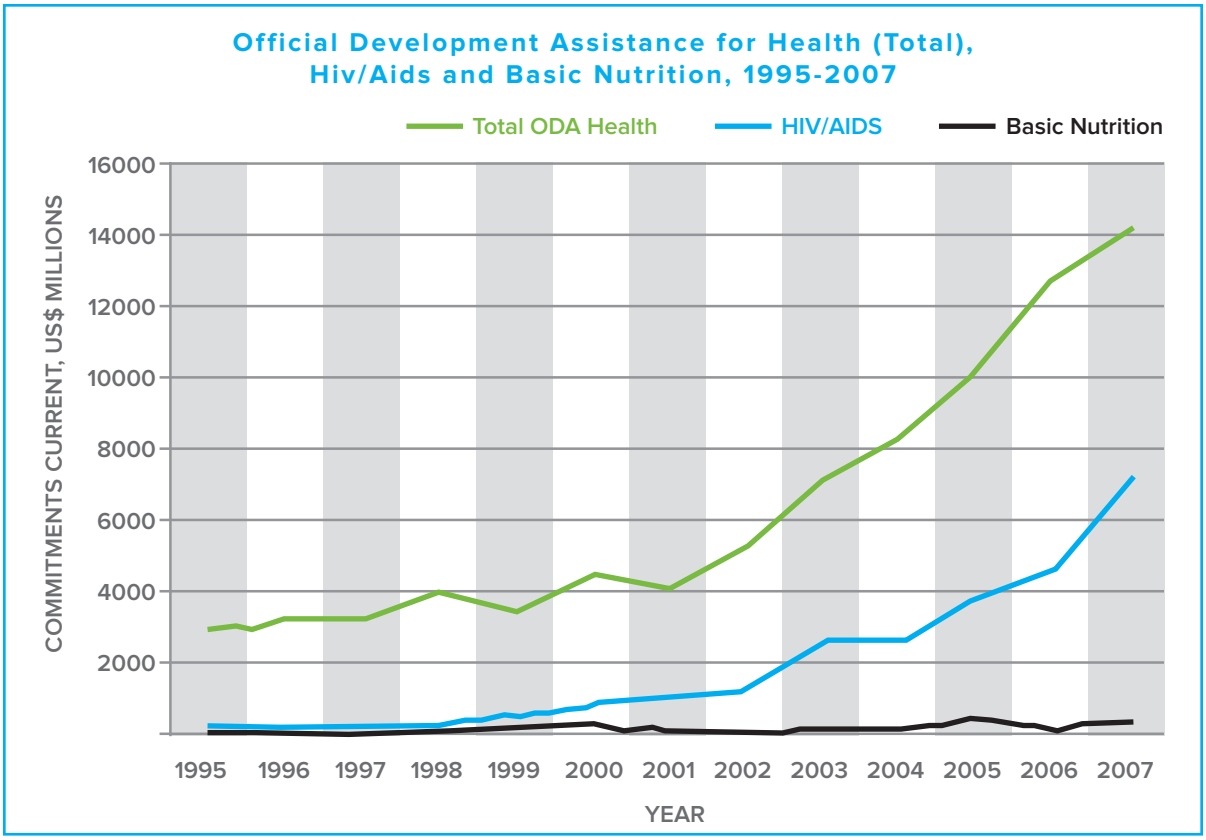

Figure 6 - Official Development Assistance for Health (Total), HIV/AIDS and Basic Nutrition, 1995-2007
Source: OECD Stat Extracts, http://stats.oecd.org/WBOS?Index.aspx?DatasetCode=CRSNEW

2. INTERVENTION-SPECIFIC CONCLUSIONS

2.1 Pre-school Vitamin A Supplementation

Pre-school vitamin A supplementation involves supplementing children 6-59 months of age with a high-dose of vitamin A twice each year (100,000 IU for children 6-11 months and 200,000 IU for children 12-59 months).

Strength of Evidence on Large-scale Effectiveness

The selected literature review assessed six country programs that primarily used twice-yearly, event-style distribution days or weeks—Bangladesh, Cambodia, Ghana, Indonesia, Nepal and Tanzania.[10] All six country programs had well documented evidence of high coverage, measured by both aggregated reports from distribution sites and periodic coverage surveys at various geographic levels. These coverage rates are similar to those achieved by efficacy trials that demonstrated a survival benefit of 24 percent – 32 percent[14,15] among pre-school children receiving vitamin A. Evidence from Nepal,[16] Tanzania,[17] and Niger[18] demonstrated plausible associations between high vitamin A coverage and trends showing decreases in child mortality.

Global coverage figures from 2004 indicate that 58 percent of children 6-59 months old received two annual doses of vitamin A[19] —a major increase from 16 percent in 1999 (Figure 7). Approximately 70 countries

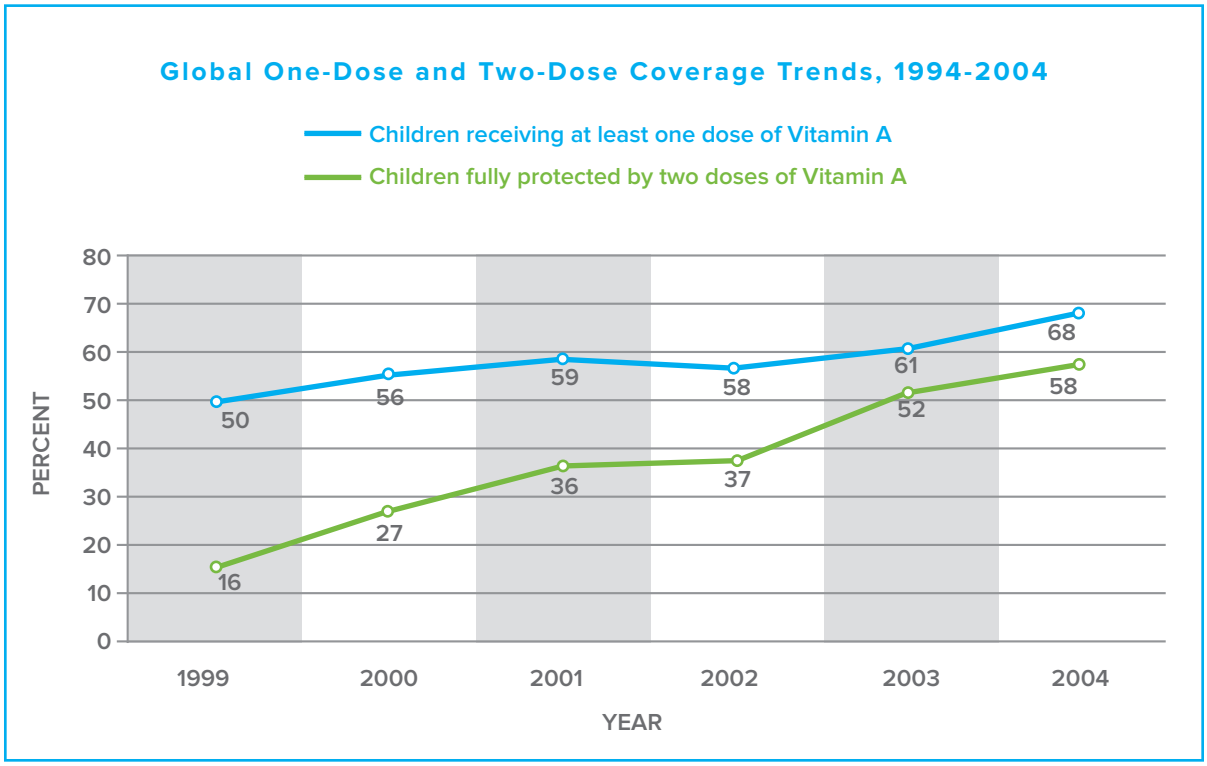

Figure 7 - Global One-Dose and Two-Dose Coverage Trends, 1994-2004
Source: UNICEF, Vitamin A Supplementation: A Decade of Progress, The United Nations Children's Fund (UNICEF), 2007

currently provide vitamin A supplementation for children less than five years of age, and 44 of these have surpassed 70 percent coverage with at least one annual dose.[19] Far fewer countries are reaching children with the recommended second dose, and only 15 countries have sustained high, twice-annual coverage for three years or more.[19]

Features Associated with Program Success

Successful large-scale universal vitamin A supplementation has several features:

Political commitment: Global partners and some governments have provided substantial and sustained financial and technical support to these programs based on compelling evidence for vitamin A supplementation as a cost-effective child survival strategy.

Logistics: Successful supplementation programs require securing reliable supplies of capsules or syrup in a timely manner. In support of this, the Micronutrient Initiative, with funding from the Canadian International Development Agency, has procured nearly five billion vitamin A supplements distributed globally over the past ten years. Still, vitamin A deficiency prevention costs, including the low cost of the commodity itself, should ideally be distributed across stakeholders, including host governments. Establishing the ability and willingness of countries currently implementing vitamin A supplementation to finance part or all of their supplement procurement costs, in the event of donor withdrawal or reduction in support, is a critical step toward achieving sustainability.

Delivery platform: Vitamin A supplementation coverage increased when "piggy-backed" onto the National (Polio) Immunization Day programs (NIDs) in the 1990s.[20] Some countries achieved alternate (non-NIDs) six-monthly coverage through special vitamin A days or weeks.[21] As NID activities have ended over the past few years, an increasing number of countries adopted twice-annual outreach events that package locally-appropriate, preventive health services along with vitamin A supplementation.[22,23] Added services include deworming, immunizations, bednets for malaria control, growth monitoring/promotion, and nutrition education. These health system outreach events are commonly called "Child Health Days/Weeks" and are targeted to children 6-59 months. Countries also use local names, such as Extended Outreach Services (EOS) in Ethiopia, and sometimes extend it to include other family-members such as "Mother and Child Health Weeks." The delivery platforms utilize community-based health workers, often volunteers, as contact points to distribute vitamin A. They have often achieved and sustained high coverage (i.e., ≥80%).

Using routine, fixed-site health center contacts as the sole delivery platform to reach children 6-59 months throughout the year has resulted in much lower coverage levels, in part, because health services are not often used after the immunization period for children,[24] unless the child is ill. Routine health center contacts, however, are often the best way to reach infants with their first dose of vitamin A as soon they turn 6 months—a time when many are particularly vulnerable to vitamin A deficiency and its adverse consequences.

Social marketing and community involvement: Strong social marketing approaches including mass media have secured active and sustained

community involvement in distribution activities.[25] Overall, however, supplementation remains largely a push- rather than demand-driven intervention, among both policy makers and consumers. Sustaining high coverage among target groups requires countries to improve capacity for community outreach and mobilization, and generate community awareness of the benefits of continued vitamin A supplementation, in addition to procuring supplements.

Capacity building: Success also has stemmed from training health workers and community volunteers to understand the rationale for vitamin A supplementation and other preventive services and to deliver them effectively. Interpersonal channels promoted public participation.

Monitoring and evaluation systems: Monitoring and evaluation data has supported advocacy and strengthened policy development and program design and implementation. Indicators for the prevalence of vitamin A deficiency were not reviewed or discussed at the meeting. The most appropriate indicators for supplementation program impact are still being debated. Field study data among young children in the Philippines, India, Indonesia, and Zambia show that serum retinol distributions have not improved after periodic, high-potency vitamin A supplementation. This was not unexpected because controlled clinical trials repeatedly showed that on average, serum retinol levels return to baseline levels three months after supplementation, even though it reduces the xerophthalmia and death risk for 6 months. Field trials over the past two decades have confirmed that vitamin A supplementation at high coverage effectively controls xerophthalmia and reduces mortality under program conditions (i.e., universal, age-appropriate, twice-annual dosing at coverage ≥ 80%). Thus, serum retinol distribution may not be a sufficiently sensitive indicator of public health impact or program performance to be useful for vitamin A supplementation. Coverage remains the desired indicator.

Coverage, increasingly defined as the proportion of children 6-59 months old supplemented twice in the last year, is the indicator that best reflects program performance, and is at present the most useful proxy indicator of public health impact. For 6-59 month-olds, in populations at-risk of vitamin A deficiency as a public health problem, supplementation should be continued until the deficiency, and risk of deficiency, has been reduced by other interventions (e.g. fortification or diet changes). Coverage data assist decision-making, as program managers can direct resources and/or technical assistance to districts with poor coverage. Coverage data also identify best practices in districts repeatedly achieving high coverage that can be replicated elsewhere.

Remaining Challenges

Although progress has been achieved, accelerating and sustaining the gains of vitamin A programs requires further effort. Only 15 countries have reported sustained coverage (>70% for two doses) for three consecutive years[19] because few countries have institutionalized delivery mechanisms to sustain current coverage levels. Where 80 percent twice-yearly coverage shows a country is "on-track," the program goal remains universal coverage, protecting all children by reaching them every six months until age five. Further country-level planning is required to coordinate supplement

delivery through routine, monthly health service outreach to infants after they turn 6 months, with twice-yearly events to cover all children 6-59 months. Ministries of Health must integrate the annual or semi-annual outreach plans into its own planning cycle, ensuring integration into the health system.

Key barriers to sustainable programming exist: Vitamin A supplementation is not a recognized need; regular community outreach required to achieve high coverage through 'campaigns' disrupts 'routine' services; and newly introduced and highly promoted health interventions (e.g., bednets) sometimes compete with vitamin A efforts. Although opportunistic linkages with other interventions produced high coverage in the past, linking vitamin A as a key to child survival has not been effectively communicated. Knowledge, attitude, and practice surveys have revealed this failing at all levels, from consumers to policy makers. The transition from a push-driven to a demand-driven intervention cannot be made without addressing this knowledge gap. Further, generous global support, from the United States and Canadian governments in particular, has driven progress and external technical assistance will be necessary in the medium term. However, to sustain vitamin A programs countries must plan to finance part of or all supplement procurement and other program costs, should donors withdraw or reduce support.

In summary, a dedicated health service delivery platform for packages of preventive services, including vitamin A supplementation, is needed to reach infants as they turn 6 months and continue covering children twice each year through five years. Program sustainability will depend on quality monitoring and evaluation systems, continued political commitment, and dedicated financial resources even as more visible and politically sensitive health issues compete for priority.

Consensus Statement

- Vitamin A supplementation programs can be implemented at scale, generally through "Child Health Day" style strategies, and are likely to reduce under-five mortality in deficient populations when high coverage rates (≥80%) are achieved and sustained over time.
- The goal for vitamin A supplementation programs should be universal twice-yearly coverage with 80 percent as the minimum for countries being considered "on-track." Reaching the last "20 percent", often those unreached by all other health services, will in most cases protect the most vulnerable.
- The desired indicator for monitoring program success should be coverage rate among children 6-59 months of age supplemented twice per year. Improved data quality for monitoring and reporting coverage at all administrative levels is therefore essential.
- Focus on achieving and reporting on high coverage disaggregated by age: infants 6-11 months and to 1-5 year-olds.
- Implement intensive community-based and special outreach strategies to achieve high coverage in areas where coverage is chronically low.
- Vitamin A supplementation programs should be sustained until alternative interventions are shown to reduce this deficiency. The time has come to institutionalize vitamin A supplementation and other child survival interventions at national levels. Vitamin A supplementation and other child survival interventions should become part of the national health system's recurrent programming, planning, financing, delivery, and monitoring systems.

2.2 Iron and Folic Acid Supplementation of Pregnant and Lactating Women

Routine iron supplementation is the current cornerstone of efforts to reduce iron-deficiency anemia during pregnancy. WHO recommends a 6-month regimen of a daily supplement containing 60 mg of elemental iron along with 400 μg of folic acid for all pregnant women. In settings where anemia prevalence is high (>40%), WHO recommends postpartum treatment for three additional months.[26]

Strength of Evidence on Large-Scale Effectiveness

Based on efficacy studies, daily iron supplementation for pregnant women and weekly supplementation for women of reproductive age improves hemoglobin concentration and iron status.[27,28] However, data showing that large-scale daily iron supplementation programs in real-world settings can achieve similar impacts on these outcomes are largely lacking. Some critics argue that large-scale maternal iron and/or iron folic acid (IFA) supplementation programs have rarely if ever had substantial impact on anemia prevalence since they are often not implemented as designed.[29] While preparing the Innocenti review, another group reviewed evidence on weekly supplementation programs (T. Cavalli-Sforza, personal communication), thus these programs were not included.

National iron supplementation programs for pregnant women from Nicaragua and Thailand were reviewed for the Innocenti meeting.[10] These national programs were implemented effectively and anemia prevalence decreased in pregnant women and in women of reproductive age. This review concluded that iron supplementation program components likely contributed to the decreased anemia prevalence, but the evidence available was not sufficient to quantify those contributions. Applying a rigorous evaluation framework to program implementation is challenging given the multiple etiologies of anemia, but without it, firm conclusions about the effectiveness of maternal IFA programs for pregnant women will remain elusive.

Key elements of effective maternal IFA programs are a clear policy, strong political support, delivery through well-attended, high-quality antenatal care (ANC) services, sufficient supplies of supplements, community support through the use of active volunteers, and a well-designed demand creation strategy.

Barriers to Effective Implementation and Possible Solutions

Inadequate political support: While most countries have maternal IFA supplementation policies "on the books", they lack government funds and political support. This low priority results from not recognizing that low hemoglobin concentration in pregnancy, not just severe anemia, is strongly related to maternal and perinatal mortality,[1] and from focusing on curative and facility-based interventions rather than preventive approaches. Therefore, strengthened advocacy is needed to ensure that policy makers are fully aware of the link between maternal anemia reduction and maternal and perinatal survival (i.e. a Millennium Development Goal) and to harness political and funding support for IFA interventions (and other anemia prevention efforts).

"A MAJOR BARRIER TO IMPLEMENTATION OF THE PROGRAM WAS A LACK OF NATIONAL POLICY FOR THE PREVENTION AND CONTROL OF ANEMIA AMONG ADOLESCENT GIRLS, POSSIBLY CAUSED BY POOR KNOWLEDGE FROM POLICY MAKERS ABOUT THE RISKS ASSOCIATED WITH ADOLESCENT ANEMIA AND LOW PRIORITY IN THE NUTRITION AGENDA."

(Multi-State Anemia Control Program for Adolescent Girls, India)

Low priority for IFA within maternal health programs: Operationally, anemia prevention component is not emphasized in routine ANC. Malaria-endemic countries are strengthening intermittent presumptive treatment (IPT) efforts but IFA distribution and compliance counseling remain weak. Maternal health guidelines, tools, and program implementation strategies often do not emphasize critical operational components such as assuring supplies, training frontline providers to counsel on compliance, and monitoring coverage. The MN community should review why these weaknesses exist and strengthen anemia prevention in existing maternal health programs.

Insufficient bundling of interventions to address the multiple causes of anemia: In many settings, parasitic infections such as hookworm and malaria, as well as other nutritional deficiencies, can greatly exacerbate anemia in pregnancy, but anemia prevention guidelines and implementation strategies rarely address these other causes.

Inadequate supplies, low utilization, and weak demand: Performance barriers in many maternal IFA supplementation programs include inadequate supplies of IFA tablets (and supplies needed to address other causes of anemia such as intestinal worms and malaria), low utilization of ANC services, and weak demand generation. Operational indicators and feasible methods for collecting, using and acting on them are needed to identify, track, and address these constraints.

Convincing evidence of effectiveness is lacking: To overcome the striking lack of maternal IFA supplementation program effectiveness data, funding must be secured to scale up and document successes and barriers to large-scale maternal anemia prevention programs.

Community-based delivery platforms to complement the ANC platform are missing: While countries are strengthening the quality and reach of ANC services, many do not have an adequate ANC platform to deliver maternal IFA supplementation to a high proportion of pregnant women on a regular basis. Complementary delivery platforms must be identified, tested, and implemented where ANC services and reach are limited. Preferred strategies should bring IFA supplementation closer to the homes of pregnant women by using community-based volunteers/workers and private sector outlets combined with social marketing.

Consensus Statement

- Conduct advocacy to strengthen anemia reduction components in maternal survival strategies. Nurture "champions" within the maternal health community to lead this advocacy.

- Secure funding to focus program efforts in 5-10 strategically selected countries to reduce anemia as part of maternal mortality reduction (MDG 5) strategies.
- Conduct implementation research on scaling up maternal IFA supplementation programs through integrated program efforts. This research should:
  - Carefully and systematically identify enablers and barriers to national-scale program implementation;
  - Identify, test, and document solutions to overcome implementation problems;
  - Guide implementation of successful solutions on a large scale; and,
  - Design and implement strategic and rigorous frameworks to monitor program performance and measure program effectiveness. Ensure indicators of both program processes and impacts reflect how the program addresses the multiple causes of anemia.
- Review and strengthen the anemia prevention component of existing maternal health guidelines and tools (global and country-level), with special emphasis on:
  - Supply management;
  - Counseling messages/skills; and,
  - Coverage and adherence monitoring.
- Where ANC contacts are low, identify and use existing community outreach opportunities and volunteers to deliver an appropriate anemia prevention "package" and support private sector marketing approaches.

2.3 Zinc Treatment in Managing Diarrhea

Based on compelling evidence from efficacy studies that zinc supplementation reduces the duration and severity of diarrhea,[30] in 2004 WHO and UNICEF recommended incorporating zinc supplementation (20 mg/day for 10-14 days for children 6 months and older, 10 mg/day for children under 6 months of age) as an adjunct treatment to low osmolarity oral rehydration salts (ORS), and continuing child feeding for managing acute diarrhea.[31]

Strength of Evidence on Large-scale Effectiveness

Despite ample evidence of efficacy and increasingly strong evidence of effectiveness,[32,33] implementing this intervention at scale is limited and not yet well documented. The most widely recognized effort is the "Scaling Up Zinc for Young Children (SUZY)" project in Bangladesh which reports achieving 20 percent national coverage.[34] The SUZY project worked with a local manufacturer, trained healthcare providers at various levels, and implemented a large education campaign using various media.

In 2008, an estimated 53 countries had changed policies to include therapeutic zinc and up to 30 countries had begun the formative research and/or pilot programs needed to develop context-specific mechanisms to deliver this new intervention (C. Fischer Walker, personal communication).

Features Associated with Program Success

From the few countries for which early experiences are available, elements likely to contribute to the of success zinc treatment in managing diarrhea are:

High rates of ORS/oral rehydration therapy (ORT) use: The SUZY project in Bangladesh reported that building on the relatively high use of ORS/ORT helped this initiative. Where current ORS/ORT usage rates are low, however, programs will need to tackle the duel challenge of increasing ORS/ORT usage along with introducing and creating a demand for adjuvant zinc treatment in managing diarrhea.

Local production and availability of dispersible zinc tablets: Locally available product was key to achieving the relatively high zinc use rates in Bangladesh.

Private sector engagement: The Bangladesh example and initial experiences in India, Nepal, and Tanzania, indicate that working with local manufacturers can create a local and sustainable product supply for the public and private sectors. Private sector distribution and marketing platforms have been effectively leveraged to distribute product, educate healthcare providers and consumers, and fund education for medical professionals (V. MacDonald, C. Winger, POUZN project, personal communication).

Packaging: A diarrhea treatment kit, zinc tablets packaged with ORS, delivered through commercial retail outlets and NGOs, has been piloted successfully in Cambodia. Packaging the two products together encouraged their combined use, and increased rural communities access to and use of the treatment.[35]

Remaining Challenges

Declining ORS/ORT rates: Diarrhea remains a leading cause of death among infants and young children, accounting for 18 percent of under-five mortality.[36] Coverage rates for treating diarrhea with ORS/ORT remain at less than 40 percent and have not improved much recently.[37] Integrated management of childhood illness (IMCI) provides the central diarrhea management strategy in most countries although its coverage remains limited in many countries. Incorporating zinc supplementation into IMCI protocols may present an important opportunity to revitalize this key child survival intervention. Leveraging private sector reach and marketing expertise is an opportunity to expand this intervention's coverage.

Global and national political commitment: Given that diarrhea can cause mortality, managing its treatment must again become a priority child survival intervention equal to other highly funded and visible programs such as HIV, malaria, and TB.[38,39] The global arena is filled with various players advocating for existing and new interventions. Funding support from donors helps introduce new interventions. Simultaneously governments make difficult choices about resource allocations for new interventions. The Tanzanian Government noted that absorbing vaccine costs under the existing Global Alliance for Vaccines and Immunization (GAVI) agreement factored into its reluctance to making financial commitments to introduce a new intervention such as zinc (C. Winger, personal communication).

Securing product: Increasingly more manufacturers in Asia and Africa are producing and registering quality zinc products (dispersible tablets, syrups,

reconstituted powders) for treating diarrhea. These products must become more widely available to address the growing demand from donors and ministries of health.

Designing effective demand-generation strategies: When introducing new interventions and products, effective demand generating strategies are needed to raise consumer awareness of the product and motivate appropriate purchase and use.

Lack of program experience: Though guidelines are available, actual program evidence is not yet available to determine the best delivery strategies and key barriers and enablers. While social marketing, private sector distribution, and public sector delivery are being explored in various formats, strategies are needed to clarify conditions for co-packaging ORS and zinc, to ensure healthcare providers and caregivers adhere to guidelines, and to create demand for ORS and zinc.

Documentation: As programs progress, experiences must be documented and disseminated quickly.

Consensus Statement

- Given clear WHO policy and guidelines, zinc is underutilized for treating diarrhea.
- Despite advances, quality products that meet Good Manufacturing Practice (GMP) standards for pharmaceuticals are still needed.
- At scale programs in diverse settings with strong monitoring and evaluation components to document performance and effectiveness are needed. The MN community must advocate and mobilize funds for such programs.

2.4 Home Fortification of Complementary Foods with Micronutrient Powders

Micronutrient powders (MNPs, also known as Sprinkles™) contain a mix of MNs in powder form that are packaged in single-dose sachets and can be added directly to any semi-solid complementary foods prepared in the household without substantially affecting taste or color of the food.[40] Iron and other essential MNs such as zinc, iodine, B vitamins, and vitamins A, C, and D may be added to the MNP sachets. Several efficacy studies conducted in different parts of the world consistently demonstrate that MNPs are as efficacious as iron drops in reducing and preventing anemia when added to complementary foods. Smaller effectiveness trials in Bangladesh, Benin, Haiti, and Vietnam have all demonstrated improved anemia rates when MNPs were provided for two or more months.[40]

Strength of Evidence of Program Effectiveness

Dary et al.[10] described two moderate-scale home fortification programs and one large effectiveness study. One program in Mongolia distributed Sprinkles™ to 15,000 children free of charge and achieved high coverage (89%) and compliance.[41] On average children took the MNPs for 13 months and 88 percent of households reported using the powders daily. Reported anemia rates declined from 46 percent to 25 percent in children 6-59 months old, with a concurrent reduction in stunting. In response to the Indonesian tsunami emergency another program distributed 28 million sachets to caregivers of 200,000 infants and children aged 6 months to 12 years. This represented

approximately 90 percent coverage in program districts within 5 months of distribution. A 25 percent reduction in anemia prevalence was noted in these districts,[42] though it was not possible to rule out all secular changes or other factors possibly affecting anemia rates in either program. Suchdev et al.[43] reported a randomized evaluation study that used a microcredit model to distribute MNPs in a poor rural Kenyan population of 60,000. This delivery model proved feasible and after 10 months of distribution, 30-40 percent of households reported purchasing the powders and using an average of four sachets per week. Preliminary results indicated a 26 percent reduction ($p<0.05$) in anemia prevalence in all children 6-36 months of age in intervention compared with control villages.

Features Associated with Program Success

Political commitment: The strong political support in Mongolia and Indonesia for the programs likely facilitated program implementation.

Distribution system: The Mongolia program's high coverage and compliance was attributable to the effective MNP distribution system and intensive social marketing activities. Community nutrition workers distributed MNPs free of charge each month to beneficiaries in their homes. This system enabled workers to reach the widely dispersed target population efficiently. Indonesia's success drew on the emergency distribution system established after the tsunami.[42] The Kenya study demonstrated that even poor households were willing to purchase powders when available and attractive. This delivery model relied less on subsidies and external funding. Final study results will identify the proportion of the population willing to purchase, and thus benefit from, MNPs in the longer term.

Social marketing/community education: All three programs employed large-scale social marketing campaigns along with community-based education to improve the compliance and acceptability of MNPs. Initial reservations expressed in all settings were overcome by ongoing public awareness efforts.

"INTEGRATING SPRINKLES™ SALES IN A MOBILE MULTIPLE HEALTH PRODUCT SALES DISTRIBUTION THAT ALLOWS PEER TO PEER SALES IS AN EXCITING MODEL FOR THE COMMUNITY, NGOS AND MOH. SPRINKLES™ IS A NEW PRODUCT IN KENYA THAT GENERATED EXCITEMENT."

(Sprinkles™ marketing distribution program, Kenya).

Remaining Challenges

Ensuring appropriate formulation: MNP composition may be tailored to the target populations' specific needs—a major advantage of the approach. MNP evaluation work has focused on anemia reduction. For example, while the Mongolia program noted anemia reduction, the prevalence of rickets did not decline. This was attributed mainly to the MNP's low vitamin D content (400 IU) relative to the high demands for vitamin D among Mongolian infants and young children who have limited sun exposure.[41] Producing MNP with higher vitamin D levels to meet

this need in Mongolia would likely address rickets. Any additional cost to tailor formulations will be marginal because the packaging costs for single sachets are 75 percent of the overall product cost (S. de Pee, personal communication).

Developing appropriate formulations for different target groups: Subsequent to the Innocenti meeting, the formulation of MNPs was further discussed at a workshop organized by UNICEF and the U.S. Centers for Disease Control and Prevention, in Bangkok, Thailand, in April, 2009 (S. de Pee personal communication). Two standard formulations were noted – one with five components referred to as the 'anemia formulation,' and the other a 15-component 'multiple MN formulation.' Reaching consensus on the MNP formulations most appropriate for different targets in different countries or even regions within countries can be time consuming. This workshop recommended that countries adopt one of two 'standard' formulations that should address iron deficiency anemia and MN needs of young children in the vast majority of countries. Countries were advised to give careful consideration before modifying one of the standard formulations to suit local needs. Issues to consider would include evidence of efficacy, safety, supply, and cost. A Home Fortification Technical Advisory Group was created to develop guidance in addressing the development of formulations for MNPs.[44]

Strengthening the evidence at scale: Many studies assessing MNP use have been small and few have assessed the willingness of childcare providers to pay for the product. Efforts by groups such as the World Food Program, in conjunction with the nutrition division of DSM Nutritional Products and others, are exploring and developing sustainable distribution systems in Bangladesh and Kenya to provide MNPs at large scale to the most vulnerable populations.

Program monitoring and evaluation: Monitoring and evaluation needs to be strengthened to contribute to the evidence base of effective practices that achieve impact. At this time rigorous evidence on MNP's effectiveness is limited.

Consensus Statement

- Efficacy study evidence shows that MN powders can reduce MN deficiencies for target populations when appropriately formulated. To realize the full potential of MN powders, they must be tailored to the target population's specific needs.
- Expand the Home Fortification Technical Advisory Group to include program implementers and the private sector.
- Secure funding for independent monitoring and evaluation to assess implementation, effectiveness and cost-effectiveness of large-scale programs to generate evidence to refine programs and maximize their impact.

2.5 Mass Food Fortification Programs

Fortification is adding vitamins and minerals to food products to restore nutrients lost during production and/or to incorporate nutrients that are absent or present in low amounts in diets. As a public health strategy, food fortification should be guided by a fundamental public health principle to prevent MN deficiencies where they exist effectively and safely and assure a healthful dietary intake of essential nutrients.

WHO[45] developed guidelines distinguishing three distinct fortification methods, each requiring a substantially different programmatic approach. Fortifying foods that are widely consumed by the general public is called mass fortification. Mass fortification, including salt iodization (described separately in Section 2.6), is usually initiated, mandated, and regulated by the government. Foods can be fortified for specific population subgroups, such as complementary foods for young children or rations for displaced populations (targeted fortification). Food manufacturers also can voluntarily fortify foods available in the market (market-driven fortification) to make them more attractive to consumers.

Strength of Evidence of Large-scale Effectiveness

(a) Sugar fortification with vitamin A

In Guatemala, Nicaragua, and other Central American countries, program coverage of vitamin A-fortified sugar exceeds 75 percent, with the fortificant level providing, on average, more than 150 percent of the estimated average requirement (EAR).[10] At these coverage and fortification levels, the population intake was adequate to address vitamin A deficiency for people over 3 years of age as evidenced by marked decreases in xerophthalmia in Guatemala, and reduced prevalence of low serum retinol in pre-school age children in Guatemala and Nicaragua.[46-48] Guatemala has maintained these successes for 20 years and Nicaragua for 10 years. In contrast, Zambia exhibits lower coverage (about 25%) and lower sugar consumption resulting in vitamin A intakes from fortified sugar that are 3 to 9 times lower than in Guatemala or Nicaragua, and provide only 26-52 percent of the EAR. Thus fortifying sugar with vitamin A can result in improved vitamin A status at the population level where sugar intake is high, coverage is high, and sugar has an adequate fortificant level. Where these conditions are not met, sugar fortification with vitamin A will still contribute to meeting vitamin A requirements of at least some in the population, even though this impact may be difficult to measure.

(b) Flour fortified with folic acid

As expected from findings in the United States and Canada,[49,59] evaluation data from folic acid flour fortification programs in Chile and South Africa showed a decrease in neural tube defects (NTDs) following fortified flour introduction, and a concurrent rise in serum and red blood cell folate.[51-53] The EAR of dietary folate equivalents provided by fortified flour ranged from 25 percent to 190 percent for South Africa and was 227 percent for Chile.[51-53] In contrast, the probable impact of folic acid flour fortification in Guatemala is considerably less, particularly in poor and rural areas where wheat flour consumption is very low relative to more affluent and urban communities.[54]

These studies demonstrate that programs fortifying flours with folic acid can improve folate status and reduce NTDs under conditions of adequate flour intake, wide coverage, and a fortification level that ensures adequate additional intake of folic acid.

(c) Food and condiment fortification with iron
Programs in Venezuela,[55] Chile,[56] and China[57] provide some weak evidence demonstrating a plausible association between iron fortified products (i.e. maize flour, wheat flour, and soy sauce, respectively) and anemia reduction. Based on efficacy studies, the amount of additional iron from the fortified food(s) necessary to impact upon biomarkers of iron status and iron-deficiency anemia rates should be >60 percent and >90 percent of the EAR, respectively.[10] A consultation facilitated by the Flour Fortification Initiative recently reviewed this evidence and drew similar conclusions that wheat and maize flour fortification improved iron status if sufficient levels of bioavailable iron forms were added.[58] Sodium-iron EDTA was the iron form recognized as having the strongest evidence of efficacy and effectiveness. Where the iron amount provided through fortification is not sufficient for measurable impact on iron status, it may still partially improve iron status.

Features Associated with Program Success

Providing adequate additional intake of bioavailable MNs:
Successful mass fortification programs rely on a sufficient proportion of the targeted population consuming enough foods that are adequately fortified to meet their nutritional requirements for the added nutrient.

Garnering political support: Successfully introduced and sustained programs require strong political support. Once programs are launched government support can wane; this results in weak enforcement of regulations and standards.

"IN GUATEMALA, ONE OF THE KEY FACILITATING FACTORS FOR THE SUGAR FORTIFICATION PROGRAM WAS THE FORMATION OF A NATIONAL COMMISSION FOR FOOD FORTIFICATION AND THE PRESSURE IT PLACED ON THE PUBLIC SECTOR (MINISTRY OF HEALTH, MINISTRY OF AGRICULTURE AND MINISTRY OF FINANCE) TO PRESENT EVIDENCE AND RESULTS AND DEMONSTRATE THAT THE PROGRAM IS WORKING. THE NATIONAL COMMISSION IS INCLUDED IN THE FOOD FORTIFICATION LAW, WHICH GUARANTEES CONTINUITY."

(Sugar fortification program, Guatemala)

Partnering with food industry: Fortification programs succeed when many sectors are committed including the food industry and pre-mix manufacturers, public health, and nutrition research sectors. Broad-based public-private partnerships facilitate program implementation and acceptance, can prevent and solve conflicts, and can sustain fortification programs.

Implementing legislation, regulations, and standards: Mandating fortification of staple food(s) or condiment(s) with specified nutrient levels helps to ensure that only the fortified product is available in the food system. Generating political support for creating and passing these legal instruments often requires advocacy from research institutions and public health scientists. Involving the private sector is often necessary and useful in establishing appropriate specifications for fortificant levels, suitable industrial processes, labeling, and packing procedures.

Building industry capacity for quality control and assurance: Introducing quality control and assurance procedures ensures high-quality, point-of-production fortification. These procedures are not always adequately implemented, even in large formal industries.

Strengthening government food enforcement capabilities: Food manufacturers need a 'level playing field' to make mass fortification programs viable. Governments must enforce food standards and regulations. Building collaborative rather than adversarial relationships between private and public sectors around enforcement helps programs succeed.

Using large-scale production facilities: Economies of scale and the higher quality, more modern manufacturing practices of large centralized factories, make mass fortification rapid and relatively easy to implement. In contrast, fortification that relies on small-scale producers is more difficult and slower.

Considering fortificant costs: Food manufacturers generally purchase fortificants directly and transfer this cost to the consumer. Eliminating import tariffs and taxes, where feasible, can reduce added costs to the consumer.

Strengthening program monitoring and evaluation: Researchers periodically monitor and evaluate fortification programs, but monitoring and evaluation is rarely an ongoing and sustained system. Building and expanding in-country capacity to design and implement monitoring and evaluation systems that assess the quality and reach of fortification programs from point-of-production to point-of-consumption is needed.

Using dietary, nutrient intake, fortificant, and cost data in program planning: Decisions on suitable food vehicles for fortification and fortificant formulations should be based on adequate estimates of food and nutrient intake distributions. Such distributions predict coverage and thus the need for complementary interventions in high-risk population sub-groups.

Information, education, and communication: For mandatory mass food fortification programs, information, education, and communication (IEC) have increased visibility, awareness, and appreciation for programs and thus have generated consumer demand even when these programs no longer command central government attention. IEC should always be carefully designed and follow clear objectives, because often the need is to avoid program opposition rather than to promote consuming certain foods (for example salt and sugar, for which intake should be kept low).

Remaining Challenges

- Establish systems to certify premix quality in the global market.
- Build public sector capacity to enforce food standards and regulations.
- National governments need to monitor and evaluate fortification programs using local research institutions or technical assistance from international organizations. Include MN intake assessments in monitoring and evaluating fortified product(s).

- Conduct additional research to document well-designed and successful iron-fortification programs. This deserves serious attention and critical discussion.

"IN THE ECSA REGION, THE LACK OF CAPACITY BY GOVERNMENTS TO MONITOR PROGRAMS ACCOMPANIED BY WEAK MONITORING SYSTEMS HAS BEEN A BARRIER TO EFFECTIVE IMPLEMENTATION OF FOOD FORTIFICATION PROGRAMS. PRODUCERS HAVE SAID, "HOW DO I KNOW THAT MY COMPETITOR IS FORTIFYING AND FOLLOWING STANDARDS?"

(Food Fortification Program, East Central and Southern Africa (ECSA))

Consensus Statement

- Food fortification increases MN intake and can be used in combination with supplementation and other interventions.
- The public health goal of fortification is to enhance MN intake in deficient populations to improve health. Program success depends on reaching a high proportion of the deficient population with a regularly consumed fortified food product(s) that provides an appropriate level of bioavailable MNs.
- In particular settings a single food vehicle has delivered the majority of a single nutrient to most of the population. Examples are vitamin A sugar fortification in Central America, and folic acid flour fortification where wheat flour is a major staple.
- In other settings fortification programs will fill some of the MN needs for some of the population.
- Since fortification uses an existing delivery system, it has low incremental costs and thus provides a highly cost-effective program.
- Program development should systematically identify food vehicles that are produced centrally, reach an adequate proportion of target populations, and be consumed in adequate quantities.
- Predicting a national MN program's success (fortification and supplementation together) requires determining the proportion of the population that reaches, together with the diet, 100 percent of the Estimated Average Requirements for vitamins and minerals. When dietary data are not available, deficiencies of vitamins and minerals that pose the greatest threats to public health should be given priority.
- Addressing technical issues concerning fortification with iron and zinc is a high priority. A technical group should be formed to review fortification and other MN programs and should answer key questions such as (a) what are the criteria for determining iron fortification program success? (b) should electrolytic iron remain a recommended compound for fortification? and (c) should specific recommendations be developed for fortifying whole grain flours?
- The 2006 WHO/FAO Guidelines on Food Fortification with MNs should be further disseminated and used.
- The most critical fortification program actions are to strengthen implementation of food regulations, to improve program monitoring and evaluation, and to document experiences.

2.6 Universal Salt Iodization

Strong evidence exists that large-scale universal salt iodization (USI) is a feasible and effective way to control iodine deficiency. In most populations, virtually everyone consumes similar amounts of salt and does this fairly consistently throughout the year.

WHO/UNICEF/ICCIDD recommend adding iodine at median concentrations of between 20 and 40 mg iodine per kg salt, depending on local salt intake. Universal salt iodization is unique among fortification programs in being able to meet the full daily requirement for iodine for most of the population without risk of providing too much to any particular group.

Strength of Evidence of Large-scale Effectiveness

The selected literature review undertaken for Innocenti 2008 examined six country programs—Bhutan, Cambodia, Indonesia, Nigeria, Thailand, and Tibet Autonomous Region. All countries had data on household iodized salt coverage, urinary iodine, and production/import- level quality assurance, and some data on time trends of these indicators. In addition, numerous other country examples provide plausible evidence that increased household use of iodized salt is associated with marked declines in iodine deficiency (based on decreasing goiter rates and increasing urinary iodine levels) in school-age children and reproductive-age women.[59,60]

Features Associated with Program Success

The major features associated with successful large-scale USI programs include:

Legislation, standards, and regulation: Legislation must mandate that salt, either imported or produced for human or animal consumption, is appropriately iodized. Standards must guide product manufacturing, distribution, packaging, and labeling. Monitoring and enforcing these standards must be understood and accepted by all involved.

Sustained political commitment at the national and sub-national levels: Political commitment from senior political leaders and industry must be continually renewed to sustain progress and to ensure national resources are devoted to salt iodization as external supports are withdrawn. Sustained advocacy with multisectoral national and sub-national coalitions is necessary to reinforce commitment. Monitoring and evaluation data also inform the advocacy process.

Assured supplies of raw materials: Initially, the salt industry may need assistance to secure reliable supplies of adequate packaging, potassium iodate/iodide, and laboratory materials supplies. Salt producer associations can be trained to provide this assistance. In most countries external assistance needs have declined over time.

Strong control and enforcement to ensure product and process quality: Functional control and enforcement systems are necessary to ensure adequate salt iodine levels from production to consumption. These systems should be based on specified national standards for product quality, price, and manufacturing and distribution processes.

Strategic monitoring and evaluation to track and document progress: As with other MN interventions, monitoring and evaluation strengthen implementation and track and document progress in terms of coverage and health impact.

Remaining Challenges

Salt iodization programs have progressed remarkably. UNICEF estimates that about 70 percent of households in the developing world now consume adequately iodized salt,[61] up from nearly 20 percent in the early 1990s.[27] However, progress has reportedly leveled off or even slid back.[62]

Preventing backsliding in program progress: Backsliding of progress and the re-emergence of iodine deficiency disorders has caused concern, particularly when monitoring systems break down. Therefore strategies must sustain political will at national and sub-national levels, to assure iodized salt quality from production to consumption.

Reaching the unreached: Assuring that affordable iodized salt reaches all population subgroups presents challenges and requires country-level planning to implement feasible strategies to deliver adequate iodine to at-risk populations. Meeting pregnant women's needs is of concern in countries where salt iodization has not achieved adequate coverage, because urinary iodine levels are just adequate for the population, and thus likely not adequate for pregnant women.

Consensus Statement

- Salt iodization programs can be implemented at scale and will likely reduce intellectual impairment in deficient populations when adequate intake is achieved.
- Focus program efforts on achieving and sustaining high coverage levels. Ongoing advocacy is a critical component of these efforts.
- Add iodine at median concentrations of between 20 and 40 mg iodine per kg salt, depending on local salt intake.
- Commercial production and/or importation of iodized salt provide the optimal, cost-effective delivery platform for this intervention. The small cost of the iodide/iodate fortificant should be included in the production cost and absorbed by the consumer.
- Salt iodization should target the entire population, with an extra focus on reaching pregnant women.
- Strengthen quality assurance and regulatory mechanisms in iodized salt production and distribution and program monitoring systems.
- Use lessons learned in designing and implementing effective universal salt iodization interventions to inform and facilitate fortification programs considering other nutrients and other food vehicles.

2.7 Multisectoral Programs with a Nutrition Focus

Leroy et al.[11] reviewed multisectoral poverty reduction programs that incorporate nutrition interventions that address the immediate causes of malnutrition. These included conditional cash transfer (CCT) and microcredit with education (MCE) programs, and agriculture interventions. These programs simultaneously address key underlying determinants of childhood undernutrition—poverty, food insecurity, and gender inequity—and the immediate determinants of undernutrition—inadequate food intake and poor health.

Strength of Evidence of Large-Scale Effectiveness

Overall, the impact of MN programs reviewed is scant since very few programs measured MN outcomes in assessing impact. This is particularly true for CCT and MCE: although three of the five CCT programs reviewed measured MN status, all three measured only one indicator, hemoglobin; and no MCE program measured any MN status indicator.[11] Of the three CCT programs measuring hemoglobin, only one (Mexico) documented modest improvements in mean hemoglobin and in anemia reduction. Weaknesses in agricultural program evaluation designs prevented drawing clear conclusions on their impact on MN indicators, although several evaluations suggest some impact on maternal and child intake of MN-rich foods and in some cases on vitamin A status.[11]

Most programs reviewed did achieve their fundamental objective to improve household income and food availability, access, or use. These outcomes are underlying determinants of MN status. The agricultural literature also showed that globally, programs with an education/behavior change communication component improved nutrition more effectively than those focused only on production.[11]

"A KEY ENABLER IN THE IMPLEMENTATION OF THE *OPORTUNIDADES* PROGRAM WAS THE STRENGTH OF ITS MONITORING AND EVALUATION COMPONENT, ACCOMPANIED BY A WILLINGNESS OF THE PROGRAM DIRECTORS AND HEALTH SECTOR TO LISTEN TO RESULTS [AND USE] THEM AS A BASIS FOR PROGRAM PROBLEM-SOLVING."

(*Oportunidades* program, Mexico)

Consensus Statement

- Multisectoral programs have great potential to improve MN malnutrition. Thus designing and implementing nutrition components should be improved, and more rigor brought into measuring program impact and pathways of impact.
- The MN community should build stronger linkages with the broader development community within countries and within global initiatives. This will help to incorporate and strengthen nutrition interventions in poverty reduction, agricultural development, gender equity, cash transfer, and microcredit initiatives.

2.8 Micronutrient Interventions Not Addressed

The Innocenti process did not review the full spectrum of established and emerging MN interventions. Available evidence on post-partum vitamin A supplementation program performance and impact was scant. Intervention studies on infant and young child feeding practices, including nutrition education, complementary foods that provide additional energy, and MN fortification of complementary foods have been reviewed elsewhere.[63] Evidence on other MN interventions—antenatal multiple MN supplementation, newborn vitamin A supplementation, double and triple salt fortification, bio-fortification strategies, and others—is emerging. If and when these interventions are brought to scale, collecting and reviewing data on implementation performance and effectiveness will help determine what and how these interventions work in a variety of contexts.

3. SUMMARY OF EVIDENCE ON MICRONUTRIENT PROGRAM SUCCESS

In summary, based on evidence of effective implementation and impact of large-scale programs, MN interventions were classified as those that: (1) have strong evidence of effective implementation and impact at large-scale; (2) need further confirmation of implementation effectiveness and impact; and, (3) lack implementation experience at large scale but hold promise as emerging interventions.

Have strong evidence of effective implementation and impact at large-scale

- ***Pre-school vitamin A supplementation:*** Twice-annual vitamin A supplementation of children 6-59 months using a 'Child Health Day' delivery model has shown sustained success in maintaining high coverage (>80% twice annually) in many countries. This intervention has likely contributed to mortality declines observed in some countries.

- ***Mass fortification programs:*** Compelling evidence shows that under the right conditions, mass fortification programs can be effectively implemented and achieve measurable impact on MN status and outcomes. Three examples include salt iodization, vitamin A-fortified sugar, and folic acid fortified wheat flour. These programs produced population-level impacts when fortified food delivered sufficient amounts of a bioavailable nutrient to a large proportion of the at-risk population.

Need further confirmation of implementation effectiveness and impact

- ***Maternal iron and folic acid supplementation (IFA):*** Only two countries described well-implemented, national maternal IFA supplementation programs. Substantial maternal anemia prevalence reductions were documented in both countries, but given the multiple etiologies of anemia, secular trends, and concurrent interventions, the proportion of anemia reduction attributable to IFA supplementation could not be quantified. Well-implemented IFA programs need to show additional evidence of impact.

- ***Iron fortification programs:*** To date, many large-scale iron fortification programs have not demonstrated a measurable impact on anemia prevalence because they used iron fortificants with low bioavailability. More evidence is needed from iron fortification programs using bioavailable forms of iron.

Lack implementation experience at large-scale but hold promise as emerging interventions

- ***Home-based fortification:*** Home fortification with MN powders provided free of charge has been implemented effectively at scale in a few contexts, and impact data has indicated promise. One study in Kenya established the feasibility, at least in the short term, of selling the powders through a community-based distribution system.

- ***Zinc treatment for diarrhea:*** Many countries have programs that include zinc treatment in managing diarrhea, but these are largely just starting. The program's major barrier is finding locally or regionally manufactured high quality product that is registered for use in each country.

- ***Poverty reduction strategies:*** Poverty reduction programs such as conditional cash transfers, microcredit, and agricultural interventions that include nutrition components show limited evidence for improved MN impact. One exception is Mexico's *Oportunidades* program that has had positive impact on iron deficiency anemia in young children. These broader programs hold great potential to improve MN malnutrition and strengthening their nutrition components should be explored.

CALL TO ACTION

1. Advocate for a global leadership group or mechanism that will develop a unified voice on micronutrient priorities and strategies, enhance global advocacy, and strengthen programming coordination

As expected with any diverse group, the global MN community does not always agree, but the common ground is vast. The community agrees that malnutrition, including MN deficiencies, strongly contributes to the burden of disease in the developing world, and that MN deficiencies impair human, social, and economic development. Building on this common ground, the community must renew leadership in nutrition, enhance multilateral processes, and coordinate MN actions. A UN mechanism, a recognized coordinating body, or a high-level task force of representatives from key stakeholder groups could do this. The leadership group will require a secretariat.

This leadership group, with key stakeholders, should develop consensus-based and unifying priorities, strategies, and MN advocacy messages for the MN community to promote with high-level global and national policy makers ("speaking with one voice"). This mechanism can also mobilize resources and coordinate donor funding to help develop and implement technically-vetted and credible nutrition country plans. The leadership group might also organize high-level, policy-maker fora to raise awareness of MN interventions and their potential contributions to human, social, and economic development; to identify priority areas and mechanisms for national action and international support; to gain consensus on the best approaches to scale up MN interventions; and to build coalitions and partnerships among the key actors for synergistic technical input.

2. Enhance communication among micronutrient stakeholder groups

The MN community's constituency groups should exploit all opportunities to enhance communication. Each group should understand institutional limitations, perspectives, and capabilities of the other groups. Micronutrient Forum meetings, where all the groups come together, provide an excellent venue to communicate. The Innocenti meeting recognized the need to incorporate concerns and insights of country-level managers and implementers in global technical discussions. Additional strategies to enhance communication across groups include:

- Organizing country and/or regional workshops for specific tasks, such as developing country nutrition programs.
- Including stakeholder representatives when technically vetting country plans.
- Creating mechanisms and incentives to promote collaborative work within and among groups to improve performance and impact of large-scale MN programs (e.g. task force representation, pairing academics with program managers for improved monitoring and evaluation designs, and other project development or evaluation opportunities).
- Helping program implementers participate in such meetings as the Monitoring and Data Working Group of the Ten-Year Strategy Process.

3. Create mechanisms that promote and reward productive collaboration among stakeholders for effective large-scale implementation of micronutrient interventions

In the ever-changing and increasingly complex development environment, coordination, collaboration, and communication among bilateral donors, multilateral organizations, private foundations, NGOs, and developing country governments will ensure long-term success of effective MN programs. Initiatives such as REACH provide useful examples for developing country-based programming. MN partners commit to providing sustained and predictable funding, coordinated technical input, and harmonized efforts in high-need countries to support result-oriented and technically-vetted MN programs as components of national nutrition plans and strategies within broader development programs. Global donors encourage collaboration at country-level by making it a pre-condition for funding. While administratively complex, the donor community would send a serious message about productive coordination.

4. Design and implement a proactive strategy to strengthen linkages between the micronutrient community and broader nutrition, health, and development initiatives

The successes of other public health priorities such as tuberculosis and malaria provide useful lessons for the MN and nutrition communities; these include effective unified agendas and stakeholder-sponsored advocacy strategies. Engaging other sectors effectively requires coordinated outreach and approaches:

- Design and implement a clear and convincing communication strategy that translates MN deficiencies and MN solutions into messages that resonate with the specific communities (e.g. link MNs with MDG achievement to global and country missions; link MNs with burden of disease for ministries of health; link MNs to economic productivity and human capital investment for ministries of finance and education).
- Nurture champions to advocate with other global groups (e.g., maternal health around maternal anemia programs), and within countries (ministries of health, education, finance, agriculture, social welfare).
- Invite key individuals from these broader communities to MN and nutrition meetings.
- Build direct linkages with other initiatives to promote efforts to incorporate micronutrient interventions into these delivery platforms.

5. Create new opportunities to advance regular public-private sector dialogue and collaboration to solve MN problems based on where public and private sector priorities merge, and a set of mutually agreed on principles for interaction

Engaging both public and private sectors will be necessary to achieve market driven strategies that target the most vulnerable (the 'Base of the Pyramid'). Include the private sector early in product development and marketing campaigns. Partnerships must acknowledge each sector's needs when developing strategies that leverage comparative advantages and pursue common goals and outcomes. Mechanisms that encourage public-private interaction should be created.

For example:

- Create a research and development exchange among the private sector, research, and public health communities to discuss creating products that address public health problems.
- Develop guiding principles for public-private sector interactions that: i) commit to reducing MN deficiencies; ii) include independent oversight and audit of interaction; iii) create a "firewall" to exclude commercial funding sources that could unduly influence the public policy process; iv) act on scientific evidence; v) practice responsible marketing that supports a joint MN strategy; and, vi) engage the public to monitor private pledges.
- Identify strategies to reach the most vulnerable populations with market driven approaches. Identify successful practices or principles of public-private collaboration to achieve market segmentation, product development, marketing/campaigns, etc.
- Engage country-level manufacturers who have missions, incentives, and/or opportunities to target the most vulnerable groups.
- Ensure governments create and enforce regulatory environments that provide a level playing field for manufacturers.

6. Develop guidance to help country teams systematically assess the nutrition situation and the effectiveness of existing programs in their countries in order to facilitate evidence-based decision-making

Use program assessment methodology being developed to enable country teams to plan and execute participatory workshops. This will—

- Help countries use evidence, contextual knowledge, and experience to design, implement, manage, scale up, and evaluate MN programs;
- Strengthen shared understanding, ownership, commitment, motivation, and capacity to advance the MN agenda and link with broader nutrition and health agendas.

The workshops will enable national staff to use systematic techniques to—

- Identify key action plan elements to strengthen MN program design;
- Develop an operations research agenda to address knowledge gaps and uncertainties;
- Identify monitoring and evaluation system design inputs; and,
- Develop a strategic plan to oversee and generate support for the action plan.

7. Develop in-country capacity to design and implement strategic systems that monitor, evaluate, and document micronutrient program performance and impact

Review monitoring and evaluation systems in developing countries, and develop a phased plan to increase in-country M&E capacity linked with specific MN programs. Capacity should be strengthened in selected high-need countries by:

- Engaging a country-level team—program managers, implementation researchers, and global partners/donors—to define programming priorities and design, implement, and evaluate selected programs. Use the program assessment methodology described above.

- Train sufficient country-level staff to design, implement, and evaluate national nutrition programs through in-country and regional workshops. Pair in-country managers with local and/or international universities that have demonstrated expertise in this field.

8. Mobilize funds to implement large-scale micronutrient interventions

Participants agreed that developing consensus on a unified set of priorities and advocacy messages was the first step in mobilizing needed resources. This requires unifying global leadership and developing an advocacy strategy for moving MN and nutrition objectives onto high-level policy agendas. Groups interested in accelerating MDG achievement, such as the G20, European Union, U.S. Congress, bilateral donors (USAID, CIDA, DFID, JICA, etc.), foundations (Clinton, Gates, etc.), and the private sector, should be approached. Parallel efforts are needed to build in-country capacity to design, manage, implement, monitor, and evaluate program implementation because additional resources alone will not suffice.

9. Increase funds for implementation research to improve our understanding of the best ways to design, manage, implement, and finance micronutrient programs at scale within different country or regional contexts

More research funds should be directed to understanding how to get health services or technologies delivered and used by those who most need them (i.e. 'how' to do it rather than 'what' to do). Currently, the overwhelming proportion of health research funding is directed towards pre-delivery, efficacy, and diagnostic research. More practice-based evidence is needed to improve program design and implementation. Adequate research funds should be allocated to reflect this priority.

Reducing MN malnutrition requires an expanded research agenda that focuses on determinants of effective large-scale implementation of efficacious MN interventions. The "voice" of program implementers will be critical when setting and prioritizing the questions to be addressed. Implementing this research agenda requires creating incentives for researchers and research institutions to work with in-country program managers to design and implement more rigorous and strategic monitoring and evaluation systems and finding effective ways to report and publish findings. Options for defining the research agenda include:

- Convening "reverse research" forums to identify and prioritize research questions based on the needs and challenges faced by MN program policy makers, managers, and implementers; and,
- Commissioning a consultation to survey program implementers' research needs.

CONCLUSION

While scientific discoveries continue to reveal more about the biology of micronutrient deficiencies and ways to prevent them, a large gap remains in putting existing knowledge into effective action. On the continuum from scientific discovery to implementing large-scale micronutrient programs, a renewed emphasis must be placed on developing commitments, securing funding, and building institutional capacities at national scale to deliver, manage, and assess micronutrient programs. The Innocenti Process revealed large gaps in our understanding about how to develop in-country capabilities, obtain adequate and sustained levels of resources, and implement effective large-scale micronutrient programs. Until these gaps are filled, micronutrient deficiencies, affecting more than a billion mothers and children in developing countries, will continue to take their toll, leaving in their wake an unacceptable burden of preventable morbidity and mortality, and lost opportunities for human, social, and economic development. A solid foundation of scientific evidence has led to broad consensus on "what" to do—the challenge remains in identifying "how" to do it. The Call to Action in this report provides a way forward and a clear set of recommendations for all stakeholders on how to tackle this important challenge.

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Appendix 1: Participant List

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Carol Tom	A2Z Micronutrient and Child Blindness Project – ECSA – Tanzania
Carolyn MacDonald	World Vision International – Canada
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Chen Chunming	ILSI-Focal Point China and Chinese Center for Disease Control and Prevention – China
David Pelletier	Cornell University – United States
Ellen Piwoz	Bill & Melinda Gates Foundation – United States
Emily Wainwright	US Agency for International Development – United States
Emorn Wasantwisut	Mahidol University – Thailand
Esi Amoaful	Ministry of Health – Ghana
France Begin	The Micronutrient Initiative – Canada
Ian Darnton-Hill	UNICEF – United States
Jack Fiedler	The Micronutrient Initiative – United States
Jean-Pierre Habicht	Cornell University – United States
Juan Pablo Peña-Rosas	World Health Organization (WHO) – Switzerland
Luc Laviolette	The Micronutrient Initiative – India
Lynette Neufeld	National Institute of Public Health – Mexico
Mahesh Arora	Ministry of Women and Child Development – India
Marie Ruel	International Food Policy Research Institute (IFPRI)
Martin Bloem	World Food Program (WFP) – Italy
Meera Shekar	The World Bank – United States
Neeraj Kumar Sethi	Government of India Planning Commission – India

Omar Dary	A2Z Micronutrient and Child Blindness Project – United States
Pham Van Hoan	The National Institute of Nutrition – Vietnam
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Prakash Kotecha	A2Z Micronutrient and Child Blindness Project – India
Rafael Flores-Ayala	U.S. Centers for Disease Control and Prevention (CDC) – United States
Rajkumar Selwyndas	World Vision International – Sri Lanka
Ram Kumar Shrestha	Nepal Technical Assistance Group (NTAG) – Nepal
Robin Houston	A2Z Micronutrient and Child Blindness Project – United States
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Shawn K. Baker	Hellen Keller International (HKI) – Senegal
Silvana Faillace	Micronutrient Forum Secretariat/ A2Z Micronutrient and Child Blindness Project – United States
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