



THE SACKLER INSTITUTE
for NUTRITION SCIENCE



The New York
Academy of Sciences

A GLOBAL RESEARCH AGENDA FOR NUTRITION SCIENCE

*Outcome of a collaborative process between academic and non-profit researchers
and the World Health Organization*

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www.nyas.org/whatwedo/nutrition/agenda
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EXECUTIVE SUMMARY

The Sackler Institute for Nutrition Science, under the umbrella of the New York Academy of Sciences, in collaboration with the WHO Department of Nutrition for Health and Development and Humanitas Global Development, has led an initiative to identify global research needs in nutrition.

Considering the increasing burden of diseases related to nutritional issues, and the difficulties in elaborating large-scale sustainable solutions to address them, experts agree that more research is needed to examine the various pathways, interactions, and mechanisms that influence a population's nutritional status. This agenda stems from the need to consolidate existing knowledge in this field, and identify critical questions to guide future research endeavours.

NEW YORK ACADEMY OF SCIENCES AND THE SACKLER INSTITUTE FOR NUTRITION SCIENCE

The New York Academy of Sciences is an independent, not-for-profit organization committed to advancing science, technology, and society worldwide since 1817. With 25,000 members in 140 countries, the Academy is creating a global community of science for the benefit of humanity. The Academy's core mission is to advance scientific knowledge, positively impact the major global challenges of society with science-based solutions, and increase the number of scientifically informed individuals in society at large.

During 2009-2010, the New York Academy of Sciences and its collaborating partners conducted an extensive scoping exercise with more than 45 leaders across sectors who are working in nutrition. There was near-universal support for a high-level, coordinated effort to identify core areas of nutrition science research and strategically apply work in key areas to remedy the global crisis in malnutrition. To respond to this challenge, The Sackler Institute for Nutrition Science was established within the New York Academy of Sciences with a founding gift from The Mortimer D. Sackler Foundation, Inc. The Sackler Institute is dedicated to advancing nutrition science research, mobilizing communities, and integrating scientific evidence into field work.

PROCESS

A **Research Advisory Group*** convened by the New York Academy of Sciences and consisting of a panel of independent experts from both the non-profit and academic sectors, identified three Focus Areas for development of a global research agenda:

1. Environmental and societal trends affecting food and nutrition
2. Unresolved issues of nutrition in the life cycle, focusing on the mother and child
3. Intervention delivery and operational gaps

The Sackler Institute assembled **Working Groups*** for each of these Focus Areas, which then identified a total of 25 key issues of high interest and critical gaps in knowledge.

In a phased approach, a web-based consultation was implemented for each of the Focus Areas from June through September 2012. The goals of the consultation were to secure feedback on areas of nutrition science research that require more investigation and evaluation, identify key nutrition science research topics, and understand specific areas of interest. For this process, input was sought from a multitude of stakeholders, including: donors, policy makers, program implementers, the research community, and the private sector. The web-based consultation for each Focus Areas was available for a period of three to four weeks, with approximately 100+ participants from a multitude of stakeholders for each Focus Areas.

RESEARCH AGENDA LAUNCH CONFERENCE

Conference Overview

Each of the three Focus Area Working Groups presented the conclusion of their findings during a landmark conference entitled "**A Global Research Agenda for Nutrition Science**" held in New York on December 17 and 18, 2012 (see www.nutritionresearchagenda.org for details). The conference was attended by 145 participants from around the globe, representing more than 20 different academic institutions as well as government representatives, implementing agencies, the United Nations, NGOs, donors and think tanks, and the private sector.

The presence of high-level experts engaged in nutrition science led to in-depth discussions of not only the research topics and topics needing to be addressed, but also how to explore strategies to move research forward in a concerted way by engaging a wide range of stakeholders, including the scientific media who disseminate new research, and decision makers who rely on scientific findings to guide interventions and policies.

*See full list starting on Page 10



Conference Takeaways

Several lessons and suggestions to move forward were highlighted during the conference's closing remarks. Generally, the conference emphasized the following:

- Research must look at multiple outcomes and use different disciplines.
- In particular, implementation science in nutrition is critical to enhance the delivery of interventions and policies.
- Such multi-sectoral convenings give an opportunity to interact and hear the perspectives of diverse stakeholders tackling malnutrition. Enhanced networking efforts will generate even more dialogue with scientists in middle- and low-income economies.
- Communicating and keeping stakeholders engaged with the research agenda implementation is essential.

The World Health Organization and The Sackler Institute for Nutrition Science will continue to support the experts in order to:

- Finalize and disseminate the background papers, which will serve as a basis for a prioritization exercise that will then be presented to the World Health Assembly.
- Use the network generated around this research agenda to build a constituency that brings together the academicians within the Scale Up Nutrition initiative.
- Explore routes to activate the research agenda with various donors and agencies interested in these questions.

FOCUS AREA 1: Environmental and Societal Trends Affecting Food and Nutrition Among Vulnerable Groups

Focus Area 1 examines environmental and societal trends impacting nutrition, including population growth, aging, and geographical distribution; climate change and potential threats to agriculture and food security; increased global demand for food and feeds; shifting demand to store-bought processed foods; growing rates of overweight and nutrition-related Non-Communicable Diseases (NCDs); and increased gaps in health and nutrition between countries and social classes.

Development of the Research Topics

The Group identified and submitted for consultation 14 research topics blocked around the following themes:

- Measurement and modelling of multi-level factors that influence nutrition, particularly factors affecting the double burden of malnutrition
- Examining policies that harm or promote human nutrition and their differential net impact on various health and nutrition outcomes, both short- and long-term
- The food system overall – linking production, processing, and distribution of foodstuffs
- Factors underlying economic vulnerability and food insecurity
- Climate change, population trends, and environmental sustainability

The consultation reflected the complexity of adopting a holistic approach. Research topics are defined differently depending on a particular focus (undernutrition or overnutrition), geography (urban or rural), and food production perspective (small scale or mass scale). Multiple conceptual approaches are available to describe the causal and correlation pathways, associating food system approaches, policies, behavior, and their connections with the overall economic and policy environment. Finally, the sense of urgency oscillates between better understanding what is going on through improved model designs, and the identification of what works through evaluation of existing and future programs and interventions.

Nonetheless, points of convergence also emerged, stressing the following elements in research:

- Thinking and acting holistically (focus on research that can evaluate multiple inputs and address several outcomes together)
- Developing alliances (where is the most convergence of goals and incentives?)
- Building feasible, pragmatic approaches to research
- Building recognition that nutrition both influences, and is influenced by, human, social, and economic development
- Connecting nutrition, economics, and environment
- Capitalizing on the strengths of many disciplines through collaboration and communication
- Placing biology within the social/economic/natural environment
- Paying attention to measurement and delivery issues



Research Topics

Research Topic 1: Modelling an enabling environment for health and nutrition

Developing our analytical toolbox to describe and model an enabling environment for health and nutrition that connects nutritional quality, environmental sustainability, and economic profitability, adding the dimension of household vulnerability and livelihood levels, including in subsistence economies, and policies (using multi-disciplinary approaches including, for instance, climate change researchers, scientists working on health system strengthening, economists evaluating the cost of the double burden, environmental, and urban engineers, etc.).

Research Topic 2: Measuring economic and sustainability trade-offs for nutrition and health outcomes

In a real world of very complex and ever-changing interactions, there is a need to better measure economic and sustainability trade-offs in terms of nutrition and health outcomes. This requires clarifying a subset of specific result issues related to measurement and metrics:

1. Enhancing measurement of nutritional quality, status, and outcomes
2. Defining an adequate time scale to measure outcomes
3. Identifying (and finding reinforcement strategies) where there are opportunities for double- and triple-wins between nutrition, economic profitability, and environmental sustainability

Research Topic 3: Describing the interactions between the food system and nutrition

In addition to trade-offs, specific aspects of the interactions between the food system and nutrition must be better described and understood, such as:

1. Evaluating the effects of government policies for production and trade on supply and demand for certain types of food, and impacts on nutrition
2. Assessing how agricultural diversity affects dietary quality in different contexts
3. Assessing the economic viability and environmental sustainability of dietary guidelines and recommendations

Research Topic 4: Integrating individual- and household-level factors underlying economic vulnerability and food insecurity, in particular

1. What are the incentives for individuals to spend the resources (including time) to obtain healthy diets?
2. How to connect women's economic empowerment with enhanced nutritional status for women and children?

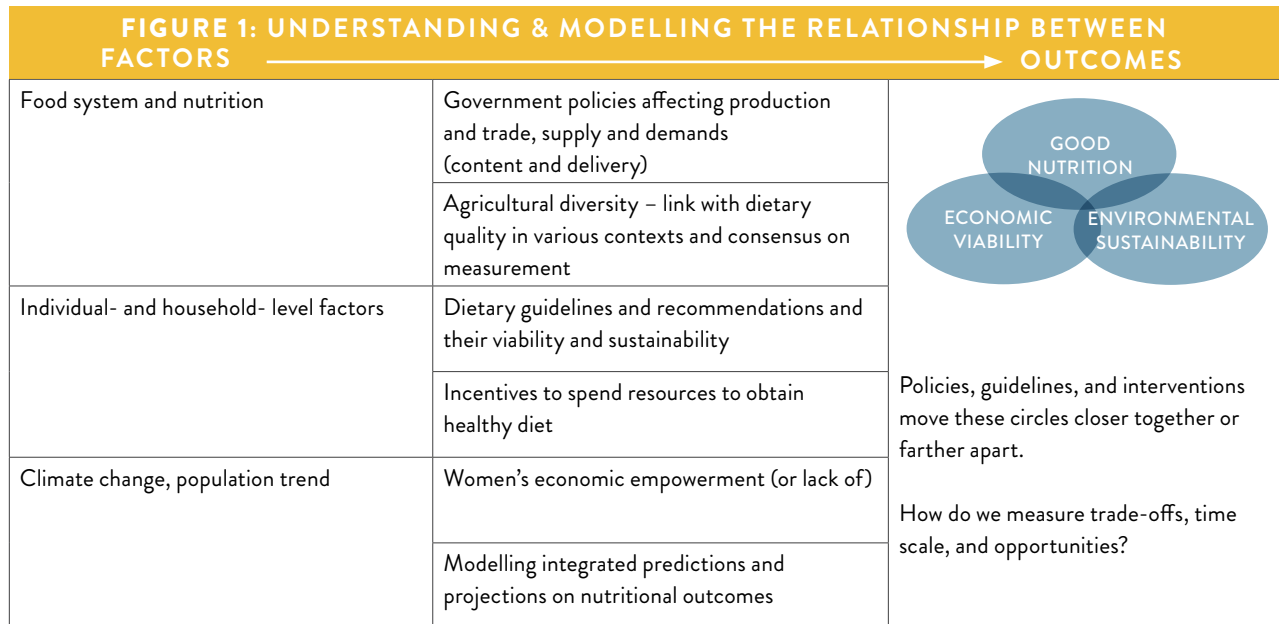
Research Topic 5: Developing nutrition-centered approaches in climate change

Such approaches need to incorporate population trends, various types of food systems (production, processing, trade patterns, and consumption), access to water, sanitation, and overall environmental sustainability, with the capacity to produce various scenarios and projection of nutritional outcomes.

Recommendations and Next Steps

While many components of the interactions discussed above are well-described, the particular challenge is to connect this knowledge together in order to obtain a comprehensive, holistic understanding of the mechanisms, pathways, and feedback loops that connect nutrition and the macro-level environment.

The articles to be published in *Annals of the New York Academy of Sciences* will continue the investigation of this topic by highlighting the need to think about complex issues and interactions in an integrated manner, specifically focusing on research that takes into consideration simultaneous assessment of outcomes in three domains (nutrition, economic, and environmental, see Figure 1). It will briefly review current initiatives and consortia addressing some of these questions and pinpointing potential gaps; as well as present some of the existing models and tools for doing this type of research. Discussing existing models will demonstrate what is doable, illustrate the ways these tools are used and identify possible synergies, notably to strengthen model-constructions and promote model integrations (e.g., applications of CGE models in addressing nutrition outcomes), as well as discuss various applications and limitations of such integrated models (for instance for policy-making, program design and evaluations, etc.).



FOCUS AREA 2: Unresolved Issues of Nutrition in the Lifecycle

This Focus Area draws attention to the mother and child, with linkage to the wider themes of women’s health in general; and particular attention to be paid to double burden contexts, such as:

- Creating food-based systems biology of nutrition and human health in mother and child
- Determining optimal nutrition during pregnancy and understanding effects on child growth, early childhood development, and long-term health

Development of the Research Topics

This Group focused on the mother and child, with a linkage to the wider themes of women’s health in general; and with the recommendation that particular attention needs to be paid to double burden contexts.

The work was divided into three interconnected themes and incorporated the results of the open consultations and recent research findings in the published literature.

Theme 1. Preconception to Early Childhood (First 1,000 Days and Beyond)

According to information from the WHO (2011), more than 13 million low-birth weight babies are born each year. These babies are often affected by severe short- and long-term health and developmental consequences. Poor nutritional status and nutrient intake for women before, during, and after pregnancy not only impact a woman’s health status and productivity, but also may have detrimental effects on birth weight, nutritional status, and early childhood development. Despite the critical role of maternal nutrition, few nutritional interventions for mothers have assessed a wide range of outcomes at sufficient scale.

Fetal and early postnatal life is a period of rapid growth and development and especially vulnerable to nutritional perturbations. Here, we have identified issues in nutrition knowledge during the first thousand days from pregnancy through age 2. This period provides a crucial window of opportunity for reducing malnutrition and its adverse effects.

Theme 2. Moving from single nutrients to a systems biology food-based approach

Traditionally, human nutrition research has largely focused on evaluating one nutrient at a time. Demonstrating the health impact of nutrients such as Vitamin A, folic acid, iron, and iodine has helped shape nutrition interventions and policy in both developing and developed countries. While it is critical to understand the role of these individual nutrients in improving health outcomes, there also is a need to use a more comprehensive approach that examines the effects of whole foods, suites of nutrients, and entire diets to complement our current scientific knowledge on single nutrients or isolated compounds.



Food-based systems biology approaches can be effective tools to address the full spectrum of malnutrition in populations globally. Using an integrated view of food systems and human metabolism will help our understanding of how foods interact with the human biological system. This approach considers entire suites of essential nutrients and other components in food that together have an influence on functional outcomes, including immune function, reproductive health, cognitive development, adult chronic disease, and others.

A food-based approach also can help identify strategies to improve functional outcomes during critical phases of human development; in particular, pregnancy and early childhood. This type of approach can improve the general quality of the diet (for example, by increasing fruit, vegetable, and animal product intake), while providing additional benefits by reducing consumption of less nutritious carbohydrates and fats, and increasing other micronutrients such as essential fatty acids and phytonutrients. This strategy is consistent with the need to lower the global risk of chronic disease and overweight that is exacerbated by consumption of poor-quality diets.

Theme 3. Malnutrition, infection, developmental and functional outcomes and their interaction with nutrition interventions

Promising interventions have targeted maternal macronutrient and micronutrient intake (*The Lancet* 2008), but research is needed to better assess long-term impacts on maternal and child health. Trials examining multiple micronutrients have yielded inconclusive results. Some findings indicate that there may be combined effects of food and multiple micronutrient supplementations on growth and development of the offspring. Additionally, information on the optimal timing of food supplementation to malnourished pregnant women and complementary feeding during infancy is lacking.

Frequent illness can impair nutritional status as energy and essential nutrients are diverted away from growth and, conversely, poor nutrition can increase the risk of infection. Infections are common in the first two years of life and an integrated view of human metabolism and diet/food systems is critical to understanding the influence of nutrition on the balance of homeostasis during health and wellness. As we begin to understand the immune response and the intestinal microbiota, the pathways through which an infection may modify the impact of nutrition interventions on child growth or mechanisms through which improved nutrition may reduce the impact of infection on child growth remain unclear.

Collectively, there is a need to better understand the impact of infection and sub-clinical conditions on nutrition and child growth/development (including birth outcome), and the interactions between nutrition, infection, and non-communicable diseases (NCDs).

Research Topics

RESEARCH TOPICS RELATED TO THEME 1, IMPROVING OUR UNDERSTANDING OF THE PRECONCEPTION TO EARLY CHILDHOOD PERIOD (FIRST 1,000 DAYS AND BEYOND)

An integrated systems biology approach is used to move towards understanding the influence of nutrition on the physiological balance of homeostasis during pregnancy and the physical growth and cognitive/motor/social-emotional development of the neonate.

Research Topic 1: Role of nutrition in Developmental Origins of Health and Disease (DOHaD)

- How does nutrition influence the development of metabolic systems (healthy “microbiome,” immunity, etc.)? What are the common metabolic pathways involved in both under and overnutrition? What are existing experimental models and translational research opportunities for studying the dual burden of malnutrition?
- What is the role of nutrition during fetal growth and development, including the role of maternal nutrition and the maternal-fetal interface?
- What are the mechanisms for and potential causes of stunting and malnutrition during early life?
- What are the mechanisms for and potential causes of obesity and malnutrition during early life?
- Determining the influence of parental nutritional factors and the long-term effects of multi-generational nutrition/malnutrition.
- What are the dietary requirements to support growth and optimize health during early life and later?

Research Topic 2: Characterizing normal growth during early life

- What mechanisms are responsible for the normal flux of nutrients in utero between mother and infant? What are some appropriate markers that reflect functional changes consequent to that flux?
- How should adequate state-specific intake regulation for both the mother (during pre-conception, pregnancy, lactation, and post-partum) and the child (in utero, during neonatal life, infancy, and early childhood) be determined?
- How should fetal malnutrition be characterized and assessed?



- Are current state-of-the-art measurements for assessment of “normal” appropriate? This would include revisiting definitions and criteria for measuring and assessing childhood growth (growth standards, definitions for preterm, stunting, catch-up growth, and moderate and Severe Acute Malnutrition [SAM]).

Research Topic 3: Characterizing and assessing optimal growth and development during early life

- How can the contribution of optimal nutrition to growth and cognitive/physical development be separated and measured?
- What is the role of catch-up growth and rapid weight gain? When can it be considered beneficial during early life?
- Do appropriate developmental markers (subjective and functional) exist to assess “normal” child development? More specifically, can enhancement of function be detected within a normal range (subtleties in cognition/behaviour beyond gross deficits)?
- How can we predict the optimal timing for nutrition interventions if we do not know how, when, and for how long this should be addressed? Specific research topics include recommendations for treatment and prevention of SAM during 0-6 months.

Research Topic 4: Describing and understanding contextual factors

- What are the risk factors and causes of adverse birth outcomes (Pre-term Birth, Low Birth Weight [LBW], and Small for Gestational Age [SGA]) and how are they related to maternal nutrition, health, and environment?
- What is the relationship between maternal nutrition, maternal mental health, maternal empowerment, and their combined effects on care giving? Related to this, how can maternal “empowerment” be better defined and measured related to maternal and child health, nutrition, and development outcomes?
- Have current nutrition requirements been adapted appropriately for vulnerable populations (e.g., for pre-term infants, specific disease states, and orphaned infants/children)? If not, what type of research can provide evidence for development of better recommendations?

RESEARCH TOPICS TO THEME 2, SYSTEMS BIOLOGY FOOD-BASED APPROACH

Research Topic 5: Creating a food-based systems biology of nutrition and human health in mother and child

- Understanding the links between food-based dietary guidelines and effects on metabolic systems and human biology.
- Integrating knowledge on molecular mechanisms, human metabolism, nutrition requirements, and behaviour to further nutrient-based recommendations and develop food-based dietary guidelines for the entire life course.
- Understanding bioavailability of nutrients and micronutrients in whole foods (most importantly: human milk, animal products, and staple foods).
- Research on suites of nutrients, including fatty acids in developing countries, nutrients not typically associated with growth (phosphorus, potassium, magnesium), and some B vitamins (choline).
- Developing food-based interventions to modify diet quality and diversity and address over and under nutrition.

Research Topic 6: Describing and understanding contextual factors

- How to describe and understand biomarkers to reflect exposure, status, and functions of individuals and population across the lifecycle, and biomarkers for evaluating response to food-based interventions, biofortification, and other dietary interventions.
- How to develop the entire food system to meet the health needs of the population, from food production and agriculture to consumers and issues affecting availability and access of food products, including economics of food choice.
- Can food systems realistically support healthy diets for the whole population?
- Developing food-based interventions to modify diet quality and diversity to address over and under nutrition.
- Can food-based approaches improve micronutrient status and do they require complementary interventions to ensure adequate intake?
- How to understand genetic variation among individuals and populations related to nutritional status and nutrient adequacy/deficiency.

RESEARCH TOPICS RELATED TO THEME 3, MALNUTRITION, INFECTION, DEVELOPMENTAL, AND FUNCTIONAL OUTCOMES AND THEIR INTERACTION WITH NUTRITION INTERVENTIONS

Research Topic 7: The relationship between markers of malnutrition (e.g., stunting in children, low height, or BMI in women) and functional outcomes

- Developing our understanding of how nutritional status (over and undernutrition) is related to response to illness (e.g., microbiome reaction, infection during pregnancy)



- What are the effects of environmental enteropathy and malabsorption on nutritional interventions and development of metabolic systems (immunity, healthy “microbiome,” etc.)?
- Nutrition and pharmacology: How do exposures to toxins in the environment and drugs of abuse interact with compromised nutritional status? Are common metabolic pathways affected in malnutrition for specific toxins (e.g., lead exposure)? What is the impact of scaling up preventive treatments for control of infections in malnourished individuals/populations, or those at risk of becoming malnourished?
- How do undernutrition and infection interact to influence the process of stunting in both mothers and children and what are the molecular mechanisms responsible for it?

Research Topic 8: Topics in knowledge related to describing and understanding contextual factors

- Definition of what aspects of “context” are most salient to describe and understand relative to health, wellness, and nutrition.
- How to develop our understanding of genetic variation among individuals and populations related to nutrition and response to illness (e.g., microbiome reaction/development during infection, infection during pregnancy).

RESEARCH TOPICS RELATED TO THE METHODOLOGICAL COMPLEXITY OF ADDRESSING SYSTEMS-BASED NUTRITION RESEARCH

The benefits of food-based approaches may include nutritional improvement, food security, cost-effectiveness, sustainability, and human productivity. At the same time, nutrition science also is influenced by economic and environmental policies and these approaches pose their own challenges, requiring additional inputs, including nutrition education and behaviour change, and strong inter-sectoral linkages with agricultural planning to supply populations with diets to meet desired health goals.

Research Topic 9: Understanding and driving basic science related to the systems biology approach of nutrition

- Integrating mechanisms of action studies and biomedical models prior to clinical interventions and preventative treatments (development and emergency settings).
- How to test the effects of combining nutrition with early stimulation (in a broad sense), and determine appropriate indicators/measures of success?
- How to determine criteria and types of evidence needed to evaluate and interpret the impact of economic growth (especially for the dual burden of malnutrition and nutrition transition) and other contextual parameters?
- How to deal with unexpected heterogeneity in studies involving various population groups?

Recommendations and Next Steps

The Working Group has invited additional researchers to join its writing team to further develop some of these themes and provide more in-depth recommendations for future research while working closely with *The Lancet* series on Maternal and Child Nutrition, to be published in 2013.

FOCUS AREA 3: Delivery of Intervention and Operational Topics

Development of the Research Topics

Focus Area 3 delves into the issues related to delivery capacity and the delivery obstacles that need to be overcome, in addition to the cost-effectiveness of delivery conduits. These include critical context-specific issues as they relate to decision making and implementation of scaling up nutrition action, such as:

- The burden of undernutrition and the role of direct and indirect interventions
- Understanding demand creation for interventions (services/product) at civil society levels
- Looking at staff competencies and ways to measure and validate behavior and behavior change
- Research on implementation and impact pathways to improve agriculture-nutrition programs

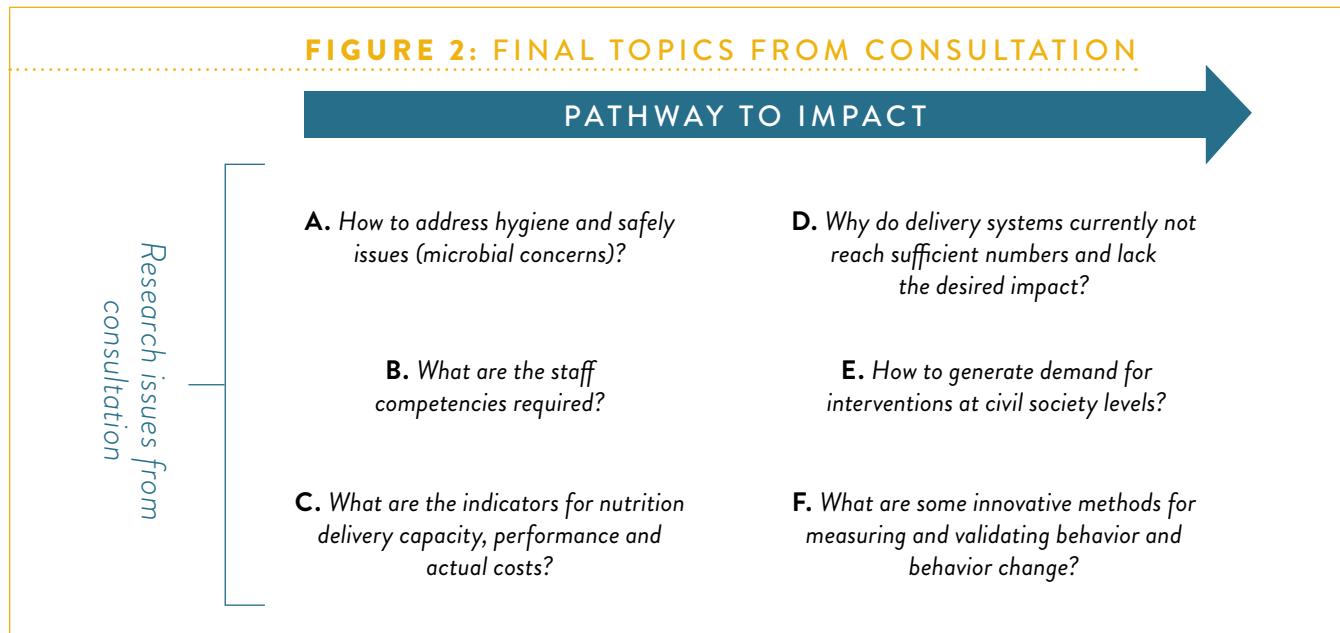
The initial research topics identified by the Group and submitted for consultation were organized as follows:

1. Research to identify innovative methods for measuring and validating behavior and behavior change
2. Research to identify required staff competencies and their impact on program effectiveness and sustainability
3. Research on adequate indicators for nutrition delivery capacity, performance, and actual costs



4. Research to understand and demand creation of interventions at civil society levels
5. Research on implementation and impact pathways to improve agriculture-nutrition programs
6. Research on why delivery systems do not reach sufficient numbers and lack the desired impact
7. Research on the safe administration of micronutrients
8. Research on optimal IYC feeding delivery systems and processes

FIGURE 2: FINAL TOPICS FROM CONSULTATION



Research Topics

The Working Group recognizes that the area of delivery sciences is too nascent to narrow in only on a set of specific questions. Instead, there is a need for a unifying approach to delivery science in nutrition around a better understanding of inputs, processes, and outcomes, as described in Figure 3.

Research Topic 1: Knowledge related to inputs of nutrition intervention

- What are the best suited intervention designs and implementation plans, and adequate content and intensity of training and staff competencies?
- What are the commodities required and how to organize procurement and production?
- What are the strategies for demand creation?

Research Topic 2: Managing the upstream, midstream, and downstream processes

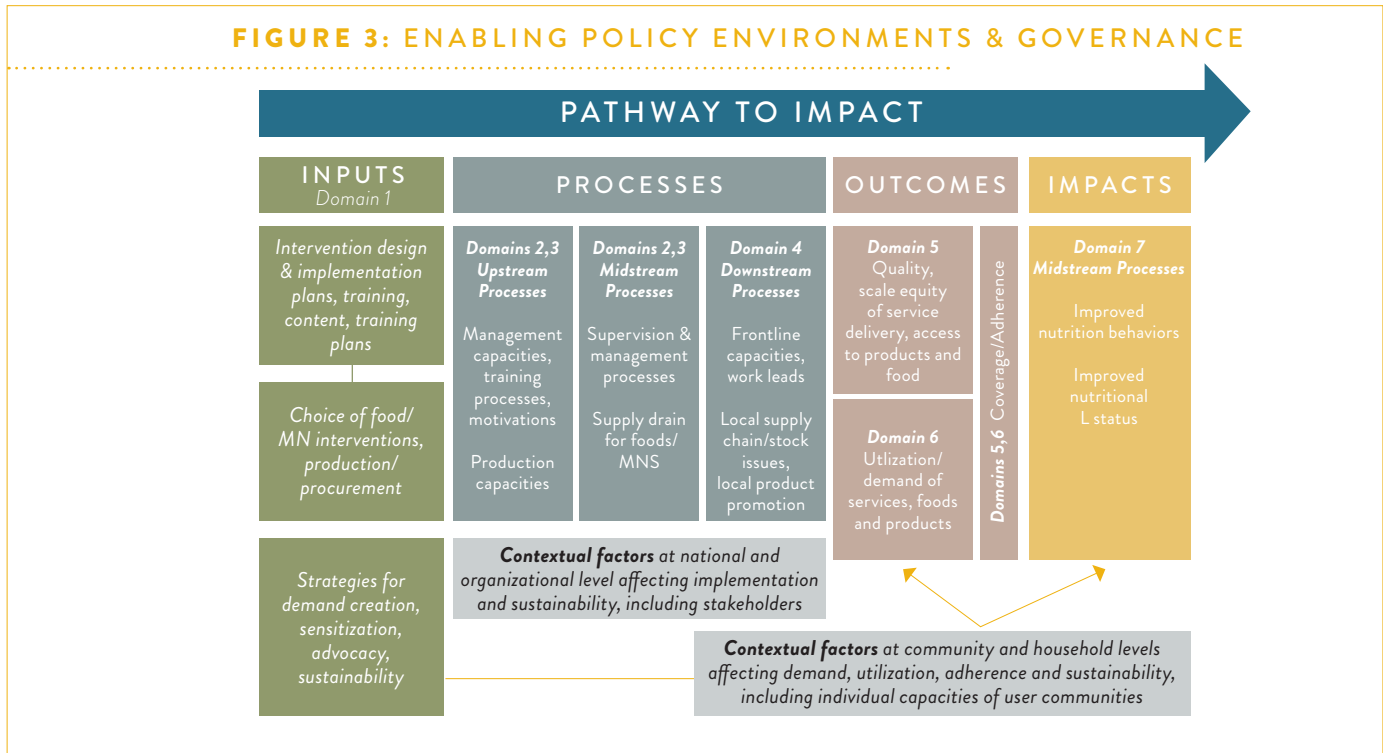
- How to evaluate and support management and production capacities and what level of training is required.

Research Topic 3: Outcomes in terms of service and product delivery and utilization

- How are these aspects measured and compared to the expected outcomes of the intervention, integrating equity, coverage, and quality dimensions?



FIGURE 3: ENABLING POLICY ENVIRONMENTS & GOVERNANCE



Recommendations and Next Steps

The Working Group's writing team is in the process of reviewing the literature and writing a narrative related to framework domains. The article will showcase examples of what "delivery science" studies and methods look like and make recommendations for moving the research agenda forward, given the diversity of interventions, delivery strategies, and contexts.

MOVING FORWARD

The Working Group's outputs will be featured in a Focus Area-specific journal article, to be published and disseminated by the Academy to extend reach of findings and recommendations. These papers will be published in *Annals of the New York Academy of Sciences* in 2013.

The insights from this process will:

- Provide an overview of what current evidence on a given topic shows
- Illustrate the topics and issues in evidence
- Guide new research endeavours in the nutrition field
- Become the basis for efforts to allow the broader nutrition community to work more cohesively and collaboratively in addressing issues in the future

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WHO COLLABORATION

The WHO has been the collaborating partner, providing guidance to the development and finalization of research gaps project. The WHO is the directing and coordinating authority for health within the United Nations system. It is responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries, and monitoring and assessing health trends.

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FOCUS AREA 3

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