



Nestlé Foundation

for the study of problems of nutrition in the world



"Live as if you were to die tomorrow. Learn as if you were to live forever."

Mahatma Gandhi



50 YEARS OF RESEARCH AND CAPACITY BUILDING

FOCUSED AND GLOBAL

MATCHING POLICIES TO NEEDS

HIGH-IMPACT – RESEARCH PROJECTS TO REDUCE MALNUTRITION

INNOVATIVE – FOR SUCCESS

CAPACITY BUILDING – AS A BASIS FOR IMPROVEMENT

SUSTAINABILITY – A KEY MISSION

ENDURABLE NUTRITION – THE PRESCRIPTION FOR SUCCESS

PUBLIC HEALTH – ORIENTATED

THE FOUNDATION 1966 - 2016

EVIDENCE-BASED – PROACTIVITY

PARTNERSHIP – FOR LONG-TERM SUCCESS

SOLUTION – ORIENTED ACTION RESEARCH

enLINK-ing FOR A BETTER WORLD



50
YEARS

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PRESIDENT'S MESSAGE

In 2016 the Nestlé Foundation celebrates its 50th anniversary: half a century of support for research in nutrition. According to the will of the Founder in 1966, the support was mainly meant to encourage work with the objective to improve the conditions for adequate nutrition in the world. Since then, these conditions have changed tremendously, and the Foundation has continuously adapted its policy of support in many ways.

When the Foundation got started, there were nearly no well-trained scientists or solid research institutions in those countries in which the need for better nutrition was most important. Much of the work supported in the early years was carried out by scientists from developed countries on target populations in such countries. Some of the work of those early years

led to important advances in nutrition science: it is highlighted in this report (see page 24-69). But very early it was clear for the Council members, who themselves often contributed significantly to these research projects, that people from the target population should participate in the work, and that the best way to improve the conditions for better nutrition of malnourished populations depends on training of a local workforce. It was the beginning of a program of capacity building by various types of support, often tailored to the specific needs of an individual, institution or a country, and today the Foundation has contributed to the training of many health professionals and scientists. In the following years many centres focusing on research in nutrition and application of the results to the local population were founded, either integrated in universities,

or in governmental organizations. Some of them have been discussed in other annual reports of the Foundation. Networks between these centres and others in developed countries were supported to train young people and to initiate common research projects. Again, the Foundation and some Council members have contributed significantly to these networks and to the training of young scientists.

But fighting malnutrition in a sustainable way takes more than knowing about and providing the type of food most appropriate to people most in need of it. Food has to be produced in the right place and take into account the specific requirements of a given population. Some of the many problems to solve in the fight against malnutrition, which in recent years means under- as well as overnutrition, are far more challenging: sanitation, clean water supply, the fight against infections, population growth, migration, education and access to information, to name just a few. Several contributions by Council members and external contributors in this report address these problems (see section 4 of this report on page 120). The role of primary-school education for every child, and especially girls, who have still less access to schools in certain regions of the world, is one of these often underestimated and neglected problems. The work of Robert Levine and his research group (page 140) has convincingly shown that primary-school education of girls becoming mothers contributes significantly to a decrease in mortality of their children, which is closely linked to malnutrition, too. As long as at least primary-school education is not offered to every child, it is unlikely that the fight against malnutrition will be won. Unfortunately the regions where malnutrition is most frequent are also the ones where universal primary-school education is not guaranteed.

Obviously numerous topics in a variety of populations and age groups have been addressed in the projects which were supported by the Foundation. In the past ten years many more projects on young children and women of childbearing age were submitted and supported by the Foundation. The choice of these two target populations is motivated and justified by scientific findings, which show that the first 1000 days of life, from conception to about two years of age, are a period of life in which the metabolism of an individual is programmed for later life and determines the risk for non-communicable diseases, such as cardiovascular disease, diabetes and obesity.

The nutritional status of young women has therefore an important impact on the future health of her child and improving the nutrition of young women and children might help to break a vicious circle in which the disease burden of one generation is passed on to the next generation. A worldwide effort to target


this population is therefore highly desirable and also supported by several MDG of the past decade and the new SDG of the United Nations. Improving knowledge on this period of life must be a common goal, and this is the reason why the Council of the Foundation chose this topic for the anniversary project of the Foundation. The Foundation decided to call for projects for a postgraduate e-learning course on the first thousand days of life for health professionals and young scientists and will finance the best of the submitted projects.

Finally we would like to thank very warmly the Nestlé Company (at that time the Nestlé Alimentana S.A.), the Founder of the Nestlé Foundation. The statutes as they were defined by the Founder 50 years ago have allowed the Foundation to decide on the allocation of grants and stipends in complete independence, based on scientific criteria and with a priority for local capacity building in low- and middle-income countries. It has been able to contribute to significant advances in nutrition science as shown by many publications in high impact journals. The statutes have also enabled us to match the policies of the Foundation to the changing needs in these countries. With Roger Whitehead, a longstanding former Council member in earlier years, we think that this is the most important reason why the Foundation has been successful.

We all hope that for the next 50 years the Foundation will be able to continue to adapt its funding policies to the needs of a rapidly changing world and help to improve the conditions for a better nutrition for the populations most in need of it.







The Council of the Nestlé Foundation
is pleased to announce, on the occasion
of the 50th anniversary of the Nestlé
Foundation, the creation of a


**POSTGRADUATE E-LEARNING COURSE
ON THE FIRST 1000 DAYS
OF HUMAN LIFE**

In 2016 the Nestlé Foundation for the study of problems of nutrition in the world celebrates its 50th anniversary. For this occasion, the Council of the Foundation decided to initiate and support the creation of a postgraduate e-learning course concentrating on the first 1000 days of human life. This course will represent a key contribution to capacity building of professionals involved in the care of mothers and children in low-income countries.

The course will represent a multi-disciplinary approach to the first 1000 days of human life, discussing the current theoretical and practical knowledge of all aspects of this period of life that are important for disease prevention and care (such as nutritional requirements during pregnancy, breastfeeding, lactation, weaning practices, monitoring growth of infants and young children, the human microbiome and more).

The course will be available for physicians, nurses, health care workers, students and others working in low-income countries.

Please learn more about the availability of this course on the Foundation's website.



In 2016 the Nestlé Foundation celebrates its 50th anniversary. Half a century of research support and capacity building in low-income countries is a unique achievement. There is no other organisation with such a long-standing engagement for and support of research in nutrition and capacity building in low-income countries. Such a "golden" anniversary calls for a strategic review, a look into the past and, even more important, to the future. What was achieved and what should be remembered will be addressed in different contributions in this Anniversary Report.

It is also the occasion to express our gratitude to the Nestlé Company, which 50 years ago saw the necessity to give the Foundation its independence and allowed it thereby to elaborate its strategy on its own.

A brief summary of the achievements is presented below.

During these fifty years the Foundation supported over 300 research projects in more than 55 low-income countries, which resulted in nearly 600 publications, many of them in high-impact journals.

50
YEARS

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& DIRECTORS

OF THE NESTLÉ FOUNDATION

As a research Foundation we can be proud of these numbers. The key criteria for support were, first, the relevance of the research question for improvement of local nutriture and its potential for implementation in the long term; and, second, the quality and quantity of local capacity building. In the last ten years, 43 students obtained Masters of Science degrees and 21 received Ph.D. degrees in nutrition while working on projects supported by the Foundation.

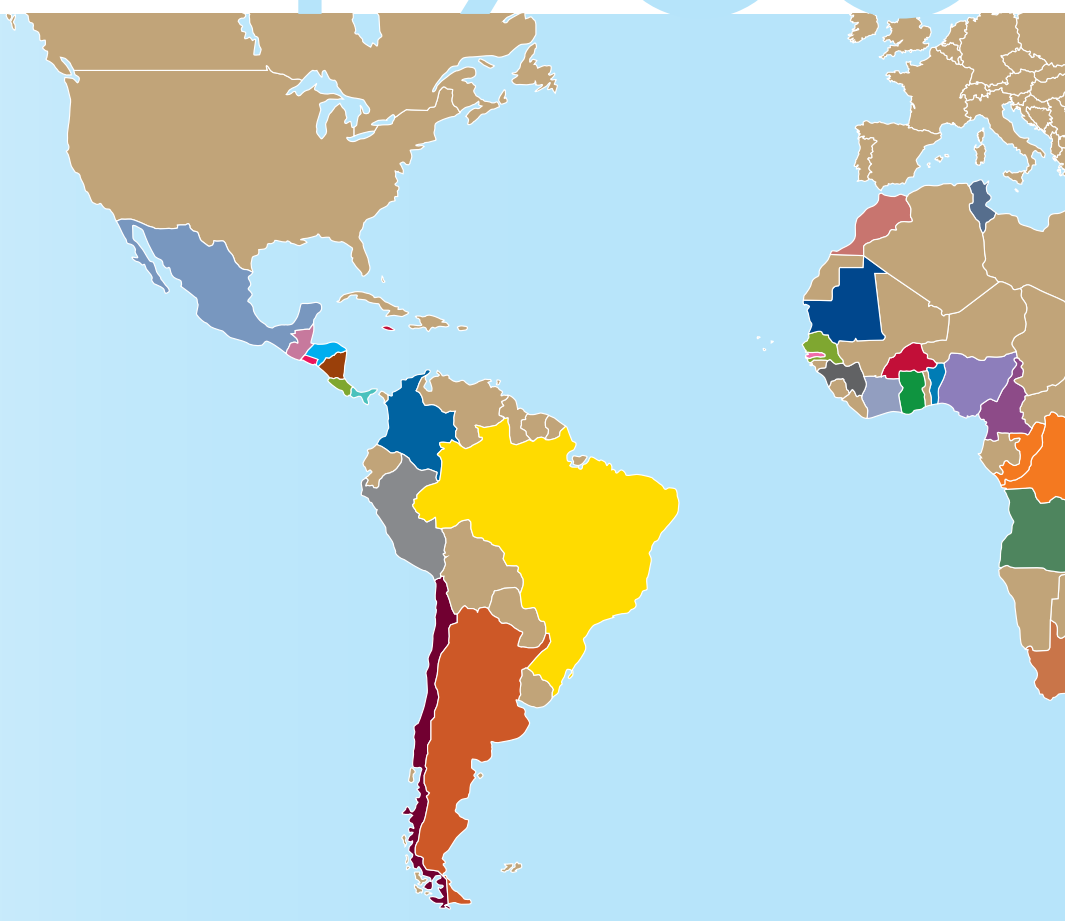
The Council is proud to have supported over 180 individuals from low-income countries to obtain

an internationally recognized University degree in the field of nutrition during these five decades. Many of them are at present engaged either at local Universities, Ministries of Health, Public Health Institutes or in international organizations such as UNICEF, GAIN or the International Potato Center (CIP), to mention just a few of them. Many of the "Alumni of the Foundation" carry on its philosophy that only local engagement by well-trained individuals will lead to a sustainable improvement in nutrition.

Activities in over

1966-

ANGOLA
ARGENTINIA
BANGLADESH
BENIN
BRAZIL
BURKINA FASO
CAMEROON
CHILE
CHINA
COLUMBIA
CONGO
COSTA RICA
EL SALVADOR
ERITREA
ETHIOPIA
GAMBIA
GHANA
GUATEMALA
GUINEA
HONDURAS
INDIA
INDONESIA
IRAN
IVORY COAST
JAMAICA
JORDAN
KENYA
LEBANON



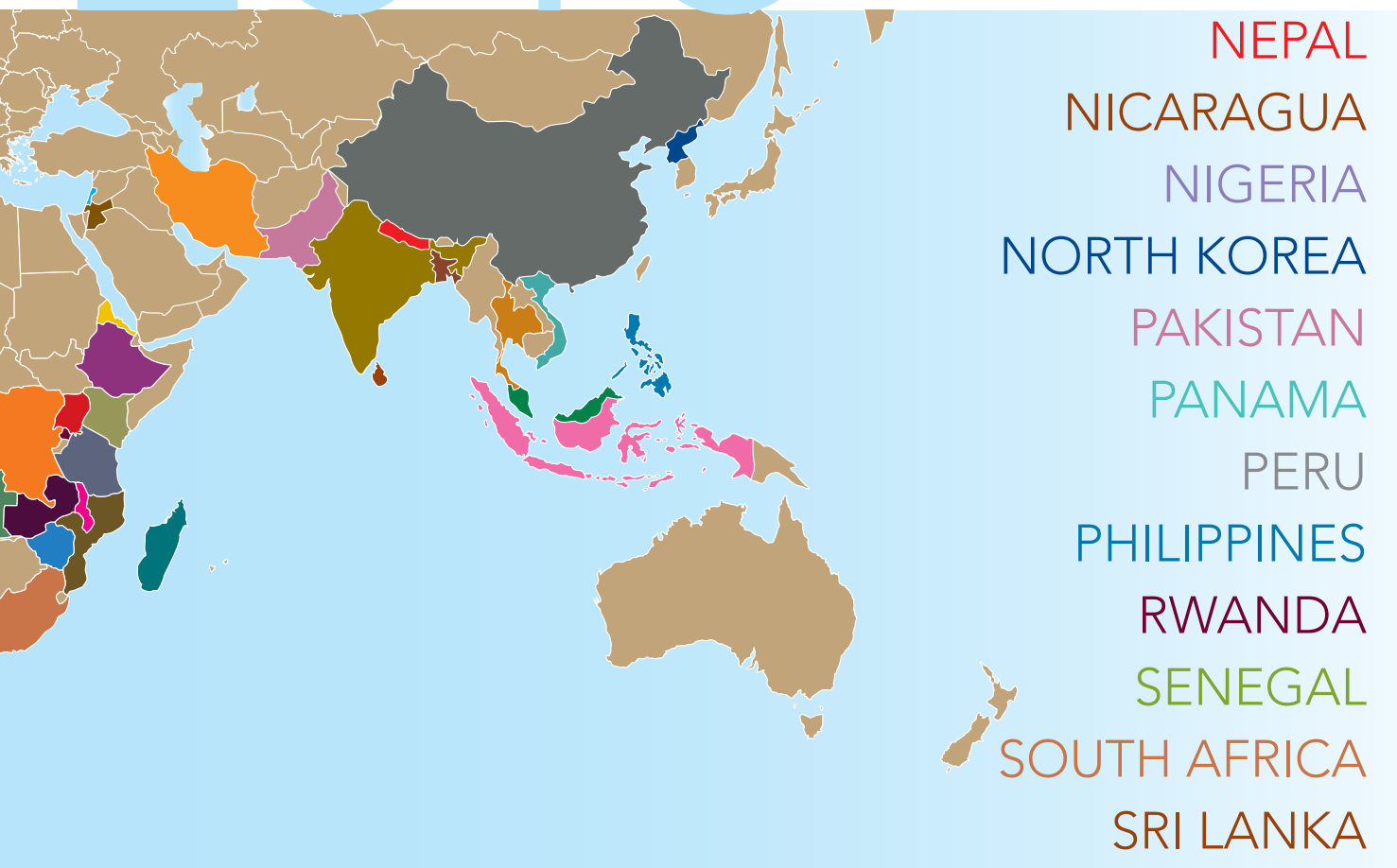
Activities on 5 continents

An investment of over 60 million USD
for research and fellowships

Over 300 research projects
Basis for nearly 600 research
publications

er 55 countries

-2016



Support of over 180 MSc. & PhD degrees

During the last 10 years support
of 43 MSc. & 21 PhD degrees





THE CREATION OF THE FOUNDATION

On 6 May 1966, at the occasion of the 99th General Meeting of Shareholders of the Nestlé Company (at that time the Nestlé Alimentana SA), it was decided to act on a proposal of the Board of Directors of the company to create a foundation whose purpose would be to promote studies for the improvement of nutrition in the world. To assure operational independence, the offices of the Foundation were created in Lausanne (Switzerland) and the Foundation managed by five Council Members and a Director. The first Council Meeting was held on 27th and 28th July 1967 and was attended by Professors Alexander von Muralt (President), Hugo Aebi, Daniel Bovet, Emil M. Mrak, Sir Norman Wright and Mr. Serge Herzen. The very first research project was entitled "Protein Malnutrition: Ivory Coast", and was approved by the Council of the Foundation in its session on 22 February 1968. The Ivory Coast was selected since the Council estimated that the research work should be done somewhere in the tropical region of Africa and in Adiopodoumé there was already a well-established Zoological Research Station operated by Swiss scientists. According to the original wording in the outline of the first project

the aim was "to put modern science and technique to the service of a pressing nutritional problem: protein malnutrition". It was suggested that the research group should consist of a medical doctor, two biochemists, one nutritionist, one agricultural expert, one or two technicians, one chauffeur and one interpreter. The relation of Africans to Europeans in the research team should be 1 : 1. The approach of the very first hour reflects already two key aspects in the policy of the Foundation: 1) There was a global approach to the basic problem by a multidisciplinary team (nutrition alone is not enough and nutrition and food cannot be separated from medicine and health and food production, i.e. agriculture); and 2) Local capacity building was central from the very first day of the creation of the Foundation and was reflected in the creation of a powerful team together with local researchers. These two strategic approaches have been pursued in sheer perfection and intensified by the Foundation whenever possible during all five decades.

Since the creation the Foundation has had 21 Council Members, 17 Advisors and three Directors, thus assuring an independent fulfillment of the mandate.



MAJOR RESEARCH TOPICS

The research agenda during the 5 decades of the existence of the Foundation illustrates the need to link different disciplines to control malnutrition. The research activities are in agreement with the enLINK circle (Figure 1) illustrating five key areas of intervention for the control of malnutrition, hunger, and poverty. The major research activities can be grouped into five categories which will be discussed in details in the consecutive sections and which can be summarized into

- Energy metabolism
- Energy, Amino Acids and Protein
- Child Nutrition and Health
- Maternal nutrition, pregnancy and lactation
- Micronutrients, Infection and Child Development

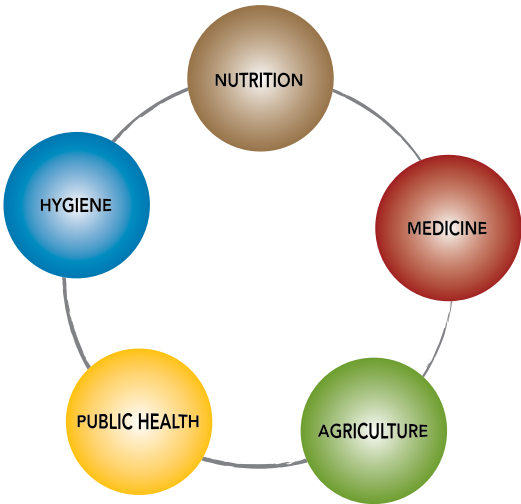
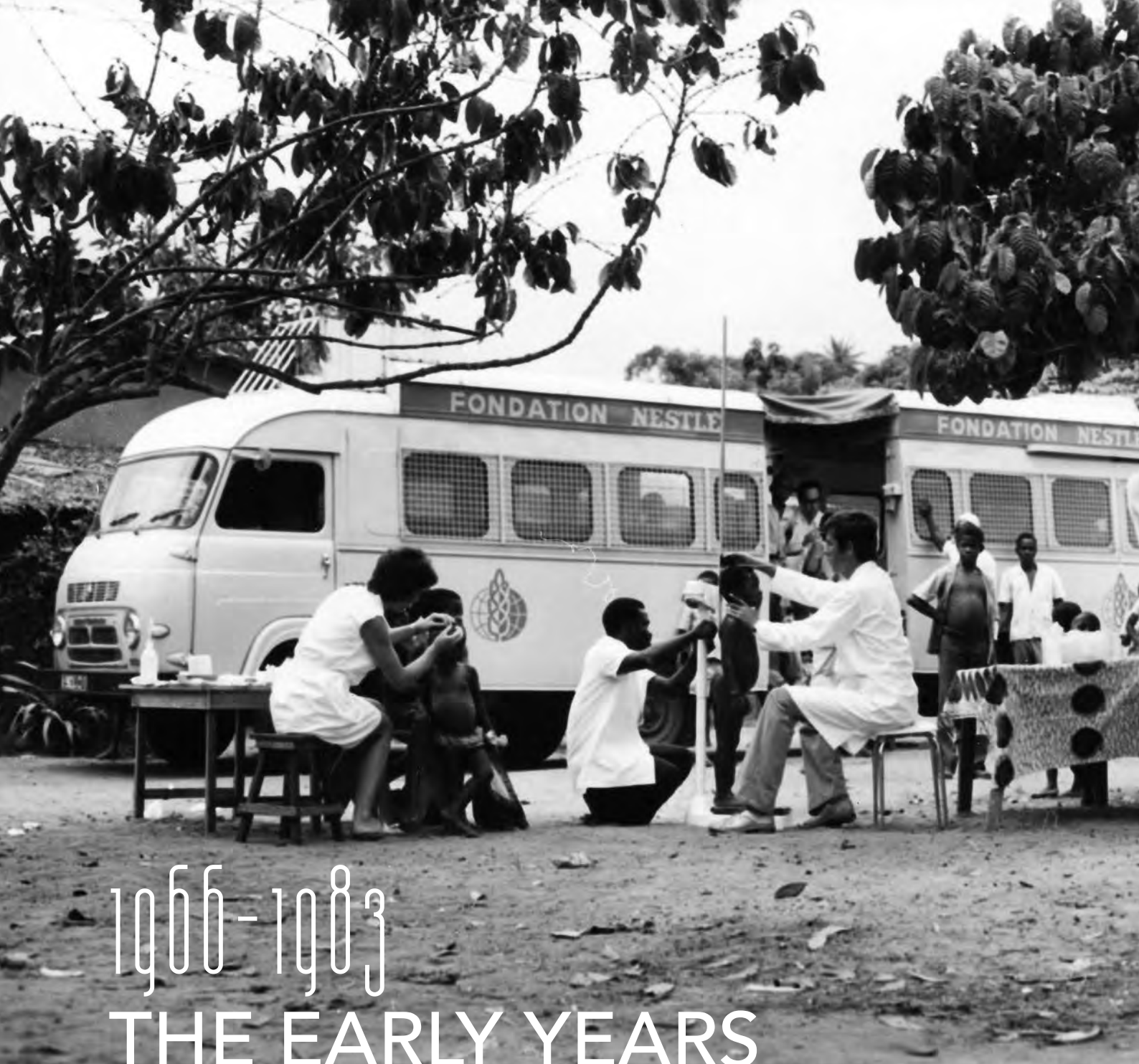


Figure 1: The enLINK circle: The five central fields of intervention for the control of malnutrition, hunger and poverty – identical to the major research areas

Table 1
Major research topics:

Topic	Number of papers
Agriculture.....	10
Brain Development	33
Breastfeeding.....	31
Complementary Feeding.....	30
Energy.....	58
Infection & Immunity	70
Iodine.....	10
Iron.....	42
Maternal Energy Metabolism	42
Micronutrient Nutriture	13
Miscellaneous	55
Nutritional Status.....	8
Nutrition Education	11
Obesity & Lifestyle.....	25
Osteoporosis & Calcium Metabolism	29
Protein Requirements.....	35
Vitamin Nutriture	17





1966-1983

THE EARLY YEARS

Roger Whitehead, CBE, PhD

Former Director,
MRC Dunn Nutrition Centre, Cambridge, UK
and Keneba, The Gambia

Scientific Advisor 1969-1977

Council Member 1977-2005

The fact that the Foundation continues to function in such an effective and productive manner after 50 years owes much to its "Founding Fathers". There could not have been a better choice as the first President than Professor Alexander von Muralt to initiate this new scientific venture. To function effectively, a nutritional organisation needs to have a broad perspective of vision. Von Muralt was the prime example of a polymath. Medically qualified, he was also a physiologist, and I remember his talking with great enthusiasm about how valuable the octopus was for neurological research because of the large size of its neurones. He was, however, also the director of a major space research centre at the summit of the Jungfrau mountain. Hearing I was a "radio ham" he discussed with me their research on sunspot activity, so important for shortwave radio communication.

In the Swiss army he had also been an artillery officer! A scientist of international repute, he had no difficulty in forming an embryo Council of equally talented people, which met early in 1968, charged with defining the nature and future research priorities of the Foundation-to-be: Professor Hugo Aebi, Professor Daniel Bovet, Professor Emil Mrak, Sir Norman Wright and slightly later, Sir Frank Young. These eminent scientists were not nutritionists by profession and much to my surprise, at the age of only 34, I was invited to be associated with the Council as an "expert" in 1968. It is within the context of this early relationship with the Foundation that I write these words about its formative years.

Defining scientific policy was not the only task for the new council. On setting up a new Research Foundation in celebration of their 100 years of existence as a Company, Nestlé decided to do so not by providing an annual allowance dependent on the company's profits but by granting a single lump sum. The Foundation would then be responsible for the wise investment of this money in a wide range of business opportunities and have to function from the financial proceeds. Although a challenge to a group of academics, this arrangement formed the basis of the scientific independence and academic freedom the Foundation and Council has enjoyed ever since. Much of the tribute for managing this new type of responsibility must be given to Serge Herzen, the first Director of the Foundation. Serge Herzen, a chemical engineer by profession, had worked for the Nestlé company happily and efficiently for a number of years and I once asked him why he had decided to apply for the Foundation post. His reply was that he had always wanted to be involved in a venture that was designed to help his fellow men. The introduction of his commercial skills, coupled with his humanitarian ethics, were certainly of great help to von Muralt and his team during these early formative years.

One of von Muralt's first scientific initiatives to get the new Foundation off the ground was to organise an international symposium on protein-calorie malnutrition. At the time this was the major focus of much nutritional research in the developing world. This was followed by a decision to establish a nutritional research laboratory in the Cote d'Ivoire, where there was already a Swiss scientific institute. One of the topics of interest at the time was the causal difference between the oedematous form of protein-calorie malnutrition, kwashiorkor, and marasmus. Cote d'Ivoire offered a good opportunity to study this as the former predominated in the wetter south of the country and the latter in the dryer north. The focus of the Cote d'Ivoire work gradually expanded, however, in line with growing international recognition of the wider ramifications of malnutrition in developing countries than just the syndromes of kwashiorkor and marasmus. The influence of milder malnutrition on brain and intellectual development

was a rational area of investigation because of von Muralt's interests in physiology. The close links between nutrition and infection were also explored but perhaps the recognition by the Swiss team in Cote d'Ivoire of the importance of an inadequate maternal diet on pregnancy outcome and subsequent lactational performance had the greatest impact on the future of the Foundation's research priorities. The UK Medical Research Council team working in The Gambia had also been conducting research on this topic and in 1979 Professor Hugo Aebi and I chaired an international workshop on the topic in Lutry, Switzerland. Hugo Aebi had recently become the president of the Foundation on the retirement of Professor von Muralt. This was to lead to the setting up of a multicentre international study, funded by the Nestlé Foundation, to clarify the precise dietary energy requirements of women during pregnancy and lactation, living under a range of differing social and environmental circumstances. This programme heralded a fundamental change in the way the Foundation was to encourage future research in the developing world.

Until this time the Council had funded high calibre research mainly conducted by expatriate scientists. The multicentre study was to be the first step in the encouragement of young national scientists to play a more prominent role. It was at this time Serge Herzen reached retirement age and the appointment of Dr Beat Schuerch, who had a special interest in medical education, as the new director, greatly assisted this fundamental change in research policy emphasis.



1983-2009 MIDDLE PERIOD

Eric Jéquier, MD

Professor of Physiology Emeritus
University of Lausanne
Lausanne
Switzerland

President of the Foundation 1983-2009

At the end of the first period (1966-1981), the council members implemented a change in policy. They decided to close the research centre in Ivory Coast where most activities of the Foundation had been carried out. The main reason for this change was the fact that the health status of the population of Ivory Coast had improved and malnutrition had become therefore less prevalent. Since nutritional deficiencies are often region- or country-specific, it was evident that the activities of the Foundation had to be carried out in the countries where malnutrition was most pressing. The new research projects should aim to identify the causes of the nutritional deficiencies as well as the pathological mechanisms involved. On this basis, one could design specific nutritional interventions to improve the health status of the population.

This ideal scenario was, however, often difficult to achieve because of a lack of adequate local human, scientific and technological resources. To solve this problem, the council decided to support in developing countries a limited number of large research projects designed by universities or research institutes of developed countries (including the USA, UK, the Netherlands, and Switzerland), provided that several criteria were met. It was required that the research activities should be carried out in collaboration with scientists of the developing country, thus enabling a transfer of scientific and technological knowledge to the local universities. This "capacity building" approach allowed several local PhD students to complete their thesis and their universities benefitted from the transfer of modern technology.

It was also decided to focus most research activities on topics of particular importance, such as the energy requirements of populations of developing countries that suffer from food insecurity, with an emphasis on the energy needs of women during pregnancy and lactation. The results of these studies, published in the best scientific journals, served as a basis for the recommendations of the experts' consultation on human energy requirements organised by the FAO/WHO/UNU in 2004. Since the requirements for energy and protein are closely interrelated, the Foundation has also been instrumental in evaluating new information on human protein needs. A major achievement was the observation that protein deficiency, a key factor responsible for malnutrition in children from low-income countries, was often partially due to a deficient energy intake. The term "energy-protein malnutrition" was coined, illustrating the importance of covering both energy and protein requirements adequately. It is of interest to consider that the same concept may also apply to the field of micronutrient deficiency: for example, children suffering from a deficit in energy and protein are more susceptible to develop iron deficiency anaemia than children with adequate energy and protein intake having the same iron intake.

With the nomination of Professor Paolo Suter as Director of the Foundation in 2002, a new change in policy was implemented. In spite of the previous efforts to improve the scientific and technological capacity of universities from developing countries, it was recognised that the participation of local scientists was insufficient in most research projects supported by the Foundation. It was decided to encourage research groups in developing countries to establish their own priorities regarding nutritional research and to carry out their research projects themselves. Postgraduate training programmes in human nutrition were organised at several African universities and experts from developed countries were asked to help in the design and the implementation of research projects. This new policy has been very successful, as illustrated by the large

number of research projects carried out by scientists of developing countries since 2003. It is noticeable that the ownership of the application by the local investigator is a strong factor of motivation.

Education is of key importance to contribute fighting malnutrition. The Foundation has taken two initiatives that have been a great success. First, the enLINK digital library was created to offer free access to scientific journals in the field of human nutrition for scientists of low-income countries. Second, the enLINK library trunk has been offered to several universities in low-income countries. This trunk contains more than 120 books, brochures and guidelines in the field of nutrition, hygiene and internal medicine. Thus, the combination of various approaches to improve the scientific and technological levels of several universities of developing countries has allowed them to design and carry out their own research projects in human nutrition. We hope that this achievement has contributed to fulfil the mandate of the Nestlé Foundation, namely to improve the nutrition of populations at risk of malnutrition.



2009-2015

THE RECENT PERIOD

Susanne Suter, MD

Professor of Pediatrics Emeritus
University of Geneva
Geneva
Switzerland

Scientific Advisor 1995-1999

President of the Foundation 2010-2015

In one of his contributions to this report, Roger Whitehead, who was a member of the Council of the Foundation for 37 years wrote: "The Council has always made sure that its research funding policy met changing needs". Needs have certainly changed much during the past years and I will describe how the Council perceived changing needs, what its priorities for funding were, and how the funding policy was adapted.

In the past six years research projects in the field of nutrition from low-income countries submitted to the Foundation have considerably changed in terms of topics addressed, at a different pace in different regions of the world. The topics have shifted from projects concentrating mainly on deficiencies of single or multiple micronutrients and strategies to

solve problems with supplementation or fortification to projects on malnutrition in which a food-based approach was preferred. Many projects associated research on malnutrition in populations with an agricultural component and an educational program. A large majority of selected projects concentrate on children under five or cover the pre-pregnancy period, pregnancy and the early childhood years, a logical consequence of scientific evidence showing that nutrition during the “first thousand days of life” is crucial for the health of the adult and for the prevention of non-communicable diseases, such as cardiovascular diseases, obesity and diabetes type 2. This trend is certainly to be supported for the years to come, since it is during pregnancy and early childhood that prevention is most profitable for individuals and also most cost-effective as a public health intervention. Among all projects submitted to the Foundation, long-term prospective studies were preferred to smaller ones and every effort to continue the follow-up for as long as possible was encouraged and supported.

To get a chance to be supported the projects must propose a capacity-building component and have relevance for public health, and the applicants are invited to reflect on what the impact of their research might be five years later; these three components are obviously linked to one another. The projects which best fulfilled these three conditions were the ones in which a member of the research team was part of or had a link to a governmental institution. For these, the chance that knowledge acquired through the project would be integrated into a health policy was substantially improved and this was the case for some projects from Vietnam and Indonesia.

Special attention was given to projects for which scientists from high-income countries recognized as leaders in their field proposed projects, usually in collaboration with junior scientists from the low-income country (often trained in their institution) where the project was to be realized. Although obviously the questions asked in these projects were original and relevant and the project of high quality, the local capacity building and the sustainability in terms of application of the results for the local population were not always considered as optimal. It was often clear that the research project was written by established scientists in the leading institution and that the local junior scientist was little involved in the elaboration of the concept and the writing of the project, which would have been an important step toward independence as a scientist. Although such collaborations will continue to be profitable for scientists working under difficult conditions in low-income countries, there is need for change in the way leading institutions from high-income countries conceive these collaborations. Moreover, an effort must be made so that highly sophisticated lab work can be established in the low-income country if it is

relevant for future investigations. Such projects must offer a real opportunity for improving the autonomy of local scientists and their institutions as a mandatory condition for funding.

As shown on the map of ongoing projects, the Foundation is active in many parts of the world. In some regions—South America, Indonesia, Vietnam, to give some examples—we receive projects from institutions which are clearly autonomous in formulating research questions relevant for their country and also in realizing the project and publishing the results. But in others, especially in Africa, the Foundation recognizes that the conditions mentioned above are often not fulfilled. This does of course not mean that such institutions do not exist, but the Foundation seems to be less well known to these institutions. At present, the Foundation explores ways to reach out to such institutions in more African countries. Even if collaborations with institutions from high-income countries continue to offer important research opportunities to local scientists, it is preferable that the definition of what topic is most relevant be determined locally.

Finally, the scientific impact of the projects supported during these six years should and will be analysed apart from their contribution to local capacity building and their impact on local public health policies. It will give information on the quality of the projects, but indirectly also on the selection procedure. But the Foundation has a longstanding commitment to contribute not only to the study of problems in nutrition, but also to the solution of these problems. We feel that capacity building in nutrition science must be an essential contribution in all supported projects, even if they propose to apply current knowledge to the special needs of their region instead of exploring new fields, and may not be published in high-impact journals favouring originality of a topic.



During the 50 years the following Council Members, Advisors and Directors assured the fulfillment of the mandate of the Foundation:

COUNCIL MEMBERS

Prof. Alexander von Muralt.....	1967-1977	President 1968-77
Prof. Hugo Aebi.....	1968-1983	President 1977-83
Prof. Daniel Bovet	1968-1980	
Prof. Emil Mrak	1968-1973	
Sir Norman C. Wright.....	1968-1970	
Sir Frank G. Young.....	1970-1980	
Prof. Emile Gautier	1974-1994	
Prof. Roger G. Whitehead	1977-2005	
Prof. Joseph Hautvast.....	1980-2010	
Prof. Henri Isliker	1980-1994	
Prof. Eric Jéquier	1983-2009	President 1983-2009
Prof. Jean-Pierre Flatt	1994-2005	
Prof. Mehari Gebre-Medhin	1995-2009	
Prof. Jehan-François Desjeux.....	2005-2012	
Prof. Prakash Shetty	2005-2015	
Prof. Susanne Suter	2010-2015	President 2010-2015
Prof. Robert Russell	2010-2013	
Prof. Kraisid Tontisirin	2011-2016	
Prof. Janet King	2011-2013	
Prof. Walter Wahli.....	2012-	President 2016-
Prof. Dominique Darmaun.....	2013-	
Prof. Petra Hüppi.....	2016-	
Prof. Benjamin Caballero.....	2016-	

SCIENTIFIC ADVISORS

Prof. Francis Aylward.....	1968-1977
Prof. Roger G. Whitehead	1968-1977
Prof. Emil Mrak	1974-1988
Prof. Pierre Ambroise-Thomas	1977-1988
Prof. Joseph Hautvast.....	1977-1980
Prof. Bernard Jeanrenaud.....	1977-1997
Prof. John Durnin	1982-1997
Prof. Jean-Pierre Flatt	1989-1994
Prof. Prakash S. Shetty	1994-2004
Prof. Jehan-François Desjeux	1995-2004
Prof. Susanne Suter	1995-1999
Prof. Claire-Anne Siegrist	2001-2003
Prof. Robert Russell	2008-2009
Prof. Kraisid Tontisirin	2008-2010
Prof. Benjamin Caballero.....	2014-2015
Prof. Ann Prentice	2014-
Prof. Petra Hüppi.....	2015

DIRECTORS

Mr. Serge Herzen.....	1967-1979
Dr. Beat Schürch	1979-2002
Prof. Paolo M. Suter	2003-



50 YEARS

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- 28 IVORY COAST RESEARCH
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- 36 ENERGY REQUIREMENTS IN THE HUNGRY SEASON
- 38 ENERGY REQUIREMENTS OF PREGNANCY & LACTATION
- 40 CHILD HEALTH & NUTRITION
- 44 PRECONCEPTIONAL NUTRITION
- 46 CHILD DEVELOPMENT
- 48 NUTRITION & INFECTION
- 50 ORAL REHYDRATION
- 52 CHRONIC DISEASE RISK
- 54 A DUAL MISSION
- 56 LEADERSHIP & CAPACITY BUILDING
- 58 IMPLEMENTATION
- 60 THE NEED FOR LOCAL PEOPLE
- 62 THE ENLINK INITIATIVE
- 64 THE ENLINK LIBRARY - 7D/24H
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- 68 FUTURE FOODS



1969-1979 THE RESEARCH CENTER IN ADIPODOUMÉ

After the creation of the Foundation it was decided that the defined aim "to study the problems of nutrition in the world" could be achieved through well-selected and promising research projects initiated and performed by the Foundation. From 1969 till 1979 a research team of the Nestlé Foundation consisting of several medical doctors, biochemists, agriculturalists, farmers, laboratory technicians and dieticians worked at the "Centre d'Etude d'Adipodoumé" (CEA) in the Ivory Coast.

The composition of the multidisciplinary research team reflects the approach of the Foundation to fulfill its mandate: the problems of nutrition could only be tackled by a combined approach considering medical, agricultural, public health, educational and last but not least nutritional aspects. This "network"

approach is also reflected in today's activities of the Foundation in the enLINK circle (see page 14).

Another key approach of the Foundation was already established in the very early days: although the initial research activities were performed by scientists from Switzerland, the team was "fortified" with local collaborators at all levels of expertise and the very final aim was—as stated in a very early report (1)—the "ivorization" of the research station, i.e. the complete takeover of the research center by local scientists.

After these initial 10 years, the Nestlé Foundation changed the strategic research approach and became a grant-giving body with clear priorities to address problems of under- and malnutrition, especially in women and children. The priority of all support activities remained in low-income countries as well as lower-middle-income countries. At the end of 1980, the Foundation's laboratory and research station in Adiopodoumé was taken over by the CSRS ("Centre Suisse de recherche scientifique", a Swiss research center under the auspices of the "Schweizerische Naturforschende Gesellschaft").



CENTRE SUISSE



IVORY COAST RESEARCH

During a 10-year period the Foundation's research activities were realized by a multidisciplinary team of the Foundation consisting of an international (i.e. foreign as well as local) team of medical doctors, biochemists, agriculturalists, farmers, laboratory technicians and dieticians. According to the final report of the activities in the Ivory Coast as well as different publications, seven major fields of research activities can be identified (1, 2):

- Observation of the nutritional status of rural pre-school children
- Studies on the relationship between physical growth and sensory-motor development of infants
- Relationship between nutrition and immunity

- Longitudinal evaluation of breast-milk composition
- Evaluation of nutrition and other environmental influences on child development
- Improvement of the protein nutriture through winged beans
- Nutrition education and implementation

Over the course of the years the team recognized the importance of implementation and nutrition education, and implementation was added as a key component in the different research fields. In agreement with the aims of the Foundation and the Council the locally assessed needs were specifically included in nutrition education activities.



A nutrition education program initiated and directed by Dr. Lamotte, a Belgian pediatrician working at the regional hospital in Bouaké, instructed and showed the mothers of pediatric patients how to prepare nutritionally well-balanced meals from locally available foods. The team also organized workshops for nutrition educators who came from various other parts of the country.

The Foundation focused already in the first decade on a food-based approach to solve the problems of nutrition in the world. The winged bean (*Psophocarpus tetragonolobus*) was identified at that time as a very good dietary protein source. Thus the Foundation started a *Psophocarpus* project in 1977 with the aim to introduce the winged bean as a protein-rich legume into family gardens of the Ivory Coast. The ultimate

goal was to make the winged bean part of the local population's diet. It was clear from the outset that the attainment of this goal was beyond the Foundation's means. Thus the Foundation's Council set three objectives for the winged bean pilot research project:

- To demonstrate that the winged bean can be cultivated in various regions of the country and to select varieties which are particularly adapted to local conditions
- To demonstrate that the products of the winged bean can be integrated into traditional dishes
- To show that regular consumption of winged bean products can have a positive effect on the nutritional status of young children



At the same time the Foundation tried to establish contacts with local authorities to ensure that the pilot research could become sustainable.

In Kpouébo (200 km north of Abidjan), several accessions of the winged bean were planted to compare growth, yield and susceptibility to local climatic conditions and diseases. The experiments were coordinated by the International Steering Committee on the Winged Bean with the aim to compare 15 varieties of *Psophocarpus* in 25 different countries. During the few years of research about the winged beans the research group of the Foundation became confident that some of the semi-governmental Ivorian organizations would continue to be engaged in the winged bean. The “Ministère de la Condition Féminine” had great interest in the winged

bean and several former collaborators continued the promotion of *Psophocarpus* in the Ivory Coast under the auspices of that ministry.

Theoretical and practical nutrition education was practiced by the research team: women were shown how to enrich different local dishes with *Psophocarpus* grains and pods. Accompanying research showed that the introduction of the winged bean had a significant effect on the nutritional and health status of the children.

A detailed overview of the research activities can be gained by consulting the research papers from this period (see publications 1-90 in the downloadable list of publications at www.nestlefoundation.org).





MATCHING POLICIES TO NEEDS

Roger Whitehead, PhD
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and Keneba, The Gambia
Scientific Advisor 1968-1977
Council Member 1977-2005

One of the problems of being in one's eighties is that you find yourself part of an increasingly small band of people who were around 50 years ago when scientific ventures like the Nestlé Foundation were just being initiated. Why has the Nestlé Foundation proved to be so successful? I believe it has been because the Council has always made sure its research funding policies matched changing needs.

I first became aware of the Nestlé Foundation in 1966 via my boss in Cambridge, Professor McCance. He had met Professor von Muralt, who had just been appointed the head of this new body. It was suggested I should visit him on one of my visits to Europe from Uganda, where the British Medical Research Council had a research unit studying kwashiorkor. Von Muralt was considering developing

a similar organisation in West Africa. He explained to me how the Nestlé Company wanted to see set up a new Foundation as part of the 100-year celebrations of its own establishment. I remember being initially worried, as a young academic naturally would be, of the academic independence of such an arrangement. His answer came quickly; it was obvious he had thought about the same matter himself. The Nestlé Foundation to study nutritional problems of the developing world would not depend on the annual profits of the Company. It would be financed out of the interest from a major grant that would be invested in the stock market. These investments and the use made of the proceeds would be under the total control of a Council of senior international scientists. It is this structure which has enabled an ever-flexible approach to changing scientific demands.

In 1968 I was appointed an expert to the Council and some 10 years later a member of the Council itself. It has been interesting to observe how the differing contributions of the individual members of the Council have kept the functioning of the Nestlé Foundation in line with national and international developments. Initially the research programmes were dominated by proposals from the western world. Indeed the Foundation established its own research unit in the Ivory Coast. This matched closely similar laboratories run by other European countries and the USA. There was a shortcoming, however, that affected all such expatriate research organisations. The scientific excellence of the research was not in question, but there tended to be too little emphasis given to the needs of aspiring nationals from the growing number of newly decolonised countries. The balance between high class, fundamental research and the applied studies needed to solve more mundane practical problems was often neglected. Clearly the most appropriate persons to pursue such ventures would be the nationals themselves, but they had rarely had the opportunity to develop the necessary research skills. Frequently their applications for funding contrasted with the more polished submissions from western countries. The Council were well aware of this and I remember lengthy discussions as to how individual submissions could be improved. The Director and his staff were frequently asked to pass on this information in a constructive way and resubmission encouraged. From my membership of other grant-awarding committees this approach was unique. Imperfect submissions would just be turned down flat!

Something more definite needed to be done. A limited number of research scholarships had been awarded by the Council from its very beginning, often

for training in high class establishments overseas, but this approach alone was unlikely to solve the problem. Having received postgraduate training there was frequently no department back home in which the post-doc could efficiently carry on with his nutrition research. This realisation led to the Council's initiative of Institute Strengthening. The basic plan which evolved after much discussion was to invite institutions where there was a definite plan for developing nutritional research to propose the names of up to six candidates at post-doctoral level who would benefit from one year's extra experience of working in a well-established research institute anywhere in the world. The choice of establishment was open but had to fit in with the defined development plan for the nutritional team. Coupled with this was an understanding within the Council that future research applications from successful trainees would receive priority consideration when they returned to their institute. I have always regarded this as one of the most inspirational achievements of the Nestlé Foundation. An associated initiative was to invite representatives from a wide range of developing countries to an excellent meeting in Switzerland (see picture). The purpose was *not* to explain what we could do for them, but to ask what they thought an organisation like the Nestlé Foundation should be doing to provide the research help *they* needed! As a Council member I know how this meeting greatly helped to clarify my own mind about priorities and policies.

I retired from the Foundation Council in 2005. New people, new ideas, but I am delighted to read in the Annual Report how the hopes and aspirations of previous Council members are seeing fruition.

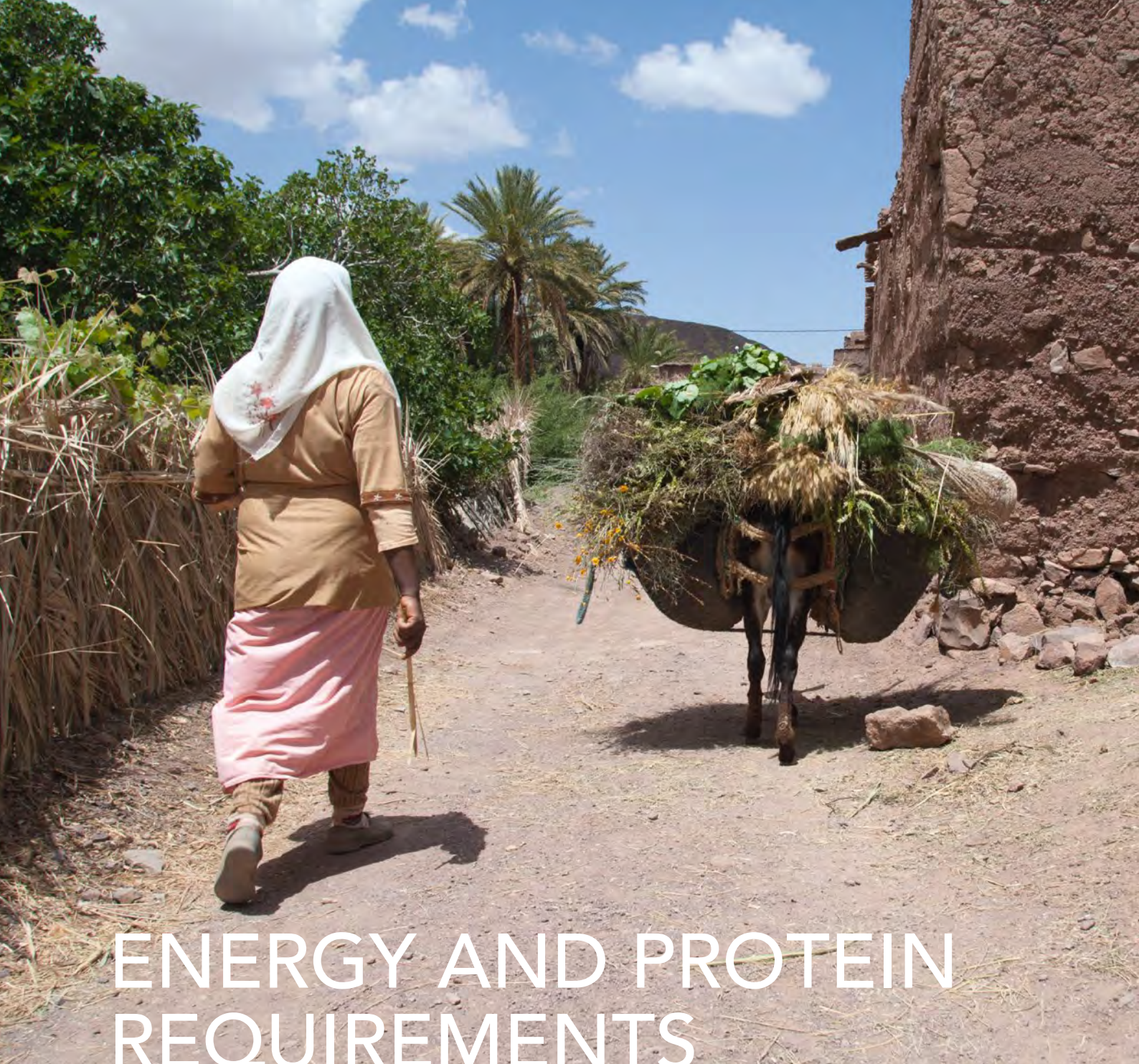
A picture from the meeting of directors and representatives of nutrition institutes from low-income countries (Vevey, Switzerland on April 10th-13th 2002):

Back row: Ma Aiguo, Eric Jéquier, Xiaoguang Yang, Mehari Gebre-Medhin, Mohd Ismail Noor, Visith Chavasit.

Middle: Angelo Hüsler, Jo Hautvast, Beat Schürch, Jehan-François Desjeux, Jean-Pierre Flatt, Iqtidar Khan, Eric-Alain Ategbo.

Front row: Ha Huy Khoi, Mauro Valencia, Elisabeth Müller, Este Vorster, Nguyen Thi Kim Hung, Salimata Wade, Drupadi Dillon, Laila Hussein, Cecilia Florencio, Joyce Kikafunda





ENERGY AND PROTEIN REQUIREMENTS

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Former Professor of Human Nutrition
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Advisor 1994-2004

Council Member 2005-2015

In the 1980s, a major shift occurred in our approach to estimating the energy requirements of man, which hitherto had relied largely on the measurement of food intake. The Joint FAO/WHO/UNU Expert Consultation Report (1985) adopted the principle of relying on estimates of energy expenditure rather than energy intake from dietary surveys to compute human energy requirements. Since then, the collection of data on the energy expenditure of infants, children and adults gained importance. Alongside the development and use of techniques such as whole-body calorimetry and doubly labelled water (DLW) to estimate 24-hour energy expenditure, the measurement of basal metabolic rates (BMR) and the calculation of physical activity levels (PAL) to compute the total energy expenditure (TEE) of free-living individuals received attention. During

this exciting period of the introduction of novel techniques and approaches for the measurement of energy expenditure we also saw an increase in our understanding of the variations in energy requirements during growth and illness and during physiological states such as pregnancy and lactation as well as the effect of ageing. Of much interest at the same time was the need to investigate the concept, mechanisms and types of adaptation to low-energy intakes which had dominated the debates until the 1980s, because of our reliance hitherto on food intake measurements; both on the principal question of what the true energy needs of men and women are, and its direct application for estimating the numbers who were energy deficient or food insecure globally.

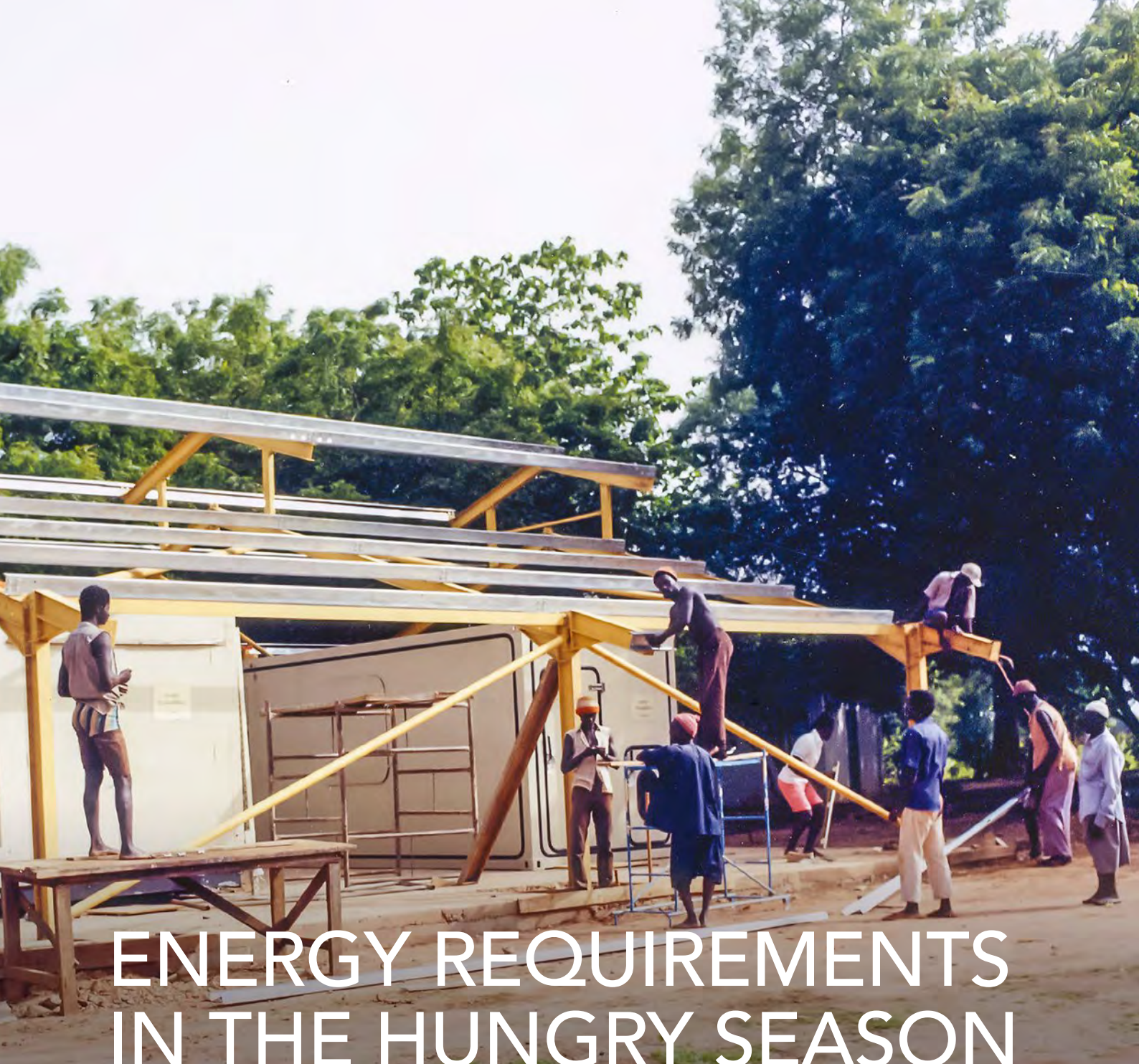
The Nestlé Foundation at this juncture played an important and pioneering role in initiating research, investing in infrastructure and supporting large research grants for research in this important area of nutrition. The support of the Foundation involved not just equipping laboratories for human calorimetry and for DLW studies, but also supporting multi-country studies for estimating the energy needs of pregnancy and lactation, as well as the measurement of the energy costs and patterns of physical activity. In addition, it supported studies investigating the mechanisms of adaptations to variations in energy intakes, particularly that related to lower energy intakes. It has thus been possible, from the research supported by the Foundation, to revise the recommendations for energy requirements of newborns, infants, children, adolescents, adults and the elderly. Much of our understanding today of the energy requirements of man as summarized in the most recent FAO/WHO/UNU Expert Consultation Report (2004) is attributable to the crucial role the Nestlé Foundation played at this critical period in the progress of nutritional science.

A decade later, the Nestlé Foundation yet again intervened at a critical period in our understanding of protein requirements and in particular that of human amino acid requirements. By the mid-1990s, the Foundation provided investments and generous support to groups of researchers involved in the use of stable isotopes for the estimation of amino acid requirements. This novel use of stable isotope tracer techniques gave estimates of lysine, leucine and threonine requirements which appeared to be lower than the estimates derived using the traditional nitrogen balance methods. Numerous important publications in international journals that arose from this research formed the basis for the recommendations made in the most recent WHO/FAO/UNU Joint Consultation report on "Protein and amino acid requirements in human nutrition" (2007).

The emerging advances in the area of energy (and protein) components of human nutritional requirements raised the need for establishing an

International Consultancy Group on this important topic. The international recognition of the dominant role that the Nestlé Foundation was playing in this scientific enterprise meant that this group of experts needed to be involved with the Foundation. In 1986, the Nestlé Foundation contributed to the creation of the International Dietary Energy Consultancy Group (IDECG) that was founded by the United Nations University (UNU) and the International Union of Nutritional Sciences (IUNS). The Secretariat of IDECG was based in the Foundation in Lausanne, with its former Director, Beat Schürch, as Executive Secretary of IDECG.

With joint support from the Foundation, UNU and IUNS frequent Working Group meetings of experts and workshops were held to study the effects of different levels of dietary energy intake on the health and welfare of individuals and societies. IDECG's objective was the compilation and interpretation of relevant research data on functional and other consequences of deficiency, change or excess of dietary energy intake. This implied that virtually all of IDECG's work has directly or indirectly to do with energy requirements (and that of protein, since energy and protein requirements are closely interlinked). The deliberations of IDECG's several meetings on topics such as chronic energy deficiency (CED), causes and consequences of CED, linear growth retardation, protein and energy requirements, limits of adaptation, protein-energy interactions, etc., has been published in peer-reviewed international literature and is also available as a series of monographs published by the Foundation (see references for this article and publication list on our web site).



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**STUDIES ON THE ENERGY NEEDS OF
GAMBIAN MEN AND WOMEN DURING THE
"HUNGRY SEASON"**

In the 1980s, the energy requirements of adult individuals were the object of much debate, as shown by studies reporting that individuals with a similar level of physical activity vary by a factor of two or more in their intake of energy without influencing body weight or body composition. The question was therefore asked as to whether adult individuals living in developing countries could adapt to the seasonal variations in the habitual energy intake of the population. These variations of energy intake result from the seasonal decrease in food availability due to the diminution of food stores before the new crops can be harvested. This question is not only

of academic interest but is of major importance to assess the energy requirements of people living in developing countries. If an adaptive response to a chronic reduction in food intake could be demonstrated without inducing a deleterious cost for the individuals, the recommendations on human energy requirements by international agencies (FAO, WHO) should be revised. Furthermore these agencies adopted the principle on using measurements of energy expenditure rather than energy intake to estimate energy needs of adult individuals.

Thanks to a collaboration between the Dunn Nutrition Center (Cambridge, UK and Keneba, The Gambia) and the University of Lausanne (Department of Physiology), a unique series of human investigations were carried out in a rural village of The Gambia (West Africa) by using a respiration chamber, an airtight room in which an individual can spend 24 hours or more. The aim of these studies was to assess whether adult individuals exhibit a metabolic adaptation during the "hungry season", a period during which their body weight decreases by 2 to 4 kg, demonstrating a chronic negative energy balance. It was a great challenge to transport the respiration chamber from Lausanne to Keneba and to make it work effectively in this rural environment (electricity was produced by a diesel engine!). A respiration chamber is a device used to continuously calculate energy expenditure of the subject by measuring the individual's oxygen consumption and carbon dioxide production.

Eighteen men were measured at three different times of the year: first, at the end of the "hungry season" (September-October); second, during the dry season (January-February), which corresponds to the anabolic phase accompanied by an increase in body weight due to the increased food availability; and third, at the beginning of the rainy season (June-July), which corresponds to the onset of the catabolic phase. Free physical activity was allowed during the 24-hour test, except for periods of imposed exercise on a treadmill.

The main results showed a decrease of 7% of the 24-hour energy expenditure of the subjects at the end of the "hungry season" compared with the period after regaining the lost body weight. This small saving of energy during the "hungry season" was entirely explained by a loss of lean body mass due to the period of negative energy balance (1). It is of interest to mention that this saving of energy disappeared when body weight and lean body mass was fully recovered during the dry season. Our results show that there is no increase in metabolic efficiency of metabolic active tissues in response to a period of chronic energy restriction. The same conclusion was reached with studies of prolonged experimental overfeeding carried out in western subjects, which failed to demonstrate a presumed "luxusconsumption", a concept that hypothesized

a decrease in metabolic efficiency in response to a chronic positive energy balance (2).

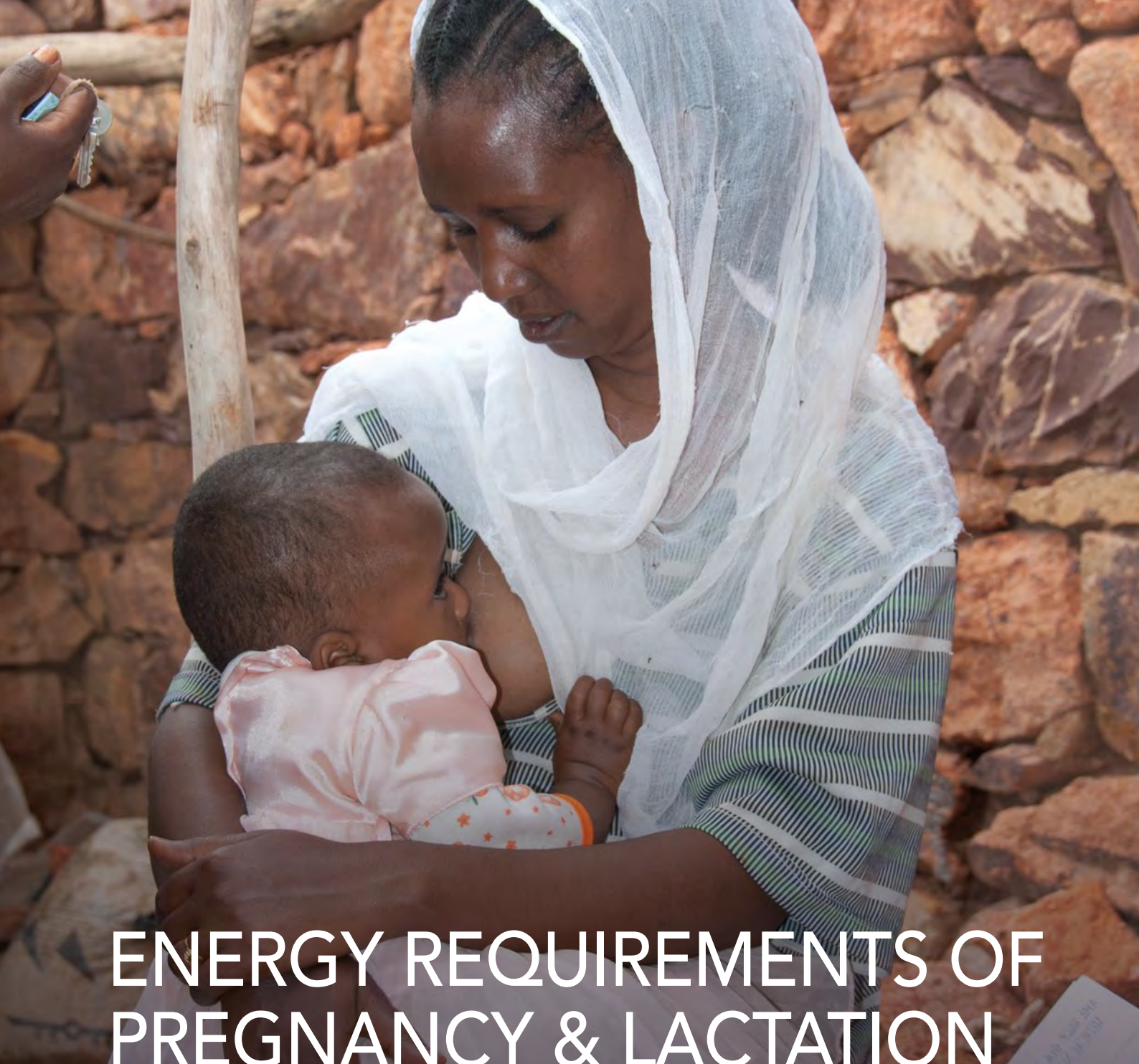
The originality of these studies relies in the duration of the measurements (a whole day and night period) whereas most investigations on energy expenditure in humans are limited to the measurement of resting or basal metabolic rate, the estimation of the total 24-hour energy expenditure being obtained by a factorial approach using a "physical activity factor". Our measurements include the thermic effects of meals, the energy expended during periods of physical activity and during the night sleep period.

The demonstration of a lack of metabolic adaptation of energy expenditure during periods of chronic energy restriction is of great practical importance. These results show that the estimation of energy requirements of adult individuals must not be corrected by the erroneous concept of a supposed metabolic adaptation to a chronic decrease in food intake.

If there is no metabolic adaptation when food intake is markedly reduced, it is important to mention that a behavioural adaptation in physical activity patterns may occur which limits work output, economic productivity and socially desirable activities. This behavioural adaptation is obviously undesirable and becomes a survival strategy. The estimation of energy requirements of adult individuals must cover the cost of all activities and thus prevent the occurrence of behavioural adaptation.

Other studies in The Gambia using the respiration chamber dealt with the energy cost of pregnancy and the cost of lactation. The results of these studies were also of interest for elaborating the new international recommendations on energy requirements. The studies in The Gambia with the respiration chamber lasted 10 years (1986 to 1995) and 10 young Swiss physicians completed their MD theses by working on these research projects. Even more important, it created an opportunity for young Gambian scientists to use modern scientific equipment in their own country and learn how to perform fundamental research into practical problems of human nutrition.

The pictures shows the installation of the indirect calorimeter in Keneba (The Gambia) at the MRC research station. A protective shelter is constructed around the calorimeter by local workers under guidance of the local and international researchers. This pictures is a reflection of the philosophy of the Foundation that one needs to invest in the local infrastructure and man power to boost local capacity and to achieve a sustainable local improvement.



ENERGY REQUIREMENTS OF PREGNANCY & LACTATION

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ENERGY REQUIREMENTS OF PREGNANT AND LACTATING WOMEN

The Nestlé Foundation organized around 1980 a broad consultation on the issue of energy requirements in pregnancy. There was a great deal of conflicting evidence on maternal energy balances under various free-living situations. One of the main conclusions by that consultation was that there was a serious lack of comprehensive longitudinal data using uniform research methods on the various components of maternal energy balance. The Nestlé Foundation consequently decided to design the most appropriate multi-centre study, of course within a certain budgetary limit, under the leadership of Professor John Durnin from Glasgow, in his function

of advisor of the Nestlé Foundation. Up to then the most relevant available data on energy requirements was studied and compiled by Hytten and Leitch. They estimated the energy cost of pregnancy of Caucasian women to be 335 MJ partly based upon the estimate for fat gain during pregnancy of 3,35 kg. What were the findings of the multi-centre studies initiated by the Nestlé Foundation in the period 1980-1985?

Longitudinal studies during pregnancy were carried out in five countries in women living under different social, environmental and economic circumstances. These countries were Scotland, the Netherlands, The Gambia, Thailand and the Philippines. The research teams used similar measurement designs and were very well trained in using the same or very similar methodologies to study the various components of energy balance. In Scotland and the Netherlands women were recruited and studied before pregnancy started. In The Gambia, Thailand and the Philippines women were recruited from week 10-12 of pregnancy onwards. Main data collected in all countries include height, weight, skinfold thicknesses, energy intake, BMR, daily activity pattern and birth weight and birth length.

The gain in fat mass during pregnancy brought a really new view compared to the estimate by Hytten and Leitch of 3,35 kg. This gain was substantially lower: about 2 kg in Scottish and Dutch women and about 1,5 kg in Thai and Philippine women. This finding consequently had a considerable impact on the calculation of the energy cost of pregnancy. Hytten and Leitch reached at a figure of 335 MJ for the whole of pregnancy, and the Nestlé Foundation studies, after standardization for maternal body weight, came to an average estimate of about 250 MJ. When expressed on a daily basis these figures arrive at respectively 1200 kJ and 900 kJ. The WHO stated that when pregnant mothers can reduce their physical activity, the average daily energy requirements might be lowered to, respectively, 840 kJ and 600 kJ.

The next question was whether the extra energy costs of pregnancy would be accompanied by extra energy intake during pregnancy. The findings of the multi-centre study did not confirm substantial increases in energy intake. Only a modest increase in energy intake of not more than on average 420 kJ per day was measured. There is not a valid explanation for this discrepancy. It is conceivable that the reduction in physical activity is higher than estimated or measured.

This Nestlé Foundation project (1980-1985) resulted in several publications in the *Lancet* in 1987, followed in subsequent years by publications in other scientific journals. Main researchers and authors at that time were John Durnin and Fiona McKillop from Glasgow; Jo Hautvast, Joop van Raaij, Meta Peek and Susan Vermaat from Wageningen; Roger Whitehead and

Mark Lawrence from The Gambia; Arie Valyasevi and Kallaya Kijboonchoo from Thailand; and Cora Barba and Peachay Tuazon from the Philippines.

The Nestlé Foundation project also had an enormous spin-off and resulted in important follow-up studies in the 1990s on energy requirements of pregnancy and lactation. For example, several studies performed in Wageningen (Caroline Spaaij, Lisette de Groot) have shown that diet-induced thermogenesis and metabolic efficiency are not really adapted in pregnancy and therefore also cannot explain the observed discrepancy in previous studies. Also other studies on energy requirements in pregnancy and lactation in The Gambia (Andrew Prentice) and in India (Sunil Piers, Prakash Shetty) in the nineties can be considered as immediate continuations of the earlier work in the Nestlé Foundation project.

The progress in research on energy requirements in pregnancy and lactation as made in the last two decades of the twentieth century would not have been possible without the initiatives and support of the Nestlé Foundation in the early eighties.



CHILD HEALTH & NUTRITION

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CHILD HEALTH AND NUTRITION IN LOW- AND MIDDLE-INCOME COUNTRIES: A LOOK IN THE REAR-VIEW MIRROR

The state of the world's children

The Global Burden of Disease Study published in Science and by WHO in the beginning of the 1990s was an important effort to produce an independent evidence-based approach to public health policy formulation. It made a significant contribution to the understanding of the epidemiology of diseases and their consequences.

To allow comparisons across conditions and risk factors, a composite measure was developed, paving the way for the concept of Disability Adjusted Life Years (DALY). DALYs from a condition are thus the sum

of years of life lost because of premature mortality, adjusted for the severity of disability.

The three leading causes of DALYs in the world in the early 1990s were lower respiratory infections, diarrheal diseases and conditions arising in the newborn period. Measles, malaria, iron-deficiency anaemia and protein-energy malnutrition completed the picture. This published material became an eloquent testimony of the loss of years of life because of premature death that children experienced in the world about a quarter of a century ago and the severity of the disability seen among the survivors. The vast majority of these children lived in the so-called low-income countries. The data also depicted how the condition of children in an overwhelming manner dominated the global disease panorama at the time.

About a quarter of a century ago, every year close to 12 million children in the low-income countries died before they reached their fifth birthday. Seven in ten of these deaths were due to acute respiratory infections, diarrhoea, measles, malaria or malnutrition or a combination of these conditions. Projections based on the mid-1990 analysis of the the Global Burden of Disease Study suggested that these conditions would continue to be major contributors to child deaths in low-income countries in the following two decades, unless concerted efforts were made to control them.

In every other death below the age of five years in low- and middle-income countries malnutrition was either a causative or complicating factor. A useful explanatory model for the evolution of protein-energy malnutrition in children at that time was the one summarized by J. Waterlow and M. Golden. Against the background of powerful factors that were operative in the traditional society, the analysis included aspects related to the perinatal period as well as nutritional and behavioural factors.

This model and several other approaches stimulated a long range of research agendas both in low-income and affluent countries all over the world and became the starting signal for investigations that would pave the way for a deeper understanding of the complex issues that enshroud infant and young child malnutrition.

Prominent among organizations that generously, systematically and durably supported research and training programmes throughout the world, in particular in low-income countries, was The Nestlé Foundation for the Study of Problems of Nutrition in the World. The Foundation not only provided financial grants for research and training but also helped significantly in building up, supporting and maintaining facilities such as laboratories and libraries as well as earmarking scholarships for higher education for these purposes.

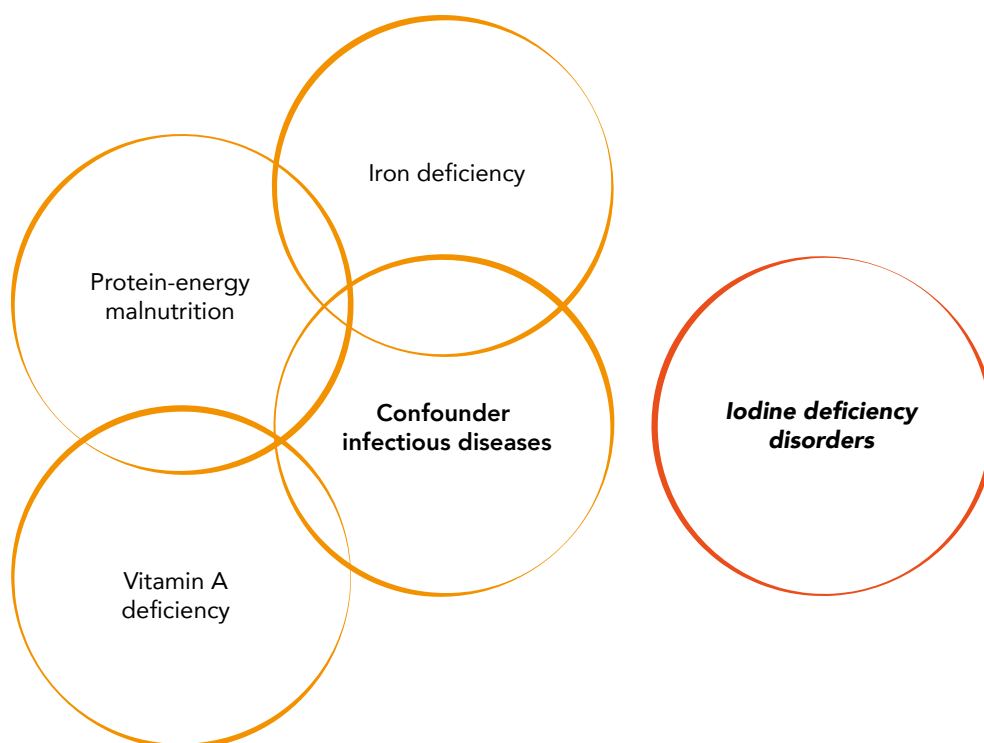


Figure 1.
The vicious circle of malnutrition and infection
(adapted from Waterlow JC (1))

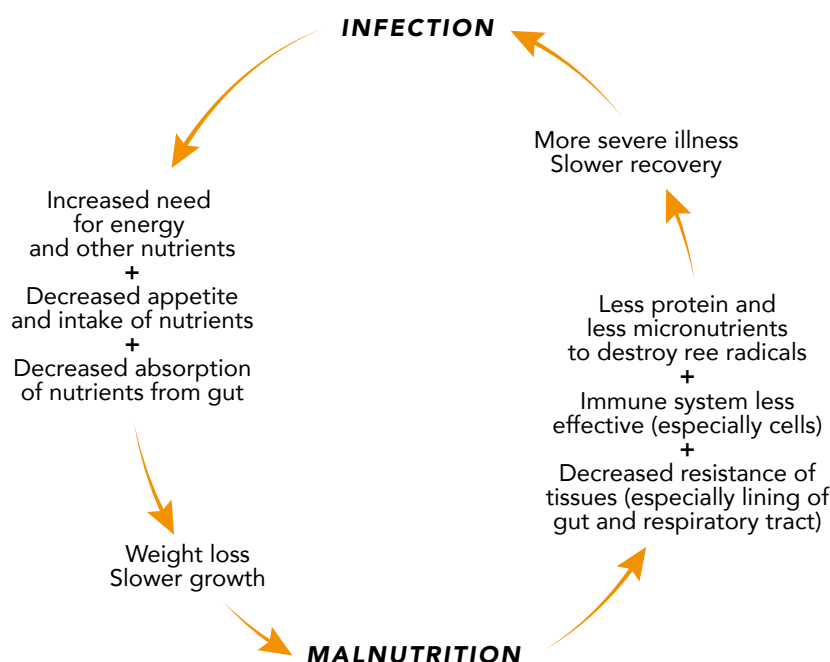


Figure 2.
The links between infections and protein-energy malnutrition
(adapted from M. Gebre-Medhin (2))

Progress in child health and nutrition and future challenges

An estimated 5.9 million under five will die in 2015. This represents more than halving of the global child mortality rate in 1990, a decline from 91 to 43 per 1000 live births, even if this falls short of the MDG. The vast majority of deaths occurred in low-income countries and were caused by infectious diseases, aggravated by poor nutrition, and manageable conditions around birth. This decline in mortality has been driven by reductions in deaths due to pneumonia, diarrhoea, malaria, the perinatal period and a dramatic decline in measles deaths.

The prevalence of underweight declined from 25% in 1990 to 14% in 2015, and the prevalence of stunting from around 40% to 24% during the same period. This is a critical achievement since close to half of under-five deaths are linked to malnutrition. However, due to population growth, the number of children affected by stunting increased by 28% in the African region. During this period the population in Tanzania increased from around 15 million to 45 million, and in Kenya and Algeria from around the same level to 48 and 40 million, respectively.

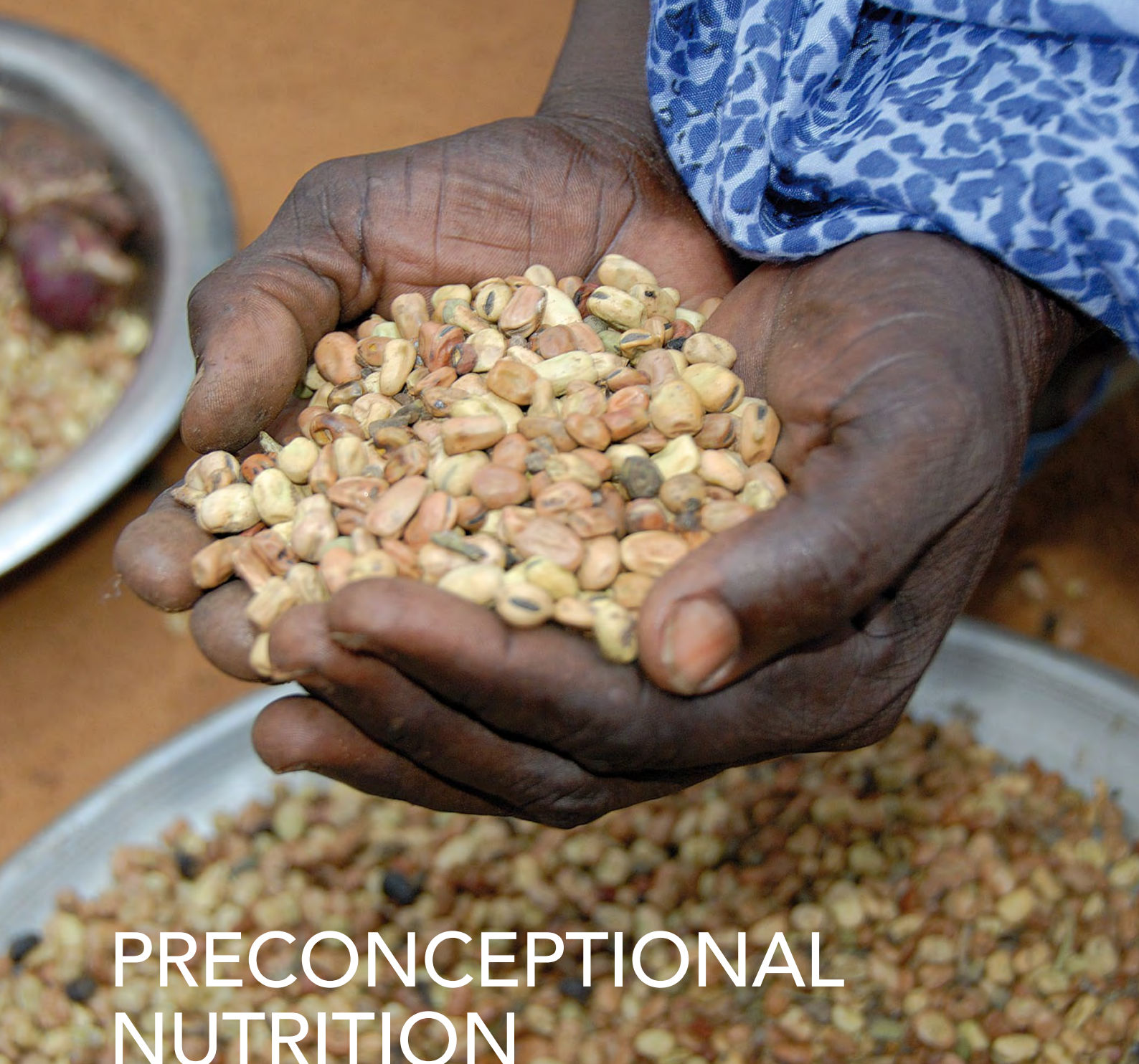
Another significant achievement relates to the increase in the rates of exclusive breastfeeding from about 28% to 38%, with 25 countries recording gains of 20% or more.

The world community has, through research and implementation, seemingly identified a number of well-trodden approaches with documented value that will help pave the way for improved health and welfare of all infants and children.

At the time of writing, the world community has seen the birth of a new strategy. On September 25, 2015, countries adopted a set of goals to end poverty, protect the planet and ensure prosperity for all—a new sustainable development agenda known as the Sustainable Development Goals (SDG). The coming years will see increased research and investment in health system and service delivery, improved coordination and integration with a view to enhanced quality of care, reduction of inequalities, bracing for the challenges of emerging non-communicable diseases (NCD), and better intersectoral collaboration. These measures are expected to benefit infants and children among others through continued reduction in low birth weight, stunting, and wasting.

Organizations like the Nestlé Foundation will continue to have a pivotal role in helping consolidate these gains and breaking new ground even in the future.





PRECONCEPTION NUTRITION

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Council Member 2011-2013

BUILDING HEALTHY CHILDREN STARTS BEFORE CONCEPTION

A farmer planting seeds to grow rice, wheat, or maize knows that it is important to prepare the ground beforehand. Often a little fertilizer or manure is stirred into the soil to enhance its growth-promoting properties. Farmers also know that livestock need to be prepared for reproduction. Thus, calves of dairy cattle are often weaned at least three months before breeding to give the mother time to replenish nutritional reserves before conception.

Women need to prepare for reproduction, as do plants and animals. Data collected from over 50,000 women in Aberdeen, Scotland, between 1948-64 showed that short, underweight women were about

eight times more likely to have a baby weighing below the 25th percentile than taller women weighing 20% above the standard weight-for-height [1]. This and other studies [2, 3] led to dietary counseling supplemented with food baskets for at-risk pregnant women. One of the best-known programs was the Montreal Diet Dispensary program initiated by Agnes Higgins, a trailblazer in the field of maternal nutrition [4]. Based on her program, the United States initiated a federally funded program for disadvantaged pregnant women that provided dietary counseling and vouchers for high-quality foods [5]. Today, maternal nutrition programs are available throughout the world [6-8]. However, there are no countrywide programs targeting women of reproductive age prior to conception.

Analysis of data from the Dutch famine showed that the timing of severe undernutrition (i.e., 400-800 kcal/d) determined the impact on fetal growth and long-term health effects [9]. Exposure during the last half of pregnancy caused the biggest reduction in birth weight, about 200 g. Exposure in the periconceptual period did not influence birth weight, but it caused mental effects, such as schizophrenia and depression [10, 11]. At the same time, studies supported by the Nestlé Foundation demonstrated that undernourished women, primarily from lower-income countries, responded metabolically to pregnancy differently than well-nourished women. For example, the energy cost of pregnancy varied widely among women from different countries, with women from The Gambia expending only about one-fourth as much as energy as women from Scotland or the Netherlands [12]. Marginally nourished women conserved energy by suppressing their metabolic rate and by gaining little fat [13]. They also conserved energy for fetal growth by reducing the time spent working in the fields or doing household tasks [14]. These studies, along with another done in Guatemala during the same time period [15], showed that the maternal energy supply is partitioned differently between the mother and fetus in undernourished compared to adequately nourished women [16]. Also, women who were undernourished as young, growing girls limit the fetal energy supply, but they partition it differently from that of women entering pregnancy with low energy, or fat, stores (Rasmussen KM and Olson RK, personal communication).

Thus, maternal undernutrition at conception or during the mother's growth as an adolescent influences the growth and development of her offspring. Recent studies have begun identifying the underlying pathways or mechanisms linking maternal preconception nutrition to birth outcomes [17]. The placenta appears to play a key role by functioning as a nutrient sensor and balancing the maternal-fetal nutrient exchange through hormonal signals and molecular mechanisms. For example, a decrease in maternal blood levels of key hormones (i.e., IGF-1, leptin, and insulin) reflects

maternal undernutrition, which then alters the activity of amino acid transporters in placental cells and limits the transfer of amino acids to the fetus [18]. Although this system probably evolved initially to balance maternal-fetal nutrient exchange when the maternal supply is low, these regulatory loops also function in the "reverse" direction that is common today among obese mothers, i.e., the transport of nutrients to the fetus is enhanced by the hormonal differences among obese compared to normal-weight mothers.

The molecular mechanisms playing a role in integrating maternal and fetal nutrition involve epigenetic remodeling of genes that begins at fertilization and continues through implantation [19]. Hypermethylation of DNA by vitamins involved in one-carbon unit metabolism (i.e., folate, vitamin B-12, and vitamin B-6) can repress the expression or silence genes and, thereby, change the offspring's phenotype. A recent analysis of the epigenetic and phenotypic changes in the offspring of mothers exposed to the Dutch famine showed that DNA methylation changes were more prevalent in individuals exposed to the famine in early rather than late gestation, suggesting that preconception nutrition is a determinant of gene methylation and, therefore, long-term health [20]. A recent study in the cohort of Gambian women, which was initially created by the Nestlé Foundation, showed that seasonal dietary differences altered DNA methylation; a higher degree of methylation occurred during the rainy season when food supplies were limited [21]. Thus both macronutrient (dietary energy and protein) and micronutrient (vitamins and co-factors involved in methylation) nutritional status in the mothers during the rainy season play a role in modulating the growth and potential of the offspring by physiological and molecular mechanisms.

In sum, data from population, human, tissue, and molecular studies demonstrate consistently that maternal nutrition at conception impacts gestational and long-term health of the offspring. The time has arrived to build healthy children before conception by providing nutritional guidance to women of reproductive age. The Nestlé Foundation recognizes the trans-generational influence of imprinted, or silenced, genes on health, demonstrating that nutritional interventions aimed at improving short-term health are not enough. Those interventions must also reduce the risk of later chronic diseases and of passing on the epigenetic changes to future children. One of the biggest challenges in nutrition today, currently under study by the Nestlé Foundation, is determining how to translate genetic/epigenetic knowledge into appropriate nutritional interventions for women with diverse dietary supplies around the world.



CHILD DEVELOPMENT

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Early life events such as premature birth affect 15 million newborns every year worldwide and low birth weight occurs in another five million term-born newborns (1). Both events affect early brain development significantly and lead to reduced skill formation and impairment of socio-cognitive development, with a clear impact on the economic success and quality of life of these individuals. Neurocognitive disorders now touch 27% of the European population: 5% or 3.3 million children suffer from learning difficulties or attention-deficit hyperactivity disorders and autism is increasing (23). Further, childhood and adult depression are increasingly recognized as having their origins in alteration of development. Cognition, language skills, and social and emotional competence are based on intact brain structure and functions that

are formed early in development and are influenced by environment. As early as 1899, Ramon y Cajal, in his studies on the making of the brain, clearly stated: "The total arborisation of a neuron represents the graphic history of conflicts suffered during its developmental life". Thus, the foundations of our human-specific skills (cognition, language, social and emotional competence) are established during early brain development and are further fine-tuned by environment. Understanding the effects of environmental changes on early brain development and defining the timing and mode of early interventions to enhance brain development will be a major task for maintaining and improving cognitive and non-cognitive skills in many high-risk populations. Several economists, including JJ Heckman, a Nobel laureate, have shown that rates of return on human capital investment is highest early in development (5).

During prenatal human brain development, a series of events takes place in order to build an adult-like brain architecture. The first trimester and the beginning of the second trimester are marked by proliferation and neuronal migration. During the late second trimester and throughout the third trimester of pregnancy, brain development is characterized by the last wave of neuronal migration (22), growth and branching of neuronal dendrites affected by poor intrauterine growth (16, 17, 21), overproduction, path selection and retraction of axonal connections (12), myelination of axons (allowing the acceleration of information transfer between neurons) (8), synaptogenesis (18) and refinement of thalamocortical networks (20) (functional maturation). The human cortex changes dramatically from the age of 20 gestational weeks, when the folding begins, up to term-age (40 gestational weeks), when all the main gyri and sulci have been formed; there is a four-fold increase in volume, a three-fold increase in cortical surface and 30-fold increase in the sulcation index (6, 10). Through evolution we know that the frontal lobe has gained considerable volume, which is linked to the increased socio-cognitive competence of humans compared to our ancestors (9). In the first six months of prenatal development, the architecture of the cerebral cortex is highly controlled by spatio-temporal gene expression. However, starting from the last trimester of pregnancy and until late childhood, when peak synaptogenesis occurs and axonal connections between neurons are established and consolidated, the patterning of cortical areas seems to be more under the influence of environment (11, 19). This is also the period when maternal pathology (leading to poor nutrition of the fetus and intrauterine growth restriction) and premature birth most frequently occur (>24 gestational weeks). Severe acute malnutrition (low weight for height) and chronic undernutrition both in the mother and the infant that leads to intra-uterine growth retardation and linear growth retardation or stunting is of great importance and leads to loss of human capital, both

through increased mortality and as well as affecting brain development and producing under-achieving populations (3, 21). Iron-deficiency anemia and iodine and zinc deficiency are major risk factors for poor early brain development and subsequent mental development and impact millions of fetuses, newborns and children every year (14).

Breastfeeding in the first six months provides proven advantages for cognitive development, as studied in large populations (4, 15). The Nestlé Foundation has contributed many studies providing evidence for the efficacy of supplemental iron and folic acid and multiple micronutrients and fortified food supplements during pregnancy and infancy in the developing world. Since 1973, 23 publications of the Nestlé Foundation have been related to child development studies worldwide.

Understanding human brain development is highly clinically relevant since many neurobiological disorders and disabilities have their origin in early structural, functional development and plasticity (2). With the advent of a non-invasive imaging tool, magnetic resonance imaging (MRI), it has become possible to address the question of where, when and how adverse conditions in fetal and early postnatal life and prematurity relate to the brain maturation and address important structure-function relationships (7, 13). If connectivity can be altered and plasticity understood, specific nutritional, educational or behavioral therapies may be developed to restore functional brain connectivity.



NUTRITION & INFECTION

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MICRONUTRIENTS, INFECTION AND CHILD DEVELOPMENT

Studies supported by the Nestlé Foundation have contributed to the increased awareness of "hidden malnutrition" —deficiencies in minerals and vitamins that are present in only small amounts in the body, and yet are essential for life. Worldwide, more than 1.6 billion people suffer from iron deficiency, which impairs hemoglobin synthesis (producing anemia), but growth and cognitive development as well, particularly after six months of age. Eighty percent of 6- to 11- month-old infants were found to have anemia in Ghana (1), and 30% of school-age children iron deficient in Mali (2). Iron, zinc and vitamin-C deficiency are common among pregnant Chinese women (3), as well as in adolescent girls who are

neither pregnant nor undernourished, in Bangladesh (4) and Myanmar (5). Less than 10% of ingested iron is normally absorbed by the gut, particularly when supplied by vegetables, due to the presence of inhibitors such as phytates. Even though vitamin C enhances iron absorption, human milk fortified with vitamin C did not increase the absorption of iron from cereals (6).

What is the benefit of micronutrient supplementation?

Studies sponsored by the Nestlé Foundation showed that, in iron-deficient Bangladeshi children, iron supplementation improved cognitive function, but psychosocial stimulation remained less effective than in children who were not anemic, so iron supplementation may need to be combined with intensified stimulation (7). Twenty years ago, correction of vitamin A deficiency was shown to decrease infant mortality. Studies funded by the Nestlé Foundation have found that the effect of vitamin-A supplementation on immunity, however, is complex, and depends on the type of virus in Mexican children with gastroenteritis (8). Supplementation of lactating women with vitamin A was shown to increase breast milk vitamin-A content (9). Whether neonates should be supplemented with vitamin A is still debated, due to discrepant recent clinical trials. Supplementation may need to be targeted to specific groups of vitamin-A-deficient infants and/or mothers. Iodide fortification of table salt was found to be associated with adequate iodide intake in pregnant women in India (10). Despite this, many have thyroid insufficiency (11).

Studies funded by the Nestlé Foundation explored how *best to deliver supplementation*. In Peru, studies using iron labeled with a non-radioactive isotope showed that supplementation of pregnant women with 60 mg/d mineral iron failed to alter iron status but improved infant growth (12). Iron fortification of complementary food may be preferable to the use of medical iron. Although they contained large amounts of phytates, cereals fortified with various salts of iron were equally effective in restoring hemoglobin level in Bangladeshi children (13). In Ghana, home fortification with a micronutrient mix was found to be as effective and acceptable whether delivered as powder, tablet, or enriched fat spread (14). In anemic pregnant women in rural China, addition of retinol and riboflavin to iron and folic acid supplementation improved the efficacy of micronutrient supplementation on maternal hemoglobin (15). Finally, local foods naturally rich in iron, or education-based strategies at time of diversification, may be viable options, since they may be more affordable and sustainable, provided the micronutrient is bioavailable. Naturally iron-rich legumes or fortification of legume preparations such as cowpea flour with NaFe EDTA was associated with improved iron absorption of stable isotope-labeled iron in Ghana (16). In healthy Chinese adults

consuming a low vitamin-A diet, an intake of spirulina, a local alga, supplying 4.5 mg β -carotene, a precursor of vitamin A, was as effective as the intake of 1 mg vitamin A (17). Supplementation with amaranth, a vegetable grown in several continents, was found to improve iron status as efficiently as a mixed mineral nutrient mixture in Kenyan children (18).

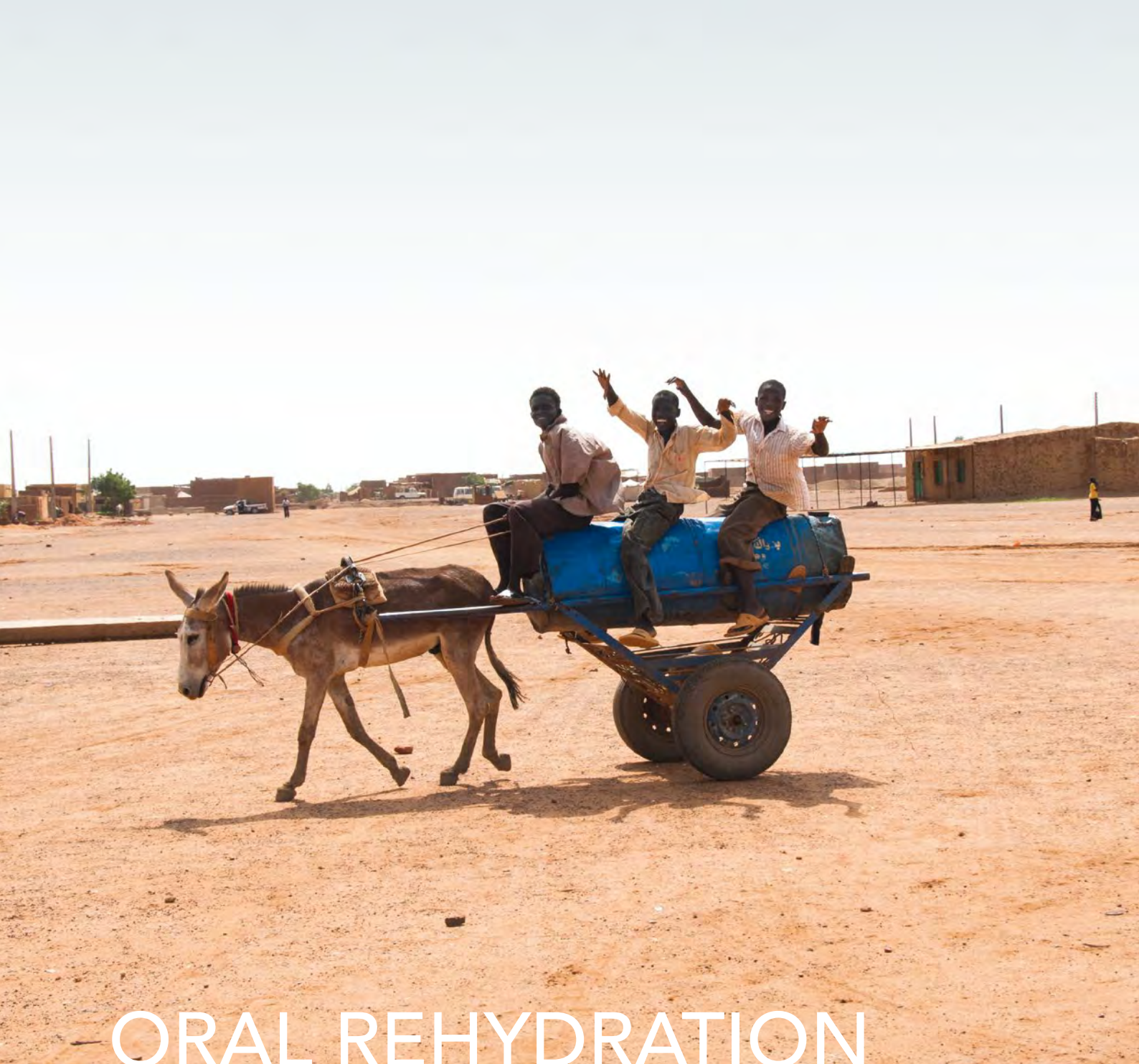
Recent studies have focused on the interaction with environmental factors. Toxic metals such as manganese and lead compete with iron for the same transporter in the intestinal lining. Iron-deficient Pakistani children were thus found to have higher manganese and lead concentrations in plasma than iron-sufficient children (19), presumably due to metal contaminants present in the environment.

What are the interactions between micronutrient deficiency and infectious disease?

Iron is an essential nutrient not only for host immune cells but for the growth of pathogens as well. Malaria (particularly, *Plasmodium falciparum* infection) is a cause of anemia, through multiple mechanisms including utilization of iron, hemolysis, and increased secretion of hepcidin, a hormone that “traps” iron. Conversely, iron deficiency has long been known to protect against malaria infection. Routine iron supplementation in areas of high prevalence of malaria may be inappropriate since a study performed in Zanzibar revealed a higher mortality among preschool children receiving iron and folic acid supplementation (20). Studies funded by the Nestlé Foundation in Malian schoolchildren with iron deficiency and *Shistosoma hematobium* infection found the incidence of malaria to be higher in groups receiving iron supplementation (21).

In summary, overcoming micronutrient deficiencies remains a global challenge. Pressing questions remain open, for instance:

- 1) who should be supplemented, i.e., should supplementation be universal or targeted towards specific groups?
- 2) which precautionary measures—such as the use of permethrin-impregnated mosquito nets to prevent malaria, or improvement in exposure to contaminants from the environment—need to be implemented along with supplementation?
- and 3) how best to supplement, considering the trend towards strategies based on education-based diet diversification or home fortification rather than the distribution of tablets of centrally prepared fortified foods?



ORAL REHYDRATION

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**OVERCOMING THE LIMITS OF ORAL
REHYDRATION SOLUTION USAGE**

That many children still die of dehydration in the world is a paradox, and even a scandal, in 2015. Dehydration is most often a consequence of infectious diarrhoea and remains one of the main causes of child death in the world. It is the direct consequence of the losses of water and salts in the stools. It is unacceptable because rehydration therapy was found to be effective in the first part of the last century when water and salt losses were replaced by equivalent solutions given intravenously. The limitation of such a technical and medical methodology was then overcome in the second part of the century when it was discovered that replacement could be given orally. Such a therapy is effective: it rehydrates in a few hours; it

is simple to deliver anywhere, even at home; and is very cheap, as the oral rehydration solution (ORS) is made only of water, salts and glucose. It was one of the major medical discoveries of the century. The present challenge consists in finding the reasons for the limitations in using such a therapy in order to further improve child health at the global level.

If mothers are grateful for the spectacular effect of rehydration in overt dehydration, they are disappointed when dehydration is not obvious to them because ORS does not reduce the main symptom, namely the volume of liquid stools. They may be reluctant to use ORS, yet the risk of dehydration is still present. Thus reducing the stool volume is an interesting target to improve ORS intake. The Nestlé Foundation was directly involved after receiving a research proposal from Vellore College, in India. Professor B. S. Ramakrishna proposed to improve ORS by adding a starch resistant to amylase. In the original ORS, glucose is the component that rehydrates by stimulating the absorption of water and salts. The innovation was to use the nutrient glucose for its functionality rather than as a source of energy. When touching the internal wall of the small intestine, it stimulates sodium absorption and, as a direct consequence, water absorption. The Indian proposal was based on a similar function for short-chain fatty acids in the colon. Thus, resistant starch being metabolised into such fatty acids by the colonic bacteria could in principle enhance the absorptive function of glucose-ORS. Indeed, it was found that the starch and glucose ORS reduced liquid stool volume in adult patients dehydrated by cholera infection. The results of the study was published in the famous *New England Journal of Medicine* in the year 2000 (1). It was received as a major advance in improving ORS and as further evidence for the beneficial effect of the functionality of nutrients on absorption. In fact, starch is the main nutrient of traditional food given by mothers, e.g. rice, sorghum, maize, but the Indian study provides a scientific basis for improving the symptomatic effect of ORS.

Other limitations have already been identified. One paradox of diarrhoea is that although it is a major cause of death, it is most often a self-limited disease. It may even not be considered as a disease by mothers because of the frequency of diarrhoea episodes—several per year in young children; it may be considered as a sign that the child is ready to walk. Thus, the decision to bring the child with diarrhoea to the health centre is relatively complex, involving grandmothers, the husband and several other people. In addition, the mother needs to find a way to run the house while she spends time to go the health centre; it may be costly. Yet, at the health centre she receives a sachet of powder that does not look like any fancy medicine for a severe disease. In the same line, the private health care professionals are reluctant to use such a sachet that may decrease their credibility; ORS

may be a threat to the physician expertise. To sum up, improving acceptance and use by families needs to address those sociological and economic issues.

When targeting the risk of death, it is important to take into account the results of epidemiological studies. Among identified risk factors are young age, malnutrition and associated diseases, rotavirus infection, and sudden and important dehydration. Those situations are difficult to address because they require a medical expertise in a disadvantaged background. In a few hospitals with long expertise in the field, like in Dahka or Kolkota, most children with severe dehydration and severe malnutrition recover. However, there is a need to further improve the treatment to be used in other settings. The Nestlé Foundation was involved after receiving research proposals from the International Center for Diarrheal Disease in order to evaluate the addition of resistant starch. The two objectives of Dr N. H. Alam were to improve rehydration by short-chain fatty acid functionality on absorption, and nutrition by short-chain fatty acids as a source of energy (2). Although no obvious beneficial clinical effects could be observed, these studies initiated an important new approach taking into account the functionality of the gut microbiome (3).

To sum up, oral rehydration therapy is effective and life-saving in dehydrated children. Mortality has been cut by fifty per cent since the initiation of the global programme by World Health Organisation, in 1980. However, much needs to be done to further reduce it. The scientific biomedical approach developing new concepts using the functionality of nutrients and colonic microbiome needs to be further developed with the most recent tools (4). In addition, other expertise needs to be involved, including sociology, economics, and marketing. Ideally, prevention by improvement of hygienic conditions and immunisation should further be implemented. Finally, in the context of the objective of the Nestlé Foundation, improving the nutritional status of children remains a main target.



CHRONIC DISEASE RISK

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MALNUTRITION AND CHRONIC DISEASE RISK

Decades ago, acute, severe malnutrition was the most urgent and visible manifestation of children's dietary deficiencies and repeated infections. A substantial research effort was focused on understanding its mechanism and defining optimal treatment approaches. As described in other sections of this report, the Nestlé Foundation was actively engaged in those efforts. At that time, the long-term effects of acute malnutrition were primarily associated with its impact on brain development, cognition, and body size.

Fortunately, the prevalence of severe acute malnutrition has been declining steadily over recent decades, and the focus is now on chronic malnutrition

or stunting. Growth delay early in childhood usually results from a combination of inadequate diet and/or excess loss of nutrients due to gastrointestinal infections. Some children are able to “catch up” and recover their normal growth pattern, but many end up having a permanent height deficit. The long-term effect of this height deficit has been shown in a number of longitudinal studies.

The nutrition transition that has been taking place in the developing world over the past several decades has exposed millions of children to an environment of widely available energy-dense fast-foods, an abundance of sugary drinks, and a sedentary lifestyle. The resulting epidemic of childhood and adult obesity is affecting primarily the low-middle income countries (LMIC), where over 70% of obese/overweight children reside.

Thus, in the current world we have two important links between “malnutrition”—interpreted as both undernutrition and overweight—and chronic disease risks: that associated with nutritional deficiencies and insufficient longitudinal growth, and that related to excess body weight.

The risks associated with stunting have been explored in several long-term follow-up studies, most notably the “Four Communities Study” conducted in the 1960’s in four villages of rural Guatemala. Over several decades of follow-up, the study has shown the lasting effects of stunting on gestational performance, income and education.

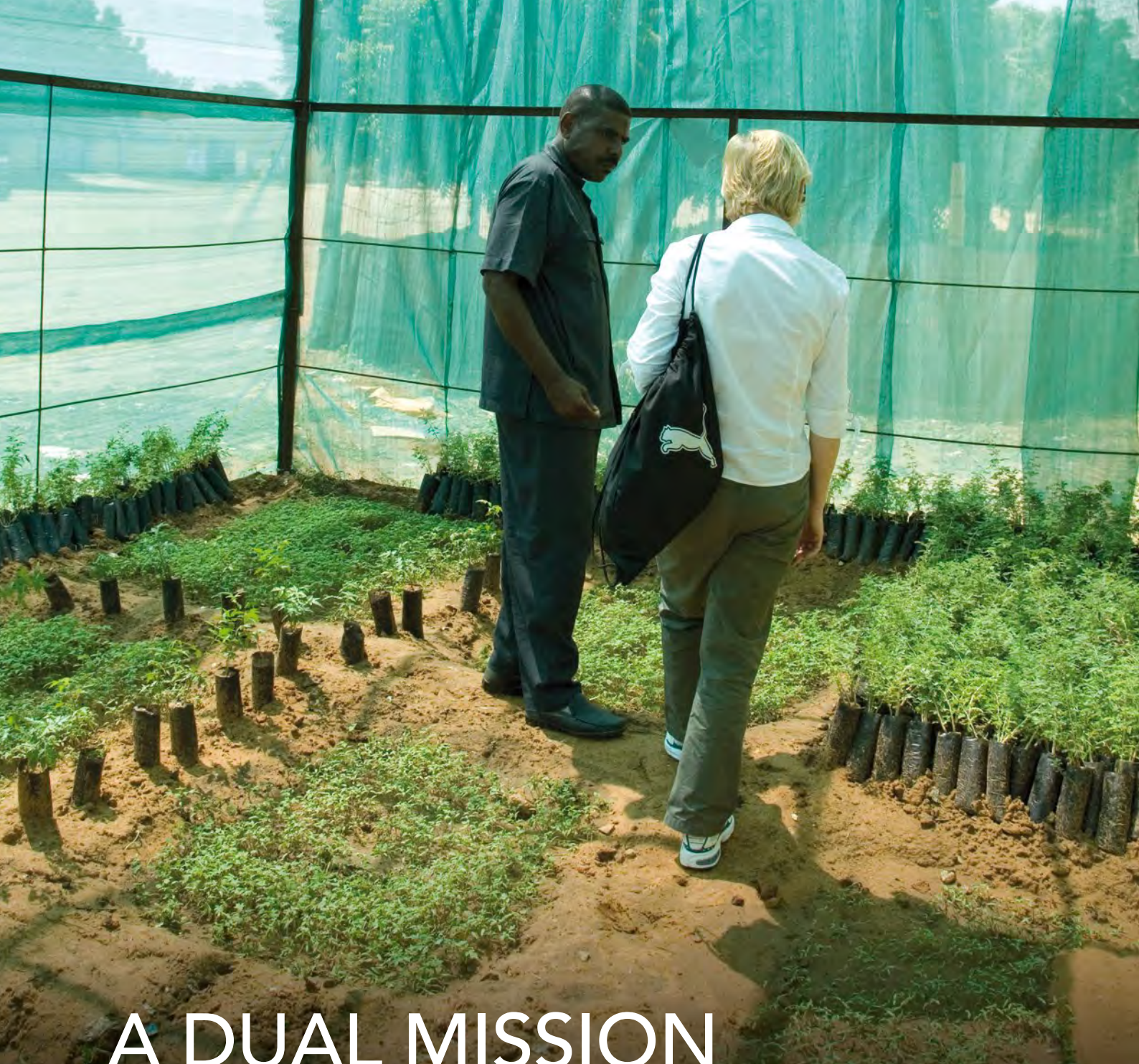
Another type of effect of early undernutrition on adult disease emerged from the work of Barker and others, who reported a seemingly paradoxical association between poor fetal/neonatal growth and excess risk of certain cardiorespiratory diseases in adulthood. Another rich source of evidence on the long-term impact of early undernutrition and adult disease emerged from the so-called Dutch famine, a tragic but well-documented period during World War II in which a large segment of the Dutch population was subjected to extreme food deprivation by a Nazi siege. Adults born during that critical period exhibited higher rates of diabetes, obesity and cardio-metabolic disorders. All these observations led to the development of a particular field of study, the early origins of adult disease, now formally known as developmental origins of health and disease. This exciting area is discussed elsewhere in this report.

The long-term risk posed by excess weight in childhood has attracted considerable interest, given the continuing rise in obesity prevalent around the world. Longitudinal studies have shown that excess body weight in childhood is a major risk factor for adult obesity. And the longer a child remains obese or overweight, the higher his or her risk of becoming an obese adult. In fact, being obese at the age of

5-10 years carries more risk of adult obesity than having one or two obese parents. Similarly, the association between child obesity and glucose intolerance and type 2 diabetes later in life has been extensively documented. In fact, the emergence of childhood obesity as a global epidemic has been followed by a dramatic rise in type 2 diabetes. The disease, which used to be called “adult-onset” diabetes, is now frequently diagnosed in children and adolescents.

Whether early obesity is also an independent risk factor for adult co-morbidities like dyslipidemias and high blood pressure is still a subject of debate. Many obese children develop dyslipidemias, making it sometimes difficult to isolate the effects of excess body weight from genetic and dietary conditions leading to dyslipidemias. Conversely, whether obese or not, children with elevated blood pressure and/or dyslipidemia are at a higher risk of retaining those conditions as adults.

The corollary of the association between early malnutrition and risk of disease is clear: preventing fetal/neonatal growth retardation and preventing excess weight gain during childhood will have a major impact on some of the top causes of illness and mortality in adults, such as cardiovascular diseases.



A DUAL MISSION

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RESEARCH AND CAPACITY BUILDING

As I started to participate in the meetings of the Nestlé Foundation's board, I quickly realized that this funding agency operated on a very different mode. I was accustomed to a process where identification of a possible weakness or flaw would relegate a proposal to an unfundable priority among numerous applications. Instead, I discovered that the Foundation makes deliberate efforts to help develop potentially successful projects. Typically this begins by correspondence between the applicant and the Foundation's Director to ensure that the proposal is consistent with the Foundation's expectations and targeted areas. These deliberately exclude issues already investigated by massive research efforts in the developed world.

Coming from the third world, where the scientific infrastructure and culture often lack modern sophistication, grant proposals are reviewed with an eye toward identifying and encouraging promising projects and assessing the applicants' potential and commitment to the research which they propose to undertake. This would often become apparent by the diligence with which they resubmitted a proposal after incorporating the advice provided by the Foundation. On occasion this evaluation could also be facilitated by a visit built into the traveling schedule of a Foundation member.

Most members of the Foundation have had extensive experience with nutritional problems in the third world. They thereby became keenly aware that completion of a research project would by itself have little chance of significantly bettering local conditions unless it left behind a significant contribution to the local infrastructure, notably by enhancing the competence of the scientific staff working there.

In support of such efforts, the Foundation spearheaded the creation of an "e-library", enabling the scientists involved in these projects, as well as any others located in the third world, to keep up with worldwide developments in nutrition and health issues and understanding. In addition, to promote general knowledge, "library kits" were assembled, which provide a selection of textbooks, some targeted for the French-speaking countries. These can be requested from the Foundation.

Occasionally, initiatives for investigations originated from a well-established academic center in the affluent world, to be developed in collaboration with local scientists. In such cases, the Foundation endeavored to make sure that the principal investigator would be located at the research site and that the bulk of the budget was to be spent there, if at all possible. Time and time again the issue was brought up seeking to verify that the project would leave behind a lasting contribution to the local scientific establishment.

In a related manner, the Foundation's aims have long included providing stipends for study at well-established centers for nutrition research. The expectation that the beneficiary would return to his or her original country have generally been met.

Occasional travel grants were provided to allow participation in targeted workshops or to attend relevant meetings.

Given its limited resources, the Foundation only rarely committed itself to continued support of investigations requiring extensive funds. However some of these made contributions of worldwide significance for example: energy and protein requirements, nutrition and child development, or

rehydration. These are described in these other sections of the report.

A project with a much more limited budget led to the development and then to the production from local ingredients of a high-nutritional-density food bar to help infants and young children to recover from undernutrition. It provides a great example of the Foundation's dual goal of fostering research and of promoting the local infrastructure by supporting the efforts of local scientists.

This constructive approach to research funding has been a real team effort. It has left those of us who are members of the Nestlé Foundation feeling privileged to have been able to participate in this endeavour.



LEADERSHIP & CAPACITY BUILDING

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FOSTERING LEADERSHIP CAPACITY

Capacity building has many definitions—but sustainability of an institution, program or skill is a fundamental goal, no matter what definition is used. In order to achieve such sustainability, there is a need to develop local leadership talent. At the Nestlé Foundation, the capacity-building and sustainability plans for any given research project that the Foundation considers for funding are deemed to be just as important as the research plan itself.

To a large extent, potential local leaders self-identify through demonstrating certain personality traits. Such traits include the ability to work well with others, the ability to communicate well with others, a sense

of fairness to others, a sense of empathy for others and a sense of enthusiasm and positive energy.

Program funders can often recognize a potential leader by the respect he or she generates from others in the community, and his or her eagerness and drive for personal betterment and for achieving advanced training (e.g. in record keeping, budgeting, supervisory skills, etc.). In a way, the potential leader is already regarded as somewhat of a role model in his or her community. There is little one can tell from diplomas that is relevant to leadership potential. However, in choosing potential leaders for further mentoring and training, one has to be keenly aware of the local cultural norms. For example, in parts of Asia where I have worked, a younger person should not be considered for a position where he or she would be supervising an older worker. In other cultures, gender considerations come into play. To go against these norms would be a set up for failure.

A good way to begin to recognize a potential leader is by holding an initial community meeting, wherein the program or project can be introduced. In Haiti, where I have been working recently, we held such a meeting last year. A young man by the name of Fenol was one of the first in the audience to ask questions and to show a real interest and curiosity about the planned project we were proposing. He spoke in a pleasantly forceful manner, which demonstrated a personal confidence. In speaking to him after the meeting was over and after most of the crowd had dispersed, I realized he really wanted to understand all aspects of the project—not only its goals, but also how the goals would be practically met. I recognized that Fenol was personally ambitious, but beyond that he was reflective about ideas. At one point I suggested some reading he could do. A week or two later, he came back to me and told me what he had read at the library, and that he had picked up several interesting new ideas from the books. One of the books was by Adam Smith. Fenol's assessment of what he had read by Smith: "now that's an interesting idea". In a poor country such as Haiti, people are concerned mainly with personal survival. In Haiti it is fairly rare to find a person such as Fenol, who is able to engage with life and ideas beyond this basic instinct for survival.

In order to foster such leaders, mentoring becomes a key element for the development of particular skills such as in project organization and monitoring—as well as for personal growth. During the mentoring process, the mentor can get a real feel for the potential leader's belief in and commitment to the project. The question that should be on the mentor's mind is: will the potential leader be able to get "buy-in" to the project from others in the community?

An example of building leadership capacity found within the grant portfolio of the Nestlé Foundation is a project on pearl millet, which was carried out in

Kenya in 2011-12. The grant proposal was submitted by a recent graduate of Loma Linda University, Dr Mueni Ndiku. Dr Ndiku wrote the proposal under the mentorship of Dr Joan Sabate, when Dr Ndiku was on sabbatical leave from the University of Eastern Africa. Thus, the initial process of writing the proposal was an immediate step in leadership development, which served to foster the growth of Dr Ndiku toward becoming an independent investigator. Dr Sabate continued to act as Dr Ndiku's mentor throughout the conduct of the project. The research project was multifaceted, with the objective of reintroducing millet as part of the diet in certain areas of Kenya. This included, among other things, testing the acceptability of millet by the target population, and an intervention study to determine the effect of eating millet on a regular basis on anthropometric measurements in children. Dr Ndiku was responsible for the execution of the project, and in the capacity, she worked closely with a project coordinator, who was responsible for such things as equipment procurement, public relations and data handling. Thus, the project coordinator also gained important leadership skills by working on this research.

Once a research project has commenced, the mentor should evaluate how well the potential leader handles difficult situations and personalities. A problem that sometimes arises when an individual is being mentored is jealousy on the part of others. Once a person in a peer group begins to rise over the others, there is a drive by those left behind to cut that person back to size ("cut the tall poppy down"). Some mentees don't want other peers to know of the mentoring process and want the mentoring to be kept a secret. In Haiti, I have witnessed malicious gossip and personal threats against a mentee. It takes a lot of support, counselling, discussion and time by the mentor in order to get the mentee through these difficult issues.

A newly mentored leader has to know the importance of careful follow through. For example, one of my newly minted local leaders did a superb job in training another person in a new skill. She watched the newly trained individual do the task perfectly once or twice and then left that person on his own. When the leader came back two weeks later, she found that the trainee had in fact forgotten the correct way of entering data on specialized forms. This was an important lesson for the new leader, as much of her time had to be expended in order to undo all the mistakes entered on hundreds of forms over the two-week period.

The mentor should be able to begin to step aside as the process moves on and give more and more responsibility to the new leader—showing trust, while monitoring activities only from a distance. The new leader can then begin to become a mentor to others, and the project or program should have a good chance at sustainability.



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FOCUS ON IMPLEMENTATION

Nutrition has been defined as a link between food and health, specifically the fulfillment of energy, protein and micronutrient requirements and the supplying of non-nutrients from food, with the ultimate goals of good nutrition and well-being for all.

Research in human nutrition therefore includes energy and nutrient requirements in situations of health and illness; physiological functions of nutrients, non-nutrients and other food ingredients such as dietary fibers, phytochemical substances and probiotics; and public health nutrition dealing with policies, strategies, programs, indicators and interventions with the aims of preventing and controlling all forms of malnutrition in various population groups and

settings from individual, household, and school to workplace, and from the local to the national to the international level.

Research not only generates data, information and knowledge for publications and patents but also plays a key role in capacity development. More importantly, it has been always recognized and emphasized that research processes and findings should be used for implementation or utilization in policy, strategy and socioeconomic development for nutrition and well-being.

During the last 50 years, the Nestlé Foundation has supported research and capacity development in nutrition and contributed significantly to knowledge of energy, protein and amino acid requirements; pathophysiology and consequence of protein-energy as well as micronutrient malnutrition; and approaches or interventions for the improvement of nutrition in developing countries. This knowledge has provided scientific evidence directly or indirectly in setting up human energy, protein and amino acid requirements by the Food and Agriculture Organization of the United Nations/World Health Organization/United Nations University (FAO/WHO/UNU) Expert Consultations; in raising more awareness for the alleviation of micronutrient deficiencies, most notably iron-deficiency anemia, which was shown to reduce cognitive and learning functions in children; and in stimulating the research interests of young nutritional scientists from developing countries.

Recently the focus of research supported by the Foundation has been on maternal and child nutrition as well as nutrition education and communication in developing countries. Several research projects that may be potentially scaled up later to be a program or policy have received valuable attention and support, including the formulation and testing of complimentary foods for the prevention of malnutrition in infants and young children; school lunch programs for nutrition and cognitive improvement in students; and nutrition education for improving infant and young-child feeding and nutritional status in specific communities. The success and implementation of this type of research in a setting or community depends on both contextual as well as program factors. Contextual factors include the socioeconomic status of the population, food availability and accessibility, the availability and quality of basic social services, tradition and culture, community organization and leadership and local participation. Regarding the program factors, focus should be on the implementation of a well-designed research project based on effective management principles to engage key stakeholders in the formulation, implementation, monitoring, evaluation, dissemination and utilization of the resulting research findings. Each successful research project will provide a best practice in that context. One program may

require several best practices to deal with various contextual challenges of nutritional problems. In remote and poor areas it will require more effort, resources and time for any research project or program to show significant nutritional improvement. In the long term, a holistic approach will evolve which employs a step-by-step intervention approach learnt from best practices using key nutrition indicators as goals for outcomes and impacts.

Recently a group of researchers from WHO, the World Bank and the United States Agency for International Development (USAID) created a common platform for advancing Implementation Research and Delivery Science (IRDS) to improve health in low- and middle-income countries (LMICs). IRDS is about using research to improve policies and program delivery, and spreading knowledge gained from implementation. It addresses a range of implementation challenges, including complex processes, inefficient use of resources, inequitable allocation of resources, and supply and demand barriers to scaling-up and sustainability. There was a common recognition that IRDS is focused on improving the implementation of health policies, programs, and interventions in real-life settings, and that the IRDS endeavor involves applying scientifically sound methods to gain knowledge and apply it to implementation problems (1). It is hoped that IRDS can be applied to implementation research in nutrition as a mean to eliminate hunger and malnutrition in various parts of the world.

Global attention to nutrition was raised during the Second International Conference on Nutrition (ICN2), which was held at the FAO headquarters in Rome in November 2014. Over 2,200 people from governments, civil society, the private sector and international agencies participated. The resulting documents were the Rome Declaration on Nutrition (2) and the Framework for Action calling for commitments from all key stakeholders and multi-strategic and interventional approaches at international, national and local levels. It is envisaged that research focus on implementation will play a crucial role in the elimination of malnutrition.



THE NEED FOR LOCAL PEOPLE

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THE NEED FOR LOCAL PEOPLE

All population research depends on local knowledge and this is particularly true for nutrition studies in resource-poor communities around the world. As many of us involved in such research have experienced, it is essential to engage local people in all aspects of the work, from study design through to data interpretation and implementation of results. There are obvious aspects where the contribution of local people is essential, such as translation, interpretation, recruitment and transport, but there are many others where the contribution is more subtle but nonetheless crucial to the success of research studies.

Only local people who know their community intimately, its customs, traditions, way of life and social norms, can

provide the local knowledge essential for successful research. For example, it is only local people who can ensure that the research is designed and conducted in a culturally sensitive way, that it is not confounded by aspects of community life unfamiliar to an outsider, that the support of those with influence and authority is obtained in a courteous and appropriate manner, and that there is effective communication with participants and the wider community. Local people also make invaluable day-to-day contributions such as providing alerts about recent births, deaths and major events, keeping contact with study participants, acting as chaperones and intermediaries, providing insights about local foods, recipes, preparation and storage, and other essential local context.

Such people are often unsung heroes, enthusiastically championing studies within their community and contributing as key members of the research effort. They are highly valued by the study team but rarely acknowledged in publications or recognised by the scientific fraternity or grant-awarding bodies. It is not uncommon for funders to question the need to involve local people beyond the principal scientific team and decline to provide remuneration for their contributions. This is not true of the Nestlé Foundation. Over the years it has fully appreciated the need to involve local people in research studies and has provided grants that have supported the development of long-standing relationships with local communities.

The extensive bibliography of research supported by the Foundation over the past 50 years gives testament to its commitment to the pursuit of leading-edge nutrition research and to scientific career development and capacity building in resource-poor countries. However, hidden within these publications are the many contributions of local people from the communities where the study was conducted, often in areas remote from the major centres of learning where the scientific team was based, which ensured that the research was successful.

My personal experience of the importance of local people is through interactions with the African and Chinese scientists that the Nestlé Foundation has supported in Keneba, The Gambia and in Shenyang, PR China. These settings represent two ends of the spectrum in the developing world: Keneba and surrounding villages is in a poor, rural farming region of tropical West Africa where multiple micronutrient deficiencies are highly prevalent and seasonal hunger, weight loss and malnutrition are common. Shenyang is a major industrial city in the north of China where winters are long and harsh, vitamin D status is poor and other nutritional problems exist. In both cases, grants provided by the Nestlé Foundation have enabled the development of local community relations that have provided the platform

for a succession of highly successful projects in both places and larger programmes of work that continue to this day.

There are many differences in conducting nutrition and health studies in such contrasting environments but knowledge contributed by local people enables these differences to be detailed and considered. Indeed, such disparities can be valuable in studies aimed at advancing global nutrition policy by investigating nutritional requirements of different populations. For example, in a study funded by the Nestlé Foundation, Drs Yan and Zhou (Shenyang) collaborated with Dr Jarjou (Keneba) and my UK group (Cambridge) to conduct a three-country study, designed to investigate the known differences in osteoporotic fracture risk (3). A plausible explanation for the lower fracture rates in China and Africa was skeletal resistance to parathyroid hormone (PTH) as a result of their low calcium intake. To test this required a set of common protocols to be developed with the help of local people that took account of the differences in context and sensibilities in each community, thereby minimising confounding by other factors. This study showed that skeletal resistance to PTH is not a characteristic of older people in China and Africa but that there are differences in renal phosphate handling that may contribute to the lower fracture risk in China. Such a definitive finding would not have been possible without a rigorous study design built on local knowledge in each country, and provides a clear illustration of the importance of local people in all nutrition and health research.



THE enLINK INITIATIVE

Sustainability and public-health relevance are key issues for all activities of the Foundation. Research projects need to result in a short- and long-term public-health implementation. Knowledge and know-how have to be sustainable at all levels of the population.

The vast experience of the Foundation's Council members as well as the Foundation's past activities led in 2004 to the creation of the **enLINK Initiative**, a project which illustrates the proactivity of the Foundation regarding its core issues.

This initiative focuses on information transfer in the area of nutrition and malnutrition as well as on the resolution of specific research questions and their implementation at the public-health level. The core competence and activity of the Foundation is the support of nutrition research in low-income countries and the creation of local capacity. The enLINK initiative is an add-on to our key activities to improve the local research activities as well as capacity.

The name enLINK comes from the old English verb "to enlink", meaning "to chain together" or "to connect, as by links". The analysis of the semantic relations of "enlink" reveals related words which illustrate our central concepts and aims: to connect, to join, to associate, to unite, to tie, to conjoin.

Our mission is to link and join cultures; to associate and conjoin institutions and people locally to study and diminish the problems of malnutrition globally.

Malnutrition can only be solved by "enlinking"—connecting—different strategies and approaches. Malnutrition has to be addressed universally by joint strategies which address many levels, looking at the level of medical issues (such as infection) and hygiene (such as water quality), proposing changes at the level of agriculture as well as in the society at

large (e.g. addressing social inequality), and, last but not least, working to improve the level of education and information.

The **enLINK Initiative** has four main levels:

1. exploration in nutrition – building practical research capacity
2. education in nutrition – building local capacity
3. electronic nutrition – the enLINK digital library
4. enduring nutrition – implementing and applying knowledge

All levels correspond to the core activities of the Foundation the last 50 years: promoting, supporting and implementing nutrition research as well as promoting and supporting local capacity building.





THE enLINK LIBRARY - 7d/24h

e-journals in nutrition

e-books

There is no education and advancement in research without access to information. Information and information access is a basis for advancement for anybody in any aspect of life, and the right to information is actually one of the basic human rights as anchored in the Universal Declaration of Human Rights. In the year 2004, the Foundation established the Internet-based enLINK digital library of nutrition research, which is now appreciated by users in more than 40 low-income countries.

The enLINK library is a concerted action between OVID Technologies, certain publishers, and the Foundation. As of December 2015, Annual Reviews, OVID Technologies, Wolters Kluwer Health, Inc., and Lippincott Williams & Wilkins participate in the enLINK library to offer high-level digital content in the form of newest editions of different e-books, including classic e-textbooks in nutrition, free of charge to users in low-income countries. For nutrition information, the enLINK library is for many users an established and appreciated personal source of information available seven days a week, 24 hours a day, all through the year.

Presently 39 e-books are accessible in full-text mode. Only a few nutrition journals are available in the enLINK library since our philosophy is to strengthen the basic "textbook" knowledge instead of highlighting new research findings which often do not make it into a textbook due to the irrelevance of the findings. Today a network approach to education and problem solution is crucial. Nutrition cannot be separated from hygiene, public health, agriculture and medicine. Thus the enLINK bookshelf has six major sections:



- I. Nutrition and Dietetics
- II. Epidemiology
- III. Paediatrics
- IV. Primary Care/Family Medicine/General Practice/Cardiology
- V. Skills & Procedure
- VI. References & Research Methodology

There are no "opening hours" for this library—enLINK can be accessed 24/7. Anyone from a low-income country, working in the country of origin, can apply at www.enlink.org to become a registered user. (The detailed registration information is available at www.enlink.org. Registration and use of the enLINK library are both free of charge.)

enLINK user statistics (December 2015)

- 378 registered users
- Registrations from 48 countries





217 COUNTRIES 34 LIBRARIES

The orange library

THE enLINK LIBRARY TRUNKS 2008-2015

Who does not know the famous book *Where there is no doctor* by David Werner? This book and many others are included in the orange enLINK book trunk from the Foundation since “where there is no Internet”, books are indispensable.

There is no education without access to information. In today's world, information access is equated with access to the Internet and portable electronic media. Yet despite all the developments in information technology and computer science, this statement is in part a misconception. It is well known that a combined, integrated access to hybrid collections of print and electronic resources is at present the most powerful tool for education. In addition, there are many geographic areas without access to the Internet, or only at high cost. There the mobile enLINK library trunk of the Nestlé Foundation fills the gap.

The mobile enLINK library consists of an orange metal trunk containing more than 120 books, brochures and guidelines from the field of nutrition and health. Nutrition cannot be viewed separately from other disciplines, especially medicine, agriculture or public health. Accordingly, the enLINK trunk also contains books such as Harrison's textbook of medicine or a textbook of tropical medicine. One can find “down to earth”, ready-to-use guidelines for the treatment of severe malnutrition or the construction of a home garden.

The enLINK trunk has the same size and layout as the Blue Trunk Library from the World Health Organization (WHO). The enLINK trunk was created

as an addition to the WHO Blue Trunk Library and covers the major issues around the theory and practice of nutrition.

The enLINK nutrition library trunk was offered as a present free of charge (including free shipment) to selected nutrition institutes in low-income countries. The first shipments took place in March 2008 to Madagascar, Burkina Faso, Nigeria, Senegal and Vietnam, and the last shipment was in fall 2015 to Eritrea.

During 2015 the last 66 trunks were shipped. At the moment no more new trunks will be compiled. In total 217 trunks have been shipped to 34 different countries. The trunks have been a welcome addition to research libraries but—especially the small trunks—were also appreciated in the daily work setting of hospitals and larger health stations.

Shipment of 217 trunks to 34 countries

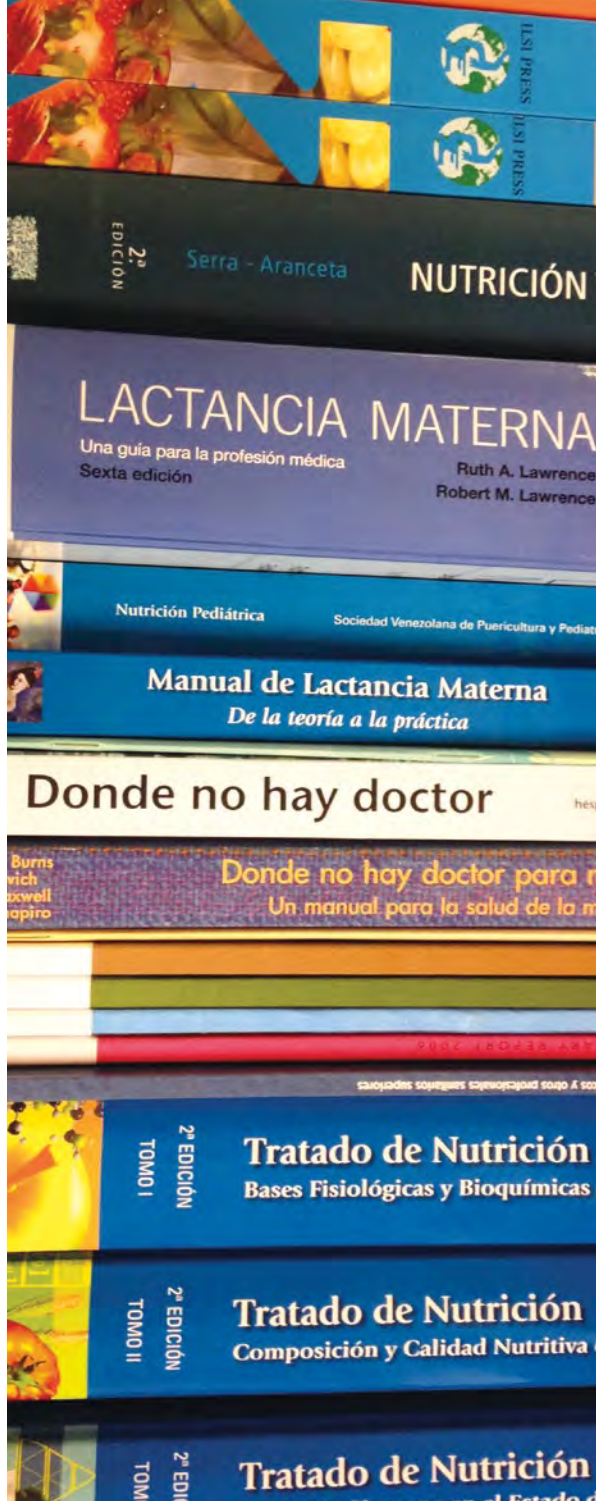
94 ENGLISH (LARGE)

94 ENGLISH (SMALL)

31 FRENCH (SMALL)

8 SPANISH (SMALL)





THE ENLINK TRUNK





FUTURE FOODS

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FUTURE FOODS FOR THE HUNGRY

Sadly, close to 800 million people in the world, or one in nine, suffer from hunger; of these, about 98 percent live in low- and middle-income countries (LMICs). However, this figure represents 200 million fewer people than the number estimated 20 years ago. During the intervening period, the world population has increased by two billion individuals. This demonstrates that hunger can be conquered. Undernutrition primarily affects mothers and children, and it is responsible for over one-third of childhood deaths.

One of the goals of the Nestlé Foundation is to advance nutritional science by supporting research that investigates food-based strategies for combating undernutrition. For the past years, the Foundation

has supported successful projects involving pregnant women, babies, children and adolescents. Many of these projects focused on problems related to malnutrition and its consequences. Through this support, the Foundation has promoted local nutrition research and increased the scientific capacity of institutions in dozens of countries. Despite the efforts of the Foundation and other organizations and institutions, the number of hungry individuals remains unacceptably high. This situation calls for urgent innovation in the production of new, affordable, healthy foods that are better suited to meet the needs of disadvantaged populations. In recent years, two areas of research have emerged that require a deeper understanding to reach this eventual goal: nutritional genomics (or nutrigenomics) and intestinal microbiota biology. Research in these areas is likely to cause profound changes in how we define food for people who are malnourished.

Foods, along with the air we breathe, are the only external natural substances we take into our body throughout our life. They continuously impact the whole organism and influence its functions. Nutrition has always been associated with health, but we have only recently recognized and investigated the effects of what we eat on the molecular networks that regulate the activity of our genome (or gene expression). Nutrigenomics is the study of how food components impact our genes and how individual genetic differences modify our responses to the foods that we eat (1). Food components, particularly micronutrients, can directly modulate gene expression. Fatty acids and some vitamins affect many cellular processes by binding to proteins within the cell nucleus; these binding events act as gene switches. Other micronutrients, such as folic acid, choline and some vitamins, act on gene expression through epigenetic modifications. For example, they promote the addition or removal of molecular tags that modify the activity of specific DNA regions or specific histones (proteins that act as spools, around which DNA strands wrap). Most of these epigenetic modifications are implemented during intrauterine life and, although they are typically reversible, they can persist over a lifetime, and they can even be passed on to offspring, up to the second or third generation. For example, a person's susceptibility to becoming overweight may be determined by the nutritional status that the parents, and even grandparents, experienced during their respective childhoods. Eventually, a more in-depth knowledge of epigenetics will aid in establishing specific nutritional interventions aimed at modifying the epigenetic profile in ways that optimize health.

One of the goals of nutrigenomics research is the application of personalized interventions for preventing diseases. Understandably, although this is not a priority for treating undernourished children, we must dismiss the notion that nutrigenomics would be a useless strategy for treating undernourished children

and for aiding developing countries in general. Both nutrigenomics and epigenomics studies have shown that adequate nutrition in early life is crucial for physical and cognitive development. It will lead to better health and increased productivity in adulthood. The consequences of early underfeeding can be detrimental throughout life, and in some cases the damage may be transmitted to the next generations. Nutrigenomics provides a means to characterize and understand the devastating effects of hunger on genome integrity and function, and how these alterations affect the health of whole populations. Therefore, nutrigenomics may be a highly effective approach for assisting international food aid efforts in designing "functional foods". For example, foods can be engineered with genomic signatures specifically tailored to the needs of a malnourished population. Hopefully, these newly designed foods will provide more promising results than the often disappointing results that are currently observed. In particular for children, nutritional interventions aimed at saving lives in the short term are currently insufficient. Interventions that aim to reduce both the risk of developing serious illnesses in adulthood and the risk of passing on epigenetic-anchored predispositions to the next generation are also needed. When they are well conceived, interventions based on nutrigenomics can benefit both individuals in rich countries and individuals who are in desperate need in the developing countries.

Over the past few years, we have learned that our body's symbiosis with complex microbial populations in the gut enables efficient utilization of available nutrients and contributes to our well-being. Intestinal microflora—or the microbiota—has a collective, intrinsic metabolism which merits consideration as an additional "organ" that is assembled early in life. It is not surprising that its composition is perturbed in undernourished children, where it remains immature(2). This immaturity contributes to the pathogenesis of undernutrition and its deleterious consequences. Tools are presently becoming available for studying the developmental trajectory of the microbiota. Thus, new studies should provide knowledge on how to promote proper microbiota maturation in children in different states of health and among children with different nutritional, ethnic, geographic and cultural backgrounds.

In the future, knowledge associated with nutrigenomics will assist in the realization of affordable, nutritious foods that can foster a healthier microbiota and elicit health-promoting host-genomic responses for populations that are at risk of poor nutrition. Emerging on the horizon, we can see new ways to steward both our genome and microbiota, with the realization of foods that integrate the rapidly increasing knowledge on how foods talk to our genome, and how microbiota and hosts synergize to optimize immune functions and energy metabolism.



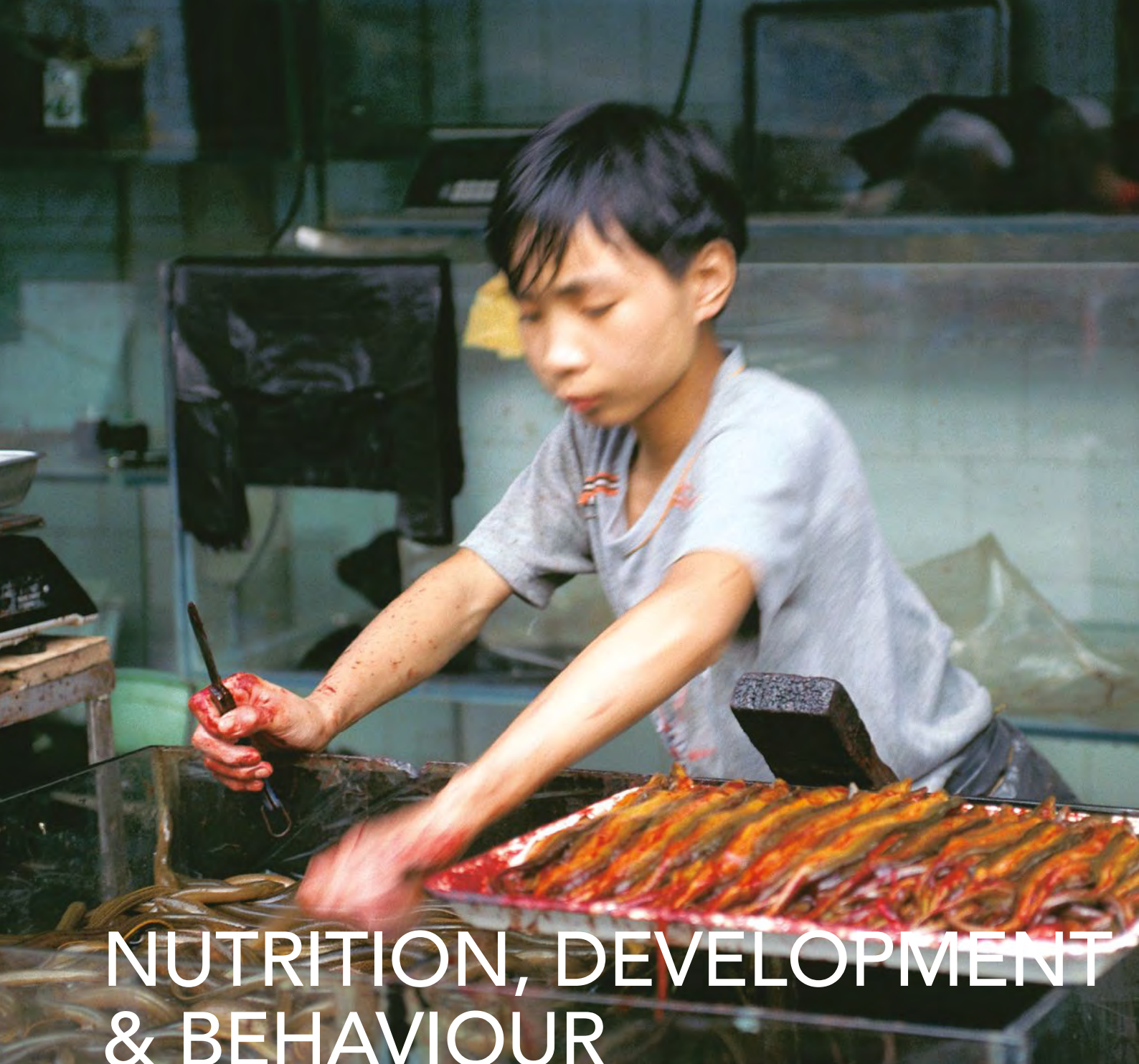


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In this section projects and activities are presented, which have been supported by a grant from the Foundation and which lead to the sustainable creation of new scientific knowledge.



NUTRITION, DEVELOPMENT & BEHAVIOUR

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NUTRITIONAL DEFICIENCIES AND HUMAN DEVELOPMENT & BEHAVIOUR

While there is a long history of speculation about the relation of nutrition to human development and behaviour (1), systematic scientific research on this issue is a relatively recent phenomena dating to the mid-1950's (2). The issue of the nature and extent of relations between nutritional deficiency and child development is of particular salience given the contribution of impaired development to inadequate school performance and reduced adult human capital (3), particularly in low-middle-income countries (LAMI), where the majority of poorly nourished children reside (4). A major contributor to the study of nutritional deficiencies and children's development in LAMI countries is Professor Ernesto

Pollitt, much of whose research has been supported by the Nestlé Foundation (references in the text designated by an * are those where there was Nestlé Foundation support, see references online).

In this paper I briefly summarize the multiple and significant contributions of Professor Ernesto Pollitt in three domains of nutrition-development relations:

- Nutritional supplementation and child cognitive and social-emotional competence
- Iron deficiency anaemia and child cognitive and social-emotional competence
- Models defining how nutritional deficiencies translate into compromised development

In appreciating Professor Pollitt's contributions in these areas what must be emphasized is that his research involves not just the question of whether nutritional deficiencies influence behaviour and development, but also the question of how such deficiencies have an impact.

Nutritional supplementation and cognitive and social-emotional development

A series of Nestlé Foundation-funded studies by Professor Pollitt and his colleagues have documented the positive impact of multiple micronutrient supplementation on children's motor, cognitive and social development (5*,6*,7*). Research by Professor Pollitt and his colleagues further shows that while the benefits of early childhood nutritional supplementation are maintained into later childhood (8*), adolescence and early adulthood (2), nutritional interventions do not necessarily have the same impact upon all supplemented individuals. Particularly noteworthy in this regard are those studies documenting that the impact of nutritional supplementation upon development varies, depending upon moderating factors such as the age of the child (8*,9*), the indices of nutritional adequacy utilized (10*) and the child's degree of prior nutritional deprivation (11,12).

Iron deficiency anaemia and development

One micronutrient that has been a particular focus of Professor Pollitt's research program is iron (13*). Based upon both associational and experimental studies, Professor Pollitt and colleagues have documented the importance of iron for children's development, both directly (14,15) and in combination with other micronutrients such as folic acid (17,18). Professor Pollitt and colleagues have further shown that the developmental consequences of iron deficiency can be seen even with mild levels of iron deficiency (14,15) and at birth (19).

Model generation and testing

Integrating across nutritional and contextual influences, Professor Pollitt and colleagues have hypothesized that insufficient nutritional intake early

in life not only disrupts brain development but also reduces physical growth, motor maturation and activity level. Reduced growth, motor maturation and activity level in turn hamper both the child's ability to explore their environment and parental use of age-appropriate rearing behaviours which, in turn, impair subsequent cognitive development (20*). Research by Professor Pollitt and colleagues has tested and refined this model (5*,7*,12,14,15,17,21*).

Professor Pollitt has also provided a conceptual framework for current and future researchers in the area of iron deficiency and development, with particular reference to the critical importance of adopting a probabilistic framework if we are to generate an accurate picture of the role of iron in development. As specified by Professor Pollitt, working within a probabilistic framework requires the systematic integration of biological and psychosocial contextual characteristics and individual difference characteristics into studies of iron deficiency and development (13*).

A number of implications follow from Professor Pollitt's theorizing. One such implication is the importance of assessing motor development as well as cognitive performance in studies of the developmental consequences of inadequate nutrition (22*). A second implication is the need to utilize multi-domain interventions and consider both contextual and child characteristics such as age when generating intervention strategies to be used with poorly nourished children (13*,17,23).

¹Theodore D. Wachs was a co-principal investigator with Professor Ernesto Pollitt († 2016) on a large-scale research project on the relation of nutritional deficiencies to infant temperament which was funded by the National Science Foundation as well as a co-author of papers on the findings resulting from this project. In addition, he worked with Professor Pollitt and other colleagues on a number of reviews which appeared in the Journal of Nutrition, SRCD Social Policy Report, and the Food and Nutrition Bulletin, documenting the current state of the evidence relating nutritional deficiencies to development in the infant and childhood years. The Nestlé Foundation supported several of the key studies of Professor Pollitt which contributed to the understanding of the relation of nutritional deficiencies to human development and behaviour (see online references).



KANGAROO MOTHER-CARE

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Director

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THE "KANGAROO MOTHER CARE" ADVENTURE

Introduction

In 1989 a team of health professionals who would later join efforts for the creation of the "Fundacion Canguro" decided to evaluate the Kangaroo Mother Care Method (KMC). This method was created in 1978 by the paediatrician Dr Edgar Rey Sanabria, professor at the National University of Colombia and head of department at the "Instituto Materno Infantil (IMI)" of Bogotá. By that time, the IMI attended 30,000 births per year, from the poorest population of Bogotá, without enough human or technological resources (even with support from UNICEF) to receive all the newborns, especially premature and low birth weight babies, representing over 20% of births. Although KMC was not scientifically supported, its

introduction at this institution helped decreased the rate of inpatient infection, dropouts and probably neonatal mortality. Determined to change those empirical practices and the controversial vision of the method as "the poor man's alternative", the team of professionals at the Fundacion Canguro developed rigorous scientific research to start the new "kangaroo adventure" with the support of the Swiss NGO "The World Laboratory", Colciencias (Colombian official institution for research), and in conjunction with the Epidemiology Department of the Javeriana University in Bogota. This adventure began in 1989 and is still on the go; new projects in new aspects of the KMC arise every day.

The Kangaroo Mother Care (KMC) method

So how does KMC works? Once stabilized after the birth, the child is placed in kangaroo position on the mother's chest in direct skin-to-skin contact. The position is initiated as soon as possible and maintained as long as possible even after the baby's discharge. Only when the child is capable of breastfeeding can the mother-child dyad go home and return to the outpatient KMC for a strict follow-up until the child reaches its full term (40 weeks). The kangaroo position is kept until the child rejects it. Children are monitored daily during the period of physiological weight loss, then until they gain 15g per kg per day, which is the normal intrauterine weight gain during the last period of pregnancy. If despite the efforts the weight gain is inadequate, the breast milk will be complemented with liquid milk for premature babies (up to 30% of the daily ration). The technique used to give the supplement is particular to the KMC program; using a syringe, the total dose is distributed during the 12 times the mother breastfeeds the baby within 24 hours, and is given to the baby just before the breastfeeding starts. The amount of liquid milk needed is given to the mother at the KMC program, to prevent them from purchasing infant formula and avoid giving a bigger ration than what is prescribed. The second stage of the follow-up starts after 40 weeks and goes until one year and looks for neurosensory or neurological sequelae caused by prematurity, and to assess psychomotor development in order to take action as early as possible in case of need. The child also receives vaccinations, and a full education on child care in the first year is given to the mother.

The path cleared by the "Fundacion Canguro"

Pursuing our ideas and searching for answers to specific issues we followed these paths: 1) evaluation of the safety of the KMC as a required first stage before starting experimental studies; 2) evaluation of the clinical effectiveness of the KMC (mortality, morbidity, somatic growth and neuro and psychomotor development) with an experimental study; 3) creation of the Fundacion Canguro seeking dissemination of the KMC worldwide; 4) evaluation of the impact of KMC on the psycho-affective development and the mother-child relationship, developed in conjunction

with Laval University in Quebec, Canada; 5) greater detailed evaluation of the KMC: nutritional aspects of the kangaroo feeding and follow-up on the oxygen-dependent children; 6) creation of Centres of Excellence to monitor the quality of the KMC in different socioeconomic levels and health systems in Colombia; 7) a spread of KMC by training teams formed by, at least, a paediatrician, a nurse and a psychologist, with a continuous transfer of the KMC knowledge (training kit, forums, online tools, etc.); and lastly, 8) evaluation of the impact of the KMC 20 years after the intervention, and its impact on the premature brain.

In 1997 and 2001, two scientific projects related to the fifth point above in this kangaroo adventure were funded by the Nestlé Foundation in Switzerland. The Foundation did not participate in the data recollection, analysis or redaction of the paper, nor were Nestlé products used in the KMC program. In the first project we: a) developed a predictive model of the need to complement the exclusive breastfeeding; b) assessed the nutritional status of premature infants followed in an outpatient KMC program in Colombia when reaching their full term, according to alimentation patterns; and c) analysed the premature child's mother's milk composition every week until term, separating the analysis of final milk. In the second project we validated the predictive model and recalibrated it according to the KMC program's population.



Discussion

Currently, inpatient nutrition has improved especially at the units where the KMC was established, and almost 70% of children starting an outpatient follow-up at the KMC program leave the neonatal units with exclusive breastfeeding. The outpatient follow-up is done on a daily and weekly basis, and the prediction rule is applied only to this category of children. The promotion of maternal nutrition is intensive. A progressive reduction technique of complemented liquid milk was developed, and almost 65% of children had exclusive breastfeeding upon reaching the 40 weeks. The fortification of breast milk is now available in Colombia and the choice between liquid milk for premature and fortification of the breast milk depends

on the hygiene conditions at home and the amount of milk produced by the mother. This prediction rule allows us to make decisions based on the probabilities of complementation from the first week in the KMC program: when the probability is high, intensive promotion of maternal nutrition is started upon the baby's arrival to the KMC; if results are not satisfactory, a feed complementation is started after three days of continuous monitoring and support, to avoid the child losing its growth capital. The effort must focus on progressively reducing the usage of complements once the growth level is achieved. If the probability is intermediate, monitoring and support are started after five days, and the same procedure as above is done. If the probability is low, every effort must focus on achieving exclusive breastfeeding. All this applies once the period of physiological loss of weight in premature infants is overtaken.

Conclusion

Direct maternal breastfeeding for premature or low-birth-weight babies followed in the outpatient KMC program represent the second component of the KMC method and is probably one of the most challenging to succeed. Time and patience is required, especially knowing the benefits of the breast milk for premature babies. One of the missions of the Fundacion Canguro is to transfer all this acquired knowledge by offering free access to our education kit, which can be obtained after registration in the Kangaroo Mother Care Learning Portal, at the following link: <http://fundacioncanguro.co/KMCT/en>.

Figure 1

Prediction rule for the need of supplementation of breast feeding in preterm infants under ambulatory kangaroo mother care (KMC) in Bogota, Columbia

Baby's size at arrival to the program







AMINO ACID REQUIREMENTS

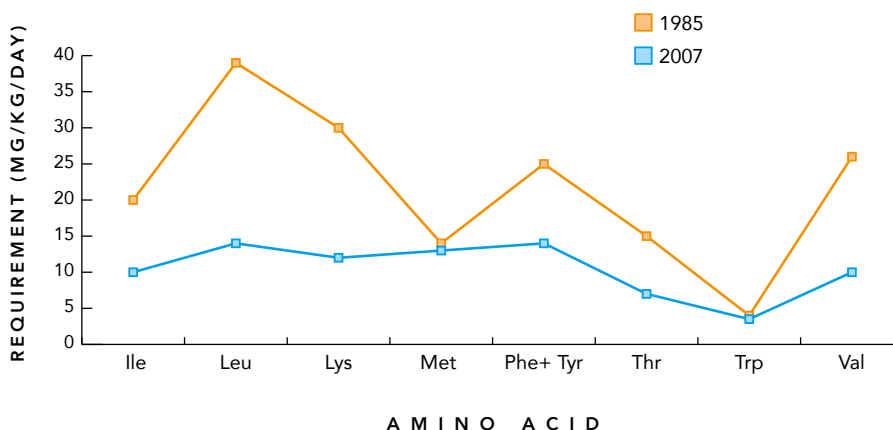
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AMINO ACID REQUIREMENTS OF HUMANS

Humans and other mammals are dependent on at least eight indispensable amino acids (IAA) that have to be supplied from the diet. However, their precise quantities in the dietary intake have been the subject of intense debate regarding the physiology of adaptation, as well as the methodology for measuring these requirements, leading to several newer and more accurate methods (1). The key to determining dietary protein or amino acid requirements is to measure their homeostasis at different levels of intakes; the minimum level of intake at which homeostasis, or a zero net balance between dietary intake and body losses, occurs, is considered to be the minimum requirement level.

Nitrogen (N) balance measures the homeostasis of the entire protein pool in the body, but it suffers from many technical difficulties and unresolved theoretical issues. More recent stable isotope tracer-based methods that track the kinetics and homeostasis of different amino acids offer more accuracy and precision of measurement; however, in many instances, these too have unresolved technical issues. A theoretically sound approach is to use leucine balance as a surrogate for N balance, since most of the potential theoretical and practical problems for measuring the loss (or oxidation) of leucine have been addressed. Leucine balance can then be used as an “indicator” of the homeostasis of any specific IAA. In this instance, the leucine balance is measured under carefully controlled conditions, with subjects adapted to their experimental diets for seven days at least, and measured over 24 hours. This is called the adapted 24-hour indicator amino acid balance (IAAB) method, and is the closest to a reference method. This method was set up at St John’s initially, with funding from the Nestlé Foundation provided to the author and Vernon Young (2). It is difficult and demanding to use, particularly on vulnerable populations; even so, it was the primary method used by the 2007 WHO/FAO/UNU Expert Committee to establish that the amino acid requirements of humans had been underestimated earlier (3, 4) (Figure 1).

Figure 1
Estimates of adult IAA requirements
in 1985 and 2007



A more convenient method is to track the oxidation of a ^{13}C labelled “indicator” of amino acid oxidation (IAAO), such as leucine or phenylalanine, in a shortened protocol that measures breath $^{13}\text{CO}_2$ output, in subjects who are adapted to their experimental diets for a shorter period of time (5). The requirement of any specific or test IAA is determined from the pattern of change in oxidation of the indicator amino acid; when the intake of the test IAA is limiting, it is expected that there would be an increased oxidation pattern of all the other amino acids owing to inefficiency in protein synthesis. As the requirement level of the test IAA is approached, the excess oxidation of the indicator

amino acid will decline, until it is at its lowest when the test IAA intake is at, or above, its requirement. The inflection point at which the oxidation of the indicator amino acid reaches its nadir is considered to be the requirement level of the test IAA. This method is easy to use and has obtained estimates of IAA requirement that are close to those obtained by the reference 24-hour adapted IAAB method (6). In that sense, it is probably the best method to deploy in resource-poor environments, or in vulnerable populations such as children. In light of the additional demands of poor sanitation and subclinical infections, as well as the digestive and absorptive inefficiency that may be imposed by environmental enteropathy, additional studies are needed on the quantitative aspects of the whole body metabolism of IAA and dispensable amino acids, particularly in subjects under different dietary and environmental conditions.

An additional dimension to protein and IAA requirements is their digestibility, particularly from plant foods: the less digestible a protein source, the more the dietary requirement. Crude protein digestibility, measured as an oro-fecal N balance, was assumed to accurately reflect individual protein and IAA digestibility, and was used in the calculation of protein quality, in the Protein Digestibility Corrected Amino Acid Score (PDCAAS) (7). However, the oro-fecal balance, as applied to IAA digestibility, had limitations since colonic bacteria could trap body nitrogen and confound balance measurements. The oro-ileal balance, determined at the terminal ileum, is considered to be a better reflection of protein or amino acid digestion and absorption, and another theoretical scoring method called the Digestible Indispensable Amino Acid Score (DIAAS) was proposed, based on ileal digestibility (8). However, the score still needs validation in humans before its general adoption, although it has been extensively measured in the pig (9).

For over 100 years, there has been a concern that the requirements of nutrients be set at the most desirable level. As Atwater (10) wrote: “A man may live and maintain body equilibrium on either a higher or lower nitrogen level. One essential question is: what level is the most advantageous? The answer to this question must be sought... in broader questions regarding bodily and mental efficiency, general health, strength and welfare”. The challenge of the future is to identify these functional indices of optimal health, particularly with different environmental challenges, which will guide future recommendations for IAA requirements in humans.



ADIPOSIITY & CARDIOVAS- CULAR RISK IN INDIANS

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ADIPOSIITY AND DIABETES AND CARDIOVASCULAR RISK IN INDIANS

The escalating epidemic of type 2 diabetes (T2D) and cardiovascular disease (CVD) in India is a major public health problem. It is conventionally thought to arise from a genetic susceptibility and rapid demographic and lifestyle transition which is obesogenic. Indians get T2D and CVD at a younger age and at a lower body mass index (BMI) compared to many other ethnic groups. Our research has shown a possible additional modifiable susceptibility in the form of intrauterine programming, which is thought to be epigenetic. One of the programmed characteristic of Indians is the “thin-fat” phenotype (disproportionately higher fat mass for a given lean mass) compared to the Europeans.

CRISIS (Coronary Risk of Insulin Sensitivity in Indian Subjects) was the first Indian study to look at accurate measures of body fat and its potential relationship with measures of insulin resistance, insulin secretion, glycaemia, inflammatory markers, and cardiovascular

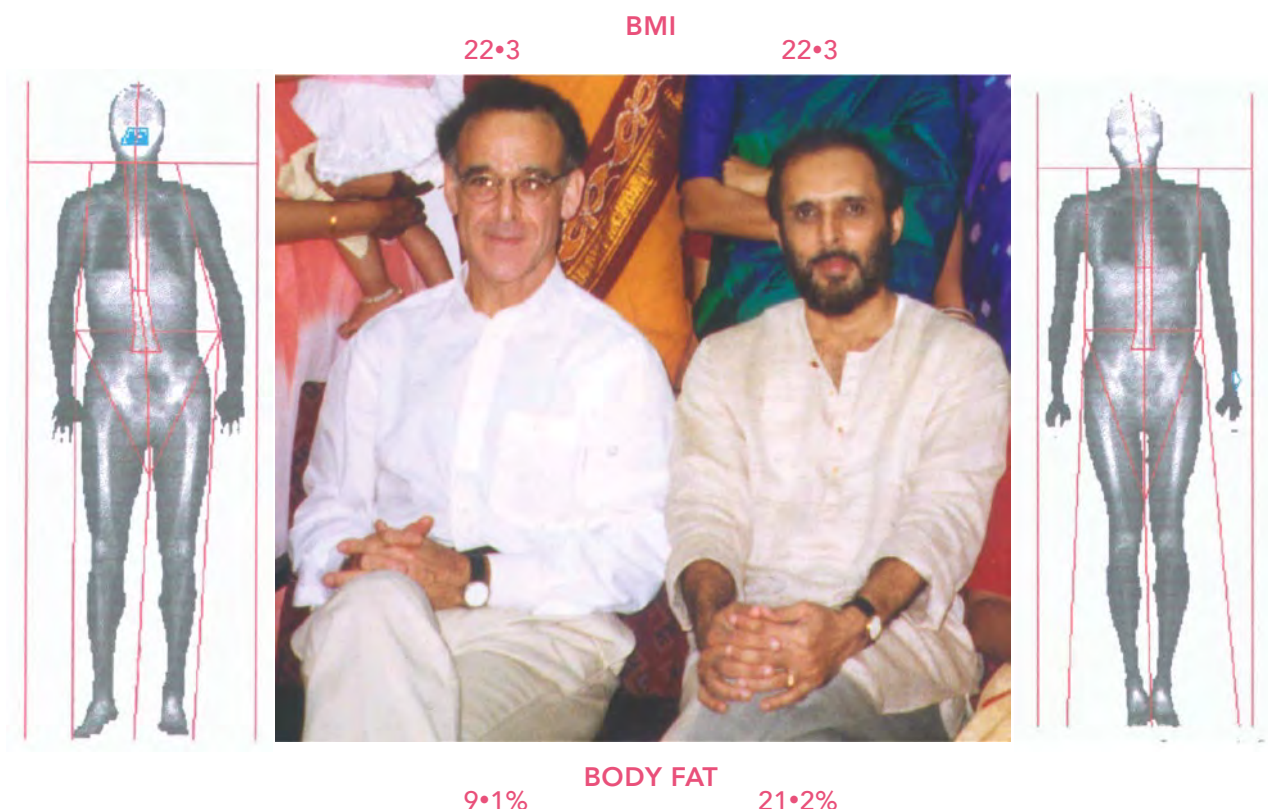
risk in rural, urban slum and urban middle-class men. The CRISIS study was supported by a grant from the Nestlé Foundation.

CRISIS included 441 randomly selected healthy middle-aged men (149 rural, 142 urban slum and 150 urban middle-class) from Pune. Those with diagnosed T2D, hypertension and CVD were excluded. Data on lifestyle, socio-economic status, nutrition and medical history were obtained. Cardiometabolic risk variables including anthropometric and biochemical parameters, markers of insulin resistance, β -cell function and inflammation were measured.

Obesity is a major risk factor for T2D and CVD. BMI is the most commonly used measure of obesity, even though it does not directly measure body fat (adiposity). The relationship between BMI (obesity) and total body fat (adiposity) differs in different populations.

in Indians (1). These findings were very relevant to the pathology associated with adiposity but many scientists had difficulty understanding the implications. Publication of the clinical picture in the Lancet (2) settled this issue (see picture).

Picture: Y-Y paradox. The two authors share a near identical BMI, but as dual X-ray absorptiometry imagery shows, that is where the similarity ends. The first author (figure, right) has substantially more body fat than the second author (figure, left). Lifestyle may be relevant: the second author runs marathons whereas the first author's main exercise is running to beat the closing doors of the elevator in the hospital every morning. The contribution of genes to such adiposity is yet to be determined, although the possible relevance of intrauterine undernutrition is supported by the first author's low birth weight. The image is a useful reminder of the limitations of BMI as a measure of adiposity across populations.



1. Relationship of body fat with insulin resistance and cardiovascular risk

We studied the BMI-body fat relationship in rural and urban Indians using two simple field methods—anthropometry (multiple skinfolds) and bioelectrical impedance analysis (BIA)—after validating these measurements against the deuterium dilution (D2O) method.

We found that body fat measured by anthropometry and BIA correlates strongly with that measured by D2O method. Moreover, the WHO-defined BMI cut-points substantially underestimated adiposity

Based on these findings, we recommended measurement of adiposity (multiple skinfolds or specifically calibrated BIA) for assessing risk for chronic diseases in Indians rather than relying only on BMI cut offs.

2. Adiposity, inflammation and hyperglycaemia

We measured glucose tolerance, insulin resistance and adiposity in rural and urban Indian men. Urban men had higher glucose concentrations compared with those in the rural men. We found a strong association between urban residence and three risk factors for diabetes: adiposity,

inflammatory markers and insulin resistance (3). These observations highlight the importance of prevention and control of adiposity to curtail the burgeoning epidemic of T2D and CVD in India.

3. Novel cardiovascular risk factors and markers of vascular damage:

In addition to the conventional risk factors (obesity, blood pressure, lipids, smoking habits) we measured some novel risk factors [von Willebrand Factor, e-selectin and carotid intima media thickness (IMT)] and markers of vascular damage. It was evident that there was a progressive increase in most of the conventional risk factors from rural to slum to urban middle-class men (4). Novel risk factors (except IMT) showed similar patterns. Thus, urbanisation was associated with increased obesity-related (conventional) as well as prothrombotic and proinflammatory (novel) cardiovascular risk factors in Indian men (4).

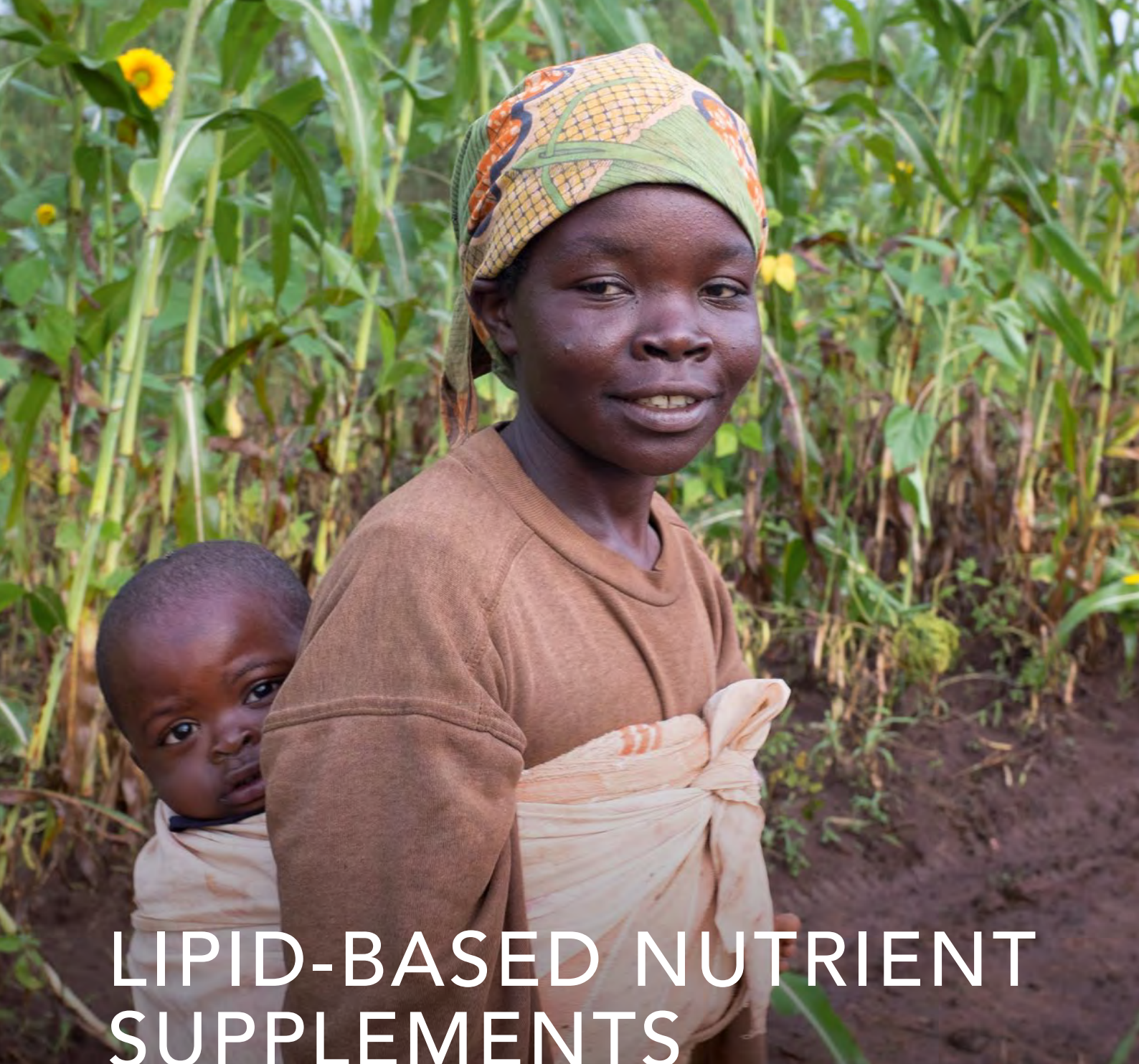
4. Vitamin B12 and folate concentration and hyperhomocysteinemia

Elevated circulating total homocysteine (tHcy) concentration is a risk factor for CVD. Indians have high tHcy concentration compared to other ethnic groups. Hyperhomocysteinemia in Indians is more attributable to low vitamin B12 status, in contrast to low folate status in the majority of other populations. We investigated the distribution and associations of vitamin B12 status and hyperhomocysteinemia in CRISIS participants.

We found that two out of three (67%) subjects had low vitamin B12 concentration and more than half (58%) had hyperhomocysteinemia (5). Vegetarians and urban middle-class residents were at a higher risk compared to non-vegetarians and rural men (5). Our findings provided a clue to investigating novel ways to investigate these mechanisms in other clinical situations. This led to the important discovery that high maternal homocysteine concentrations predict intrauterine growth retardation in Indian mothers, and paved the way for a clinical trial to improve the situation.

In summary, the CRISIS study highlighted the association between adiposity, inflammation and cardiovascular risk in middle-aged men. It showed that the rural-urban difference in cardiovascular risk was substantially ascribable to different levels of adiposity. It re-emphasized the thin-fat Indian body composition and provided clues to a possible nutritional basis for these characteristics.





LIPID-BASED NUTRIENT SUPPLEMENTS

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DIFFERENT TYPES OF SUPPLEMENTS FOR HOME FORTIFICATION OF COMPLEMENTARY FOODS

The first randomized controlled trial to compare different micronutrient supplements—a crushable tablet, a micronutrient power, and a fortified spread made using groundnut paste, vegetable oil, powdered milk, and micronutrients—for home fortification of complementary foods for the prevention of childhood malnutrition in low-income countries, which was carried out in Ghana (1), was sponsored for the most part by the Nestlé Foundation. Dr. Seth Adu-Afarwuah, then a PhD candidate at UC Davis, and his supervisor, Prof. Kathryn G. Dewey, in collaboration with Prof. Anna Lartey at the University of Ghana, enrolled infants attending monthly weight monitoring and promotion

sessions in an urban centre (Koforidua) about 85 kilometres north of Accra (the national capital) for the study. Mothers of these infants were given one of the three supplements, and were asked to mix it (one crushable tablet, one sachet of micronutrient power weighing one gram, or 20 grams of fortified spread) with a small quantity of the child's food, and feed it to the child daily from six to 12 months of age.

Begun in 2003 and completed in 2006, this study showed that all three supplements were well-accepted, had a positive impact on motor milestone acquisition and reduced iron deficiency anaemia by 12 months of age (compared to children who received no intervention), but only the consumption of the fortified spread (then referred to as Nutributter) was associated with greater length-for-age and weight-for-age z-scores (compared to the other two supplements) (1, 2). The Nutributter group showed no growth faltering during six to 12 months of age. These results suggested that Nutributter (and, possibly, similar products) promoted child growth during the period from six to 12 months of age when growth faltering is usually common, and had the potential for use among other vulnerable groups, such as pregnant and lactating women.

The consequences of the Nestlé Foundation's sponsoring of this pioneering work in Ghana have been remarkable. In the years following the Ghana study and another study from Malawi showing consistent results (3), supplements similar to Nutributter, now referred to as Lipid-based Nutrient Supplements (LNS), have been used extensively in numerous intervention trials in developing countries around the world. Although LNS (including Nutributter) is not yet officially recommended for scale-up in countries, major Non-Governmental Organizations have distributed it in various programmatic situations in many countries.

Among the recent intervention studies using LNS, two of them (the iLiNS [International Lipid-based Nutrient Supplements Project]-DYAD trials) which emanated from the previous work in Ghana (1, 2) and Malawi (3), and were conducted in the respective countries using the same design, deserve mention. In these studies, our group provided one type of LNS to women during pregnancy and the first six months post-partum, and another type to their infants from six to 18 months of age, as a strategy to improve maternal and child nutrition during the "first 1000 days". Although birth outcome results from the Malawi DYAD trial were inconclusive and there was no impact on stunting at 18 months (4), results from Ghana showed a positive impact on birth size particularly among primiparous women (5), as well as on child growth by 18 months of age. The encouraging results from Ghana support the inclusion of LNS as one potential element in the menu of interventions aimed at reducing stunting in developing countries, although its effectiveness

may depend on the local context and the presence of other concurrent interventions such as illness treatment, provision of water, sanitation and hygiene facilities, and adequate care practices.

No doubt the Ghana study supported by the Nestlé Foundation helped bring attention to the potential benefits of LNS supplementation for women and children in low-income settings, and stimulated much additional research. It is hoped that evidence from ongoing trials using LNS will be used to guide policy on various options for delivering multiple micro- and macro-nutrients to vulnerable target groups. Thus, the Nestlé Foundation's investment in the Ghana study in 2003 is likely to produce positive returns for many years to come.

At the time of the study SAA was affiliated with the Program in International and Community Nutrition, University of California, Davis, CA, USA, and AL was affiliated with the Department of Nutrition and Food Science, University of Ghana, Legon, Accra, Ghana.



READY-TO-USE FOODS

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REHABILITATION OF SEVERELY MALNOURISHED CHILDREN IN SENEGAL (WEST AFRICA)

A severely malnourished child is characterized by a very low weight in relation to height and/or the presence of nutritional oedemas. Severe malnutrition, commonly called SAM (severe acute malnutrition), is associated with a high risk of death if inappropriate treatment is provided. This was the case in Senegal (1) before WHO recommended a protocol based on skimmed milk, oil, sugar and a mixture of vitamins and minerals (F75 and F100) administrated during the initiation of cure and the rehabilitation phase (2).

Later on, a dry, solid, ready-to-use food (RTUF) equivalent to F100 but with a higher energy value than F100 was proposed to eliminate the risk of

bacterial contamination through the addition of water (3). However, the efficacy of RTUF had never been tested.

The Nutrition Laboratory of the Faculty of Sciences, University Cheikh Anta Diop (UCAD), Dakar, Senegal, tested for the first time the efficacy of a commercial RTUF provided by Nutriset through a research project entitled "Rehabilitation of severely malnourished children in Senegal (West Africa): Use of a local solid food equivalent to WHO F100 with high energetic value", funded in 2002 by the Nestlé Foundation. This first and original study, on the comparison of a solid ready-to-use food and a liquid, milk-based diet for the rehabilitation of severely malnourished children (a randomized trial), was published in 2003, and the results clearly indicated that RUTF can be used efficiently during acute severe malnutrition (4).

A second trial was then undertaken to test a locally made ready-to-use therapeutic food similar to the commercial RTUF, but aimed at treating uncomplicated cases of severe malnutrition at home. Home-based rehabilitation using local RTUF was also effective and successful (5). By now the protocol and end evaluation of acute severe malnutrition (SAM) treatment has been greatly improved, but our results largely contributed to the international use of ready-to-use therapeutic food (RUTF) in the dietary treatment of SAM.

Another important outcome expected from the Foundation's grant was to increase the capacity building of the UCAD through research and training. Dr El Hadji Issakha Diop completed his PhD thesis on the subject in 2004 under my supervision. Afterwards, he joined the NGO Valid International, and then HKI. He works as an international expert for the management of community rehabilitation of SAM, and has trained health workers in many African countries.

It was not only the career and skills of this young scientist that the project has helped. At the Nutrition Laboratory of the University Cheikh Anta Diop de Dakar, three Master's students from our Master's training course in Food and Human Nutrition, following in Dr Diop's footsteps, have completed their degrees on similar subjects: Dr Amina Yaya épouse Mohamadou in 2003 (in memoriam), M. Christian Adjoudjoune Tendeng in 2005, and M. Abdou Badiane in 2012. The second person is currently an expert in nutrition at the International Committee Red Cross (ICRC). Rehabilitation of SAM is a course module of the Master's degree at the University.

More importantly, after the skills gained by the Nutrition Laboratory team on this important area of rehabilitation of SAM, the team organised in 2007, 2009, and 2011 short residential training courses for professionals on SAM rehabilitation, thereby

strengthening Senegalese health workers' skills in this area. These courses, organised with the collaboration of the Health Centre Saint Martin in Dakar, were unique in the Francophone sub-region. We all are proud of having saved the life of several Senegalese children. Such an initiative would not have been possible without the support of the Nestlé Foundation.



A kwashiorkor at St Martin



Few days after F75



During F100 rehabilitation phase



TEXTING TO PROMOTE BREASTFEEDING

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SHORT MESSAGE SERVICE TO IMPROVE INFANT FEEDING: A STORY FROM CHINA

Mobile technology is increasingly used in the health sector for health services delivery, health promotion interventions and disease prevention programs, also known as m-health. Mobile phone short message service (SMS) is the most widely adopted and inexpensive mode for delivering m-health, allowing easy access at any time and place [1, 2]. In China, the ownership of mobile devices is high: the majority of users are 18 to 40 years of age, and include nearly all expectant and new mothers. On average, 1,200 messages are sent from each phone annually. This presents an opportunity to use SMS in promoting healthy infant feeding practices [3].

Breastfeeding and appropriate infant feeding are important to ensure a child has a healthy start in life. In 2010, we developed and implemented a SMS intervention to assess the effect of SMS on promoting breastfeeding or improving infant feeding practices and preventing childhood obesity in Shanghai, China, with support from a Nestlé Foundation Small Research Grant [4-9]. This is the first community-based intervention study to assess the effectiveness of promoting early infant feeding through SMS.

The study, a quasi-experimental design, was carried out between December 2010 and October 2013 in Shanghai, China. Four community health centres (CHCs) were purposively selected from two districts. A total of 582 women were included, 281 in the intervention group and 301 in the control group.

The intervention, one weekly text message sent to mobile phones of women in the intervention group, was carried out from the beginning of the third trimester (28 weeks gestation) to 12 months postpartum. The intervention messages, 180 to 210 characters in length, were developed based on the WHO Breastfeeding Guidelines and consultation with paediatricians, community child health workers and infant feeding literatures. They were relevant to milestones of early child development and responsive to the specific needs of expectant mothers and new mothers. The messages were sent from a computer-based platform, using either "Fetion" or "Frontline SMS" software programs available from the Internet free of charge. There was no cost for mothers' receiving messages. Participating mothers in the intervention group were also encouraged to communicate actively with the research team through SMS. Participants in the control group received the usual health care services during late pregnancy and postpartum, as did the intervention group.

The SMS intervention was effective in promoting exclusive breastfeeding (EBF). At six months postpartum, 265 mothers in the intervention and 284 in the control groups were followed up. Compared with the control group, the intervention group had a significantly longer median duration of EBF at six months (11.41 weeks, 95% confidence interval [CI] 10.25 - 12.57 vs 8.87 weeks, 95% CI 7.84 - 9.89; $P < 0.001$); the hazard ratio for stopping EBF in the intervention group was 0.80 (95% CI 0.66 - 0.97, $P = 0.026$). The intervention also showed significantly increased awareness of WHO breastfeeding guidelines and knowledge of infant feeding in the intervention group at 12 months. Although there was some reduction in inappropriate infant feeding practice such as "food for reward", "soft drinking consumption", and children's BMI and BMI z-score at 12 months and 24 months in the intervention group appeared to be lower, the difference between the intervention and control groups failed to reach statistical significance.

The strengths of the intervention, elicited through qualitative interviews with mothers in the intervention group at 12 months postpartum, include factors such as: convenient and repeatable access; information can be shared with friends and family members; timely support and anticipatory guidance; and trustworthy resource (see below).

"I saved all messages. I usually shared them with my mother-in-law [...]. Sometimes she does not agree with me on some infant feeding practice, so I show the message to her. For example, she wanted to feed egg to the baby at four months, I declined. But she continued to try and said she fed my husband (eggs) when he was four months. After I showed the message to her, she stopped" (BF to 10 months, returned to work at four months).

"I feel the messages are like a friend of mine. I do not go to the internet to search for specific information now. I am accustomed to receiving the weekly message and feel this is a very natural thing" (EBF to six months, returned to work at 4.5 months).

"The messages were sent timely, [the contents are] always a bit earlier than what will happen" (EBF, four months postpartum).

The perceived weakness of the intervention includes the limited information load due to the limited words, and a desire for the contents to be further personalized.

The SMS intervention is promising in improving mothers' knowledge on infant feeding and some infant feeding practice. A large-scale cluster randomized controlled trial is needed to further test the effectiveness of SMS on the improvement of infant feeding practice and childhood obesity prevention.



FLOUR FORTIFICATION: PROOF OF EFFECTIVENESS

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EFFECT OF IRON-FORTIFIED WHEAT FLOUR WITH AND WITHOUT ZINC, VITAMIN A, AND FOLIC ACID, ON ANAEMIA IN INFANTS

Iron fortification of wheat flour and other cereals has been recognized as an effective intervention to reduce iron deficiency anaemia and other micronutrient deficiencies. For several decades, wheat flour fortification with iron and B vitamins has been a strategy to reduce anaemia in many developed countries. Today, cereal fortification with micronutrients has also been implemented in many low- and middle-income countries, in order to prevent anaemia and other micronutrient deficiencies. In 1996, the government of Peru decided to fortify all wheat flour with 30 mg iron/kg, and in 2005 the level of fortification of iron was increased to 55 mg/kg, along with added folic acid 1.2 mg/kg, thiamine 5 mg/kg, riboflavin 4mg/kg and, niacin 48 mg/kg. This study was conducted during 1999 to 2001 and showed evidence that iron fortification of wheat flour effectively can reduce anaemia in children.

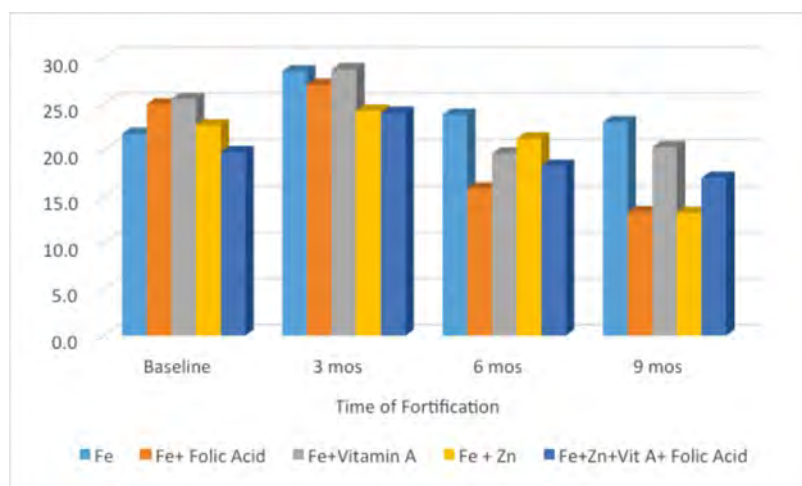


Figure 1.
Changes in anaemia prevalence (%)
by time and group of fortification

Group of fortification		Time of intervention			
		Baseline	3 mo	6 mo	9 mo
Fe	Hb (g/L)	112.8± 12.1	110.0 ± 11.9	112.3 ± 14.3	114.8 ± 13.0
Fe+Folic Acid	Hb (g/L)	113.5 ± 11.5	111.2 ± 10.7	116.3 ± 13.0	120.0 ± 12.9
Fe+Vitamin A	Hb (g/L)	111.9 ± 10.6	111.0 ± 10.8	114.4 ± 13.0	115.8 ± 13.0
Fe+Zinc	Hb (g/L)	114.2 ± 12.2	113.6 ± 11.5	115.0 ± 12.8	116.4 ± 11.6
Fe+Zn+FA+Vit A	Hb (g/L)	114.4 ± 11.4	113.8 ± 13.3	115.8 ± 14.3	118.5 ± 15.0

Table 1.
Changes in haemoglobin by time and group of fortification (mean ± SD)

We conducted an efficacy study to measure the effect of a fortified wheat flour with iron and to evaluate if the combination of iron with micronutrients would have a greater effect on anaemia and micronutrient status in children. In a double blind RCT we enrolled 832 infants in 5 groups: a) iron, b) iron + zinc, c) iron + vitamin A, d) iron + folic acid and e) iron + zinc, vitamin A + folic acid. The criteria for entry into this trial was infants with birth weight > 2500 g, breast-fed healthy infants six months old, born in Lima or in other places in the coastal area, living in the study community, and that parents signed the informed consent form.

Depending on the study group, the premix for enrichment provided (per 100 g flour):

- Iron: 4 mg as ferrous sulfate
- Zinc: 3 mg as sulfate
- Vitamin A: 300 RE as retinyl palmitate
- Folic acid : 800 µg

The flour was prepared as a complementary meal, with milk, sugar and oil, and prepared and served at community kitchens near the children's houses. Consumption was registered daily by weighing the plate pre- and post-meal. The intervention was for 9 months. Haemoglobin and other micronutrients were measured at entry into the study and at three, six, and nine months of consumption of the fortified meal. In addition, children were evaluated every month at the community health centre and field workers visited the

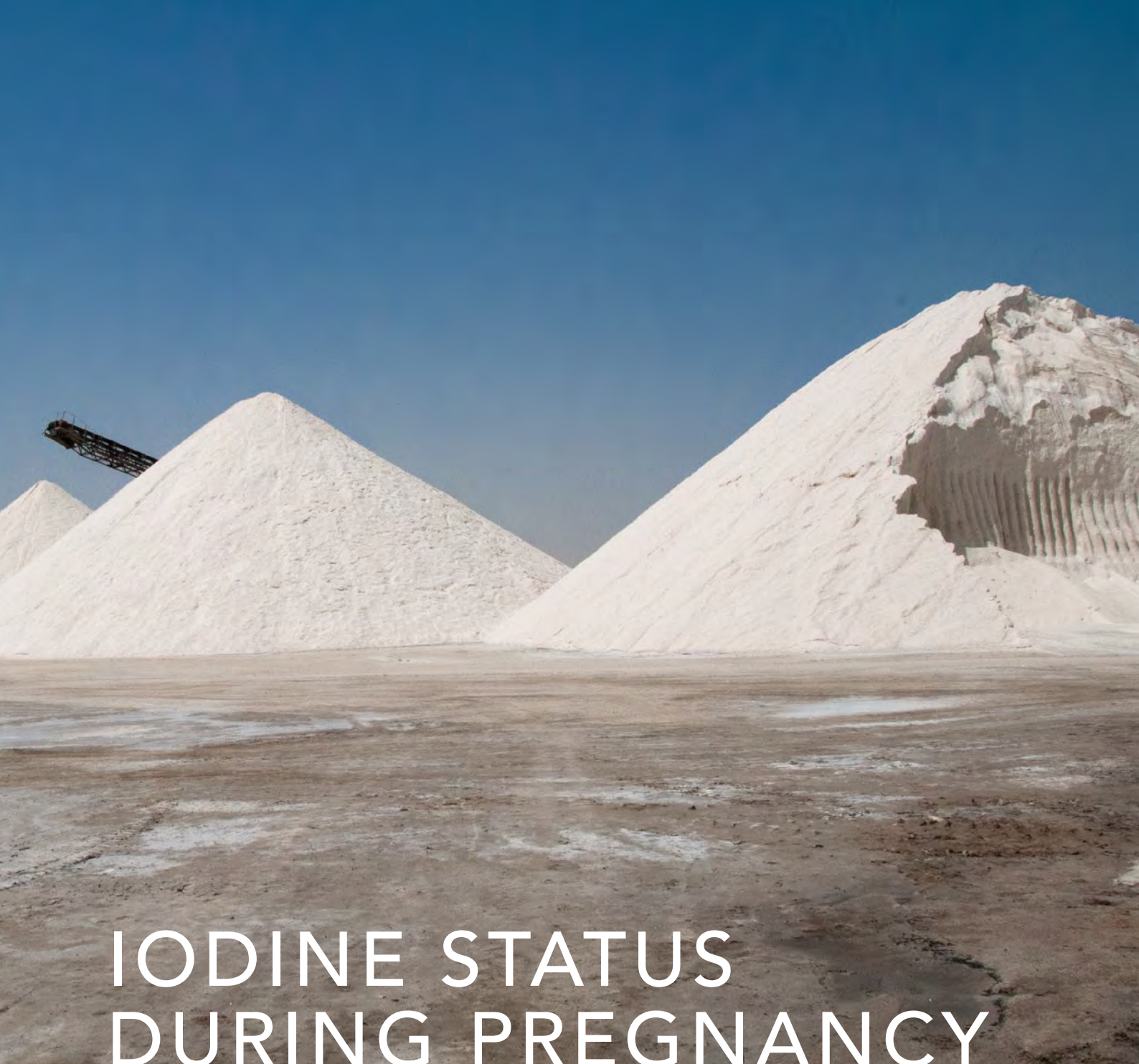
child's house twice per week to register morbidity.

A major outcome of the fortification trial was anaemia prevalence. At entry into the study, 20-26% of the infants were anaemic (Hb <105 g/L) and there was no significant difference among the groups (Figure 1). After three months of intervention, the prevalence had increased slightly in all groups to 24-29%, despite all groups having received Fe-fortified flour, but there were no significant differences among the groups. In all groups, the anaemia prevalence decreased after six months of fortification to 16-24%, but there were no statistically significant differences by group of fortification. At nine months of fortification, the prevalence of anaemia in all groups had decreased further to 13-23%, but there were still no differences by group of fortification. Mean haemoglobin values at the end of the study had increased significantly, compared with baseline values, but the net difference was not significantly different among groups when controlling for initial values (Table 1).

Conclusion:

Wheat iron fortification alone and with other micronutrients was shown to be effective to control anaemia in children less than two years of age, which suggests that the addition of these micronutrients did not affect iron absorption. Although the addition of other micronutrients such as zinc, folic acid and vitamin A did not have an impact on anaemia, there may be other functional outcomes that might justify multiple micronutrient fortification.

The study was supported by the Nestlé Foundation.



IODINE STATUS DURING PREGNANCY

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DEVELOPMENT OF NEW NORMS FOR INDICATORS OF IODINE STATUS DURING PREGNANCY WITH SPECIAL REFERENCE TO THE PREVALENCE OF MENTAL RETARDATION IN CHILDREN

Background

Akesu Prefecture in the Xinjiang Autonomous Region of China is regarded as an iodine deficiency endemic area, with average iodine concentration in water of less than 2.5 mg/L. Despite the implementation of universal iodized salt in the whole of China, it has been found that the proportion of adequately iodized salt in Akesu was around 70%. The median urinary iodine in a sample of lactating women in the townships of Chaerqui and Tuokexun was found to be below 100 ug/L. The average IQ levels, evaluated by

the Chinese version of the Raven Test, in a sample of schoolchildren in the area was 80 points.

Aims of the investigation

The three main objectives of the present longitudinal prospective study were: a) to compare TSH and T4 levels during pregnancy with the levels of urinary iodine, b) to investigate the possible role of iron nutrition as a confounder in an area with inadequate iodine status, and c) to relate iodine and iron nutrition to psychomotor development in a sample of infants and children on a longitudinal prospective basis.

Study population and methods

Baseline survey: A sample of 300 school children and 104 infants 0-2 years and their respective mothers were investigated. The results confirmed the assumption that Akesu was both an iodine and iron deficiency area and thus appropriate for the purpose of the study.

Study population and methods: A total of 774 pregnant women participated in the prospective longitudinal follow-up during which samples were collected on three different occasions, namely weeks 12, 24, and 34 of gestation. A total of 327 pairs of lactating mothers and their infants took part in the follow-up. Fifty healthy women of childbearing age took part in the follow-up as controls. The study lasted from 2009 to 2013.

Indicators of iodine status included urinary iodine concentration, thyroid hormones (FT3, FT4, TT3, TT4, TSH), and thyroid antibodies (Tgab, TPOab). Iron nutrition was assessed using serum iron, serum transferrin and haemoglobin. Urinary iodine excretion was determined on all the infants followed by assessment of intellectual development using the Denver Developmental Screening Test and the Gesell Scale. All subjects who were diagnosed as having iodine or iron deficiency were given appropriate treatment. Blood sampling was avoided whenever it was deemed inappropriate for cultural reasons. Due to technical reasons and the young age of babies and infants, hearing screening tests were not performed in all cases.

Main preliminary findings and considerations

1. Our data suggest that due to the relatively low coverage of iodized salt in the area, pregnant women who reside in these communities can be regarded as being at risk of iodine deficiency.
2. The occurrence of simultaneous iodine and iron deficiencies in the study area could be confirmed.
3. Over 15% of the pregnant women were diagnosed as having hypothyroxinemia.
4. The incidences of anaemia, iron deficiency and iron deficiency anaemia ranged between 12% and 38%.
5. The iodine status of both the lactating women and their babies seemed adequate.
6. The effect of mild iodine deficiency on thyroid hormone levels should be looked at closely. Further analyses will be carried out regarding possible effects of urinary iodine levels in the range of 100 ug/L to 150 ug/L on indicators of thyroid function.
7. Thyroid function might still be affected by iron deficiency in pregnant women even after the iodine deficiency has been adequately corrected. The generally inadequate dietary intake and poor nutritional status of the women in Akesu requires further analysis of the data before the issue of iron as a confounder can be elucidated.
8. Further analytical work will be carried out to determine the influence of subclinical hypothyroidism on the intellectual development of the infants using the Developmental Screening Test confirmed by the Gesell Scale.

Overall the team is currently involved in cleaning and reanalysing all available data with some of the aims mentioned above.

The project, which is fully financed by a generous research and training grant from The Nestlé Foundation for the Study of Nutrition in the World, has been of great benefit to the teaching and research activities at Tianjin Medical University, enabling five students to undergo postgraduate training and providing material for information in Chinese. The project has also made it possible to establish a fruitful collaboration between Tianjin Medical University and Uppsala University as the team prepares to publish the relevant observations jointly in international journals.



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DIARRHOEA (CHOLERA), GUT MICROBIOTA AND CHILD HEALTH IN BANGLADESH

The human gut harbours a diverse microbial community, including 400-500 different species of bacteria performing an array of important metabolic functions for the host, namely production of short-chain fatty acids and vitamins (vitamin K and biotin), nutrient absorption, and fighting against invading pathogens (1,2). Diarrhoea and poor child health are longstanding problems for many developing countries where sanitation is poor and safe drinking water is scarce. In Bangladesh, a child under five years of age frequently suffers from moderate to severe diarrhoea, on average three to four times a year. In acute cholera, the gut of patients is washed out due to purging and frequent loss of loose stools. This

also causes the anaerobic environment of the gut to be disrupted and the commensal microbiota to be expelled and replaced by aerobic and pathogenic bacteria. Nowadays, it is evident that intestinal microbiota have a profound influence on maintaining health and the modulation of disease manifestation. In Bangladesh, which is one of the most densely populated developing countries and where about half of the children under five years of age suffer from acute malnutrition and growth stunting, nonetheless data on gut microbiota of children of different nutritional status are lacking.

In the year 2004 our team received a grant from the Nestlé Foundation for a project entitled “Molecular and biochemical analysis of intestinal microflora in malnourished children with cholera treated with oral rehydration solution with and without amylase resistant starch”. This was the starting point for a series of interesting projects.

Our metagenomic studies of nine different children with cholera (age 2-3 yrs) at different time periods—on day 0 (immediately after admission and before administration of any medication), day 2, day 7, and on day 28—provided evidence that acute diarrhoea (cholera) results in the expulsion of major commensal bacteria of phyla Bacteroidetes, Firmicutes, and Actinobacteria, and that the harmful Proteobacteria colonize the gut during acute and convalescence states (4). These commensal bacteria gradually increased in the gut in the post-cholera period but could not reach the level of healthy children after one month.

In another metagenomic study we observed that the healthy children had a significantly higher number of OTU (Operational Taxonomic Unit) in their gut than that of the malnourished children (healthy vs. malnourished: 546 vs. 310). This study also revealed that the members of the phyla Proteobacteria including pathogenic genera were predominant in the gut of malnourished children compared to their healthy counterparts (3).

Our antimicrobial susceptibility assay on 15 healthy children (2-3 yrs) revealed that the gut of children can serve as an important reservoir for pathogenic genera autochthonous to the aquatic environments. Approximately 78% of the bacteria isolated from the gut of healthy children (2-3 yrs) were found to be resistant to multiple numbers of antimicrobial drugs (multidrug resistant, MDR) (unpublished data, manuscript under preparation). The data appear in agreement because the antimicrobial therapy in acute diarrhoea, which excludes most of the gut microbiota, selectively allows only the antibiotic resistant microbiota to restore and colonize the gut in children living in the poor hygienic condition where access to pure drinking water is scarce (4). Thus, the corollary has been proposed that these children are

more likely to suffer from frequent diarrhoea and wasting that could result in growth stunting, which is widespread in developing countries, including Bangladesh.

We also observed a predominance of extended-spectrum beta-lactamase (ESBL) producing, Gram-negative bacterial genera, which included recognized enteric and opportunistic pathogens in the gut of minor children in this antimicrobial assay, which might reflect the basis for floral immaturity, as observed in the gut of Bangladeshi children (5), and also reflect growth stunting, a scenario common in these children who reach their adulthood still malnourished. It is therefore evident that more children will suffer from diarrhoea due to MDR bacteria that continue to take shape in the changing climate and the resulting sea-level rise, which is a reality for Bangladesh, the most densely populated country where more people are vying for high land while the saltwater is creeping farther and farther inland, inviting the deadly bacterial pathogens.

Acknowledgement:

This study was conducted at the International Centre for Diarrhoeal Disease Research, Bangladesh, with partial support from the Nestlé Foundation, Lausanne, Switzerland (Grant no. 00332). icddr, b acknowledges the commitment of the Nestlé Foundation to the centre's research efforts. icddr, b also acknowledges the contribution of the Governments of Australia, Bangladesh, Canada, Sweden and the UK for providing core/unrestricted support.



POSYANDU REVIVAL

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EMPOWERING POSYANDU: INTEGRATED HEALTH AND NUTRITION SERVICES IN INDONESIA

Posyandu is a community-based health and nutrition effort which is from the community, managed and held by the community, and intended for the community in carrying health and nutrition development to the community in Indonesia. The Nestlé Foundation supported us to empower *Posyandu* through nutrition training for the *Posyandu*'s cadres and participants.

The education level of the *Posyandu* cadres was relatively low. The Indonesian government has established a nine-year basic education program. The goal is for Indonesian citizens to accomplish this nine-year education, six years at an elementary school and three years at a junior high school. In general, though, the cadres did not finish their education at a junior high school or only graduated from an elementary school.

With this low education level, cadres need training in health and nutrition to be able to serve the

community to improve children's nutritional status. By participating in this project cadres had the opportunity to have training in nutrition.

In each *Posyandu*, there were five cadres. Each month a *Posyandu* provides services to the community. About 50 children under five come to *Posyandu* to have their growth monitored. Becoming a *Posyandu* cadre happened naturally, as someone who started assisting the cadres in preparing the activities at *Posyandu* was then invited to be a cadre by the older cadres. A job as a *Posyandu* cadre was volunteer work. The majority of the cadres were housewives (55.6%), while others were sellers (22.2%), early childhood teachers (PAUD) (16.7%), or farmers (5.5%).

Cadres are the most important element in activating *Posyandu*. Without cadres *Posyandu* will not run. Cadres are also the spearhead of a health service at the village level, looking after the health of pregnant mothers, children under five and the elderly. Early detection of health problems at the community and village levels, for example poor nutrition, can be identified from the information given by the cadres to the medical officers at the sub-district level. Even many of the cadres play a role in helping village members get access to a hospital at the residential and provincial levels, for example applying for health insurance or subsidized hospital expenses, taking patients to hospital, etc. Cadres were the closest persons and played a central role in the *Posyandu* activities.

The presence of extension activities motivated the mothers of children under five to visit *Posyandu*. Therefore, empowering the cadres to understand nutrition and health better is of paramount importance, so they can become reliable counsellors at their *Posyandu*. The nutritional training conducted during the intervention program in this action research is a real step towards the empowerment of the *Posyandu* cadres.

The adequacy and completeness of the *Posyandu* facilities and infrastructure also motivated the mothers of children under five to visit *Posyandu*, because they improved the comfort and promptness in service. However, almost all of the *Posyandus* still faced problems of the availability of the facilities. Permanent *Posyandu* buildings were not always available and therefore most of the *Posyandus* used the house of one of the cadres; the availability of weighing scales, microtoise tapes, tables, chairs, as well as a couch or mattress for the examination of the pregnant mothers was also limited.

The action-research activity was able to improve the nutritional knowledge of the *Posyandu* cadres and also the mothers of children under five. The importance of the nutritional education in the long term is to improve eating habits, which in the end

can improve the nutritional status of the children. *Posyandu* cadres as the spearhead of the nutritional service at the community level play an important role in preventing malnutrition among children under five. The increasingly good quality of *Posyandu* is reflected in one of its quality elements, that is, the increase of the cadres' ability in providing a nutritional program service for children under five. It is expected that the cadres, who are increasingly skilled, will be able to inspire the community to regularly participate in the *Posyandu* nutritional program so the nutrition problems among the children under five can be better overcome.

The equipment the *Posyandus* had to operate the nutritional service program were still limited. In this action research the *Posyandus* in the research site, with help from the Nestlé Foundation, received various kinds of facilities to support the *Posyandu* operation, such as media for nutritional extension (posters, flipcharts, leaflets, etc.), tables, chairs, couches, mattresses, weighing scales, microtoise tapes, etc. It is expected, with the more complete equipment and facilities, that the *Posyandus* will be able to provide better nutritional services.



UGANDA

INSTITUTIONAL SUPPORT

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CONTRIBUTION OF THE NESTLÉ FOUNDATION TO CAPACITY BUILDING AT MAKERERE UNIVERSITY FOOD TECHNOLOGY AND NUTRITION DEPARTMENT

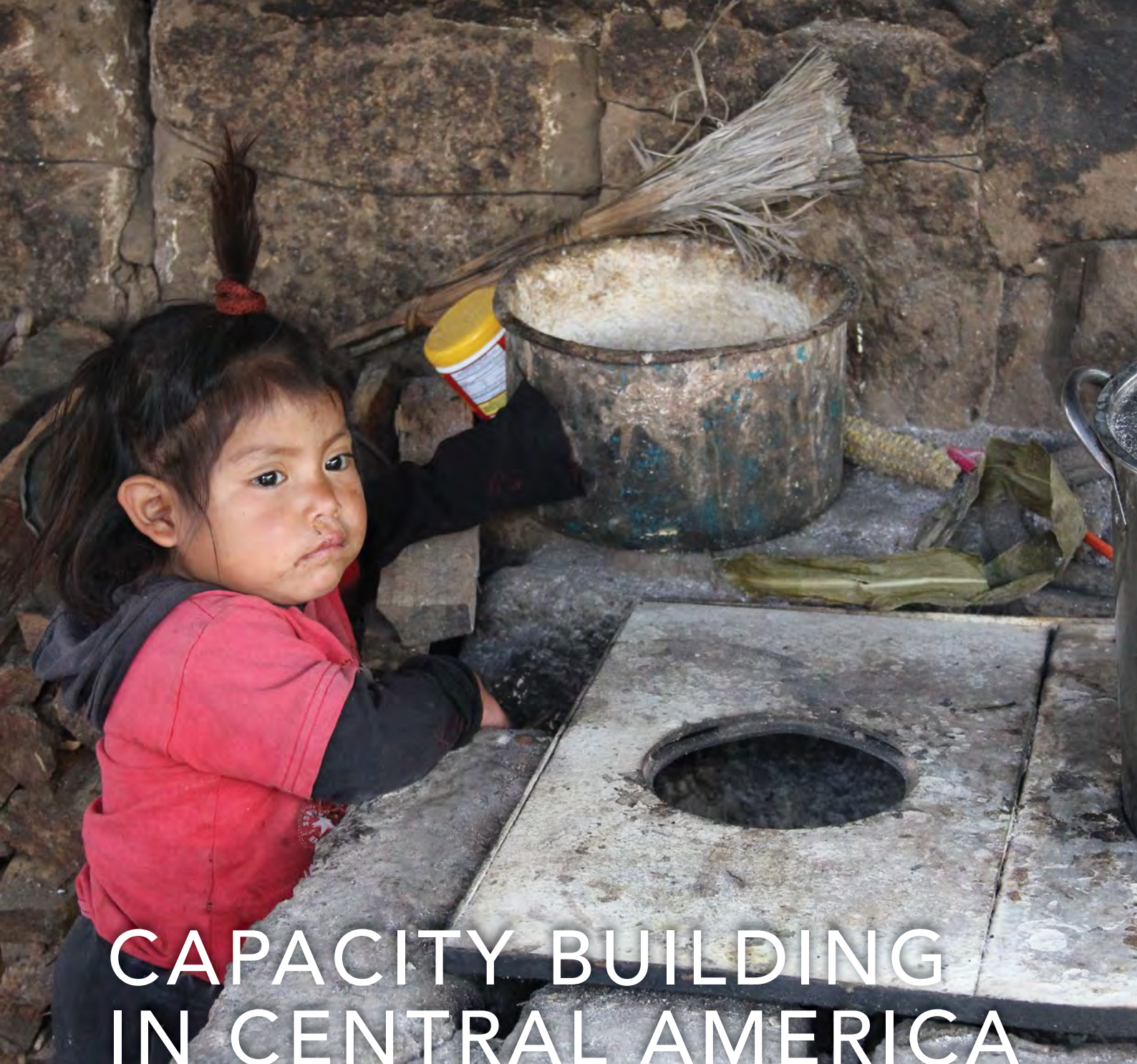
In 1989, Makerere University established the Department of Food Science and Technology to develop human resources for food technology, postharvest technology, value addition and nutrition. In 2003, the Department initiated the Master of Science Degree in Applied Human Nutrition, which was the first ever postgraduate programme in human nutrition in Uganda. The programme was established after realizing the great need for human resource capacity in the area of nutrition to address the many nutrition-related problems in the country. The Nestlé Foundation has, over the years, supported various nutrition capacity-building initiatives in African institutions. At Uganda's Makerere University, the Nestlé Foundation supported the establishment of the above Master of Science in Applied Human Nutrition programme by supporting a retired and very experienced Professor of Human Nutrition,

Professor Roger Whitehead, to come and assist in the planning and implementation of the programme. This played a key role in building a strong foundation for the degree programme. In addition, the career and professional development in the field of nutrition has been enhanced through collaborative scholarships that were offered by the Nestlé Foundation to pioneer graduate students on the Master programme.

The Foundation was the first organization to support the new MSc Degree in Applied Human Nutrition at Makerere. The targeted and focused support was done in four ways: First, the Foundation sponsored students in the inaugural year of the programme (all five MSc students work now either in local universities or for international organizations on the African continent). In addition to the tuition and research fees for the five students, the Foundation supported field work for the entire class of 20 students. Further, the grants of the Foundation were helpful for the purchase of desktop computers for the student computer lab and a laptop computer and an LCD projector for teaching and course work as well as the purchase of badly needed laboratory equipment. This greatly increased the quality of our laboratories, especially the nutrition laboratory. As already mentioned, the Nestlé Foundation supported the renowned Professor of Nutrition, Professor Roger Whitehead, to come to Makerere University in several consecutive years to facilitate the nutrition programme through both teaching and supervising the postgraduate students in their research. One of the courses he taught was "Nutrition in the life cycle"; he also supervised seven students through completion of their Master's degree, including those supported by the Foundation. Further, the Foundation also sent 20 copies of the textbook *Present Knowledge in Nutrition* along with a variety of other hard-copy nutrition textbooks, as well as providing access to a Nutrition Digital Library, all of which are in the School Book Bank for use by both the staff and students not only of the Department but the University as a whole. Furthermore, the Foundation funded an important research project on the potential of amaranth grain seeds to improve the nutrition and health status of under-fives in Uganda. A number of high value, nutrient-enhanced food products have been produced under the auspices of this project and are being utilized to feed different categories of vulnerable people in the country.

In addition to his work at Makerere University, Professor Whitehead was also invited to Kyambogo University, an upcoming public university formed in 2003, to provide more counsel on collaboration and capacity building for nutrition. Through his recommendation, the Foundation equipped the department with two boxes containing over 50 textbooks in human nutrition and related subjects. The books have been helpful to students and staff in advancing their knowledge in nutrition.

The unique contribution of the Nestlé Foundation to Makerere- and Kyambogo Universities in Uganda demonstrates a clear commitment to nutrition capacity-building, as it has contributed to the increase in the critical mass of professionals with the knowledge and skills to improve nutritional health. In addition to this achievement in Uganda, the Nestlé Foundation has supported other professionals and professional societies to advance professional careers and activities in nutrition. This has yielded more concerted nutrition advocacy efforts, resulting in nutrition being more appreciated by key stakeholders, including policymakers. Given its capacity, the Nestlé Foundation has the necessary leverage to institute more robust partnerships for improved nutrition research through continued support in form of competitive grants to encourage dietary innovation; by supporting training through increasing access to literature and tools; as well as by providing technical, infrastructural and professional development support to educational institutions, departments and programmes dealing with food and nutrition training and research in Africa.



CAPACITY BUILDING IN CENTRAL AMERICA

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A NOTE FROM GUATEMALA

On this, the 50th anniversary of the Nestlé Foundation for the Study of Problems of Nutrition in the World, we join in the recognition and congratulations that are due. This is a series of reflections on the Foundation's influence and impact in Central America, in Guatemala within that region, and at the Center for Studies in Sensory Impairment, Aging and Metabolism (CeSSIAM) within Guatemala in particular. CeSSIAM celebrated its 30th anniversary in 1985.

Research Grants and Educational Support to CeSSIAM:

The "sensory impairment" in our title is inspired by the efforts against nutritional blindness caused by vitamin A. The Nestlé Foundation provided

CeSSIAM with an early support grant to explore issues of vitamin A bioavailability for the fledgling Center. Later, in conjunction with the late Professor Clive E. West at Wageningen University, a larger award was obtained in the mid-1990s to support the doctoral studies of Guatemalan physician Dr. Jesus Bulux, who examined the acute effects of maternal supplementation with oral vitamin A and iodine on the content of these nutrients in the post-dosing breast milk and the consequences for the infants' exposure. This connection facilitated exchange-student opportunities for at least six pairs of Wageningen university students, including one named Marieke Vossenaar, to come for supervised elective research training in Guatemala. It produced five publications from these students, unrelated to the central doctoral theme.

Most recently, in 2011-12, the Nestlé Foundation provided the now CeSSIAM professional Marieke Vossenaar with funds for the project "Feeding practices in Guatemalan infants: Adherence to the WHO recommendations and barriers to their implementation". This was a collaborative financing arrangement, with comparable funding through the Sight and Life (S&L) in Basel to collaborator Dr Colleen M Doak at the Free University of Amsterdam for a project of a comparable title. Together the Project was known as "Xela Babies" for the local name (Xelaju) of the site, the province of Quetzaltenango in the Western Highlands of Guatemala. The inquiry about children in the first year of life was supported by the Nestlé Foundation and that in the second year by S&L. The collection of the nine publications from the Xela Babies project to date is presented in the online references (1-9).

The support received from the Nestlé Foundation at CeSSIAM does not stop there. We have been affiliates of the enLink digital library service since its inception, helping to resolve a problem in developing countries with no access to virtual libraries by providing the latest and most complete scientific journal literature. CeSSIAM has its main headquarters in Guatemala City, but it also has two outlying annex sites in the interior of the country: in Sololá (headed by Dr. Mónica Orozco) and Quetzaltenango (headed by Ms Rosario García). The Foundation's enLINK library trunk program provides a collection of useful textbooks and publications in Spanish as a language-appropriate educational resource throughout Latin America. As of November, 2015, trunks are present and at the disposal of the staff and students at all three CeSSIAM facilities in the country.

The International Dietary Energy Consultative Group (IDECG) and Guatemala:

CeSSIAM had the opportunity to participate with the IDECG during a decade plus of activities beginning in 1985. It was a privilege to have sat in on one of the first international gatherings of this body, which was convened in 1987 at the Institute of Nutrition of

Central America and Panama in Guatemala City, with a theme of the interaction of energy and protein. The then Director of the Nestlé Foundation, the late Dr Beat Schürch, was a friend and colleague from even earlier, with his attendance at all of the important international meetings of the era.

With the theme of aging inscribed in the title of CeSSIAM, one of us (N.W.S.) was invited, in 1999, as the keynote speaker and a working-group member of the Impact of Human Aging on Energy and Protein Metabolism and Requirements, to an IDECG workshop hosted in Boston, Massachusetts at the Tufts/USDA Human Nutrition Research Center on Aging. It resulted in the two publications listed in the online references (10-11).

The Synopsis:

The Presidents of the Nestlé Foundation in the CeSSIAM-association years, Professor Eric Jecquier and Professor Susanne Suter, and the respective Directors, Drs Beat Schürch and Paolo Suter, have shown the winning combination of flexibility, creativity and pragmatism, all rooted in Swiss culture and heritage; they have had the vision to invest in the young: young students and professionals, young institutions, and young and fresh concepts and ideas. They correctly perceive the resource needs affecting low- and middle-income societies, and have mobilized several successful and productive projects of research funding and educational support. We appreciate the role the Foundation and its insightful leadership has played in strengthening numerous elements in Central America, and specifically our institution. Let us hope that the second half-century of operations will be as successful as the first.



GAMBIA

INSTITUTIONAL SUPPORT

Roger Whitehead, CBE, PhD

Former Director,
MRC Dunn Nutrition Centre, Cambridge, UK
and Keneba, The Gambia

Scientific Advisor 1968-1977

Council Member 1977-2005

THE NESTLÉ FOUNDATION

AND THE UK MEDICAL RESEARCH COUNCIL

As described elsewhere in this Report, links between Foundation and British nutritional scientists working for the UK Medical Research Council began in the mid-1960s through the friendship of two great physiologists: Professors McCance and von Muralt, plus Sir Frank Young, Professor of Biochemistry at Cambridge, who became a founder member of the Nestlé Foundation's governing Council. These relationships encouraged scientific plans and ideas being shared between UK-funded developments in Uganda, East Africa and Nestlé Foundation initiatives in the Ivory Coast, West Africa. One early example was the design of robust mobile laboratories that could be used for studies in the more remote parts

of Africa! Later, when the UK research was moved from Uganda to the village of Keneba in The Gambia, West Africa, working visits occurred between the two groups of scientists. Ultimately, the Foundation's funding strategies evolved and the Ivory Coast research centre closed; paradoxically, this was a change that was to lead to an even closer association. Young Swiss scientists now came to Keneba for a wider nutritional science experience and an early one, Elisabeth Mueller, ultimately became a senior administrator at the Foundation's office in Lausanne.

Prior to the 1970s all the research carried out in UK Medical Research Council establishments was completely British-government funded but gradually it became recognised that additional sources of finance would be required if the excellence of research was to be maintained. This realisation enabled studies to be initiated using funds from the Foundation. Following an international meeting on maternal dietary needs during pregnancy and lactation organised by the second president, Professor Hugo Aebi, the Foundation funded a multi-centre study in five countries to clarify how mothers from different socioeconomic backgrounds accommodated the metabolic energy costs. Keneba represented the most under-privileged population with the lowest dietary energy intake.

The results obtained are discussed in another section. They indicated the need for further studies at a more fundamental level. By this time Professor Eric Jequier, a recognised authority on the use of whole-body calorimetry, had been elected President of the Foundation. His skills and experience paralleled those of colleagues in Cambridge and the decision was made to finance and design an instrument capable of accurate work under the demanding conditions of tropical Africa. Despite numerous problems this proved to be money well spent and established how the most up-to-date techniques can be used in the field as long as there has been appropriate planning. The introduction and running of the Swiss built whole-body calorimeter in Keneba represented the closest period of scientific collaboration between the two funding bodies. Scientific research, however, was not the only beneficiary of this association. Between 1986 and 1991, for example, six young medical graduates from the University of Lausanne came to work in Keneba, plus others in the next five years. Not only did they gain experience in physiological research, but by joining in with the treatment of patients attending the associated clinic they also developed knowledge and skills in preventive and therapeutic tropical medicine. It was not only the careers of young Swiss scientists that were helped. During the same period it was possible to create two short-term scientific posts for young British post-doctoral scientists.

More importantly, however, the link with the Nestlé Foundation contributed to our ability to further

the scientific training and education of Gambian colleagues who were initially employed as technical assistants. Through a grant from the Foundation it became possible for Dr B Sonko to successfully study for a PhD at the University of Cambridge in the use of mass spectrometry for nutritional research. Subsequently, arrangements were made with the UK Open University so that Gambian postgraduates could carry out their research for a PhD in Keneba under appropriate supervision. Further postgraduate candidates became beneficiaries under this scheme. Between 1996-97 Momodou Darboe was also enabled to attend a course leading to a Master's degree from the London School of Hygiene and Tropical Medicine. He subsequently returned to the research station in Keneba to study for his PhD. These higher training initiatives were all assisted by the financial flexibility offered by the contributions of the Nestlé Foundation to the overall running of the Gambian laboratory.

Elsewhere the importance of trainees being able to return to their home country and continue to pursue a productive research programme is emphasised. It is especially pleasing to see that in 2012 Dr Momodou Darboe was personally successful in being awarded a research grant from the Nestlé Foundation to study "Prenatal and young child nutritional supplementation and early childhood body composition, growth and development". This is an in-depth controlled community study involving not only diet and general growth but also the healthy accumulation of lean tissue mass and improvement of functions such as motor development among young Gambian children. This is a good example of what the Nestlé Foundation has always wanted to achieve.



RESEARCH ACTIVITIES AT SEAMEO RECFON

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Director

Paulus Daniel Sahanggamu, MSc
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Regional Centre for Food and Nutrition
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Southeast Asia still faces huge challenges in addressing nutritional problems, especially in children and women of childbearing age. SEAMEO RECFON, as the Regional Centre for Food and Nutrition, is obliged to contribute in addressing this challenge, using an evidence-based approach. Therefore, in line with its mission, SEAMEO RECFON performs various research projects focusing on maternal and child nutrition.

The research results are then disseminated to stakeholders as well as policy makers to be considered for policy formulation. SEAMEO RECFON provides technical assistance during the implementation of

nutritional programs or delivering messages about nutritional guidelines, which will be applied to local contexts at the regional/provincial/district level together with the program implementer and other partners.

Nutritional problems among childbearing-age women such as anaemia, chronic energy and micronutrient inefficiencies, are among the research topics focussed on by SEAMEO RECFON, as those deficiencies may affect the nutritional health and well-being of the women themselves as well as the future generation. Using a lifecycle approach, different age or physiological groups are among the subjects covered in our research in the southeast Asian countries, such as adolescent girls, pregnant women and lactating mothers. Vitamin A, riboflavin, folate, iron and zinc deficiencies were evident among adolescent girls, while anaemia reduction among pregnant women is still a big challenge. Our research results on anaemia have been considered by policy makers in formulating policy.

Stunting and micronutrient deficiencies, as well as serious undernutrition among under-five children are still prevalent in some countries, such as Cambodia, Indonesia, Laos and Myanmar. These issues are closely related to inadequate intake of nutrients from food. Nutrient-dense foods available locally can potentially improve the nutritional adequacy of food. The use of locally available foods has been emphasized by the World Health Organization and UNICEF in their Global Strategy for Infants and Young Child Feeding. The recommended locally available complementary feeding which fits the local context is expected to result in increased long-term complementary feeding practices compared with general recommendations. In this context, WHO has provided a tool as a food-based recommendation, namely "Optifood", with a linear programming approach to develop local nutrition guidelines that are specific and affordable. SEAMEO RECFON has been involved in a variety of preliminary studies related to the development and the use of linear programming in various urban and rural areas and in different socio-economic settings in Indonesia. SEAMEO RECFON has also conducted community intervention studies on the effectiveness of Complementary Feeding Recommendations developed using the linear programming approach, in Indonesia and Myanmar. The results are promising, and yet to be expanded in other Southeast Asian countries.

SEAMEO RECFON research topics also cover the effects of improper nutritional status on growth development, reproductive and cognitive functions. A combination of micronutrient supplementation improved linear growth in infants. Micronutrient deficiencies may indicate risk during pregnancy. Micronutrient fortification improved verbal learning and memory among schoolchildren.

The research activities at SEAMEO RECFON have been carried out in collaboration with various institutions. In particular, SEAMEO RECFON acknowledges the contribution of the Nestlé Foundation with research funding since 2000. During those years, SEAMEO RECFON has been able to conduct research on a wide range of topics and covering different stages of human life. Along with the Foundation's continuous support, SEAMEO RECFON also gained capability in doing research and has been able to disseminate the results in international scientific fora.



CONDITIONS FOR SUCCESS

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AFTER 50 YEARS IN THE CONGO: WHY IS THERE STILL MUCH TO DO AND WHAT WOULD BE THE CONDITIONS FOR SUCCESS?

Preschool consultations have always been an excellent way to improve children's health in the Democratic Republic of Congo.

In the colonial era, an important part of the medical service was assumed by the religious (Catholic or Protestant) missions. In Kangu-Mayumbe (D. R. Congo), on Sundays after high mass, a nun used to stand at the door of the church with her table and weighing scale. The young mothers would come to her with their babies, the nun would take the babies in her arms, put them down on the scale, then give them back to the mothers and write down a few

mysterious numbers on a little notebook. At that time, pyrimétanine was trendy. The nun gave then the child a little tablet. The mother was quite convinced that the fact that the nun had taken the child in her arms, then put him or her on a "machine" resulted in a protection of the child for the whole week. Indeed, it looked obvious that the nun had a "supernatural gift" that she used to protect the child's health. The little white tablet was the "perceptible sign" of that protection. So, all that was quite mysterious.

After independence in 1960, as we felt it was important to make the mother aware of her responsibility, that method quickly disappeared. We offered then to make a weight sheet ("the good way to health"). The nurse in charge of that job started with setting up a little chat on various subjects about health and nutrition. We then designed four little brochures to help the nurse prepare her educational chats:

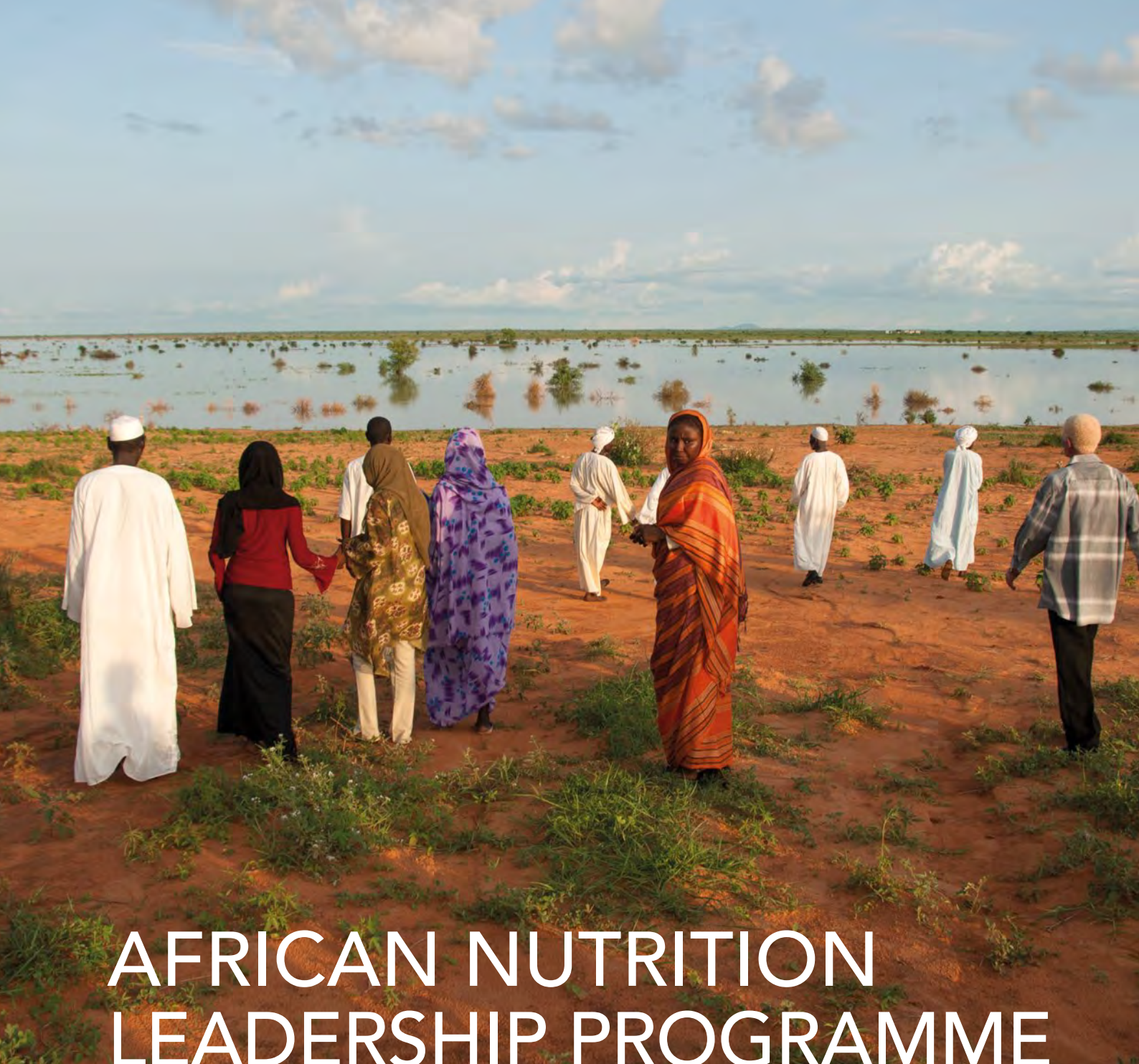
- *For my baby to be born in good health* (antenatal consultations)
- *Your children's health* (how to protect the children's health from birth to beginning of school)
- *Why get your children vaccinated?* (the role of vaccination in the defence against diseases)
- *The child's malnutrition and its consequences.*

After her talk, the nurse explained to the mothers that the instrument, the baby scales, was in fact nothing mysterious. It was just like the scales used by shopkeepers to buy the villagers' products. She explained that the child belonged to the mother, who was thus the one to take charge of the supervision of his or her health. After the talk, the nurse wrote down, in front of the mother and after a short explanation, the child's weight on the weight sheet. Then she gave the mother the sheet in a plastic envelope, telling her again that she was responsible for that sheet and she was supposed to bring it back at the next consultation. Thus the mother felt aware of her responsibility. That is how the practice of preschool consultations with talks on various subjects about health, but particularly good health, spread all over Congo. The team of the Kangu Centre made and then spread in the various provinces of the country more than five million of these sheets.

After 1990, big disruptions, looting everywhere in 1991 and 1993, and finally rebellions and wars, brought about the end of all forms of cooperation; a lot of foreign missionaries left the country, among them the nuns who were too old; the standard of living plummeted and poverty increased. In a few months, nearly all the preschool consultations disappeared as well as the use of the weight sheet. Indeed, at that difficult time mothers had many other things to worry about than to go and sit at educational talks. Survival was a priority.

The solutions offered for the future. If we want to hope to see children's health improve, we must first consider a rise of the standard of living, a reduction of poverty, but above all, better schooling, of girls particularly. It is a long-term job that requires the collaboration of many other services in addition to the medical service. Yet, let us not lose hope as we notice various positive factors on the horizon. Young mothers well educated at school come to ask us why the educational talks and use of the weight sheet have disappeared. What we sowed between 1960 and 1990 is still germinating and we hope that effort will produce fruit. In the mean time, we can see that the situation is really difficult for many rural families in Congo. Yet we keep hope.

On March 31st 2015 Clément Nzungu Mavinga died. He worked with Dr. Courtejoie for several decades and was till his untimely death the director of the Centre pour la promotion de la Santé. He guaranteed and ensured for all his life the right way forward for global improvement and social justice.



AFRICAN NUTRITION LEADERSHIP PROGRAMME

Johann Jerling, PhD

Director

Haemostasis, Leadership Development
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Many living in Africa suffer from an unacceptably high burden of malnutrition. The good news is that there is a high level of commitment to change the sad statistics, but commitment has to be turned into action, and scaled-up nutrition interventions have to be delivered to where those suffering live. The development and nurturing of transformational leaders that will make this happen is now of critical importance. In Africa, improving nutrition, and thus lives, is all about change. Our ability to build relevant structures and systems and to make effective use of the ever increasing international assistance being promised will to a large extent be determined by our ability to lead and manage change efforts. Change is led by individuals, individuals who assume leadership at all levels of all systems and structures independent of their rank or position. Individuals who lead form

where they stand. The early recognition of the fact that we have neglected to develop leadership skills amongst those working in nutrition was the driving force for the establishment of the African Nutrition Leadership Programme (ANLP) in 2002.

The aim of the ANLP is to develop transformational leadership capabilities in early and mid-career individuals working in the broad field of nutrition in Africa. The first African Nutrition Leadership Programme was held in November 2002 in South Africa and was hosted by Johann Jerling from North-West University and Xikombiso Mbhenyane from the University of Venda. Since then, 13 programs have been run and 325 individuals from 34 African countries are now part of a pan-African ANLP Alumni network.

Initially the primary focus of the annual 10-day programme was leadership capacity development at the individual level. In time, and as the programme has grown, the need for institutional leadership development arose and the ANLP is currently developing and expanding its capability to also fulfill this need. It is exciting that the ANLP is now involved with initiatives to scale up nutrition leadership development across the continent at the institutional, multi-sectorial team and individual level.

This is all happening at a time when leadership development is now high on the global nutrition agenda. The multi-sectorial nature of the solutions necessary to deliver nutrition at scale has highlighted a critical gap that can only be filled by the development of individuals, teams and institutions with leadership capabilities. Capabilities that include self-awareness, balancing conflicting demands and the ability to create aligned commitment amongst diverse but important stakeholders. In the social realm, ANLP focusses on the ability to build and maintain relationships, communicate effectively and the ability to develop others. In the work facilitation realm, management skills and the abilities to think and act both strategically and creatively and to initiate and implement change are key. Developing these complex and compound capabilities requires time and serious commitment from both the individuals themselves and supporting organisations. It requires leaders who have the vision to think ahead and work towards a future they might never see.

Since its inception, many partners have supported the efforts of the ANLP and without their commitment and willingness to get involved and work for results that will only be seen later, the ANLP would not be where it is today—a leader in leadership development.

The ANLP has been, and continues to be, on the forefront of nutrition leadership development. It is

with great enthusiasm and an unshakable belief in a future that looks better than that which the statistics present that we act on our commitment to develop more leaders to ensure a better Africa for all.



DO NOT FORGET SOUL CARE

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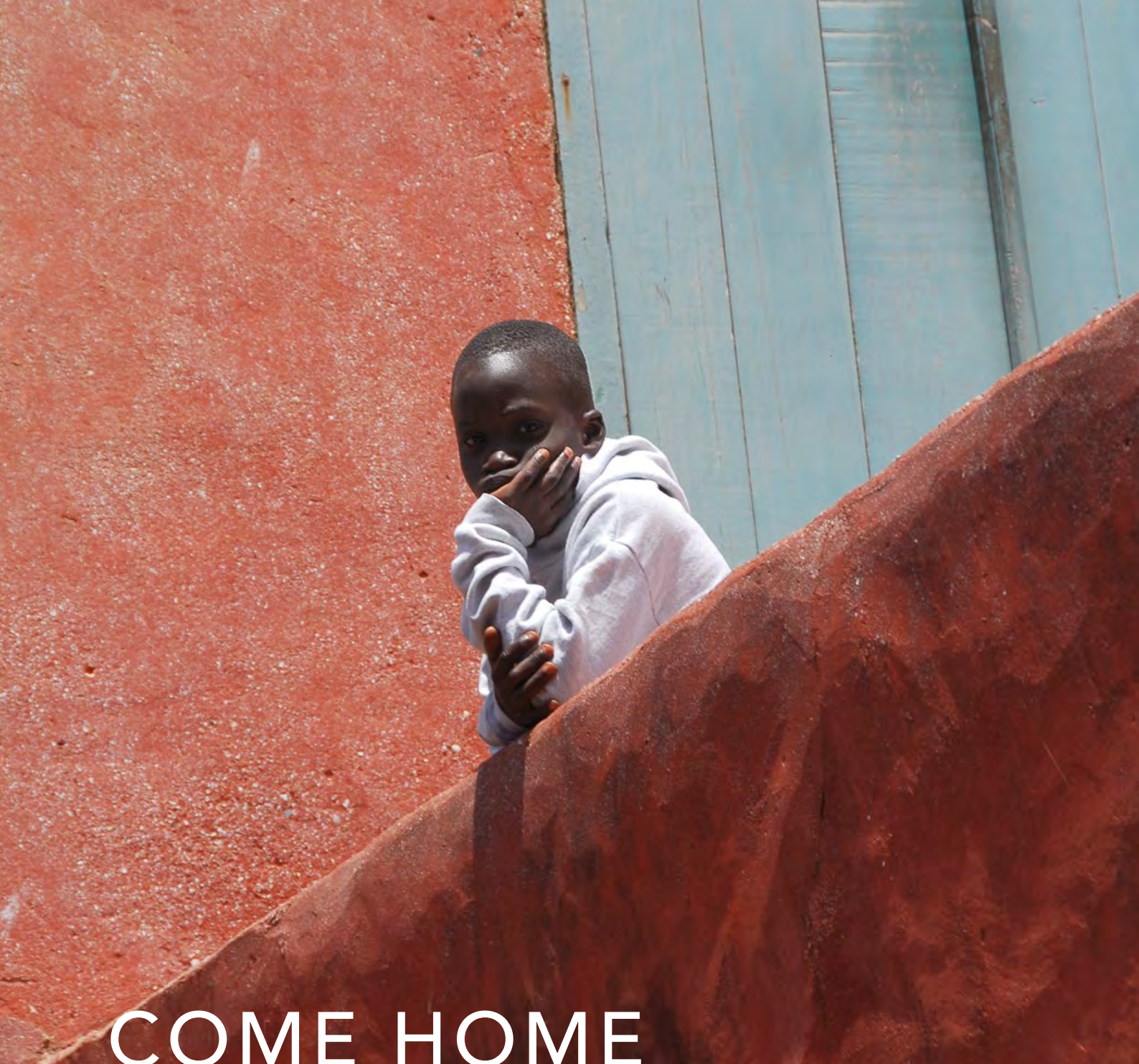
Singapore

A FOUNDATION WITH A HEART AND SOUL

I have been passionate about food all my life. My interest in food can be traced to my early childhood growing up in Ceylon (Sri Lanka). I was born in Colombo and lived in a hill town called Kandy. Perhaps it's the name of my town — "Candy" spelt with a "K" — that spurred my interest in food! After my graduation in Food Technology, I had a passion to pursue a career in Human Nutrition. My interest in nutrition was inspired by my late father, who was a zoologist. I recall his saying one day that guinea pigs were unable to synthesize vitamin C! This fascinated me and drew me to find out more about nutrition. At that time, there were no courses in Human Nutrition in the South Asian region. In order to fulfil my dream, I had to study overseas. My next challenge

was to secure a scholarship. Where would I obtain a scholarship from? It was even more fascinating how I “found” the Nestlé Foundation. I was a regular visitor to the British Council Library in my town of Kandy. I often visited it to read British journals and books. In the reference section, I came across a book entitled “Foundations of the World” and there I discovered the Nestlé Foundation and read about its vision and mission. I contacted the Nestlé Foundation and expressed an interest in studying Human Nutrition at the London School of Hygiene and Tropical Medicine. The Director of the Foundation at that time, Mr. Serge Herzen, was most encouraging and offered me a scholarship provided I secured a place at the London School of Hygiene, which I did. My two year Masters Programme in Human Nutrition at the school was the most intellectually rewarding and life-changing period in my entire life. After my MSc my tutor, Professor John Waterlow, encouraged me to pursue a PhD under his supervision. With encouragement and support from Professor Roger Whitehead and Professor Eric Jéquier, I was delighted to be awarded a scholarship from the foundation to read for a PhD in Human Nutrition, once again at the London School of Hygiene and Tropical Medicine. In 1983, at the tail-end of my PhD, I returned to Sri Lanka and was caught up in the civil war. During this time of great personal grief and tragedy, I was genuinely touched by how the Foundation cared for me. They were not only concerned about my personal safety but were also keen to help me in any way they could with my academic career. For over a year, they funded a post-doctoral programme in the UK and supported me both personally and professionally. The civil war shattered my dream of working in Sri Lanka. I had to make a new life in Europe and rise up from the ashes of despair. It was a trying and challenging time. As it was not possible to return to Sri Lanka, I obtained a position as a lecturer at Oxford Brooks University. During my time there, I initiated a series of studies notably on diet-induced thermogenesis, basal metabolic rate (BMR) and energy regulation. In 1985, the FAO, WHO and UNU published a new set of predictive equations for estimating BMR. The Chairman of this committee was Professor John Waterlow. When I mentioned to him that the equations developed did not include many subjects from the tropical region, he requested that I re-analyse the world literature on BMR. With support from Director Dr. Beat Schürch and funding from the Nestlé Foundation, we developed new predictive equations to estimate BMR which have now come to be called the “Henry equations” for BMR. These equations have now been adapted by all EU countries and in several dietetic and nutrition departments worldwide. They are currently widely used to estimate energy requirements in humans. This example illustrates once again how supportive and pivotal the Foundation was to my academic development. Having spent nearly three and a half decades in Europe, I returned to Asia in the summer of 2011. I came to Singapore as the founding Director

of the Clinical Nutrition Research Centre within the Singapore Institute for Clinical Sciences (A*STAR). Much of my research training, my wide contacts in Europe and my association with the Nestlé Foundation have been of great professional significance here. The centre in Singapore is the largest “all under one roof” nutrition laboratory in Asia. Our dream is to develop a centre of excellence where collaborative partnership and research to ameliorate global malnutrition will be the main focus. Much work remains to be done. We all have a small but significant role to play in this journey. The Nestlé Foundation’s motto is “for the study of problems of nutrition in the world”. In a world where half the population is overweight or obese and the other half undernourished, the Foundation plays a pivotal role in training and supporting the leaders of tomorrow. I was privileged to be a Nestlé Foundation Scholar. I owe the Foundation much gratitude for making me what I am.



COME HOME

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Nutrition for Health and Socio-Economic
Development in Sub-Saharan Africa (2009-2015)

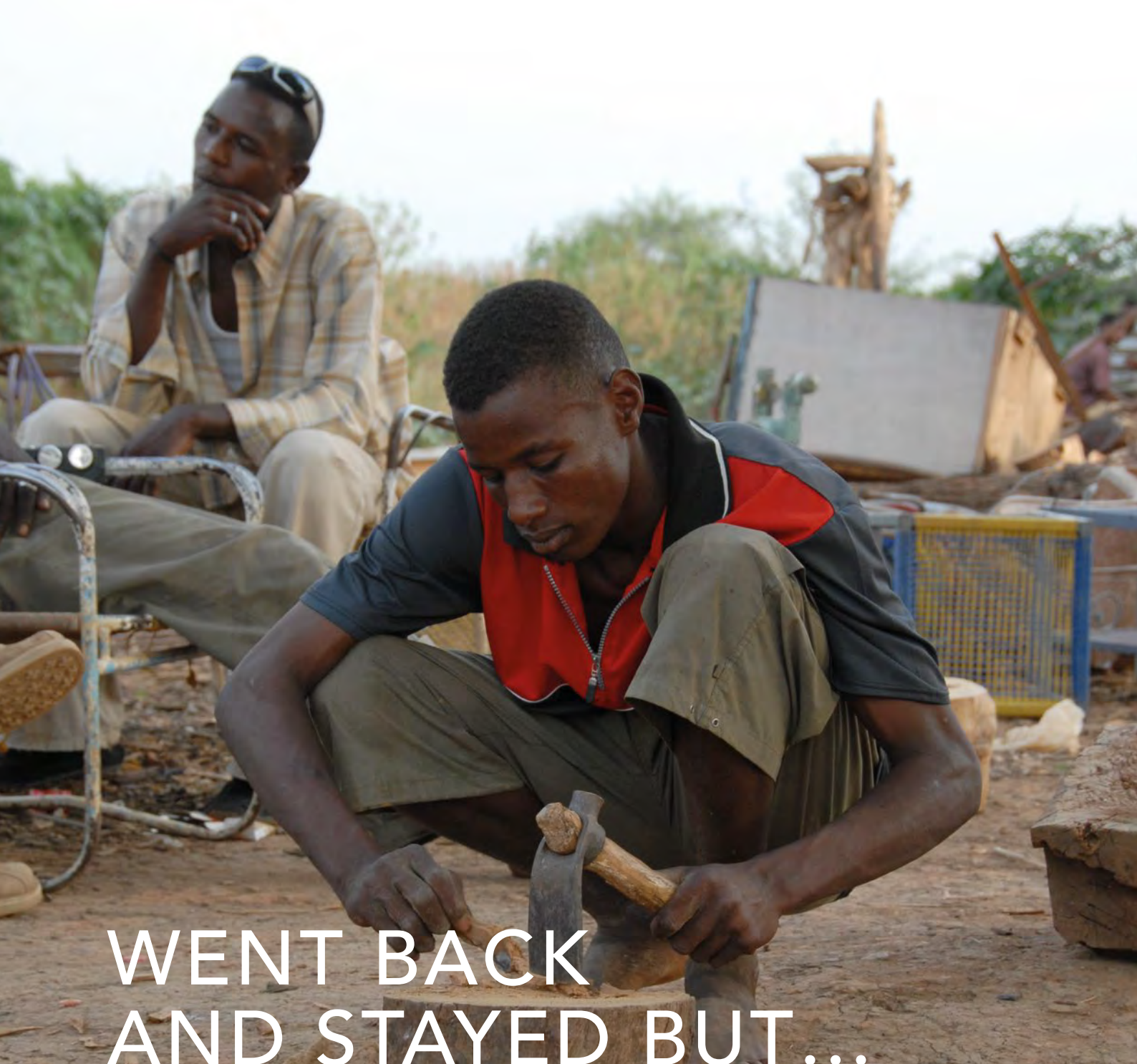
Getting the privilege to study in another country is a unique opportunity we must take advantage of when it comes our way. I had the opportunity of studying in Canada and the USA for my Master's and doctoral degrees, respectively. There are many benefits of studying in another country, especially in countries that are more advanced than mine. I was exposed to new and modern techniques in my field of study. I had the chance to meet accomplished professors I had read about. As a graduate student, my supervisors made it almost mandatory to attend the annual nutrition conferences. The networking among my graduate student colleague was great. My school colleagues have now become my professional colleagues. These professional networks were critical for me as I built my career.

It all started in 1979 when nine of us were sent from my home country of Ghana to study in North America. I pursued a BSc in Nutritional Biochemistry and then a Master's in Nutritional Science. When I completed my Master's in 1985, I packed my bags and decided to come home. It was not an easy decision. In fact, my friends felt I was crazy to make a decision like this at a time when most professionals were leaving Ghana for greener pastures. I was determined. I got home without a job waiting for me and no vehicle. After several months I was invited for an interview at the University of Ghana and was accepted immediately. There was a mass exodus of university professors from the country so there were vacancies waiting to be filled. I served eight years as a lecturer and the University then nominated me for a Fulbright Scholarship to the University of California, Davis for my doctoral studies in International Nutrition. Looking back at the choices I made regarding my professional career, the best decision I made was to come back home to start my career.

Many young people today believe it is almost impossible to launch a successful professional career from our home countries in Africa. I am the first to disagree with this. The going was not easy but with determination, hard work and persistence it will work out. I started small as a lecturer and researcher, working on small local grants. Today I am involved in large studies, many of which are impacting maternal and child nutrition. The World Health Organization's Multicenter Growth Reference Study, of which I was the local Principal Investigator in Ghana, has resulted in the release of the WHO Child Growth Standards, which has been adopted for use in 125 countries. I have conducted randomized controlled trials to find ways of preventing undernutrition among children during the vulnerable complementary feeding period.

Africa is in need of researchers and well-trained professionals who will contribute to the development effort. Africa is the continent that did not meet most of the Millennium Development Goals by 2015. Among the many constraints is the high burden of malnutrition Africa carries. Thankfully much attention has now been drawn to improving nutrition, especially in Sub-Saharan Africa. Many African countries have now joined the Scaling Up of Nutrition (SUN) Movement. By this they have openly declared their determination to address undernutrition in their countries. Over the last five years we have seen unprecedented attention to nutrition at the global level. Resources are now being re-directed to nutrition. The stakes are high for addressing nutrition in Africa. This is the time for us to grab this opportunity. Many organizations are now looking for competent nutritionists to hire to support their programs in Africa. During my tenure as President of IUNS, we have established a re-orientation grant for students from developing countries who have completed their training programs in developed

countries, who can apply for this grant to help them settle in and launch their professional careers in their home countries. A key ingredient for Africa's success in addressing malnutrition is a competent workforce at the country level to develop and support its nutrition programs. The 2030 agenda recently agreed upon by countries at the UN General Assembly presents another opportunity for Africa to strategically position itself and build the needed partnerships to reduce the high burden of malnutrition. As young professionals you can contribute to this global agenda. Take the opportunity to improve yourself. If you have the opportunity to study outside your country by all means take advantage of it but, come back home. Africa needs you.



WENT BACK AND STAYED BUT...

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In our previous article published in the 2012 annual report, entitled "Yes, we are back", we shared our experiences of being "brain gain" rather than "brain drain" for our home countries (Benin, Kenya and Ghana) after training in a developed country (Wageningen University, Netherlands). We shared why the three of us decided to come back after training abroad. Although we are enthusiastic with being back home, our professional experiences over the last three to four years have been varied, with both exciting and challenging times that we want to share.

Work experiences

We all returned to our home countries and did not have to find jobs from scratch because we were already employed. Having returned home with

higher degrees and working for a while, we have had opportunities to grow professionally and expand our professional networks.

I (Abdul-Razak) was promoted to a senior lecturer and given the responsibility to head my department within two years of my return home. It is a challenging responsibility but I am enjoying the opportunity it affords me to actively participate in the nutrition landscape of Ghana. Holding the baton of leadership was initially daunting but having benefited from leadership training for nutrition professionals gave me the confidence that I was ready for the role.

I (Evariste) was given more academic and management responsibilities. After my doctoral studies, I was appointed head of the Nutrition Section of my department, then deputy head and I am currently serving as the Head of Department. This has allowed me to build up experiences and networks that I am very happy with.

My (Catherine) return to the government department went beyond the legal requirement of bonding for a period but giving back to my employer who had allowed me to pursue my studies. As time went by, however, I began questioning myself: was I in the right place for my professional growth? Did I not deserve a better package at the end of the month after having trained this far? I therefore decided that after two years it was important to change to a new position that would develop my career. This decision was critical and greatly influenced by my post-PhD fellowship in a women's leadership program. I am currently working in a development organization where my research skills are better utilized and am learning more of implementation research and program work. Indeed, I am satisfied that I am giving back much more to the society in my current position. Observing what is happening in the nutrition field in Kenya continues to be exciting for me and being part of the process gives me even greater joy. Interacting with a poor mother who just needs a little money for the day's meal, and the following day meeting with the policy makers of the country to deliberate on how we can move the nutrition agenda forward can only steer me to greater purpose in this professional journey. The young women whom I also have the opportunity to introduce to the professional limelight make me even more eager to make Kenya a better place for tomorrow.

Challenges

Work environment

The work environment poses many challenges, partly because of inadequate infrastructure and ill-equipped work environments. Using the University of Abomey-Calavi as an example, Evariste said that "each year, the number of students admitted increases greatly without concomitant growth in infrastructure and equipment". He added that the

2015 student population exceeds 100,000, with an average annual growth estimated at 12.5%, putting the work environment in perpetual deficit. There is a similar situation in my university, Abdul-Razak said. There is growing fear, unfortunately supported by facts, that tertiary education has become "mass production rather than scholarship".

In the university environment where both Evariste and Abdul-Razak work, access to required teaching and research facilities (electricity, internet connection, laboratory equipment, adequate reading materials, etc.) are in short supply. Acquisition of high-tech research equipment is not easy. For advanced research technologies, we are still dependent on laboratories abroad.

Research funding

In general, research funds made available by international cooperation and research-supporting agencies are more substantial than that of our home governments. Looking for funding at the international level is for us an opportunity to get more money for research and teaching as well as for development projects. Unfortunately, more often than not, this is guided more by how to comply with funding conditions and donor priorities instead of taking into account national research priorities that often are not even clearly defined.

Looking forward...

We envision a situation where our countries' governments will invest more resources into higher education and research and have clearly defined national research priorities and funding strategies. Funding should not be limited to basic research but also support relevant implementation research that allows for scale-up of workable interventions. Researchers are founts of knowledge, experiences and expertise. For the researchers in public institutions, governments will have to go beyond the research priorities to their individual wellbeing, including better remuneration and social protection, thus sustaining a long-term and productive "brain gain". Having elaborated the opportunities we have had for professional growth upon return home, we are also aware of the responsibilities we have towards contributing to setting national research priorities and identifying funding mechanisms (entrepreneurial research leadership). Collectively our status has shifted from informed onlookers of the nutrition landscape in our home countries to key stakeholders. We are hopeful that a critical mass of "brain gain" is being built towards improving capacity of nutrition leadership on the continent. We count on you to RETURN and STAY as well.



THANKS FOR COMING BACK

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THANKS FOR COMING BACK: YOU'VE MADE THE RIGHT DECISION

Introductory words

Highly skilled people, I have noticed that, just like many others, you decided to stay abroad in Europe at the end of your studies. You had the possibility to share your knowledge back home but you preferred to stay abroad. I know that you could not make the decision without thinking about the possibilities you would have once back in your home country: to share the acquired knowledge in capacity building, to have a job with a good salary, to have access to quality health care, to have the facilities to perform the job and research activities that you like, to manage probable adaptation questions for your family, to find your way in the administrative system, etc. I know you

were asking yourself if you would actually be able to access a good quality of life at such a high level once back in your home country. I could imagine that you wanted to come back but because these questions were so redundant without many answers, you started having some doubts.

Before moving abroad

Before moving abroad, you studied at your home university and showed you were a very good student during your training. You completed your degree and worked to serve your country and to make your contribution to its development. You had a salary and were living quite a peaceful life. The salary was actually low but you did not perceive it as such. It was enough to live on, albeit not to finance a luxurious life, but still it gave you the opportunity to gain work experience. It is normal that once you acquire some of this work experience, you aspire to a better life. This aspiration gives you the will to study further and to further specialize in your area, especially in a domain that is not too common in your country. Your thoughts were right as far as you could come back after your study so that your country can benefit from your knowledge, and possibly develop study programs in your domain of specialization or find another way to share your newly acquired knowledge. Because you were sure to come back to your country, you could benefit from scholarships and fellowships from the country. You can understand it is a big investment and part of the contribution of people from the country. Maybe your parents, for whom it was also an investment, helped because you could not benefit from scholarships from the Government. You moved abroad for your studies, which is very nice. Your parents were hoping that you would come back after your study period was over to enjoy the achievement of their efforts.

Your first days of life abroad

After moving to Europe, you realized that life is different than in your own country. The difference from a social point of view was very negative. You received a big social shock, one which persisted actually throughout your stay. However, considering the working conditions and administration performance point of view, the difference was very positive. You could dream of bringing such a performance to your home country. You noticed that the educational system is very developed and that learning conditions are very good, as are the working conditions. In addition, you now had the opportunity to perform some student jobs during your holidays and it became clear to you that salaries are much higher than in your home country. You also realized that the health system is almost perfect. You however forgot that life costs much less and that traditional medicine can also be very helpful in your home country.

You started thinking of staying abroad

The studies were moving smoothly, and you were nearing the end of your program. You started thinking

about a good job or the right job for you. You thought that because you were now more specialized in your study area, the right job was no longer in your home country and that only countries abroad could offer you the best job. You had already forgotten that you promised to serve your country after completing your studies and to help even to contribute to capacity building in your domain of expertise! You argued that in your host country, you would have all the facilities to work in nearly perfect conditions; you would have a relatively high salary even if you did not get the right job; you would have the right health care at the right moment. Yet your home country also deserves an improvement of its work conditions and this need to be done by people like you.

At that time, I got into touch with you, asking you to come back, before it got too late. You did not want to listen; you wanted to extend your stay, and you were looking for means to have a permanent residence permit or even take on the citizenship of your host country. I even explained to you that you did not need all this when you are highly skilled in your country. Because you are highly skilled, you will most often get visas wherever you go. It is true that living with no need of asking for a visa is better, but you will not struggle with this back home. You were thinking that in your home country, there is not much evolution compared to the developed country. You were thinking that job opportunities are sometimes scarce for a specialist such as you had become; that the salaries are mostly low and there is almost no social security for you; that health care systems are sometimes deficient and life expectancy is generally low and that the political situation is sometimes not enviable. You may be right. Nevertheless, I assured you that there is a place for you in the system and that your arrival will be beneficial in improving the training system, and you may even have to possibility to further study if needed. In any case, the decision was yours.

While staying abroad

After all the thoughts mentioned above you had managed to extend your stay and finally got a permanent residence permit. You applied for jobs and luckily got a very good one with good salary. After a while, your work agreement turned into a permanent one, which opened a window of opportunity to you, especially with the banks to take out a loan. You bought a house, a car, various furnishings for your house and your daily life with the possibility to pay within 30 years! You were then heavily in debt and had to work very hard. The thing you were most afraid of was the bankruptcy of your employer. You were so afraid you would then be unable to pay back the bank loan and would lose all you had acquired and also to have lost time. Unfortunately, this was not far to come. At that same moment, a good and a lovely social life, job and limited loan were looking for you back home

without finding you. You have also noticed now that despite your willingness to integrate, you remained a foreigner after all these years.

Your friends who came back some time ago were doing quite fine even though they were living in their country. You had probably heard that your friends had the right job back home though they are highly skilled. They have good salaries and good opportunities. Your friends have received support from their elders and are now living an enviable life back home. They also have houses, cars, various furnishings and appliances, almost without loans or with very limited loans. I was telling you that I would help you to be reintegrated in the system. I really wanted you to come back before you became a foreigner in your own country. In fact, if you do not come back early, there will be many specialists in your domain and you will easily lose such a leadership opportunity forever. You will even forget about what you have learnt so far.

You are back home

Now that you are back, I'm surprised that you have such a profusion of new ideas. Only those who have seen many other things abroad can convert so many problems into business opportunities. It means that you are more prepared than many of us to create your own business and be self-employed. You can even become an employer and deserve respect from others and a good social life. What you have learned abroad needs to be shared for local development and to improve capacity building in institutions of your country.

Thanks for coming back: You've made the right decision

Yes, the beginning may be hard, but you have support from elders and family members to find your way in the system back home. You will now live a normal life in an environment where almost everybody cares about you. You will find a good job or create one. You will contribute to capacity building and hence to the development of your country. You will travel again whenever you want and will be in a hurry to return to your lovely home country where you are more than at home. **Thanks for coming back! You've made the right decision.**





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REQUIREMENTS FOR SUCCESS

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Former Director,
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Scientific Advisor 1968-1977
Council Member 1977-2005

**WHAT IS NEEDED FOR SUCCESS
AND SUSTAINABILITY?**

As one of the longest-serving members of the Nestlé Foundation Council, from the mid-1970s until 2005, I have been asked to make a few personal comments on what I think is required in order to make a worthwhile, long-term scientific contribution to solving some of the nutritional problems of the world, especially those of the poorer countries. I do so both from the perspective of an individual scientist as well as a member of scientific research funding organisations such as the Nestlé Foundation. I was lucky to work for an organisation that enabled me to develop a long-term association, mainly with Africa but in later years also with China. Without the prospect of a reasonably stable career it is impossible to make the required commitment. I fear this is something that is becoming increasingly difficult for young scientists to achieve nowadays. This is true both for those from the developing world itself as for scientists from industrialised countries with a desire to use their expertise to help the less fortunate. Between 1959 and 1973 I worked in Uganda at a research unit established by the UK Medical Research Council at Makerere University to study protein-energy

malnutrition. In 1973, largely for political reasons, this work then had to be transferred to The Gambia in West Africa. I directed the nutritional research there until 1998, although by this time I was head of the MRC Dunn Nutrition Unit in Cambridge and thus had to delegate day-to-day responsibility to a series of very able resident scientists and paediatricians. This proved a good arrangement as it brought in young blood with fresh ideas. Older scientists are not always aware of when their critical creativeness is beginning to become a little ossified! In retirement I have been lucky enough to be asked back to Uganda to help with the setting up of a Master's degree in Applied Human Nutrition and also to aid the establishment of Dietetics as a profession.

The UK Medical Research Council is renowned for the quality of its fundamental research and naturally this was expected of us, too. At times, however, this exclusive pursuit of scientific excellence presented something of a problem. Our research could be viewed as rather esoteric when surrounded by more elementary practical problems that needed to be solved. This was particularly the case in The Gambia, where our unit was established in a small village more than 100 kilometres from a hospital. We quickly decided it would be unethical to run a major long-term community-based research programme without making a meaningful contribution to that society and the one we were best able to offer was a clinic service for the surrounding villages, which until our arrival had been largely non-existent. Inevitably this put up the cost of the research considerably, a fact that needed much justification with our funding body! But it was essential. It not only helped the local community but also contributed greatly to the overall success of the research by gaining the necessary collaboration.

Clearly not all research programmes in the poorer countries of the world require this level of "overheads" but the principle remains. Achieving a scientific objective should not be detached from the prevailing problems of the people one is studying. It was, for example, because of the creation of this socially cooperative environment that a project involving the introduction of a highly complex whole-body calorimeter system into this remote rural setting became a practical proposition. This was to define the extra dietary energy (Calorie) needs imposed during pregnancy and lactation in women living on marginally adequate diets. It was funded by the Nestlé Foundation. In these days of ever-tightening budgets it is to be hoped that research funding will still be able to accommodate this principle of 'no research without service'. Unless this is adopted the quality of research achieved in the past is less likely to be replicated. Coupled with this concept of being part of the community one is studying is the need to create scientific opportunities for all the people with whom one is working. Exactly what is required is bound to depend on educational background. In Uganda with

its already well-established university system by the 1960s it was possible to do this at a graduate and post-graduate level but in rural Gambia we had to start much earlier, sometimes with pre-secondary and secondary school leavers. Nevertheless, some eventually became graduates and even went on to be awarded doctorates.

No expatriate body is going to remain in a country forever, but if their work is to continue, an effort is also needed to ensure that a framework of continuing association and support has also been established. Nothing is more disillusioning for a young researcher trying to carry on a research programme that may have been initiated successfully by others if they become academically isolated. This is especially important for post-doctoral researchers trained overseas and who then find themselves severely hampered on returning to their own country by a lack of research facilities and a supportive research environment. Many become lost to research by the lure of working in another country for one of the international agencies. This ethical responsibility for a long-term commitment naturally imposes problems for some scientific funding organisations but I am pleased to say the Nestlé Foundation, as indeed my old employers the UK Medical Research Council, have long recognised their responsibility in this regard.

Another difficulty limiting the sustainability of high-quality research in the developing world is a poor academic infrastructure. Not only might equipment and its repair or replacement be difficult, there can also be critically inadequate library facilities. Just before I left the Foundation Council the new Director, Paolo Suter, introduced two schemes to help alleviate some of this latter problem, the enLINK Initiative involving the provision not only of a digital library devoted to nutritional research but also the creation of two metal boxes which safely transport and store books and other documents essential for first-class nutritional therapy and research. I myself have seen these in use in Uganda and know how such initiatives can bring considerable scientific benefit for those with otherwise limited library facilities. The question of equipment availability and its repair can represent a more serious difficulty. If, however, the researcher in Africa or Asia has had the opportunity to establish links with better-funded laboratories elsewhere and can use its equipment during visits, this can encourage him or her to consider studies of a more in-depth nature. Tenacity of purpose is essential in all branches of research and this is especially true of nutritional research in the more impoverished parts of the world. Selecting the right young people, backed by visionary funding bodies, can overcome most problems. Lateral thinking from both is essential. Nutritional research requires people who can think at many levels—clinical, cellular and molecular—but also from a sociological and economical perspective as well. It makes big demands of everyone!



CREATION OF LOCAL CAPACITY

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**HOW TO CREATE CAPACITY FOR LOCAL
RESEARCH IN NUTRITION**

Nutrition is riding high on the global agenda. Many development agencies, which a decade ago did not see nutrition as an important development issue, have now included nutrition in their strategies. These programmatic shifts have occurred thanks to the efforts of the Lancet nutrition series of 2008 and 2013; the Scaling Up Nutrition Movement; and more recently, the Nutrition for Growth event in the UK in 2013; as well as the Second International Conference on Nutrition held in November 2014 by the FAO and WHO. The release of the Global Nutrition Reports and the Africa Union Malabo Declaration have also helped to keep nutrition on the agenda.

The 2030 Development Agenda has presented the world with another unique opportunity to work together to make the world a better place and to “create the future we want”. These commitments will only end up as rhetoric if they are not backed by tangible and sustained capacity for action at the country level.

The weak institutional and sub-optimal training and research in nutrition in sub-Saharan Africa has been highlighted by several recent publications (1-6). With the thousands and billions of funds pledged to address undernutrition in Africa, what proportion of this will go into strengthening local capacity for training and research in the region? What proportion will go into building the region's weak infrastructure? Digital technology has made access to information so easy for many parts of the world. Yet, many countries in sub-Saharan Africa are still grappling with basic needs such as good sanitation, potable water and electricity. Waiswa, in a recent article entitled "Productive global health research from Africa: it takes more", asked this question: "Can development be achieved without Africans themselves? (7)

In the following section, we suggest general approaches for creating local research capacity for nutrition.

Create opportunities for African researchers to engage with peers in scientific discourse

In West Africa, it has been reported that only 25% of 23 postgraduate academic programs observed had international collaboration (2). In a globalized world where electronic connectivity has enhanced opportunities for networking, an appropriate mix of in-person and virtual mechanisms that foster academic networking and mobility can rapidly enhance competency sharing, leading to enriched quality of research and mentorship. There already exist some mechanisms for promoting academic mobility including small-scale efforts like those offered by Academics without Borders (8), and large-scale efforts through the International Nutrition Foundation (9) and some EU-funded projects designed to benefit researchers in developing countries. There is, however, no question that the scale of capacity deficits in nutrition in developing countries will require even more of such mechanisms that are designed and targeted at nutrition professionals in low-income settings.

Create opportunities for research funds to address local research problems and build local capacity

Researchers often look outside their institutions or countries for research funding, a situation which has sometimes contributed to implementing research that does not address immediate needs of the countries (5). While external funding is inevitable in low-income settings, there is a need to enhance the research management capacity of local researchers to ensure that the research is linked to local needs. Local researchers should be involved in the concept development, proposal writing, and implementation of the study, as well as the writing of papers. There are some examples of best practices where external funding has been tailored towards building local capacity as well as addressing nutrition needs of

the local peoples. For example, the University of Ghana's Department of Nutrition and Food Science has recorded tremendous success in being able to translate a number of foreign-funded nutrition research grants into capacity-development mechanisms, including the Research to Improve Infant Nutrition and Growth (RIING), Enhancing Child Nutrition through Animal Source Food Management (ENAM), International Lipid-based Nutrient Supplement Project (iLiNS) and the International Development Research-International Research Chairs Initiative (IDRC-IRCI). In each of these grants, a capacity-building component was included that enabled Ghanaian students to pursue doctoral training in the collaborating northern universities. Students did their course work in the foreign universities but had to carry out their research work in the project sites in Africa. The students felt empowered by being part of a large research consortium and part of the research deliberations. Several of these students are now back and are playing key roles in training other students. It is important to also promote south-south learning opportunities as a way to address the need to enhance research capacity building.

Create opportunities for local researchers to access bibliographic resources

Facilitating access to online bibliographic resources and the information literacy that goes with having access to these resources, competence in scientific communication is urgently needed. The Nestlé Foundation's enLink program that makes e-journals available to researchers in developing countries is certainly a step in the right direction. University libraries can be supported with good internet facilities and free online access to journals for researchers in developing countries. To support access to teaching materials, the International Union of Nutrition Sciences (IUNS) is collaborating with several nutrition societies in Africa, Europe and North America through the E-Nutrition Academy to develop teaching materials for use by tertiary institutions in Africa. The African nutrition societies are in the lead in determining the topics of relevance for African end users.

Create opportunities to build institutional infrastructure for research

Beyond the individual scientists, the institutions in which local researchers work in should also be prioritized as part of capacity-building efforts. One of the key capacity needs of research institutions is research management competence, including grant management, research quality control, logistics management and collaborations. In some cases, the capacity that is needed at the institutional level is in the form of equipment. This need can be met through various options including collaborations that allow equipment loan or transfer, as appropriate, or laboratory sharing. In other cases, the capacity needed is training on how to use equipment. Often,

some basic equipment may be out of the economic reach of the institutions. Effective collaborations can enhance the opportunity for obtaining such equipment at subsidized costs through vendors of collaborating partners in the Global North.

Create a conducive environment to make it easy for those trained to settle in their jobs

Once human capacity has been built it is important to retain it. We have often heard of stories where newly recruited graduates get to their work stations and do not have an office, a desk or computer. These very basic requirements are taken for granted. There is room for partners to provide facilitation grants to support early career recruits to settle into their jobs. Under its capacity-building task force, IUNS has established a re-orientation grant to enable early-career nutrition scientists who have completed their doctoral training and wish to return to start their careers in their home countries to apply. The small grant can be used for small pilot research or for setting up their workplace. The need for such facilitation grants is high and it will be helpful for other groups to join this effort.

In conclusion, the goodwill towards supporting Africa to address its nutrition and other development challenges is high. The 2030 Development Agenda has opened up a new page to start afresh but it is also important to build on the lessons learnt from previous global efforts such as the MDG. The key message we must not lose sight of is that unless Africans themselves take control and manage Africa's challenges, it will be a futile circle. It is for this reason that the global community must put more effort into building the capacity of Africans to manage Africa's challenges.





NEEDS & DEEDS

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CAPACITY BUILDING FOR NUTRITION TRAINING AND RESEARCH IN AFRICA THROUGH A UGANDAN LENS: NEEDS, DEEDS, CHALLENGES AND SOLUTIONS**Background**

Nutrition plays a critical role as a process and outcome of sustainable human and socio-economic development. While progress in the reduction of food insecurity and malnutrition is being witnessed in other continents, the pace has been slow in Africa despite billions of pounds and dollars of development assistance (1). At the end of 2014, over 230 million Africans were estimated to be undernourished, representing nearly one-quarter of the 800 million undernourished people in the world (2). In many countries, malnutrition has perpetuated poverty and prevented them from attaining the Millennium Development Goals. Uganda and its East African counterparts, Kenya, Tanzania, Rwanda, Burundi and South Sudan, are categorised among the 34 high-malnutrition-burdened countries that account for 90% of global undernutrition.

This article examines the capacity question in the context of technical and institutional resource capabilities, to unravel why adequate nutrition for all Africans has remained elusive despite its having been on the global development agenda for a long time. We address the question: what urgent capacity gaps need to be addressed so as to sustainably reduce the burden of malnutrition in Africa? We discuss modest strategies of mutual interest that can spur the African household into a nutritionally self-sufficient unit that is resilient to vagaries of market instability and global inequality.

Capacity building in nutrition: what do we mean?

The United Nations defines capacity building as a long-term continual process of development that focuses on understanding the obstacles that inhibit people, governments, international organizations and non-governmental organizations from realizing their development goals, while enhancing the abilities that will allow them to achieve measurable and sustainable results (3). Capacity building uses a country's human, scientific, technological, organizational and institutional resources and takes place at individual, institutional and societal levels. In the context of human nutrition, it involves the ability of actors to meet the food- and nutrition-related obligations required of them by use of the resources and means available to them.

The missing linkages in nutrition-relevant capacity in Africa: The gap

A competent workforce with capacity and capabilities at their disposal is vital for any nation fighting the scourge of malnutrition. The capacity-related challenges limiting many Africans from accessing and availing themselves of adequate food and nutrition services are numerous. While there are high aspirations to improve the nutritional well-being of the population in Africa, prospects are limited by weak human resource uptake and capacity, and the absence of training and research that is fit-for-purpose (4). In the recent past, support from development partners like the Nestlé Foundation and philanthropic agencies have contributed to evidence-based research in nutrition in Africa. However, sustainability is a challenge as many African countries still lack capabilities to institute and maintain the infrastructure needed for robust training and research in nutrition. Country-owned and supported nutrition research and innovations programmes are grossly lacking in Africa and need to be instituted. Moreover, academic institutions undertaking nutrition training and research in Africa are in dire need of trainers and basic equipment for effective training and research. Additional technical and financial assistance to African institutions is of the essence to support infrastructural developments, training of researchers and state-of-art laboratories to support novel research. In essence, the requirements for strengthening capacity for training and research are clear: appropriate knowledge, tools

and skills; competent and well-motivated training workforce; inputs including adequate financial resources, infrastructure, equipment and essential supplies; an enabling policy environment; as well as updated and harmonised nutrition training curricula.

Closing the gap: Harnessing the capacity potential for nutrition improvement in Africa

Building the much-needed and relevant nutrition capacity for Africa requires a critical focus on the diversity of the continent's potential. Firstly, vulnerability to malnutrition needs to be understood and amplified using a coordinated framework of multi-sectoral and cross-disciplinary measures. In effect, relevant indicators on nutrition such as diet diversity and quality, nutrient intake, food availability and access, child care and immunisation, deworming and nutritional status indices on stunting, wasting and underweight, should be integrated into the broader community development frameworks, i.e. become part of routine extension services in agriculture, health, education and community mobilisation to ensure that the problem is mitigated and managed at the grass-roots level.

Secondly, limiting the capacity gap requires strengthening research and innovations through robust public-private partnerships. This may address the dismal performance in home-grown funding for research and innovations in nutrition-related issues. In effect, the research priorities on the continent need to be mapped by stakeholders through collaborative consensus to enable growth of sustainable and formidable problem-driven national research agendas.

Conclusion

In conclusion, our diagnosis of the nutrition capacity problem in Africa has established that despite the slow progress being witnessed, more can be achieved if existing initiatives are strengthened. African nutritionists and institutions need support to be more innovative to reach beyond their disciplinary boundaries so as to mutually engage with relevant stakeholders through public-private partnerships. Sustaining effective nutrition capabilities will require multi-stakeholder efforts in positioning nutrition as central to sustainable development at all levels and generations of society.

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SUCCESS MADE IN THAILAND

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**THAILAND'S SUCCESS IN ALLEVIATING
MATERNAL AND CHILD MALNUTRITION**

Thailand has achieved remarkable success in reducing maternal and child malnutrition since the 1980s. Antenatal care coverage increased steadily from 35% in 1980 to 95% in 2006, while anaemia in pregnancy was reduced from around 60% to 10%. Prevalence of underweight in children under five also reduced strikingly from 51% to less than 10%. Prevalence of stunting declined from over 10% in 1995 to 6% in 2008. Active participation of key stakeholders, including the public sector, professionals, the private sector and those affected, has been essential in all working processes as it has been recognized that no single sector can act alone to alleviate malnutrition.

The National Rural Development Committee had acted as an umbrella group and developed the Poverty Alleviation Plan that was implemented in 1982 in rural areas. This was a multi-stakeholder model which incorporated nutrition goals and indicators into the strategies, programs and actions implemented at the community level (district and below). Provision of basic services (agriculture, health, education and local administration) have been made available in all areas. Mass mobilization has been implemented by a community volunteer system of one volunteer per 10 households in order to increase coverage to all and to reach those previously unreached. Community leaders and volunteers collaborate with service providers to take remedial actions based on the basic minimum indicators (BMNs) that incorporated nutrition indicators. Roles of agriculture and food systems under multi-sectoral efforts included strengthening food production for the subsistence economy, production and promotion of supplementary food from local healthy snacks for mothers, and the production and promotion of complementary foods for infants and young children from local ingredients.

Pregnant mothers received supplementary food, multivitamin and iron tablets as well as nutrition education through antenatal care to reduce low birth weight and nutritional anaemia. Infant and young children received basic services including promotion of breast feeding and appropriate complementary feeding, immunization and growth monitoring and promotion. Moderate and severe cases of malnutrition received complimentary food based on a mixture of rice, legumes and sesame, which was prepared in the community. Significant improvement of maternal and child nutrition was observed already after a few years of implementation and more drastically and continued improvement was seen later.

In 1992, Thailand initiated school lunch and school milk programs (SLP and SMP) starting from kindergarten and gradually expanding to cover Grade 6. The SLP provided a budget for each child per day during the academic year, with meals prepared in school from local food supplies based on weekly or monthly menus. As part of their SLP, some schools adopted agricultural programs, including the cultivation of vegetables and fruits, the raising of fish and the production of chicken eggs. For the SMP, at first school milk was prepared from imported milk powder. However, with the promotion of local dairy farming and industry, the supply of fresh milk from local farms to the SMP increased from 12% in 1992 to 37% in 2009. This strategy is a win-win situation as the SMP generates income for farmers. In the meantime, schoolchildren gained nutrition and health benefits from milk for their growth and development. The alleviation of maternal and young child malnutrition, coupled with the SLP and SMP from kindergarten to

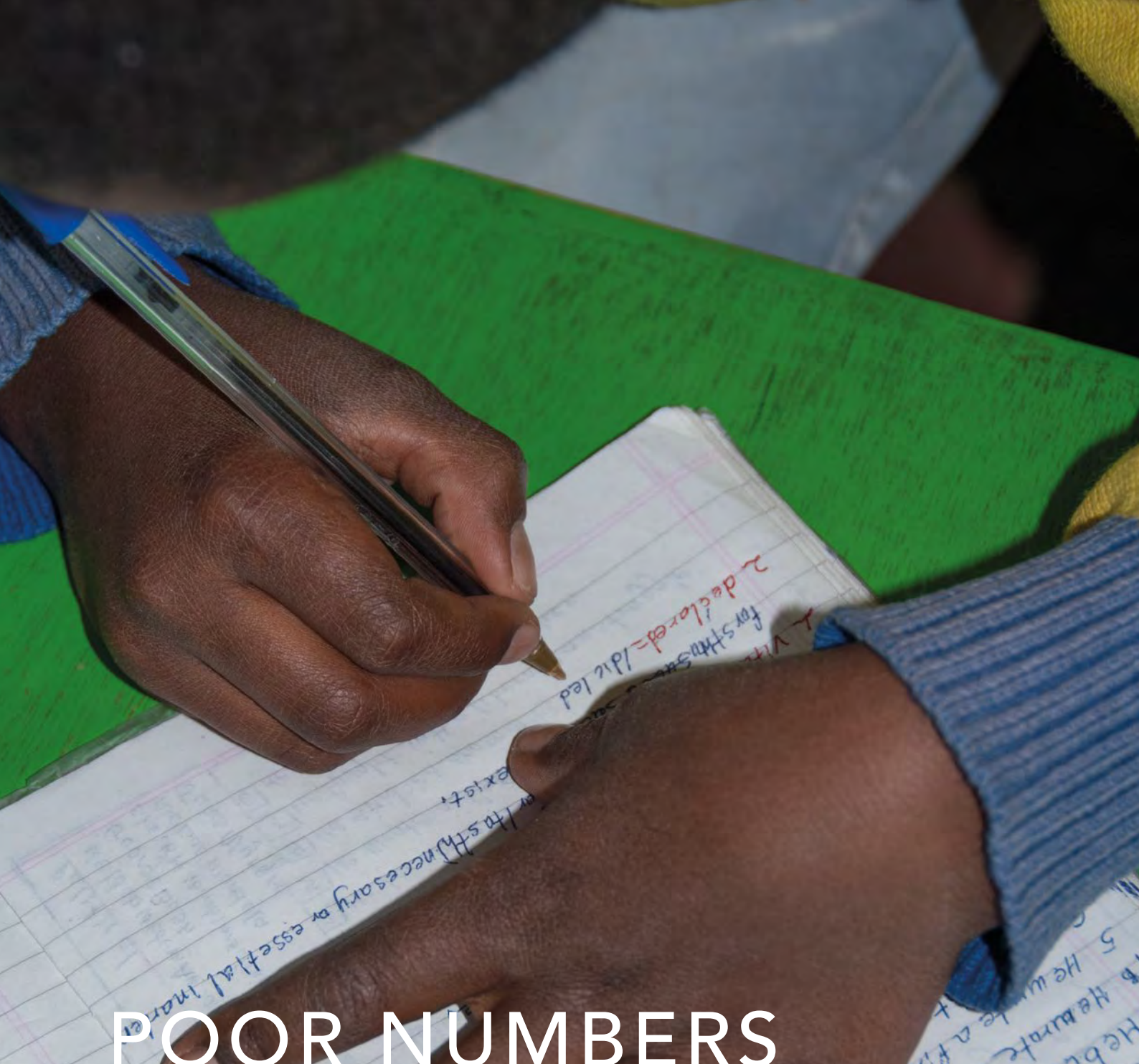
Grade 6, led to a significant decline in stunting among children, and most remarkably among underfives.

The school milk program is an example of the inter-sectoral linkage among education, agriculture, industry, local administration and health. The dairy farm and processing industries have grown significantly since the start of this program due to the increased demand for milk. Initially, school milk was produced from imported milk powder which was supplied mainly by private dairy industries. But over time, a large number of dairy cooperatives with processing facilities became the main suppliers of school milk. Moreover, numbers of milk cows and milk production have increased significantly and steadily since the 1990s. The Ministry of Health has been involved in setting milk standards and the quality control of milk, as well as in developing and establishing nutrition indicators for monitoring the nutrition and health of school students.

This success required national commitment to sound nutrition strategies and goals and led to community-based actions composed of basic services and maximum participation in a volunteer system to reach all people and to alleviate malnutrition using nutrition indicators.

Thailand currently is facing an increasing prevalence of overweight, obesity and non-communicable diseases (NCDs) and some remnants of undernutrition. Successes from the past based on multi-stakeholder and multi-strategic approaches will be implemented at the community level and at various settings such as schools and workplaces using nutrition and NCD indicators to guide collaborative and remedial actions between service providers and communities.

The National Food Committee, a forum for food management, has developed a strategic framework for food management, providing policy and strategy addressing food security, food quality and safety; research; and the linkage between food, nutrition and health. Agriculture, food and health systems will play an even greater role in ensuring adequate supplies of healthy and safe foods for consumers at local, national and international levels with the aim of good health and well-being for all.



POOR NUMBERS

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POOR NUMBERS: THE NEED FOR BETTER DATA

Numbers rule the world. All aspects of life—from health to the GDP—are based on many different data sets. However, the measurement of population health or analysis of economic development is a challenging task and we all know that some of the data are “problematic”. GDP numbers and other statistics, which we often treat as facts, are not facts; they are products, and they are produced under difficult conditions. This is a knowledge problem which is doubly biased. We know less about income and growth in poor countries, and we know less of the economic condition of those who are the poorest in those poor countries. The errors of measurement are of significant magnitude. A recent example comes from Ghana, where a change in the statistical material underlying the calculation of

GDP meant that the GDP of the country was revised upwards to the extent that Ghana's recorded GDP per capita almost doubled. In effect, overnight the country was re-classified as a middle-income poor country instead of a poor country.

The knowledge problem does have implications for governance. Big decisions are made because of these numbers. Increasingly in economic governance, the trend is to let hard facts and evidence prevail where judgment and negotiation used to rule. So for instance, the decision to give Ghana, or any other poor country, access to concessional lending through the World Bank is based on these statistics. The re-classification made a mockery of the facts in this decision process. How could Ghana be classified as a poor country one day, and then move to being a lower-middle-income economy the very next day? What then about the GDP levels of other poor countries?

The problem I describe in *Poor Numbers* focuses on the data needed for economic governance in Sub-Saharan Africa. When I did my survey of basic methods of estimating GDP in 2011, covering 34 countries, I found a very uneven level of knowledge. The IMF recommends that a base year for GDP estimation should be updated every five years. I found that only a handful of countries are able to fulfil that standard, and that for most countries the base years are about a decade or older. When Ghana did such a dramatic jump in income, it was a result of changing the base year from 1993 to 2006. For Nigeria, the current base year is 1990.

Thus we are approaching a quarter of a century since we have had a reasonably accurate picture of Nigeria's economy, probably the biggest economy in Sub-Saharan Africa. Even before the revision, it is about 50 times the size of Malawi's economy. That so much economic activity is not accounted for in our current data makes any factual statement of the aggregate trends of growth and poverty in Africa look very uncertain.

But baselines and methods are only the surface. What really matters is basic data availability. As described in my book *Poor numbers: How we are misled by African development statistics and what to do about it*, the process of aggregating, adjusting and agreeing upon the final numbers of GDP is a process filled with arbitrary and discretionary decisions, which is based on negotiation and subjective interpretation. In the empirical social sciences, it has been fashionable to use the binary categories of "soft" versus "hard" or "subjective" versus "objective", to distinguish between interpretative qualitative scholarship and research based on inferential statistics. This distinction is imaginary. This is of course true for statistics from Europe, North America and elsewhere, but for poorer countries it is a problem of bigger magnitude.

The problem is not isolated to GDP numbers—the knowledge problem regarding GDP is a symptom of the availability of reliable data from statistical systems in poor countries. What we are accustomed to treating as facts are indeed products. The supply of data has constraints—and basic factors such as manpower, budgets, infrastructure and the basic problem of converting complex social systems into simple statistical measures in societies where information is not regularly recorded has serious implications for the quality of the data supply. This should be obvious, but it has not been. So far the treatment of this question has been alarmingly naïve in the development community. We need to wake up to this fact, because the difficulty of provision of statistics in poor countries must have implications for both how we use and how we demand numbers in the decision-making process.

Perhaps the most visible public commitment to results-based policy and evidence-driven policy was the adaptation of the Millennium Development Goals (MDG) in 2000, when UN members pledged to commit policy and funds towards reaching the eight goals, measured by 18 targets and 48 indicators. In retrospective it was strikingly naïve to assert this extent of measurability without a systematic understanding of how data can and should be generated by these weak statistical systems.

It was a classic mistake of failing to ask what *can* be measured, and a result of just considering what *should* be measured. The list of targets and indicators was based on wishes and demands rather than an appreciation of what could be supplied. One of the basic failings derived from failing to understand, for instance, is the distinction between administrative data and survey data. Administrative data are the statistics that are available due to the day-to-day operation of governments. In many richer countries, the data required to fill out the global data spreadsheet to fulfil the data need of the MDGs are readily collectable from their government agencies. In most poor countries that is not the case. In order to fill the gaps in the global data agenda, these countries need to collect these data as survey data. For a standard Household Budget Survey this involves filling out a long questionnaire that takes a day to complete for a couple of thousand households. The exercise costs a few million dollars and takes a couple of years to complete.

The problem of the hailed "data revolution" and the influential calls for moving to "paying for results" in development is that it has not been accompanied by a sustainable statistical policy. A sustainable statistical policy means not only thinking about data demand, but also being concerned about data supply. The statistical offices in poor countries have long been neglected. We often talk about accountability in development, but we forget to invest in the ability of

citizens to make their states accountable to economic and social policy. Currently, the demands for data are not regulated with a thought of how these demands for measurement coheres with the need for data for citizens in poor countries.

It is a real tragedy that the statistical capacities of Sub-Saharan African economies are in such a poor state. African development statistics tell us less than we would like to think about income, poverty and growth in Sub-Saharan Africa. One of the most urgent challenges in African economic development is to devise a strategy for improving statistical capacity. This system currently causes more confusion than enlightenment. However, governments, international organizations and independent analysts do need these development statistics to track and monitor efforts at improving living conditions on the African continent.

Poor numbers are too important to be dismissed as just that.

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THE RIGHT TO INFORMATION

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**THE RIGHT OF ACCESS TO INFORMATION:
A FUNDAMENTAL PILLAR OF
CAPACITY-BUILDING AND DEVELOPMENT**

Part of the wide appeal, as well as the conceptual and practical complexity and multi-dimensionality of the idea of “transparency” or “access to information” (ATI), is that it can be all things to all people. To some, ATI is about defeating corruption, on the basis that “sunlight is the best disinfectant”; while to others it is ATI’s close relationship with ideas of participation in parliamentary and policy-making processes that is compelling.

Yet, to others, ATI serves as a “leverage right” that enables people to exercise or claim other rights. This was the idea that emerged from the extraordinary

work of the MKSS movement in Rajasthan, India over a decade ago. MKSS's most significant innovation was to develop a particular methodology by which public records would be obtained using the state-level ATI law and then verified by triangulating the information with information obtained from secondary sources as well as from the people directly affected through a public hearing process.

I had the privilege of witnessing several of these *jan sunwai* hearings. The first occasion concerned the local village's hospital and the availability, allocation and cost of medicines dispensed by the hospital staff. The information revealed by the public contradicted the official records and suggested that the administration of the hospital was in urgent need of reform.

In another, I witnessed the public exposure of corrupt practices that a devious group of state-licensed ration-dealers had cruelly used to exploit unwitting, indigent members of the local population, who had been cheated out of basic supplies of foodstuffs and fuel that they needed for basic survival.

Like a scene from an Arthur Miller play, with all the tension and under-currents that such a theatrical comparison implies, the *jan sunwai* examined the records that had been accessed from the government authorities, compared them to the records of the licenced ration-dealers and then the public testimony of those who had been cheated. Initially cocksure and contemptuous of the process, by the end the ration-dealers were running for cover—literally and legally—despite their clumsy attempts to disrupt the proceedings. Soon, most had lost their licences; others were arrested, charged and jailed; and the Rajasthan government took steps to reform and strengthen its system for helping the poor.

This work inspired similar civil society organisations and movements around the world who, in different ways, adopted the MKSS motif: that "the right to know is the right to live".

Presented as such, ATI takes on a different complexion. Yes, it remains important for journalists seeking to uncover wrong-doing in government—whether an expenses scandal in Westminster or a party-funding scandal in France or South Africa—but the area where the most interesting and important work on ATI has taken place in the past 15 years is in developing countries where social power relations are in flux and where the political economy may serve to obstruct development aims and ambitions.

Hence, ATI has become to be seen as a "power right"—one that can tilt power relations even just a little in favour of those who are traditionally less powerful and less "capacitated" and who are struggling to get the attention of the powerful

decision-makers who govern over them, whether in the public or private sector.

The impetus for ATI can be found not just in the many ATI laws that have been passed around the world in the past 20 years—over 80 now, and counting—but in more complex transparency initiatives such as the Medicines Transparency Alliance (META), which sought to increase access to information along the complex pharmaceutical value chain so as to enhance access to affordable drugs, and the Construction Sector Transparency Initiative (CoST), which is directed towards ensuring the public gets full value for money in big publicly funded infrastructure projects.

Infrastructure investment is critical to poverty reduction and economic development. Sub-Saharan Africa's infrastructure needs alone are valued at about US\$93 billion per year. And yet, globally, up to US\$4 billion is wasted every year through mismanagement and corruption. This can lead to poor and dangerous infrastructure whilst undermining the economic growth potential of infrastructural development.

CoST drives accountability and government responsiveness through an assurance process, an independent review that checks the information disclosed for accuracy and compliance—simplifying the data and highlighting issues of concern to guide and inform citizens. Through a process of citizen engagement, CoST enables citizens to use this knowledge to demand changes and improvements in behaviour from the public and private protagonists.

Multi-stakeholder initiatives such as CoST recognize that the biggest developmental levers, with the most intense political economies, cannot easily be governed by traditional modes of democratic governance and that institutional innovation is necessary. Bringing all the most powerful actors into a process that prompts them to voluntarily set new standards of information disclosure is one way of responding to the transnational, multi-actor complexity of the biggest contemporary public policy challenges.

The well-known oil and gas sector transparency—the Extractive Industry Transparency Initiative (EITI)—was the vanguard for these innovations that go "Beyond Government", to borrow the title of the book that EITI officials Jonas Moberg and Eddie Rich recently authored.

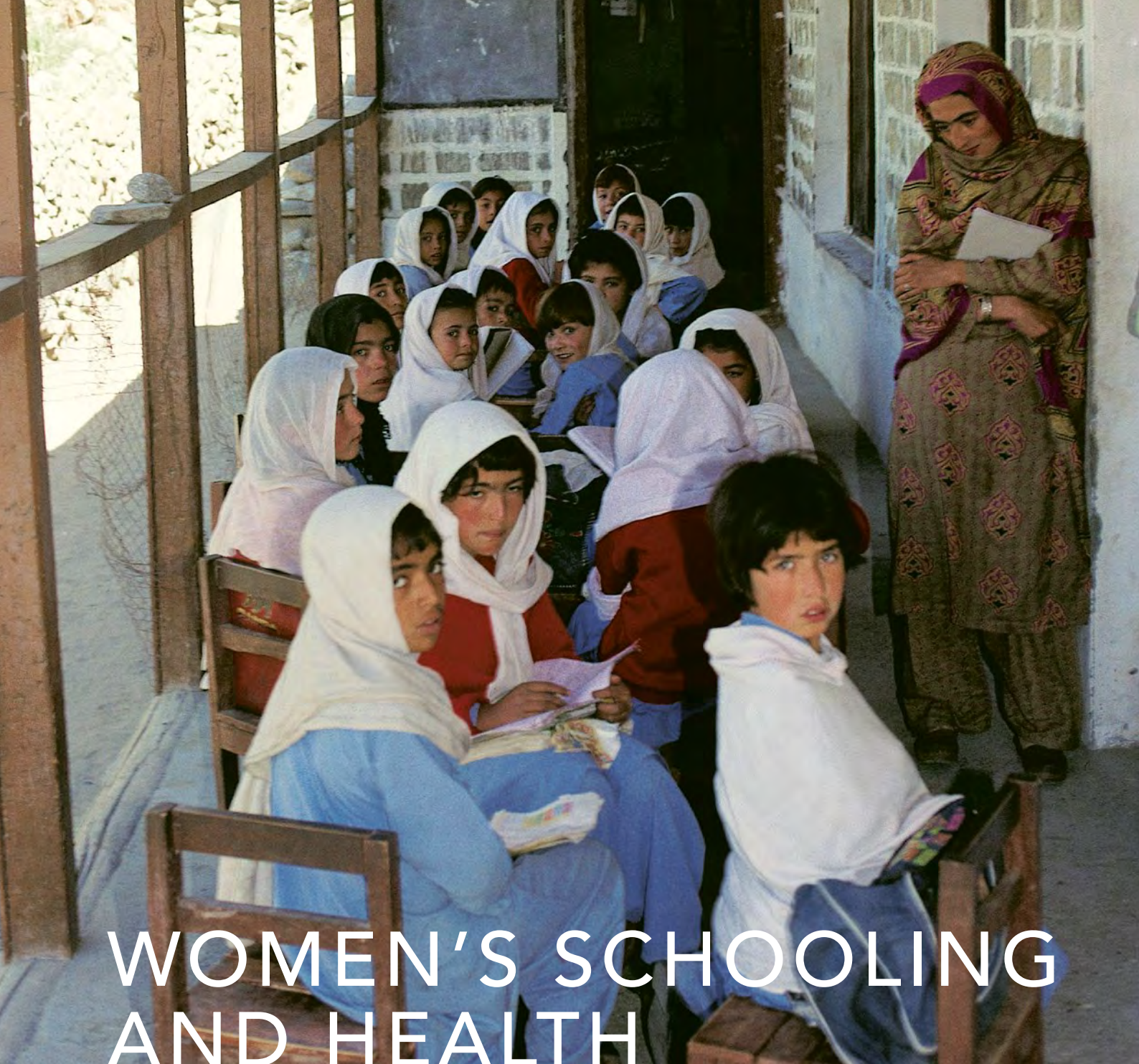
The emerging academic literature on the theory of ATI—for so long under-developed in comparison with the dramatic advances that were made in the practice of ATI around the world—describes multi-dimensionality of ATI in terms of its "multi-rationale" and its "multi-functionality". And in a sense, ATI has a chameleon quality: it can achieve different things and can do so on the basis of differing conceptual underpinnings.

But it is within ATI's relationship to development, to socio-economic rights and justice, and to efforts to build capacity in developing societies and their institutions, that practitioners and donors will continue to find the most rewarding evidence of how increased transparency can prompt greater accountability.

Without access to information, the playing field will never be level; some actors will always be more powerful than others simply because they know more and because by excluding others the information asymmetry will continue to undermine efforts to build more just and equal societies. Modern information and communication technology offers some of the means to support these ends. Yet, real capacity cannot be built without first recognizing the powerful role that information plays and how access—or a lack of access—to information can inspire or impede real social change.

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WOMEN'S SCHOOLING AND HEALTH

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Four years ago my research group published *Literacy and Mothering: How Women's Schooling Changes the Lives of the World's Children* (LeVine et al. 2012, Oxford University Press). With findings replicated in four diverse countries (Mexico, Nepal, Venezuela and Zambia), we showed how literacy could be the long-sought pathway from the schooling of mothers to the health of their children. We argued that even small amounts of literacy, which we assessed in mothers of young children, improves their health navigation skills and helps explain the decline in child mortality rates of the less-developed countries since 1960. The book was well received, with positive reviews in demographic journals and the Eleanor E. Maccoby Book Award of the American Psychological Association, but it has not yet been rewarded by the longitudinal studies that would put its findings to even more rigorous tests.

The United Nations Millennium Development Goals (MDG) for 2015 has generated a new debate over school expansion. MDG no. 2 is universal schooling, and while that has not been achieved, the number of out-of-school children has fallen by almost half, and net enrolments of primary-school-aged children have increased from 80 to 95% in South Asia and from 60 to 80% in Sub-Saharan Africa. Educational testing specialists at the OECD and elsewhere complain that this expansion has come at the expense of quality, as indicated by PISA (Program for International Student Assessment) test scores (at age 15) showing that in some developing countries like Mexico a majority of pupils fail to meet the most basic level of proficiency. They claim that no good can come from expanding schools of such evidently low quality. But demographers and epidemiologists counter that reducing child mortality (MDG no. 4) comes from getting more girls in school regardless of quality.

As we see it, the PISA exam, designed for modern societies in Western Europe and elsewhere, does not measure whether schools are doing any good at all but only whether students meet academic standards set by those societies. We have no doubt that many of our Mexican mothers would have failed the PISA test when they were 15. But we found that they acquired—and retained—skill in reading comprehension and the ability to use the abstract language shared by schools, clinics and other bureaucracies, enabling them to understand health messages in the mass media and report illness episodes coherently to a nurse or doctor. In our larger survey done with UNICEF Nepal, we also found that mothers with more schooling had more health knowledge than those who had less or none, reflecting both involvement with the mass media and use of health services.

In many years of working with women in less developed countries, we discovered several features of their usual environments in school and home that magnify the women's education effects found in demographic and health surveys:

- **Child marriage.** When girls do not attend school, they are often married as children and serve as subordinates to elder women in their families. Having lost the chance to go to school, they become mothers of children without the status to operate on their own.
- **Teacher-pupil interaction.** When girls attend school, it is the first time they experience an unrelated adult talking to them in a setting outside the home authorized by the government. This makes the heavily scripted teacher-pupil interaction of the classroom a memorable learning experience for girls.
- **Protecting children against health risks.** As mothers, women in less-developed societies are

responsible for protecting their children against health risks, while their counterparts in modern societies have effortless access to an environment shaped by public health measures (purified water, pasteurized milk, sewage disposal, garbage collection) that protect child health. In less-developed countries, only an educated mother boils the child's water for 15 minutes, while in the modern world, a mother need only turn on the tap—regardless of her education. No wonder schooling makes such a difference in the less-developed countries!

- **Unschooling mothers.** Without schooling, mothers lack not only the autonomy to act on behalf of their children's health but also the literacy skills that would help them navigate the health services that might save their children's lives.

We believe that our research has provided unique insight into the processes by which women's schooling is translated into better health in many developing countries. But we need further research on literacy in context in those countries.



POPULATION GROWTH

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POPULATION GROWTH: THE CHALLENGES AHEAD

The world has changed incredibly in the last 200 years. Advances in hygiene and medicine have led to a seven-fold increase in population, while new developments in science and technology, powered by a four-fold increase in the per capita use of natural resources, have significantly increased human well-being—although wide disparities remain.

Unfortunately, on a finite planet, this pattern of growth is not sustainable. Indications abound that the Earth is in global ecological overshoot, with humankind gradually destroying the resources on which life depends (1).

One of the challenges for the world in the coming years is to transition towards a society where well-being continues to increase, while inequalities decrease, but resource consumption and pollution decline and population growth is limited. Such a transition will be complex and full of difficult choices because our planet's problems are inter-related.

For instance, although the growth in population is ultimately dependent on agricultural output, this output itself hinges on the health of the world's ecosystems. These ecosystems in turn depend on the growth of industrial output and its associated pollution. Anthropogenic climate change—a direct consequence of the thirty-fold increase in energy consumption from the beginning of the industrial revolution—is a good example of what happens when this complex web of linkages is pushed beyond its limits. The changing climate is already affecting food production around the globe and its consequences will become more important as the planet warms further.

The Earth's biosphere and the planet's inhabitants are a finite ecosystem, though we rarely think about it this way. Logically, for an ecosystem to be sustainable none of its subsystems can continuously grow. This is why expanding population and the continuous increase in economic activity are unsustainable, at least in the long run.

To avoid the worst consequences of overshoot, which will eventually cause our ecosystem to collapse, the causes of unsustainable growth need to be addressed.

It is easier to understand why the population cannot keep growing forever. Because increased economic activity is thought to be a positive outcome in our society though, curtailing this appears contradictory. Nevertheless, if we are to achieve long-term sustainability, something must change in our economic and financial systems, too.

A recent report from the United Nations (2) provides a demographic perspective on how the world's population has changed since the 1994 Cairo Conference on Population and Development and projects the trends into the future.

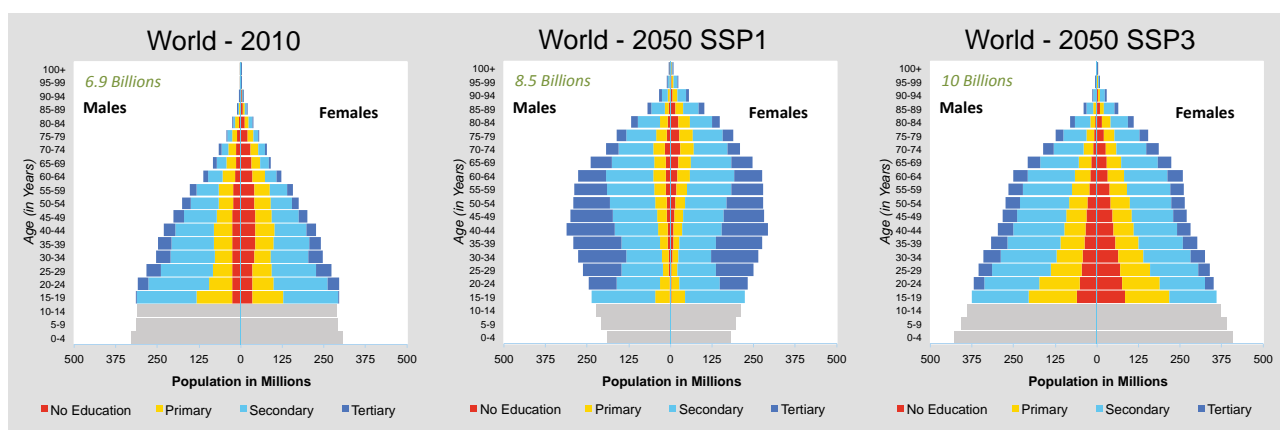
In the last twenty years, the world's population has grown from 5.7 billion to 7.2 billion people. We add a further 82 million each year. If this trend continues, the world's population will reach 9.6 billion in 2050, even accounting for the anticipated decline in female fertility.

These numbers are staggering, particularly when humanity is already failing to provide adequate nutrition for almost one billion people. How can we feed an additional 2.4 billion people in 2050?

Fifty years ago, the Green Revolution created higher yielding varieties of wheat and rice and this helped us avoid a global food crisis. The situation is different now. Much less additional arable land is available, yields are falling and yet crop productivity needs to increase by more than 50 percent. This will require fundamental innovation in plant science, as well as a wider acceptance of genetically engineered crops. Such a productivity increase can only be achieved if present inefficiencies in food production and distribution are also addressed. To produce enough food the world must manage many elements, from the impacts of climate change to stimulating rural employment. Yet, no factor is more crucial than the population of the planet.

Thankfully, a transition to a world with a smaller (and even falling) population is achievable. The key is education, particularly of young girls, since empirical data show that better educated women have fewer children. This simple change can lead to one billion fewer people in 2050 than currently anticipated. It is illustrated in the Figure below, taken from a recent study of Kc and Lutz (3).

Figure 1: Population of the world in 2010 by age, sex and educational attainment and in 2050 under different socioeconomic pathway (SSP) scenarios (see text for more details) (3))



Mitigating and reversing the ecological impact of continuously increasing economic activity is more challenging. This is because there is no agreed strategy for an economic transition towards a less environmentally destructive economy. How a steady-state economy would be structured is itself not clear, since fundamental concepts like compound interest and return on investment, vital to the stability of the finance sector, are intrinsically connected to economic growth. Nevertheless, we can greatly reduce the impact that our economy has on the Earth's environment.

This requires decoupling, as much as possible, resource use from economic well-being, as well as redesigning our industrial systems to make them restorative by design—moving to what is known as the circular economy.

Resource decoupling depends on increasing efficiency while preventing the so-called rebound effect, where the resource savings are used up by increased consumption. In a circular economy, products are designed for re-use from the start, decreasing their long term impact on the environment. Contrary to popular belief, such an economy can even boost employment, because maintenance, upgrading and re-manufacturing is more labour intensive.

The crucial question is whether humanity will respond to the present challenges and achieve a smooth transition to a sustainable world.





MIGRATION

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International migration has become one of the most controversial issues in a rapidly globalizing and often violent world. In many countries and world regions, passionate debates about migration have risen to the highest levels of domestic and international politics, unsettling national elections and parliaments, challenging bilateral relations between source and destination countries, convulsing large regional confederations such as the European Union, and roiling multilateral bodies such as the United Nations and its regional and specialized agencies.

“International migration” includes a wide range of categories, to which are attached equally numerous legal provisions and distinction: economic migrants vs. refugees; voluntary vs. forced; legally authorized vs. unauthorized/irregular/illegal; permanent vs.

temporary. Some argue that humanitarian principles require even more categories, not (yet) codified in law—e.g., migrants departing from failed states that are unable to protect them, or “environmental refugees” fleeing climate change, volcanic eruptions, or degraded farmland and fishing areas. The boundaries among these categories are fuzzy, and often contested. Suffice it to say that migrants seek to move internationally for many reasons—to escape persecution; to flee conditions of civil war or endemic violence; to join family members; to seek better economic opportunities—and often for combinations of such motives.

Because the many categories of international migrants have different legal rights in both international and national law, it should be expected that would-be migrants will seek to be classified under categories that offer them the most attractive rights and opportunities. Hence political debates about migration policies often end up focusing on how particular sets of migrants should be classified. Others reject such debates as misplaced, arguing instead that international migration is an irresistible “global flow” that is simply too powerful to be managed directly through national and international legal regimes; from this perspective, those seeking to regulate international migration must resolve its “root causes”—poverty, inequality, war and other forms of violence, human rights abuse.

The reality that tens of millions of would-be international migrants are seeking “refugee” status is a source of much debate. They are disproportionately women and children, who unless provided protection by governments or international agencies face serious risks to their health, nutrition and, in some cases, to their very lives.

Under the post-war UN Convention Relating to the Status of Refugees of 1951 and its 1967 Protocol, signatory states agreed to admit and to protect “refugees.” Unfortunately the Convention’s definition of “refugee” is much narrower than everyday usage—those outside their country of nationality and unwilling to return “owing to well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion” (1). In effect the post-war “Refugee Convention” recognized that the large numbers of people displaced by such “persecution” during the 1930s and 1940s were among the most threatened of all, given that they could hardly call upon their own governments for protection. A sub-category, “asylum seekers”, differed from the Convention’s “refugees” only by their location—asylum-seekers have already entered another country (whether lawfully or not) and are seeking the right to stay under the refugee definition.

Signatories to the Convention admirably agreed to provide special protections to those who qualify

under its definition of “refugees,” but not to other would-be migrants—even if their lives and well-being might be equally desperate due to conditions of poverty, violence, starvation, absence of health services, etc.

Therein lies the origin of much modern contention about international migration—a set of perverse and unintended outcomes that have arisen from national policies and international conventions that were intended to be humanitarian. Would-be migrants who cannot qualify as “refugees” and cannot obtain lawful entry visas to countries to which they wish to move would be (and frequently are) well-advised to seek the special rights accorded to “refugees” and “asylees”. The advice they receive is simple: find a way to gain access to the territories of liberal democracies such as member states of the European Union, the United States, Australia or other similar countries, and then claim asylum in hopes that the humanitarian but often overstretched asylum adjudication systems of these countries will allow them to remain for years, or ultimately permanently. If this means risking their lives on unseaworthy smuggler boats in the Mediterranean, or engaging the services of violent smuggler networks operating out of Turkey, Mexico, Taiwan, or China, so be it.

This situation poses what theologians call “tragic choices”—choices that bring into conflict the ultimate values by which societies define themselves (2). Is it possible for people and governments to make non-tragic choices among the tens of millions of desperate people who wish to gain entry and legal residence in their countries? If those subject to “persecution” (i.e., “refugees” as defined by the Convention) continue to be accorded special rights of admission, how should they deal with others who decide to risk their lives in unseaworthy boats on the high seas, or in the hands of criminal smuggler networks, in order to gain unauthorized entry that enables them to claim asylum?

Such desperate efforts also may present what professionals in banking and insurance call “moral hazards”—when government guarantees or private insurance encourages individuals and corporations to take financial risks that they otherwise would avoid. In the humanitarian context, what should be the response to concerns now being expressed by many EU governments that large-scale naval patrols to rescue boat people in the Mediterranean have perverse moral-hazard effects by encouraging even greater numbers to undertake such mortal risks?



URBANIZATION

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WHAT CITY-CENTRIC DEVELOPMENT MEANS FOR AFRICA — AND FOR ITS HEALTH POLICIES POST 2015

The post-2015 global development agenda puts a somewhat different slant on old understandings of development and is, potentially, a game changer for African cities. The recently agreed-upon global sustainable development consensus makes cities more important and, simultaneously, shifts ideas on the way positive urban health outcomes are to be achieved. The new thinking opens up space for health interventions via urban design and management and gives more attention to non-bio-medical activities that could improve the health and well-being of the continent's urban residents. But will the SDGs (Sustainable Development Goals) necessarily help feed African cities?

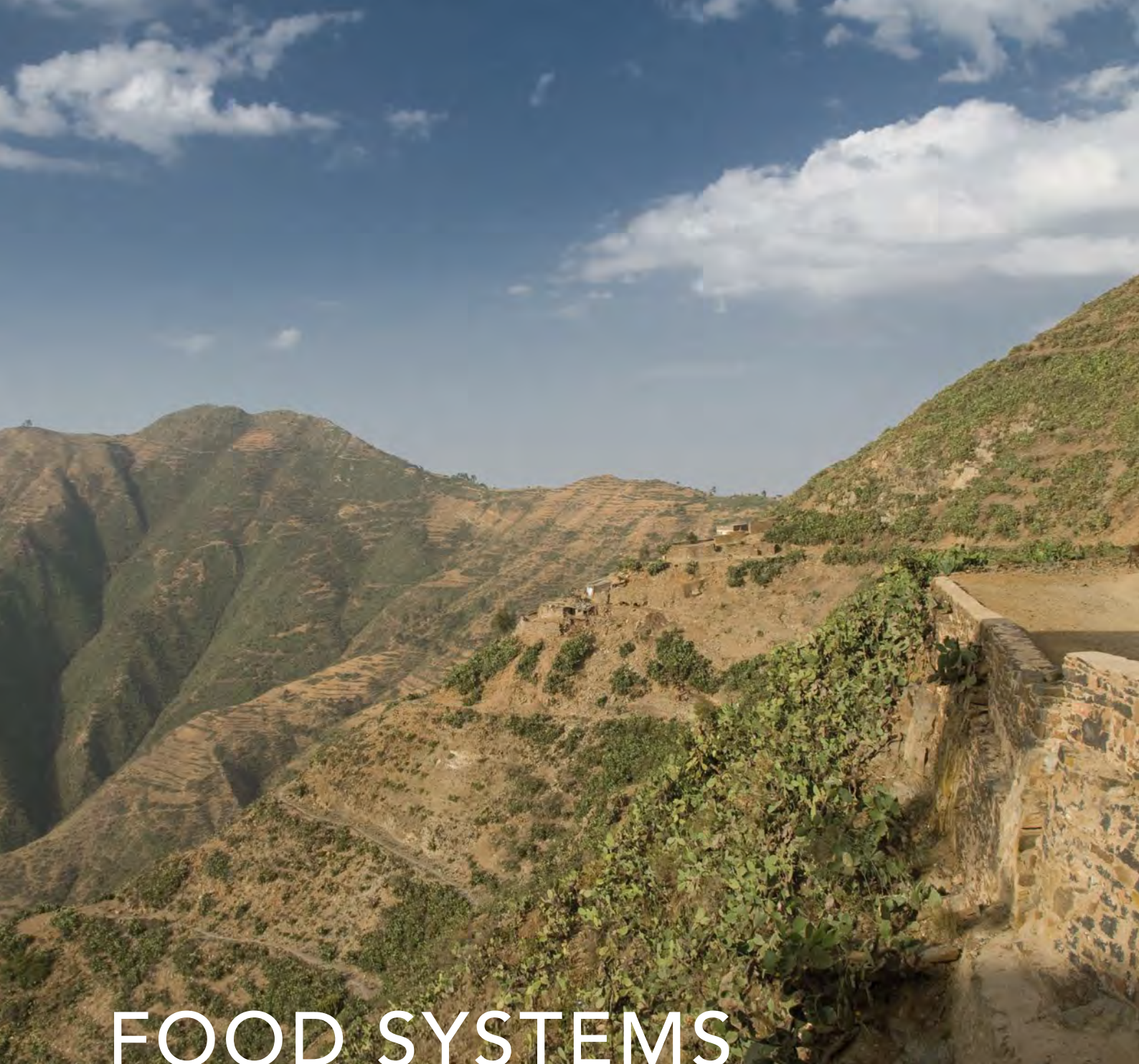
While many doubt the importance of such high-level global policy deliberations, others argue that formal international agreements shift the overall normative position of governments and can create important political spaces of operation. For anyone interested in achieving basic human rights for urban residents, the Sustainable Development Goals (SDGs), approved by the UN in September 2015, do offer an important new vision that challenges the global status quo in four core respects:

- The SDGs apply to everyone, regardless of where in the world they live—the first time that there has been recognition of a “universal agenda”, where our future is understood to be common and intertwined. By implication, the developmental aspirations and minimum health outcomes of the poorest residents of Kigali are viewed in the same light as those of citizens of Zurich. The post-2015 agenda in other words abandons the idea of a dual standard of (health) development for rich and poor, developed or developing contexts: all lives matter.
- The SDGs highlight the centrality of cities as global pathways of environmental as well as social and economic change. By implication, if the urban health sector is to respond to ecological and climate-induced risks, reduce exposure to hazards (such as flooding, but also air pollution and poor water quality) and ensure that the planet our children inherit is not depleted and corrupted—then attention must be given to the collective impacts of production and consumption within and across every city and town. In a similar vein, ensuring the health and well-being of the world’s poorest and least-protected urban residents is, because of the globally connected system of cities, a matter of international and not just local or national concern.
- Each SDG is accompanied by a set of targets that will be monitored through selected indicators. Designing the evaluation framework of global development performance offers immense opportunities (and not inconsiderable risk). The integration of different forms and sources of data (including health informatics) into the post-2015 local, national and global systems of assessment will inevitably shape the focus of investment and the allocation of new developmental resources and capacity. Benchmarking for 2015 represents possibly the biggest opportunity ever to realign the evidence base and change policy direction, including integrating geospatial and statistical analysis to better reflect the complex systems that underpin human health in cities.
- The vision for 2015 is city-centric. Mindful of the fact that more than half of the world’s population now lives in cities there is, unsurprisingly, a

dedicated “Urban Goal” (to make cities safe, inclusive, sustainable and resilient). Importantly, what Goal 11 acknowledges is that national and sub-national action is required to achieve all other post-2015 global targets. For the food and nutrition sectors the SDGs focus on cities, positioning them as pathways of sustainable development and not just sites of intervention, thus presenting a major challenge to rethink the entire consumption, production and distribution of urban food.

The post-2015 agenda will reverberate across all nations, but should have most relevance in Africa, the continent where the shortfall or development deficits are most pronounced. Guided by the post-2015 agenda, African cities and towns, many of which are still to be built, emerge as priority areas of action. There is obvious interest in the rapid expansion of African cities and towns as these are the sites where middle-class consumption is only just starting to grow and where the youth, future consumers, dominate. As such, these are places of hope and change that represent a wonderful opportunity to innovate, to do things differently and to demonstrate ethical practices. The problem is—as the dire health outcomes attest—that emergent and expanding African towns, cities and regions are also home to some of the world’s most vulnerable and poorest people. They are sites where there is weak state regulatory capacity, where elite-capture is rampant and where capital is looking to maximize its profits. Under these conditions sustainable development of the kind envisaged by the sponsors of the post-2015 agenda is not an inevitable outcome. Because much future development assistance, research and political intervention will be framed by the post-2015 agenda, it is imperative that the health and nutrition sectors are able to position their needs within this discourse—or provide compelling alternatives on what the most useful interventions for urban food security should entail.

Whether overtly framed by the post-2015 agenda or not, careful and responsible action amidst the opportunities that African cities present is imperative in all sectors, or we will all fail. In the health sector, priorities include affordable access to basic nutrition and health care but also building safe and resilient urban environments. It is not just houses and neighbourhoods that provide personal safety and a sense of belonging, but also access to nutritious and affordable food or freedom from exposure to wider environmental risks such as water and air pollution. Many of the health aspirations implied by the SDGs require systemic change in cities, which are as likely to be taken up in national strategies that relate to urban design, taxation or subsidies, as they are in the dedicated activities of the health professionals. Promoting urban health and well-being as part of an overall strategy of urban transformation has never been more exciting or challenging.



FOOD SYSTEMS

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FOOD SYSTEMS, HUMAN HEALTH AND NUTRITION

In spite of rapidly increasing food production and large global food stocks, a large share of the world's population still suffers from nutrient deficiencies. While food is plentiful, much of it is rich in dietary energy and poor in nutrients. A focus on producing calories rather than nutrients has resulted in expensive nutrients and inexpensive calories. It is, therefore, not surprising that the prevalence of chronic diseases associated with overweight and obesity is increasing rapidly while deficiencies in nutrients continue to be widespread. A large proportion of the world's population does not consume a healthy diet, either by choice or because they do not have access. Thus, efforts to improve

nutrition and associated health should aim to change consumer behaviour and enhance access to a healthy diet.

While direct nutrition interventions, such as health and nutrition education, and targeted food distribution programs as well as primary health care play important roles, nutrition-related interventions in the existing food systems offer underutilized opportunities for improvements in health and nutrition. The specific interventions should be tailored to each context but the following are likely to be relevant in most contexts. Agricultural research has been very successful in expanding production and reducing unit-costs of production of cereals. Lower consumer prices, increasing consumption and reduced deficiencies in dietary energy resulted. Given the successes in reducing energy deficiencies, it is now time to refocus agricultural research towards expanded production and reduced unit-costs of nutrient-rich food commodities, including vegetables, legumes and fruits. This could help reduce the price of nutrients and contribute to a more diversified and nutritious diet. Instead of measuring crop yields in tons of food per hectare, it would be useful to move towards a measure of the amount of nutrients per hectare.

A number of other interventions to reduce the price of nutrients could be pursued. Government support of improved varieties of nutrient-rich food commodities, fertilizer subsidies targeted to such commodities and enhanced extension and advisory services to producers are examples. Public and private investments in value chains for nutrient-rich food commodities could reduce marketing costs and consumer prices. Commodity-specific subsidies and taxes such as the elimination of VAT on nutrient-rich foods and taxes on foods and beverages with high content of sweeteners and sugar may be effective in certain contexts. However, the impact will depend on consumer preferences and behaviour. For example, a tax on beverages with high content of sweeteners among people with a strong preference for such beverages may in fact reduce the consumption of nutrient-rich foods in order to maintain the beverage consumption at the higher prices. Similarly, consumer savings from the elimination of value added taxes on vegetables may be spent on consuming more empty calories.

A refocus of food processing from inexpensive, ultra-processed foods with high content of sugar, sweeteners and fat towards inexpensive nutrient-rich foods, associated with nutrition education and an advertising campaign to promote such foods would help slow down the trend towards an obese, nutrient-deficient population. Post-harvest fortification of foods short of essential nutrients has been effective in reaching some urban populations, although most rural poor have been missed. Biofortification, which

is still in its infancy, although it has already been successful in sweet potatoes, offers very promising opportunities for reaching nutrient-deficient rural and urban populations, particularly those whose diet consists of one or two basic staples such as maize and cassava, high in calories but low in nutrients.

Interventions to reduce poverty should be a goal in itself but the impact on nutrition and associated health may be positive or negative, depending on the context. The additional incomes may be spent on excessive intake of dietary energy, resulting in obesity and chronic diseases, while nutrient deficiencies may continue to exist. Unfortunately, that appears to be rather common in environments with access to cheap calories. Widespread iron deficiency in low-income obese women is a case in point. Poverty alleviation is most likely to result in nutrition improvements when accompanied by access to inexpensive nutrients and education and in the absence of advertising campaigns for ultra-processed foods.

The nutrition effects of food systems, which include smallholder farmers in low-income countries, may be improved by alleviating the pressure on women's time, through productivity-increasing, time-saving innovations and redistribution of intra-household responsibilities, making more time available for the production of nutrient-rich foods in home gardens or farmers' fields, food preparation and storage, child care and participation in food and nutrition deliberations and technical advice.

Assuring good health and nutrition during the pregnancy period and the first two years of a child's life, currently referred to as the "1000 days after conception" is of particular importance because of the risk of irreversible damage to the child during that period. A large share of low-income pregnant and lactating women is in semi-subsistence farming. Many are nutrient deficient. Iron deficiency is particularly prevalent. Changes in the portfolio of the crops and livestock produced and consumed by these women towards more diversity is likely to lead to a more diversified diet, with a higher content of nutrients. Changes in food systems towards the production of a diversified portfolio of foods, with lower unit-costs of nutrients, would also help replace weaning foods consisting mostly of sugar water and other empty calories with a more nutritious food.

In a market system, the behaviour of farmers, processors and others in the food system must be guided by what is demanded at a price sufficient to assure a reasonable economic return. Nutrition goals will change their behaviour only if such changes are compatible with consumer preferences, economic goals and government policy. That is an important but often overlooked consideration in the current well-meaning but sometimes naïve debate about more nutrition-friendly food systems.



SUSTAINABLE FOOD SUPPLY

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WHY AND HOW TO TRANSFORM AGRICULTURE AND THE FOOD SYSTEM TO PROMOTE A SAFE, SECURE AND SUSTAINABLE GLOBAL FOOD SUPPLY

Food security has been at the centre of all societies' concerns ever since humanity settled down, and started to grow its food, rather than relying exclusively on hunting and gathering. Human ingenuity has led from the global society barely making it from one harvest to the next, and quite often failing because of the weather, pests or other natural disasters, to a scandalous level of surpluses and waste that are now reaching about half of the global production when one considers the losses along the value chain from production to consumption. While some 800 million people still suffer from chronic hunger,

about 1.5 billion are obese, and another 300 million suffer from type-2 diabetes, both due to the inadequate quality and diversity of today's food supply and consumption patterns, both in developed and developing countries. It also happens that most of the hungry and obese are mostly found among the poorer layers of society. The agriculture and the food system we have presently is also a major threat to our soils, water, biodiversity, ecosystems and their vital services and our rapidly changing climate.

How did we get to such a situation, and what do we need to do to remedy the situation? Those were the framing questions for the most ambitious report ever written on agriculture and the food system, at the global and regional level. The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) report, commissioned at the Sustainable Development Summit held in South Africa in 2002 by six UN agencies and the World Bank, was managed through an original and new form of multi-stakeholder bureau with half government and half civil-society representatives and occupied some 400 scientists and experts, from farmers to professors in all agriculture and food-system-related disciplines from all continents over a period of four years. The report, *Agriculture at a Crossroads* (Island Press, 2009), was endorsed by 59 countries in March 2008. I had the honour and privilege to co-chair the report with a colleague, Prof Judi Wakhungu from Kenya. The key findings, which were not to the liking of all the parties represented, were absolutely clear about the need for a paradigm shift in agriculture and the food systems, that business as usual was no longer an option. The agriculture and food systems need to be radically transformed, meet the criteria of multi-functionality and become part of the solution to climate change, rather than be one of its primary contributors and also its victim. A prerequisite for the transformation is the need for the new system to be anchored in the family and smallholder farmer realm, as it is these that are both the largest producers of food consumed today, and also the poorest segment of the population, both in developed and developing countries.

The IAASTD, in very in-depth analyses of the past 50 years, concluded that although there were some benefits in the short term, overall the green revolution failed to address the key issues of hunger, which are access to—rather than supply of—food. At the same time, the increased production had disastrous effects on the environment, polluting ground and surface waters with insecticides and herbicides that became needed inputs to help the stressed plants survive pests and diseases as well as weed competition—all characteristics that landraces of the main staple crops would have resisted naturally. In addition, the new super varieties were also very thirsty, needing increased amount of water to produce up to expectation. However, the miracle did not last.

Pests and weeds increasingly posed a problem, due to resistance to pesticides and herbicides, and today the same pattern repeats itself with the genetically modified crops. Clearly nature did react strongly, as per expectation of a few agronomists and farmers who had decided to take another course of action, namely investing in knowledge, nature and sustainability. These modern, science-based practices are the model for the recommendations of the IAASTD as to what the world's farmers should implement across the globe, with the necessary local adaptation to match the ecological, social, cultural and economic requirements. They produce healthy food for healthy nutrition, thus keeping people, the environment, animals, plants and soils healthy.

We do know what and how and also why we need to act with a sense of urgency at transforming the agriculture and food system. However, the system can only be changed if consumers are part of the transformation process as well. The food system is and needs to be circular and holistic. Diets have to become more diverse, with a larger component of fruit, vegetables, pulses and grains, and less—much less—meat and other animal products. This will in return allow the farmers to introduce healthy crop rotations to produce healthy nutrition, devoid of chemical residues and contaminations from fungal toxins. These farmers also conserve soil, restore degraded soils and substantially mitigate and reverse climate change by taking the CO₂ underground.

Sustainable agriculture practices can produce sufficient quality and diverse food to nourish a population of some nine to 10 billion people. In the areas that produce in excess, such as the USA and Europe, production needs to be adjusted downwards on quantity and upwards on sustainability and quality, to follow the much-needed change of consumption patterns. In the developing countries that have food deficits, production needs to be increased to a level that meets the needs. This is absolutely feasible with the many new and proven methods of land and water conservation linked to sustainable, smallholder farmer agricultural practices.

To control the devastation of industrial agriculture on a global scale, true pricing has to be introduced. This means that all externalities have to be included in the price of the product, which would in effect render large-scale industrial production uneconomical, given its negative impact on soils, water, health, pollinators, biodiversity, climate, etc.

If we want to ensure the long-term survival of humankind, we have to satisfy the needs of everyone and stay within our planetary boundaries. Not only can we afford to make the changes, but we certainly cannot afford not to make them.



POLICIES FOR IMPROVEMENT

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OVERCOMING NUTRITION ISOLATIONISM: CO-INVESTMENTS AND POLICY CHANGE FOR NUTRITION IMPROVEMENT

There has been progress in nutrition awareness since the global food crisis in 2008-11. The Scaling Up Nutrition (SUN) initiative is noteworthy, food fortification has been scaled up and proven its value for addressing micronutrient deficiencies, social safety net programs with cash transfers and nutrition components expanded in many low- and middle-income countries. There is a tremendous growth of promises, but actual progress of results is yet to be seen. It took 21 years to come together for a second International Conference on Nutrition in 2014 with unclear follow up; G7 positioned themselves in 2015 with the commitment to bring 500 million

people out of undernutrition, but concrete actions are not yet communicated; and above all, the SDG (Sustainable Development Goals) goal number two to end hunger includes the target to “by 2030 end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under five years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons”.

All these commitments need a framework and related accompanying implementation research in order to avoid strategic failure. But framework and related implementation research at scale are missing. Actually there are two frameworks. The current scientific and political discourse is impaired by the two dominating frameworks: One provided by FAO where food and nutrition security depends upon the availability of food (production and trade), access to food (purchasing power or self-production), the utilization of food for nutrition and the stability of the food system (related markets and prices) (1,2). This framework pays little attention to health. The other framework developed by UNICEF and applied in the Lancet nutrition series (3) identifies the basic and immediate causes of maternal and child undernutrition. This framework includes health especially of children and mothers, but the links to economic and political contexts and to agriculture are not defined. Ill-designed priorities for programs and policies may result from this dichotomy of frameworks, and synergy potentials are missed (4). And both frameworks have difficulties capturing the causalities of “nutrition transition” towards obesity.

Particularly problematic is the lack of attention to three broad contexts that constrain nutrition progress: the contexts of politics, ecology and education systems.

- 1) Determinants of health and nutrition problems such as discrimination, marginalization and conflicts require a framework to capture these causes and identify solutions (5). Nutrition problems are deeply rooted in institutional, rights and governance deficiencies, which affect food systems, agriculture and health sector performances. These dimensions must not be treated as distant framework conditions, as done in both frameworks mentioned above.
- 2) The other big neglected conceptual link of central importance are the hygiene and sanitation deficiencies, interlinked with infrastructures of drinking water, sanitation and sewage systems, and these often are connected to agricultural irrigation. Without overcoming these interlinked health environment problems in the increasingly crowded world, isolated nutrition or toilet action programs have little effect. The clean-up of entire systems is called for. The investments will be very large, and have not yet made it sufficiently onto the public health investment agendas.

- 3) Since good nutrition is crucial for children’s physical and cognitive development, as well as their productivity and earnings as adults, early childhood nutrition should be strengthened and expanded to ensure universal coverage. This entails linking the nutrition agenda with sound educational systems upgrading. There is too little private-sector engagement in food fortification and nutrition in developing countries in such areas as the delivery of low-cost healthy children’s foods. New alliances among the private and public sectors and nongovernmental organizations (NGOs) are needed for that.

Setting priorities requires sound metrics that account for multiple actions taken to change systems contexts, not just isolated nutrition intervention studies. Such metrics need short- and long-run components: A focus on lives saved and livelihoods improved (measured by reduced mortality and morbidity) should be combined with economic productivity metrics (measured by lifetime earnings). A framework that includes both of these concepts may be helpful for informed policy discourse on priority setting.



LAND-GRABBING

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LARGE-SCALE LAND ACQUISITIONS AND FOOD SECURITY: THE NEED TO TURN "LAND GRABS" INTO RESPONSIBLE INVESTMENT

Large-scale land acquisitions as a transnational solution to food insecurity

Over the last decade, states and private investors have increasingly acquired millions of hectares of fertile land in countries like Madagascar, Ethiopia, Uganda and Senegal, and post-conflict countries like Sudan and the DRC. While the focus has primarily been on Africa, large land investments have also been made in parts of Asia and Latin America. These large-scale land acquisitions have been stimulated by the growing demand for bio-energy and the opportunities this has offered to international and local investors, but also by the global food crisis (2005-2008), when surging

food cereal prices caused concern in countries with few agricultural possibilities, such as the Gulf countries and South Korea, about their dependence on food imports. These countries have obtained large tracts of land abroad in order to enhance food security back home. The uneasy paradox, however, is that these transnational strategies for improving food security may, and often do, affect food security in the countries where the land is acquired, in particular when the interests of international investors coincide with those of national and local elites to the detriment of the local population.

When large scale land acquisitions turn into “land grabs” threatening local food security

Large-scale land acquisitions often involve land from small local farmers, whose families’ food security depend on these plots, be it because they consume the food crops grown or because the commercial crops produced constitute the pillar of the household income. In the face of land investors, they are often stimulated or forced to leave their lands. Since the influential report by GRAIN (2008) (1), this practice has increasingly been labeled “land grabbing”.

Not all large-scale land acquisitions in the “global South” can be considered as “land grabbing”, but in practice, even when land acquisitions are legal per se (and our research has shown that this is often the case), they not seldom turn out to be “land grabs”, as in the process of land acquisition, illegal things occur and the rights of the local population are violated. Promised compensations are for instance not, or not fully, paid; people are not properly informed; or too late, making it difficult for them to defend their rights and act pro-actively. In addition, compensations rarely make up for the loss of productive land and concomitant food security; poor farmers however may feel obliged to accept the offer as they are always in need of cash in order to meet short-term needs.

Large-scale land acquisitions may also threaten food security in the long run, where lands are leased for a number (ranging from some 20-90 years) of years, but where land leasers do not invest in sustainable production methods, thus depleting the land. When the land will finally be returned to the local community, the latter is left with degraded and infertile soils.

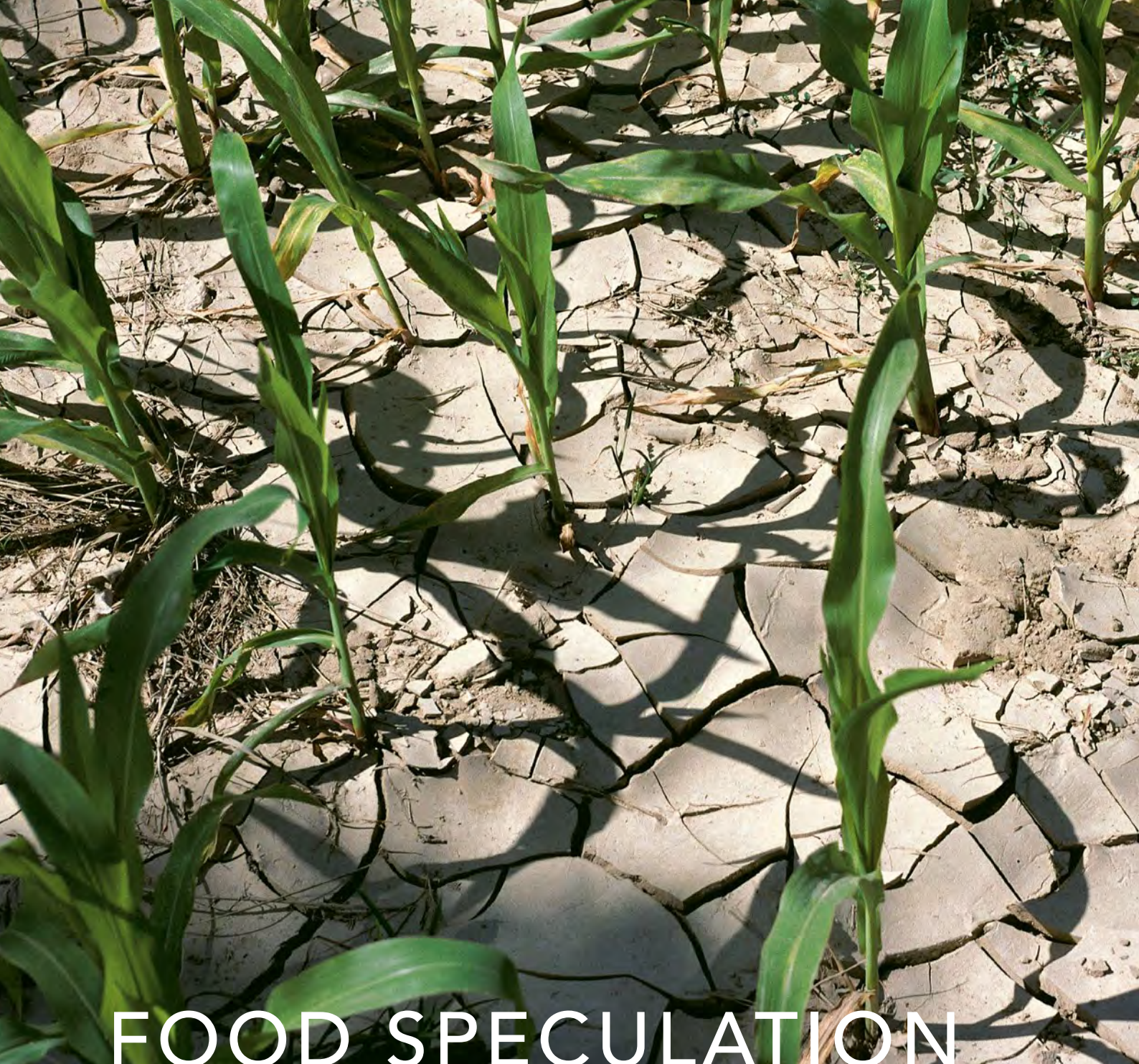
Ensuring local food security:

From land grab to responsible investment

As is also stressed by Cotula (2), the impact of many recent large-scale land acquisitions on local food security is too early to measure. Short-term negative consequences, such as the loss of agricultural land, may later be mitigated by new jobs created by the investment, thus enabling local families to buy food on the local market. But if local food security is not taken up as an issue from the start in the planning of an investment involving a large-scale land acquisition, it cannot be assumed that the food security problem will be resolved automatically. Local farmers, both

men and women, should be helped to invest their compensation productively, for instance by helping them setting up schemes for growing food crops or investing in other productive activities. Investing companies should be held to account so that they keep their promises of creating local jobs, and investing in knowledge transfer and the like, while they should also be obliged to apply ecologically sound production systems and strategies. As we have argued elsewhere (3), the problem is often not so much the rules and regulations, but the lack of control and practical implementation. In view of power imbalances, local communities will often have difficulties in holding businesses and local and national elites accountable.

Others have to come to their support. There is a task for governments, donors, (international) NGOs, consumers, etc. here. Researchers have their role to play, too, helping in finding locally adapted solutions, both in environmental, ecological, and social-cultural terms. Only armed with knowledge, a shared ethical dedication, and a longer term view, will it be possible to turn land grab practices in responsible investments fostering both global and local food security. We have to urgently work towards this aim.



FOOD SPECULATION

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FOOD PRICE SPECULATION AND FOOD RIOTS

In 2007 and early 2008 the prices of grain, including wheat, corn and rice, rose by over 100%, then fell back to prior levels by late 2008. A similar rapid increase occurred again in the fall of 2010. These dramatic price changes resulted in severe impacts on vulnerable populations worldwide and prompted analyses of their causes.

Many qualitative discussions of rising food prices suggest that multiple factors are important. However, researchers at the New England Complex Systems Institute (NECSI) developed a quantitative model of price dynamics which demonstrates that only two factors are central: speculation and corn-to-ethanol conversion (1,2).

NECSI introduced and analysed a model of financial speculator price dynamics describing speculative bubbles and crashes. Deregulation of commodity markets over the previous decade by the U.S. government enabled increased levels of speculation in agricultural markets. NECSI's model further showed that the increase in corn-to-ethanol conversion in the U.S., due to federal subsidies and mandates, can account for the underlying price trends when we exclude speculative bubbles.

A model combining both the shock due to increasing ethanol conversion and speculators quantitatively matches food price dynamics. Results are shown in the first figure. The blue solid line represents the UN Food and Agriculture Organization (FAO) Food Price Index, a measure of global food prices, and the ethanol supply and demand model is shown by the blue dashed line. Dominant supply shocks in the model are due to the conversion of corn to ethanol. The results of the speculator and ethanol model, which adds speculator trend following, including the way speculators shift between equities and commodities for maximum projected gains, is shown by the red dotted line which closely matches the FAO data.

NECSI's results imply that changes in regulations of commodity markets that eliminated restrictions on investments and government support for ethanol production, currently over 40% of U.S. corn, have

played a direct role in global food price increases. The rising food prices have subsequently led to widespread social unrest.

In 2011, protest movements were pervasive in countries of North Africa and the Middle East. These protests were associated with dictatorial regimes and often considered to be motivated by the failings of the political systems in the human rights arena. NECSI has shown instead that food prices were the precipitating condition for social unrest, and a specific global food price threshold for unrest was even identified (3).

The role of global food prices in social unrest can be identified from news reports of food riots. The second figure shows the FAO Food Price Index and the timing of reported food riots in recent years (red dashed vertical lines correspond to beginning dates). The inset shows the FAO Food Price Index from 1990 to 2011. In 2008, more than 60 food riots occurred worldwide in 30 different countries, ten of which resulted in multiple deaths, as shown in parentheses in the figure. After an intermediate drop, even higher prices at the end of 2010 and the beginning of 2011 coincided with additional food riots, as well as the larger protests and government changes in North Africa and the Middle East known as the Arab Spring. There were comparatively fewer food riots when the global food prices were lower.

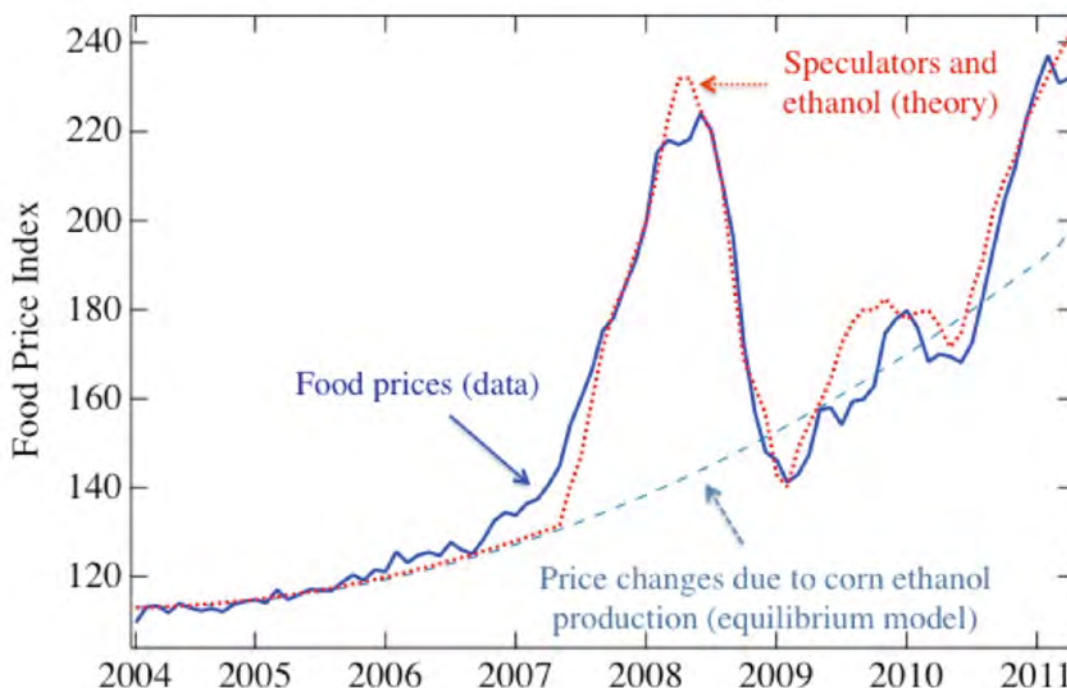


Fig 1. Food prices and model simulations. The FAO Food Price Index (blue solid line), the ethanol supply and demand model (blue dashed line), where dominant supply shocks are due to the conversion of corn to ethanol so that price changes are proportional to ethanol production; and the speculator and ethanol model (red dotted line) that adds speculator trend following and switching among investment markets, including commodities, equities and bonds.

Prior to the unrest, on December 13, 2010 (indicated by the blue vertical line), NECSI submitted a report to the American government analysing the repercussions of the global financial crises, and directly identifying the risk of social unrest and political instability due to food prices. This report, submitted four days before the initial trigger event, the action of Mohamed Bouazizi in Tunisia, demonstrates that it is possible to identify early warning signs before events occur.

Prediction is a major challenge for socio-economic analysis. Understanding when and whether prediction is possible is important for science and policy decisions. NECSI's predictions are conditional on the circumstances, and thus allow for policy interventions to change them. Whether policy makers will act depends on the various pressures that are applied to them, from both the public and special interests. Complex systems analysis can play a key role.

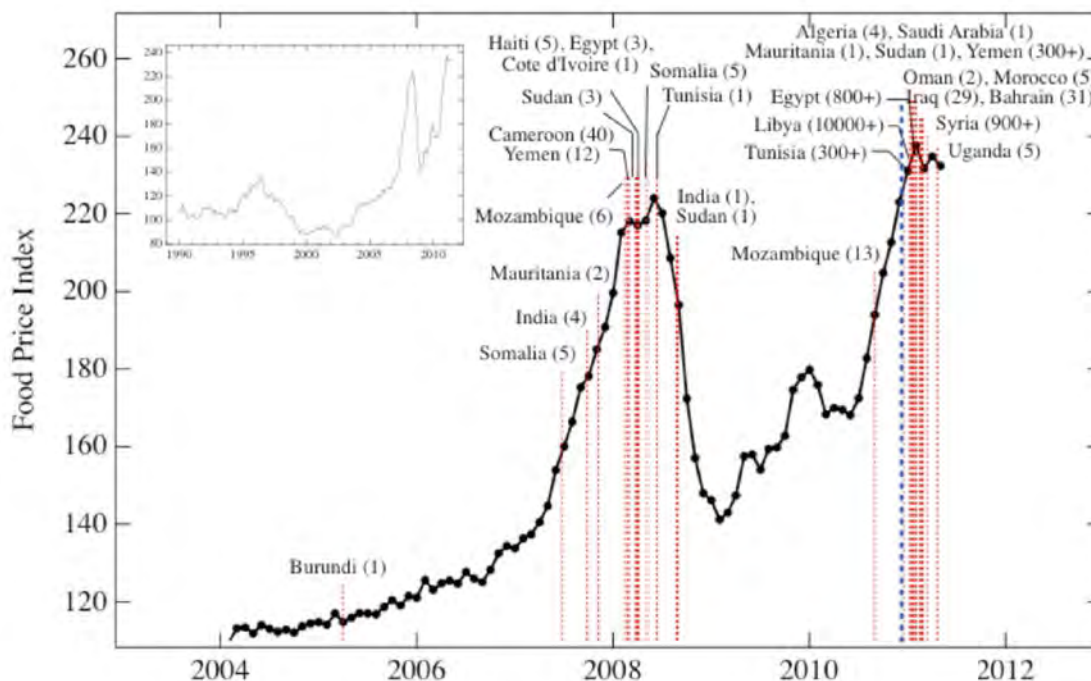


Fig 2.

Time dependence of FAO Food Price Index from January 2004 to May 2011. Red dashed vertical lines correspond to beginning dates of "food riots" and protests associated with the major recent unrest in North Africa and the Middle East. The overall death toll by mid-2011 is shown in parentheses. Blue vertical line indicates the date (December 13, 2010) on which NECSI submitted a report to the U.S. government, warning of the link between food prices, social unrest and political instability. Inset shows FAO Food Price Index from 1990 to 2011.





SOCIAL INEQUALITY & OBESITY

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SOCIAL AND ECONOMIC INEQUALITY AND OBESITY

Obesity is at unprecedented levels in high-income countries and increasing rapidly. In some countries rates have doubled in just a few years (1, 2) and over a quarter of the adult population are estimated to have a body mass index (BMI) greater than 30. However, obesity is not confined to developed countries but also increasing rapidly in low- and middle-income countries (LMICs) as their populations become exposed to obesogenic environments (3). Indeed, the global obesity epidemic has grown fastest in lower-income countries relative to wealthy countries (4), such as Brazil, China, Samoa, South Africa and Malaysia, where urban obesity prevalence has grown steadily through the 1980s and 1990s (5). Obesity has

serious consequences for mental health and physical health, conveying an increased risk for hypertension, type II diabetes, cardiovascular diseases, gall bladder diseases and some cancers (6), and may have adverse financial effects (7).

While genetic factors may still affect individual susceptibility, the rapid changes in the prevalence of obesity point to environmental causes. During the epidemiological transition in which chronic diseases replaced infectious diseases as the leading causes of mortality in developed countries, obesity changed its social distribution—the poor grew fat while the rich became thin (8). Studies in Latin America and the Caribbean show that among countries going through this transition both malnutrition and obesity may occur in the same family (9).

Public health policy-makers have highlighted the important contribution of individual health behaviours—over-consumption of low-cost energy dense food and lack of physical activity—to rising obesity, and focused (prevention strategies) on the role of food labelling and marketing, food availability and access to opportunities for physical exercise. However this ignores the psychosocial factors that influence health-related behaviours (10, 11), the role of stress as an underlying cause of obesity (12, 13) and the wealth of evidence pointing towards an association between obesity and inequality within a country.

Over a decade of research suggests that, among developed countries, levels of obesity are related to within-country income inequality (6, 14, 15). Obesity prevalence tends to be lower in countries where income differences are smaller, and the differences between countries are large: in the economically unequal USA, over 35 per cent of adults are obese, ten times higher than Japan, a far more equal country, where only 3.4 per cent of adults are obese (16).

While the pathways linking obesity to inequality do include total calorie intake and physical activity, studies in Australia, the UK and Sweden (17-20) reveal that the amount that people eat and their level of physical activity fails to fully account for social class differences in weight gain and obesity. Other explanations are required. People with a long history of stress seem to respond to food in different ways from people who are not stressed: they deposit fat around the middle of the waist, and tend to have increased food intake and different food choices to those who are not stressed (6).

Structural factors involving the promotion and pricing of foods are partially to blame for the social distribution of obesity—poorer people are more likely to buy cheap, energy-dense foods and more likely to be targeted by marketers selling these products (21)—however, it is not clear that these will vary with income inequality. The explanation lies elsewhere:

low social status increases people's anxiety and stress levels and reduces their ability to exercise control over their lives. Overeating is a response to this stress and, as the stress levels increase in line with inequality, so too does obesity (15). The psychosocial effects of inequality on obesity are most acute among the poor, as shown by the tendency for obesity rates to be highest among the poor. However, in unequal countries obesity levels are higher across the income spectrum.

This relationship between obesity and inequality fits a wider pattern. Income inequality has been associated with numerous health and social outcomes—infant mortality, mental illness, violence, teenage births, imprisonment, wellbeing, obesity, young people's maths and literacy scores and social cohesion (15, 22-24). Although the impact of inequality tends to be most severe lower down the social ladder, outcomes are also poorer even among the better off, because inequality damages the whole social fabric, increasing social divisions, status insecurity and status competition (23, 25-28).

Strategies to improve future wellbeing, lower mortality, avert the trends in rising obesity and improve social cohesion must look beyond the immediate triggers to target the underlying causes of why, for instance, people continue to live a sedentary lifestyle and eat an unhealthy diet, and how these behaviours provide comfort. The behavioural and psychological changes needed to improve wellbeing are bound to inequality reduction (15). It is only through lessening the burdens of relative poverty and concerns about social status across the status hierarchy that we will improve the real quality of life in high- and increasingly also middle- and low-income countries.

¹ Kate Pickett is together with Richard W. Wilkinson the co-author of "The Spirit level: why more equal societies almost always do better" (Allen Lane Publisher, 2009)



DOUBLE BURDEN

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FROM POVERTY TO RICHES: THE DOUBLE BURDEN OF DISEASE

The world has undergone profound changes in the 50 years since the Nestlé Foundation was established. For the most part these changes have been very much for the better; for instance, in the villages in which we work in rural Gambia, the under 5y mortality rate has dropped about twelve-fold from a terrible starting point of ~430 per 1000 births. In recent decades the prevalence of stunting and underweight has declined markedly worldwide and many regions have reached their Millennium Development Goal targets, whilst others have made substantial gains even if they have missed their target. Building on this progress the new Sustainable Development Goals now strive to end all malnutrition by 2030.

This would all be good news if not for the fact that the threats of obesity and the associated non-communicable diseases (NCDs) are rising as fast as the old forms of malnutrition and infectious diseases are diminishing. The phrase the “Double Burden of Disease” conveniently captures the challenge to nations and their health services that accrues from

having to simultaneously deal with these contrasting conditions. Visitors to any tertiary hospital in a low-income country will see for themselves what a strain these dual enemies pose to all components of the health systems. The accompanying pictures put a human face on this challenge. They were taken on the same day in the same hospital; a child being rehabilitated from severe acute malnutrition lies just a few metres away from an obese woman at risk of amputation of her diabetic foot.

On the face of it the reasons for the rapid transition from under- to over-nutrition might seem simple: poor people consume a traditional diet with few processed foods and have to work very hard to make ends meet; as they become more affluent they consume western-type diets with energy-dense processed foods and expend much less energy in physical labour. But hidden amongst these simple truisms are a number of complexities that exacerbate the problems of the double burden.



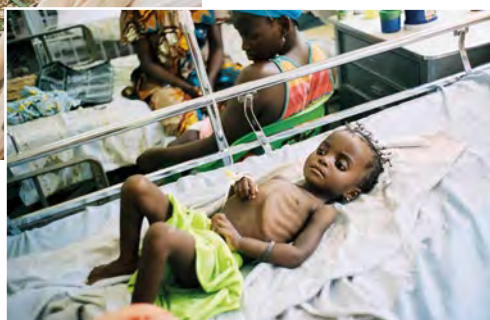
First, nature has ordained that babies of undernourished mothers undergo physiological adaptations in utero that are designed to better equip them for a future life of frugal diets (the “thrifty phenotype”) (1). Such adaptations are helpful if conditions remain the same throughout that individual’s life but become harmful if there is a later transition to affluence (2). This creates a special risk in populations undergoing very rapid demographic transition. The theory of the developmental origins of health and disease (DOHaD) (3) that describes these associations is now a topic of extensive research.

There is further evidence that stunting in infancy (which surprisingly can often be found in families where there is parental obesity) will be associated with an inappropriate body composition in later life. There is also emerging evidence that there are inter-generational influences at play. The mechanisms by which nutritional deprivation in one generation can exert an influence on the metabolic status of children or even grandchildren remains a matter of intense debate, but it is plausible that epigenetic alterations laid down in one generation can escape the widespread “wiping” of the epigenome that occurs very soon after conception and hence transmit

such messages across generations. These epigenetic echoes of the ancestral environmental exposures may limit the extent to which the current generation can adapt to current conditions. In public-health terms the implications of these effects might be that it will be difficult to overcome a history of malnutrition and growth failure within a single generation and might very well be hazardous to try to do so. Children growing up in rapidly transitioning families and societies might later suffer a higher burden of NCDs. This challenges the view that we should intervene as hard as possible to get children to grow faster; perhaps a more patient approach would gather less collateral damage?

The most distressing aspect of the double burden and of the rapid emergence of diabetes and hypertension across transitioning countries is that the under-developed and under-resourced health systems in such countries are unable to provide the kind of high quality care that is available in the most affluent and developed nations. As a consequence the sum of human misery created by severe NCDs is far greater in poorer countries and case fatality rates are shockingly higher.

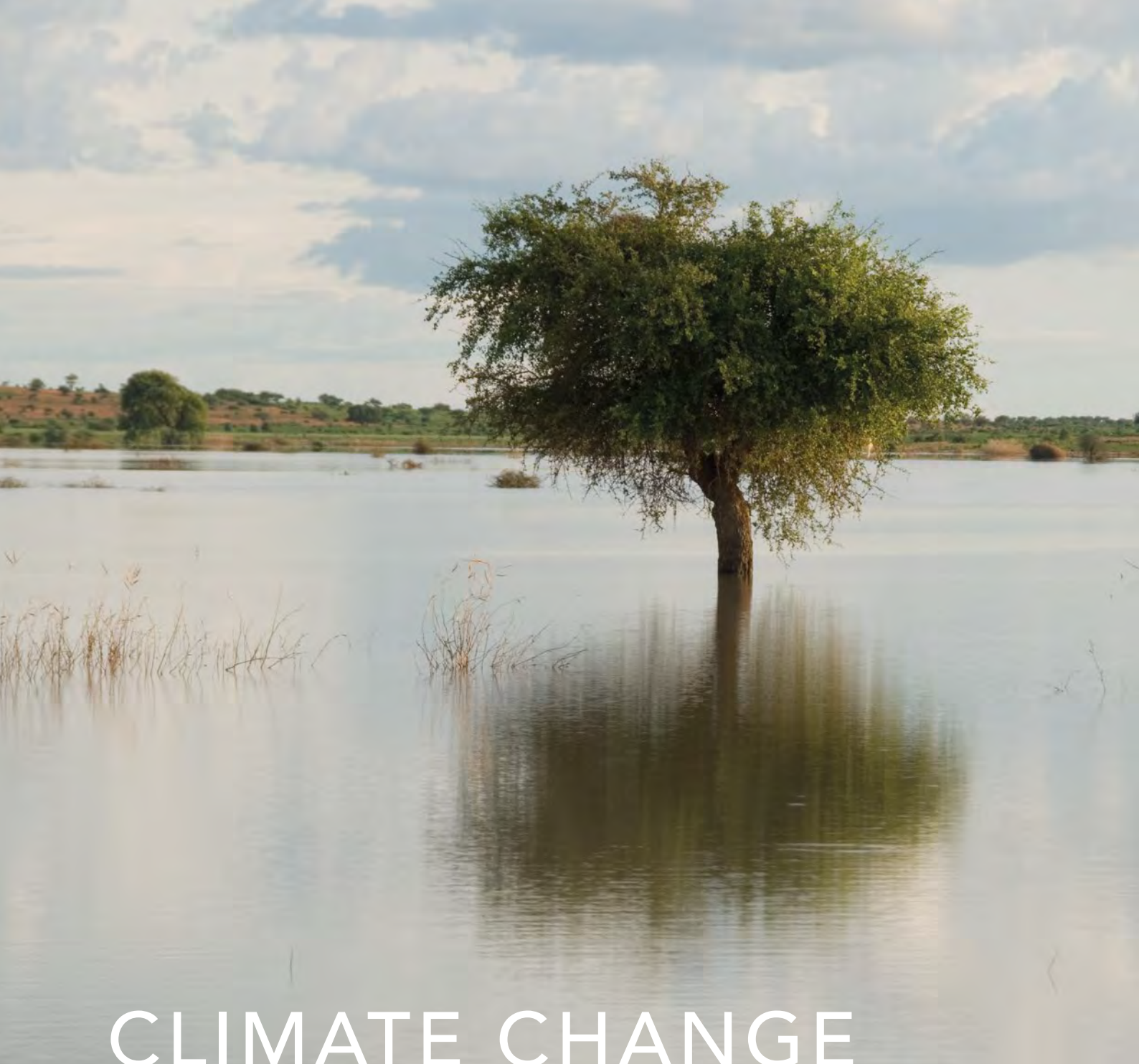
It would be logical to hope that the governments of poorer countries could look at what has happened in rich countries and learn the lessons of history, but sadly this is very hard to achieve. In the first place



even wealthy countries have no easy solutions for the pandemic of overweight and obesity. And any government that tried to prevent its population from accessing the obesogenic temptations of development would soon have a revolt on their hands. Detailed analyses of the many factors

that combine to cause obesity and its consequent ill health, such as the UK’s Foresight Report on Obesity (4), have concluded that the solution will require an equally complex and multi-faceted approach with coordinated actions across most domains of government. This will be beyond the scope of most nations struggling to cope with the unfinished agenda of infectious diseases and perhaps the greatest hope lies with education. Many families do manage to navigate a route to maintaining a healthy weight. These tend to be better educated and it must be hoped that education—in all its facets—will lead the way in overcoming the juggernaut of NCDs that will otherwise swamp the health systems of Africa and Asia.

As the Nestlé Foundation moves into its next 50 years it will no doubt adapt its research priorities and play its own unique role in helping to tackle these changes in the nutrition-related health issues faced by nations. We wish it all strength in these endeavours.



CLIMATE CHANGE

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A THREAT TO THE PRIMARY RESOURCES OF LAND AND WATER

What the science tells us

"Climate change is one of the greatest challenges of our time." This is the assertion of the parties to the United Nations Framework Convention on Climate Change made in the Copenhagen Accord in 2009. The scientific information concerning this problem has been delivered to the UNFCCC by a series of comprehensive assessment reports by the Intergovernmental Panel on Climate Change, IPCC, since 1990. The Fifth Assessment Report (1, 2) concludes:

- Human influence on the climate system is clear.
- Continued emission of greenhouse gases will

cause further warming [...], increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems.

- Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks.

The power of these statements, which summarize the detailed scientific assessment, lies in the fact that the member countries of the IPCC have approved these formulations verbatim and in consensus.

Carbon dioxide concentrations in the atmosphere are now unprecedented in human history and 30% higher than during at least the last 800,000 years. They are rising more than 100 times faster than during the past 20,000 years due to the burning of fossil fuels and deforestation. Similar observations hold for methane and nitrous oxide, the two other important greenhouse gases. The chemical composition of the Earth's atmosphere is now fundamentally different from that which prevailed before the industrial revolution. Based on multiple lines of independent evidence from the atmosphere, the ocean and the cryosphere, IPCC has concluded that *warming in the climate system is unequivocal*. This warming increases sea level directly by the thermal expansion of the warming ocean water, and indirectly by the melting of the glaciers and the loss of mass from Greenland and Antarctica.

Numerous other changes have been detected over the past 50 years in all components of the Earth System. Among these observations are reductions in the Arctic sea ice cover in both extent and thickness, melting of the Greenland and Antarctic ice sheets, shrinking of glaciers worldwide, changes in the global water cycle and increases in the occurrence and strengths of extreme events such as the doubling in the frequency of heat waves. The warming and many of the consequent changes are caused by the increase in greenhouse gas concentrations and other substances in the atmosphere. This conclusion arises from the combination of global model simulations and observations which permit the attribution of the observed changes to various drivers and causes. This robust scientific evidence is encapsulated in IPCC's conclusion that *human influence on the climate system is clear*.

Anthropogenic climate change, however, has far greater dimensions than just those observed and projected. We need to recognize that climate change threatens our most important resources for life on Earth. These two resources are land and water.

Resource land shrinks in size

The resource land is irreversibly reduced by the rise of sea level globally, on average at a rate of 3.2 cm

per decade over the past 20 years (Fig. 1). Further sea level rise, as is already committed by the past greenhouse gas emissions, will have severe and pervasive consequences for coastal communities, meaning many hundreds of millions of people. Land is a primary resource to live and grow food on. The impact of the global increase in greenhouse gas concentrations reduces this primary resource continually. Rising sea levels also increase the vulnerability of these settlements to extreme events such as cyclones and sea level surges caused by them. Therefore, adaptation has become a continuous necessity. So far, adaptation happened to a sea level rise of 19 cm since the beginning of the 20th century, noting that complete adaptation to this change was not necessary since many coastal infrastructures have only been built in the course of the 20th century. Comparing this with the committed adaptation under a business-as-usual scenario, another 70 cm, and considering mature infrastructure and established coastal settlements that must adapt, this indicates the dramatic challenges ahead. Many regions are likely to encounter their limits of adaptation already in the 21st century. As for sea level, adaptation limits also exist for ecosystems on land and in the ocean.

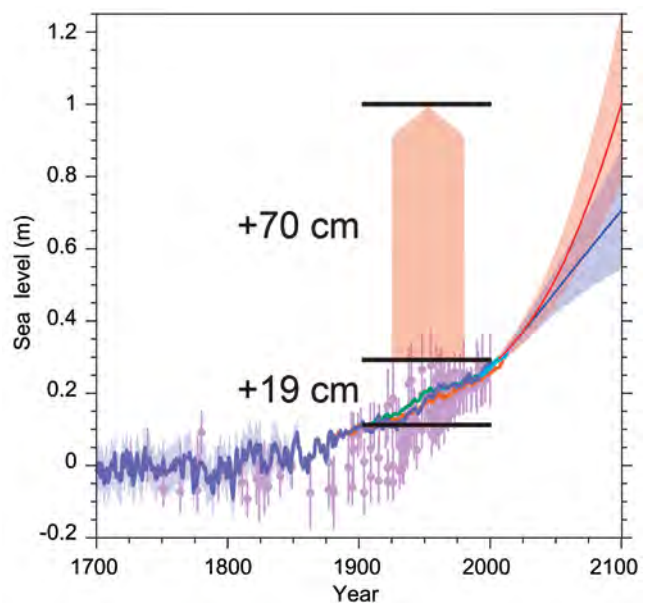


Figure 1: Resource land: Past and estimated future changes in sea level depending on the greenhouse gas emission scenario. Figure modified from (4).

Water: Too much or too little?

Climate models are excellent tools to estimate future changes caused by increasing greenhouse gas concentrations in the atmosphere. These models are complex and consist of components describing the atmospheric and ocean circulations, their interactions, snow and sea ice cover and land surface

processes. Simulations covering the past 150 years are compared with observations demonstrating large-scale agreement and thus lending confidence to use such models for climate change projections. In addition to estimates of regional warming, they are also able to provide us with projections of changes in the global water cycle (Fig. 2). Depending on the greenhouse gas emission scenario these models provide information on the amount of annual and seasonal precipitation on the globe. Keeping the warming below 2°C, the target envisaged by the Paris Agreement (3), changes in precipitation are less than 10% in most regions of the world. Such a change is not much different from the year-to-year variability in the water cycle and thus adaptation is possible. In a “business-as-usual” scenario precipitation changes in response to the warming are much larger and reach increases of more than 50% in tropical and high latitudes, while decreases of more than 30% are projected to occur in other regions, primarily in sub-tropical latitudes. The warming that occurs worldwide therefore causes large regional differences in the changes in the water cycle. Those latitudes that are already today challenged by frequent flooding (mid to high latitudes) will receive even more precipitation, whereas dry latitudes will receive even less water. The risks of drought and water scarcity therefore will increase, which will become a serious issue in these regions.

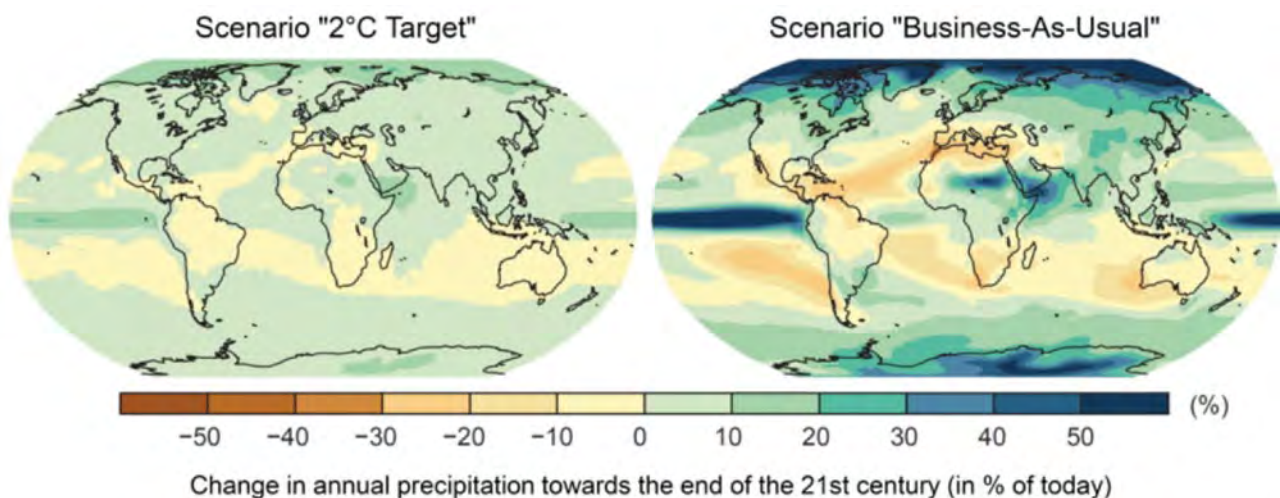


Figure 2:
Resource water: Estimated changes in annual precipitation depending on the greenhouse gas emission scenario. Figure modified from (4).

Taking a resource view of the climate change problem therefore brings the challenges into a clear focus. Limiting climate change to 2°C will require adaptation already now. This applies both to humans and ecosystems. As illustrated with the water cycle, many regions will be able to successfully adapt to these changes with ecosystem services, such

as food production, continuing on a global scale. However, a business-as-usual scenario will lead to a world that is fundamentally different from the one we now know. The warming will exceed 4°C relative to the end of the 20th century. On top of the slow warming, extreme events such as heat waves may reach magnitudes that are beyond the physiological tolerance. The primary resources of land and water will undergo unprecedented changes. Regions will emerge in which survival is possible only with a massive investment in technological infrastructure, such as cooling, freshwater production and irrigation. Such adaptation will be extremely costly, costs that will add to the those incurred by climate-related damages and disasters. Many regions will have difficulties confronting such challenges.

In some regions the changes will grow beyond the capacity for adaptation, for both human systems and ecosystems. Food production will be seriously damaged in areas which will experience more drought or where flooding will modify growing conditions on farmland. Continued growth of atmospheric carbon dioxide will further acidify the surface ocean. This, compounded with the warming, will impact many marine ecosystems and habitats with consequences that are still to be fully explored. It is clear, however, that acidification will make the shell formation of many marine organisms much more difficult. A burning question concerns the limits of the adaptation capacity of marine organisms and ecosystems (5).

The consequence of climate change resulting from business-as-usual is evident: as the primary resources become more difficult to access and or may disappear altogether, migration will be the only option left for people. The potential for conflict caused by such a development is unfortunately evident, already today.

Taking a broader perspective, we should recognize that addressing climate change is a sheer necessity if we want to achieve the Sustainable Development Goals that were agreed to by the United Nations in 2015. Effective climate change mitigation is an indispensable start on the pathway towards the Sustainable Development Goals and will accelerate reaching many of them. Business-as-usual, on the other hand, undoubtedly makes these goals unachievable. Addressing climate change, therefore, must be an integral part of any strategy to reach the Sustainable Development Goals.





THE LAST TABOO

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TIME TO REVIEW LINKS BETWEEN OPEN DEFECTION AND STUNTING

Sanitation—the safe disposal of human excreta—is a subject that has been shrouded in taboo and shame for too long. The Millennium Development Goal (MDG) for sanitation was only introduced in 2002, two years after all the other goals were agreed, following intense lobbying for recognition of this essential service. As a consequence, more than one in three of the world's people still do not have access to an adequate toilet and at least one billion still resort to so-called “open defecation”, on railway tracks or river banks, in the fields and behind bushes, or in plastic bags which are then indiscriminately disposed of—the “flying toilet”. We are very far from achieving the MDG goal of

halving the proportion of people without access to a safe and hygienic toilet, let alone achieving universal sanitation. The result is an appalling toll of both morbidity and mortality, particularly amongst small children, and, perhaps as significant, terrible indignity for women and girls, and danger for them as they seek somewhere to relieve themselves under cover of darkness. As rapid urbanisation continues and slums grow—possibly to reach three billion by mid-century—the problems and suffering multiply.

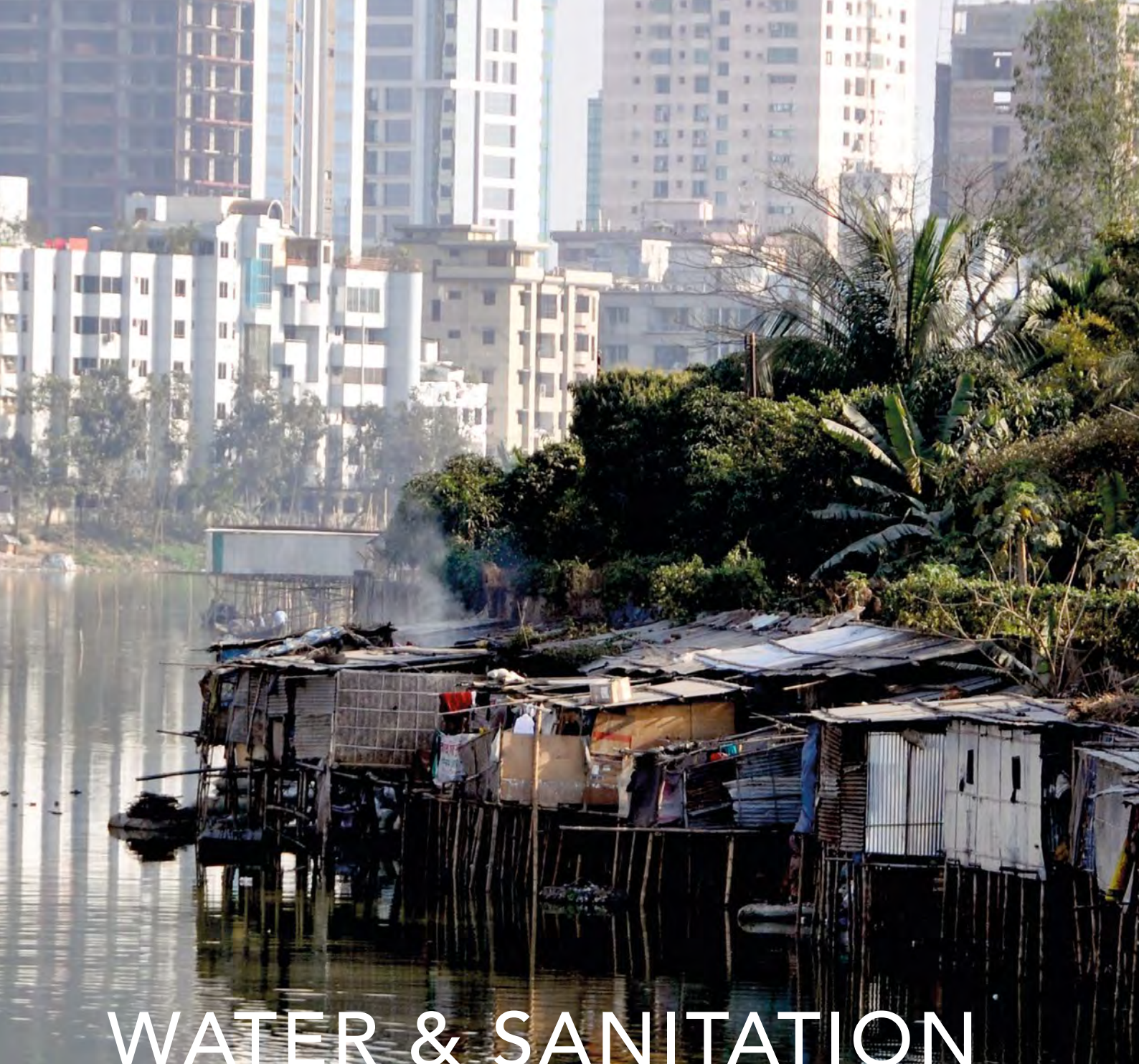
The WASH (water, sanitation and hygiene) sector has been preoccupied with reducing diarrhoea amongst under-fives as the principal indicator of our success, but recently this stance has been challenged (1). New evidence has emerged of connections between open defecation, undernutrition, stunting and poor development amongst small children. Jean Humphrey of the Johns Hopkins Center for Human Nutrition published a short but ground-breaking article in 2009 (2) in which she reminded us that the Lancet's Maternal and Child Undernutrition Series estimated that sanitation and hygiene interventions, implemented with a hugely optimistic 99% coverage, would reduce diarrhoea incidence by 30%, which would in turn decrease the prevalence of stunting by only 2.4%. On the other hand she suggests that environmental enteropathy, characterised by villous atrophy, crypt hyperplasia, increased permeability, inflammatory cell infiltrate and modest malabsorption, and caused by ingestion of faecal bacteria in large quantities, is a key cause of child undernutrition. She therefore posited that the impact of poor sanitation and hygiene on growth, and consequential mortality, cognitive and economic outcomes, might have been substantially underestimated.

Since Humphrey's article, the WASH sector has been debating and researching this topic with interest and vigour. In particular, Dean Spears and his colleagues have been investigating links between open defecation, child growth and cognitive achievement. They have produced convincing evidence that open defecation can account for much of the excess of stunting in India, where this sanitation practice is very common, over that amongst poorer children in Africa. Studies of ingestion of faeces are, as yet, rare, but one such observation of caregiver-infant pair behaviour in rural Zimbabwe (3) calculated that an average one-year-old child may swallow 1g of chicken faeces, 20g of soil and 400ml of contaminated water, resulting in the ingestion of millions of E coli bacteria every day, particularly from the ever-present chickens with whom the infants co-exist on the ground. Although the majority of faecal bacteria ingested by young children may be coming from chickens and other animals, as their exploratory behaviour involves much finger sucking, inadequate hand washing after defecation also results in ingestion of human faecal bacteria.

Recent research by the UK's Institute of Development Studies (4) has shown that access to sanitation is second only to the quality of food supply in its "potency" amongst various factors aiming to reduce child stunting. With stunting rates in both South Asia and sub-Saharan Africa standing at around 40%, the need for improvements is enormous, but the challenge is likewise very significant. Sue Coates, the UNICEF WASH chief in India has noted that when it comes to stopping open defecation in that country, construction of toilets, as advocated by PM Narendra Modi's new Swacch Bharat (Clean India) campaign, is not the main problem. Six hundred million still use this practice in India and many prefer defecating in the open, believing it is healthier and nicer than toilet use. "The real problem", Coates suggests, "is promoting a social demand for initial and sustained toilet use. It would be like telling Americans or Europeans that they should now defecate in the street. We're overlaying our belief system, norms and mindsets on others; this is a very complex development scenario."

As Robert Chambers (1), a guru for many in international development circles, wrote recently: "For many nutritionists, the strong links between faecally-transmitted infections (including environmental enteropathy) and stunting are still a blind spot: the mouth remains visible and attractive, and the anus hidden, as in daily life."

¹Ben Fawcett is a practitioner, teacher and lobbyist with 35 years' experience in the WASH sector; he is currently a lecturer at the International WaterCentre, Brisbane. Author of "The Last Taboo – Opening the Door on the Global Sanitation Crisis", Earthscan Publisher, London, 2008



WATER & SANITATION

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SHIFTING GEARS IN WATER AND SANITATION FOR DEVELOPING COUNTRIES

Water and sanitation are indispensable to life and health, and fundamental to human dignity, development and well-being. There are hardly any other factors so closely influencing other development objectives, such as nutrition, gender equality, education and poverty reduction.

As the Millennium Development Goals (MDGs) era ends, we water and sanitation professionals have mixed feelings about this 15-year period. Much has been achieved, but more still needs to be done. The MDG target called for halving the proportion of the population without sustainable access to safe drinking water and basic sanitation between 1990 and 2015.

Global access to improved drinking water sources has increased from 76% in 1990 to 91% in 2015; 2.6 billion people have gained access to an improved drinking water source [1]. These figures, however, hide disparities in coverage, as the disadvantaged, marginalized and poor still lack access and suffer most. Also, measuring access to improved water sources gives limited indication as to the water's safety, namely whether its microbial and chemical quality allows for safe consumption. As some have surely experienced, drinking water directly from a tap in a developing country can be a high-risk endeavour, even if considered an improved source.

In sanitation, there has been much less progress. 2.4 billion people remain unserved. The situation is even worse if we look beyond the fact of "having or not having an appropriate toilet". What happens to the wastewater discharged from flush toilets, or to the faecal sludge emptied from septic tanks or pit latrines? Around 90% of all collected wastewater/ faecal sludge in developing countries are discharged directly onto land or into surface water without treatment. This water is then often used as a drinking water source, and for washing, bathing and irrigation. Indiscriminate discharges without treatment also take place in residential areas where cholera outbreaks during rainy seasons are typical—transmitted through faecal contamination of food and water due to poor sanitation. The challenge increases given rapid urbanization, climate change, increasing pollution and depletion of water resources combined with the lack of technical skills, poverty, inequality and limited political priorities.

What have we learned and how can we—sector experts, researchers, development agencies, foundations and philanthropic organizations—have more impact? First, it is important to acknowledge that water challenges typically arise from local contexts. Local stakeholders are the champions that must address and prioritize water issues and create enabling environments for fostering improvements. Although global policies, such as declaring water and sanitation a human right, can act as a vehicle to increase political will, each country has the duty to implement and ensure this human right.

Blueprint solutions do not exist. Replicating success needs adaptation and adjustment to local contexts in terms of technology and with regard to social, institutional and economic processes to ensure implementation and sustainability. Yet, in low-income countries, capacity and investment in research and development is still severely lagging [2]. In 2007 Ethiopia only had 20 researchers per million population, compared to 3,600 in Switzerland or 4,600 in the USA. To enhance knowledge, the Swiss Federal Institute of Aquatic Science and Technology (Eawag) launched a free-of-charge Massive Open Online Course (MOOC) series, "WASH in Developing

Countries", in 2014. With a total of 15,132 enrolled students and practitioners—40% from low- and middle-income countries—the demand for the first two courses was enormous. This innovative learning concept can flip the classroom model, as students watch lectures outside of the classroom and then engage in discussion and exercises in the classroom with an instructor's guidance. Eawag is currently developing more MOOCs for 2016 and beyond in collaboration with the École Polytechnique Fédérale de Lausanne (EPFL) and the World Health Organization (WHO) (www.eawag.ch/mooc).

The sector also needs more applied research to adapt new knowledge to local conditions, yet this is an area that has been quite neglected. Research questions derived from local demand are more likely to create ownership among local actors, improving the chances of adoption and implementation. Developing technologies and services that enhance employment and income opportunities while improving health are obvious pathways to success. As water, energy and food resources are intricately linked, developing concepts and tools towards a more balanced stewardship of these resources is of urgent need.

With the Sustainable Development Goals adopted by the UN member states, water and sanitation has obtained a high profile. The wording of the "water goal" is exciting as it now includes the word "management" and, thus, sets a focus on safe handling of excreta and water from a system perspective—rather than just counting toilets or people with taps. It will require more than a technological fix, and calls for an interdisciplinary approach with stakeholder involvement and participation to tackle water and sanitation issues in a holistic way.



IMPLEMENTATION RESEARCH

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IMPLEMENTATION RESEARCH: BRIDGING SCIENCE AND PRACTICE

Over the last fifty years, there has been remarkable progress in the science and delivery of nutrition programs around the world. Through the science of discovery, many effective nutrition interventions have been identified, such as iron-folic acid supplements during pregnancy, promotion of breastfeeding during the first six months of life, or home fortification with micronutrient powders during early childhood. Several nutrition interventions have been implemented at large scale. Salt iodization has eliminated iodine deficiency in many countries, and many countries require fortification of industrially milled cereal grains.

Vitamin A supplementation programs have saved the lives of millions of infants and children, in addition to combatting nutritional blindness and other morbidity.

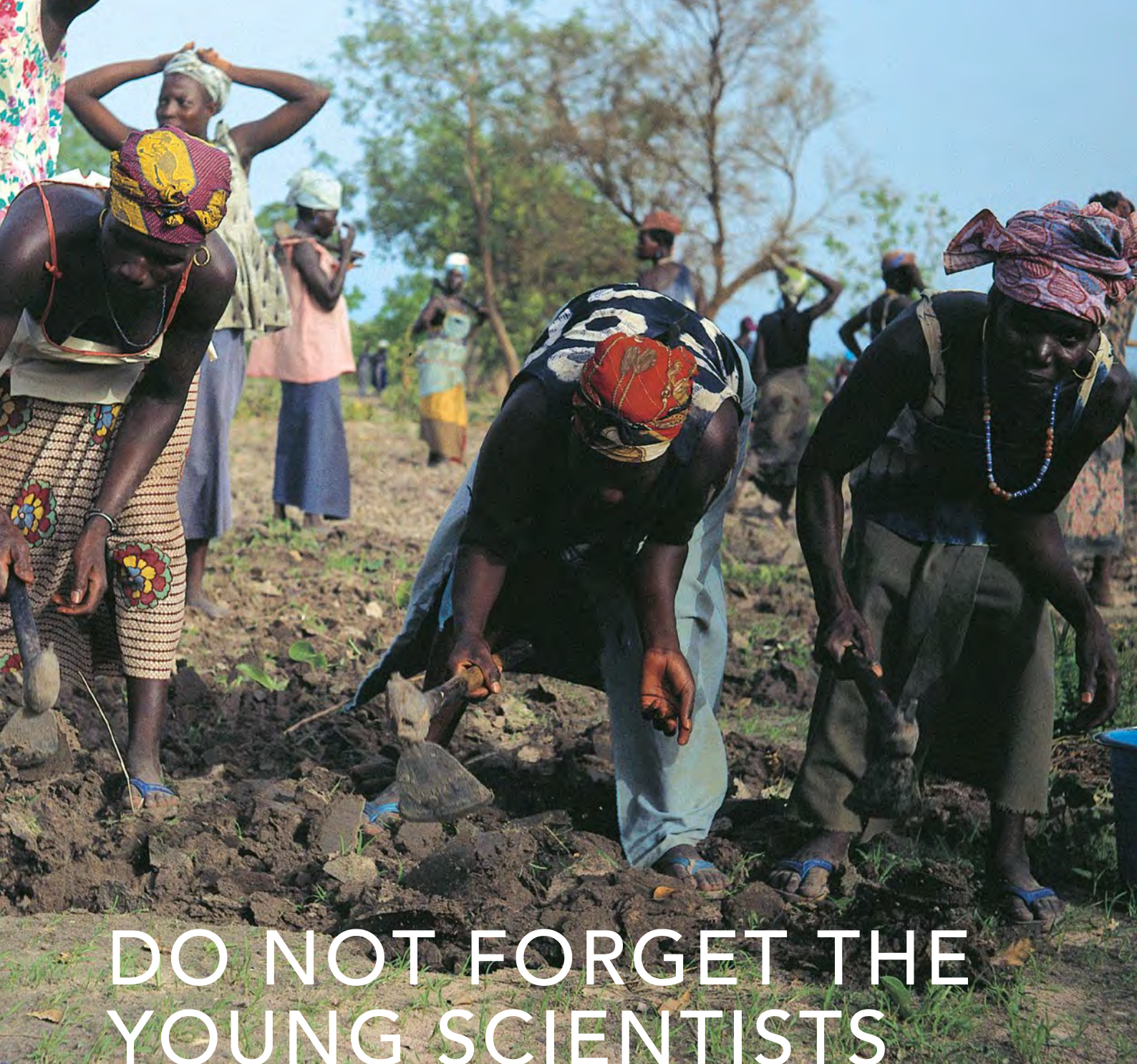
Yet major gaps remain in delivering sustainable nutrition programs at large scale, and in reaching the most vulnerable populations. Significant challenges remain in addressing how to deliver programs effectively across a diversity of changing contexts, where resources are scarce, capacity to implement can be quite limited, and social, political, and economic barriers may thwart even the best intentions of policy-makers, implementing agencies, and researchers. This is where implementation research can help.

Implementation research is an emerging science, coming from many different research traditions and disciplines, including those founded in management improvement, operations research, policy evaluation, process evaluation, participatory action research and the dissemination of evidence-based medicine (1). As a result of such a mixed heritage, there are many definitions, theories and tools in the field. A broad definition that can be used across research traditions is that implementation research is the scientific inquiry into questions concerning implementation. Implementation (derived from the Latin *implere*) is the act of fulfilling or carrying out an intention, which in health research can be a policy, a program or an individual practice (2). Implementation research can address any aspect of an implementation problem, from the barriers to implementation, to implementation processes and their intended and unintended effects. The aim is to understand *what*, *why* or *how* interventions work in “real world” settings, and to test approaches to improve them.

Implementation research is versatile, and can be used to address a wide range of implementation problems. These include answering problems about: understanding context for designing or re-designing a nutrition program; assessing the performance of a service delivery organization; informing how to improve implementation of a project; strengthening food, nutrition, and health systems; supporting the scale-up or integration of nutrition interventions; helping organizations develop capacity to learn; and providing accountability for policy-makers and program beneficiaries. Prior research on implementation across a range of social services has shown that successful implementation involves interventions at multiple levels, specifically where: **organizations** provide the infrastructure for training, mentoring, and review of outcomes; **practitioners** receive coordinated training, coaching, and performance assessment; **communities and consumers** are involved in the selection and evaluation of programs and practices; and **government** policies and regulations support program implementation (3). Implementation research is not the domain of a single

discipline. It engages a wide set of stakeholders, and when addressing complex problems, tends to employ multiple disciplines and methods. In addition to the traditional nutrition disciplines, this can involve disciplines such as psychology and behavioral sciences, management, economics, engineering, epidemiology, management, systems sciences and policy and political sciences. Given its potential to bridge the gaps between science and practice, there is growing momentum in global health and nutrition to advance the field, as demonstrated in the call to action at Health Systems Global (see: <http://healthsystemsglobal.org/the-irds-statement/>), and the recent formation of the Society for Implementation Science in Nutrition (see: <http://www.implementationsciencesociety.org/>).

Implementation research is about fulfilling the promise of research to improve the lives of people around the world. It is research that answers questions about how to deliver nutrition interventions in very different contexts to different populations, to ensure that they are effective, equitable, efficient and of high quality. It informs policy-makers, practitioners, consumers, researchers and program sponsors on practical matters of relevance. Given today's health and nutrition challenges, the more relevant question is not whether implementation research is needed, but how to ensure that an implementation research agenda is put in place for every important nutrition policy and program.



DO NOT FORGET THE YOUNG SCIENTISTS

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AFRICAN GRADUATE NUTRITION STUDENTS NETWORK (AGSNet)

Malnutrition is still a major developmental obstacle in many African countries. Many of these African countries failed to meet targets for the United Nations Millennium Development Goals (MDGs) by the end of 2015. As the world moves on to the next set of development goals—Sustainable Development Goals (SDGs)—it is critical to evaluate why many African countries failed miserably to meet the targets of the MDGs. There are so many reasons for the inability of African countries in meeting the MDGs. One of the many reasons is the lack of inter-country collaboration, sharing and adoption of good practices, which is important considering that the malnutrition conundrum is similar across the continent. Another

reason, which is given the least or no attention at all, is the lack of tapping into a pool of young, talented, energetic, highly motivated and patriotic Africans to contribute their quota to the fight against malnutrition. These young Africans are well trained ready and willing to contribute their part to eliminate or reduce to the lowest minimum malnutrition in Africa. What this pool of young Africans need is the exposure, platform and freedom to contribute their part. A critical assessment of the two reasons highlighted shows a fundamental undertone, which is lack of trust and to some extent mutual respect between African scientists/researchers between and even within countries. Another obstacle is the "system" which for some reason does not want to give room to young Africans to play key roles in the fight against malnutrition on the continent. It is a commonplace to see young Africans frustrated because they feel unheard and under-utilized. It is customary to see the same "old" faces at conferences, workshops or symposia to discuss solutions to malnutrition in Africa, with the young African and his/her opinions neglected to the background. The basis for all these scenarios is simple; they are young and "inexperienced". However, given the opportunity and "freedom" to contribute their quota, young Africans are more than willing to contribute meaningfully to the fight against malnutrition.

In 2002, African students then pursuing graduate studies at Cornell University in the USA initiated the African Graduate Nutrition Students Network (AGSNet). The AGSNet was formed to create a platform to build in its members at a formative stage of their studies and professional careers a spirit of collaboration and sharing of ideas to solve problems and ignite their passion to contribute to the promotion and enhancement of better nutrition in Africa. AGSNet is a global society for graduate nutrition students studying in every corner of the globe—Africa, Europe, Asia and North America. It has a membership of about 400 graduate students and young professionals on four continents studying diverse aspects of nutrition with the zeal to play their roles in addressing the malnutrition situation in Africa and the world. Young Africans yearn to be part of finding solutions to nutrition problems in Africa. Members are keenly interested in African nutrition and wish to apply lessons learned from other continents to solve the nutrition problems in Africa.

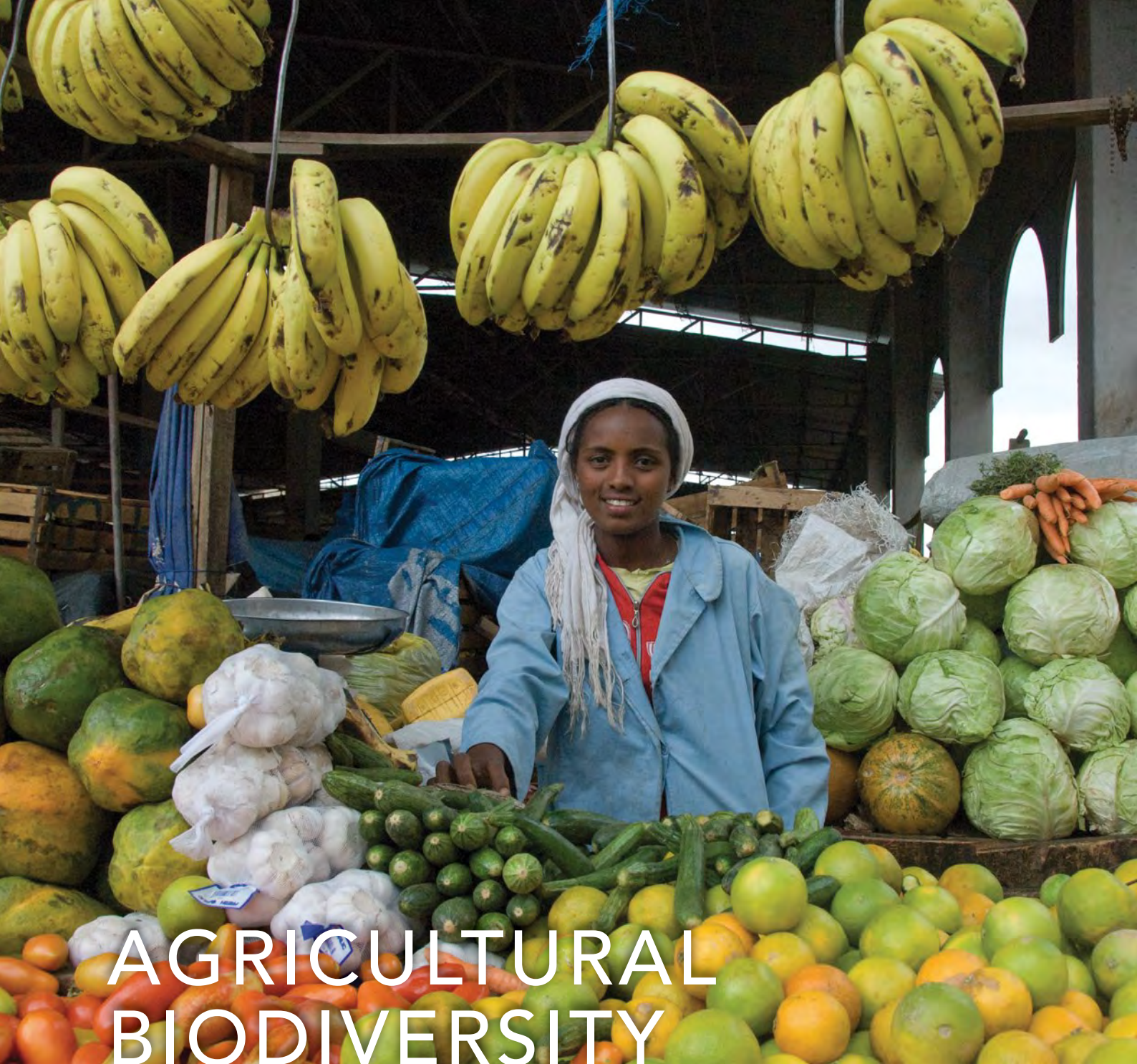
Apart from bringing graduate nutrition students together, AGSNet also provides a unified voice for young nutritionists and showcases the potential of the young African nutritionists as partners to improve the statistics of malnutrition, health and development in Africa. In spite of the efforts of the AGSNet and a few other organizations, many of these challenges discussed above still exist in Africa. The older generation owes it to Africa to "run along" with the young to inject new insights and innovation

in addressing malnutrition. The older generation must recognize the fact that young people are required to maintain the acceleration and serve as advocates for situating nutrition in the centre of program development and policy formulations for total development in Africa. It is worth noting that many funding agencies readily support the older, established generations rather than the young ones, thus denying young ones the opportunities for dissemination, capacity building and much-needed exposure.

In its quest to tap into every opportunity for the benefit of its members, the AGSNet continues to explore collaborative opportunities with like-minded organizations. So far the network has benefitted from immense support from societies and networks with similar overall goals of tackling malnutrition via capacity building. The American Society for Nutrition (ASN) is currently providing the opportunity for individual and systemic mentorship to the AGSNet to effectively run a global network with young and mostly under-resourced membership. Many other organizations such as the UN University, Nestlé Foundation, or Sight and Life have in various ways supported the AGSNet in its quest to create opportunities for young Africans to contribute their quota to fight malnutrition. Some of these efforts include linking young professionals and graduate students to scholarships, access to reading and research materials through platforms like the enLINK library by the Nestlé Foundation, or updates on current situations on global nutrition issues and conferences.

As part of plans to increase awareness of the potential of young African professionals in addressing the persistent malnutrition issues in Africa, AGSNet plans to hold special fora at Experimental Biology in the USA and ANEC VII in Morocco all in 2016.

Young African nutritionists are the future and the only assurance of a sustained effort towards eradicating malnutrition in Africa. It's imperative that they are recognized as a key partners playing a crucial role in the fight against malnutrition on the continent. This pool of young Africans should be seen as a "strength" complementing the effort of the older generation. This is one of the principles of AGSNet and we welcome any such opportunities from likeminded individuals and organisations.



AGRICULTURAL BIODIVERSITY

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USING AGRICULTURAL BIODIVERSITY TO NOURISH PEOPLE AND SUSTAIN THE PLANET

Bioversity International's vision is that agricultural biodiversity nourishes people and sustains the planet. Bioversity International delivers scientific evidence, management practices and policy options to use and safeguard agricultural and tree biodiversity to attain global food and nutrition security.

Malnutrition is becoming the leading global public health challenge of the 21st century. True, we have made significant progress against one form of malnutrition—undernourishment. In 2013, the number of people suffering chronic hunger was 795 million (1) —200 million less than 20 years ago. But other forms of malnutrition, namely overweight

and obesity, and micronutrient deficiencies—the lack of essential vitamins and minerals required for proper growth and development—are on the increase. Today, over two billion people are affected by micronutrient deficiencies (2). Furthermore, the worldwide prevalence of obesity has more than doubled between 1980 and 2014 (3).

According to the World Health Organization, most of the world's population now live in countries where overweight and obesity kill more people than underweight. And these burdens exist together—in the same country, community or even family.

The main cause of malnutrition is unhealthy diets, which usually lack diversity. While economic growth has helped reduce the number of undernourished, rising incomes have been accompanied by a switch from traditional foods to diets rich in calories, fats, sugar, salt and highly-processed convenience foods with not enough fruits, vegetables, beans and pulses.

Of the 7,000 species of plants used as food since the origin of agriculture, today just three—rice, wheat and maize—provide over 50% of our calories from plants. Yet many neglected species have a huge potential to improve diets and nutrition. Moreover, they are often better adapted to growing in harsh conditions, with increased resistance to crop pests and diseases, tolerance of poor soils and environmental change. With climate change predicted to decrease yields of major crops by 2% and demand set to increase by 14% every decade up to 2050, using a wider range of species for food and nutrition security is becoming even more imperative.

Market demand for more starchy staples in the food basket is not the only reason these neglected foods have fallen off the menu. A lack of improved varieties or access to good quality seeds, arduous cultivation practices, difficulty of processing, little if any access to market chains and a negative image as “foods for the poor” are all contributing to their decline. This multi-faceted challenge requires a multi-disciplinary approach, working with different stakeholders in the food system, from farmers to the private sector, to improve cultivation and processing practices, to promote awareness of the benefits of traditional crops and to establish links to local markets. An example of how we are implementing this approach at Bioversity International is through a 10-year, multi-partner collaboration to bring back traditional nutritious Andean grains like quinoa in Bolivia and Peru, carried out with support from the International Fund for Agricultural Development. Rediscovered in recent years for its nutritional properties, quinoa has a high protein content, a unique amino acid composition and is rich in minerals, fatty acids and vitamins. This crop can contribute to global food security, especially in areas where the population has

no access to adequate sources of protein, or where there are environmental constraints to food crop production.

One important step was to work with rural communities to create value-added products from the grains which could be sold in the more lucrative urban markets. An alliance with an upmarket high street coffee shop chain, Alexander Coffee—the “Bolivian Starbucks”—helped to promote the grains and put attractive products such as quinoa cake on the menu. These kinds of market links are vital not only to improve livelihoods but also to make traditional foods trendy again.

Another step was the introduction of a threshing machine which reduced the time taken to remove the bitter saponin coating from quinoa—an arduous processing task traditionally undertaken by women—from two hours to just seven minutes.

Similar efforts by Bioversity International and many partners in India have seen the traditional staple crop of nutritious and resilient minor millets returning not only to the food menu, but being added to India's National Food Security Act (2013), meaning they are now available to more than 800 million people at a subsidized rate. And it is not just grains which are our focus but any combinations of locally available foods, whether from the farm, the market or the wild, which will contribute to improved food and nutrition security. Take for example, the vitamin-A-rich banana. While people around the world may consider banana as a snack or something to slice on your morning cereal, it is a staple food in many parts of Eastern Africa, where it is prepared in many ways, such as mashed, like potatoes. In Eastern Africa, people eat up to 11 bananas a day. This part of the world also has high incidences of vitamin-A deficiency, causing increased susceptibility to infections, and in severe cases, permanent damage to both eyesight and development. There are up to 1,000 varieties of banana around the world, and Bioversity International is working with partners in Eastern Africa to identify varieties of bananas that are high in vitamin A, and then to integrate them into a more diversified daily diet that can help to stem this health problem.

A recent report sponsored by the Chicago Council on Global Affairs concludes that malnutrition is imperilling health and hampering economies and that the global food system must be made more productive, nutritious and sustainable. Specifically, the report recommends making greater investments in agricultural research to enhance crop and food plant variety, thus helping build more nutrition-sensitive food systems.

That is the goal Bioversity International continues to strive towards, for the benefit of everyone involved in the global food supply system, from farmers to consumers and, not least, for the good of the planet.



OVERCOMING HUNGER IN INDIA

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OVERCOMING HUNGER AND MALNUTRITION IN INDIA

All available data, including the Hunger Index of the International Food Policy Research Institute as well as the FAO, indicate that the malnutrition burden is unacceptably high in India. Consequently, several social protection measures, including ICDS (Integrated Child Development Services) and school noon-meal programs for children, have been introduced. India is also probably the only country which has by an Act of Parliament made the Right to Food a legal right. The National Food Security Act 2013 introduces a lifecycle approach to nutritional support beginning with the first thousand days of a child's life. In addition, the Act makes the senior-most woman in the household the operator of the food entitlements, thereby giving explicit recognition to the role of women in managing household food security. Another important feature of the Act is the enlargement of the food basket from the points of view of procurement and public distribution in order to include millets and other so-called "orphan crops", which are best described as climate-smart nutri-cereals. The enlargement of the food basket should provide scope for dietary diversity and inclusion of crops which are rich in micronutrients.

When India became independent in 1947, it was described as a country destined to lead a "ship to mouth" existence, since the public distribution system

was largely supported by the import of food grains from the United States under the PL480 program. Thanks to the green revolution of the sixties, it was possible to shape India's agricultural destiny in a more optimistic direction. The production of wheat, rice, maize and the other food crops went up speedily. The introduction of new plant types capable of utilizing irrigation water and mineral nutrients in an efficient way led to rapid progress. Indian soils used to be described as both "thirsty and hungry" but the introduction of irrigation projects and fertilizer factories altered the situation. Nevertheless, due to lack of adequate purchasing power, poverty-induced malnutrition persisted on a large scale, with the result that India was described as a country having "grain mountains and hungry millions". Also, environmental problems like soil erosion, ground water depletion, and pest epidemics became important. I therefore made the following statement in my address to the Indian Science Congress at Varanasi on January 3, 1968:

"Intensive cultivation of land without conservation of soil fertility and soil structure would lead ultimately to the springing up of deserts. Irrigation without arrangements for drainage would result in soils getting alkaline or saline. Indiscriminate use of pesticides, fungicides and herbicides could cause adverse changes in biological balance as well as lead to an increase in the incidence of cancer and other diseases, through the toxic residues present in the grains or other edible parts. Unscientific tapping of underground water would lead to the rapid exhaustion of this wonderful capital resource left to us through ages of natural farming. The rapid replacement of numerous locally adapted varieties with one or two high yielding strains in large contiguous areas would result in the spread of serious diseases capable of wiping out entire crops, as happened prior to the Irish potato famine of 1845 and the Bengal rice famine of 1942. Therefore, the initiation of exploitative agriculture without a proper understanding of the various consequences of every one of the changes introduced into traditional agriculture and without first building up a proper scientific and training base to sustain it, may only lead us into an era of agricultural disaster in the long run, rather than to an era of agricultural prosperity."

I coined the term "Evergreen Revolution" in order to emphasize that we should achieve productivity in perpetuity without ecological harm. The famous scientist E. O. Wilson made the following remarks on my concept of an Evergreen Revolution:

"The problem before us is how to feed billions of new mouths over the next several decades and save the rest of life at the same time without being trapped in a Faustian bargain that threatens freedom from security. The benefits must come from an evergreen revolution (as proposed by Swaminathan). The aim of this new thrust is to lift production well above the levels attained by the Green Revolution of the

1960s, using technology and regulatory policy more advanced and even safer than now in existence."

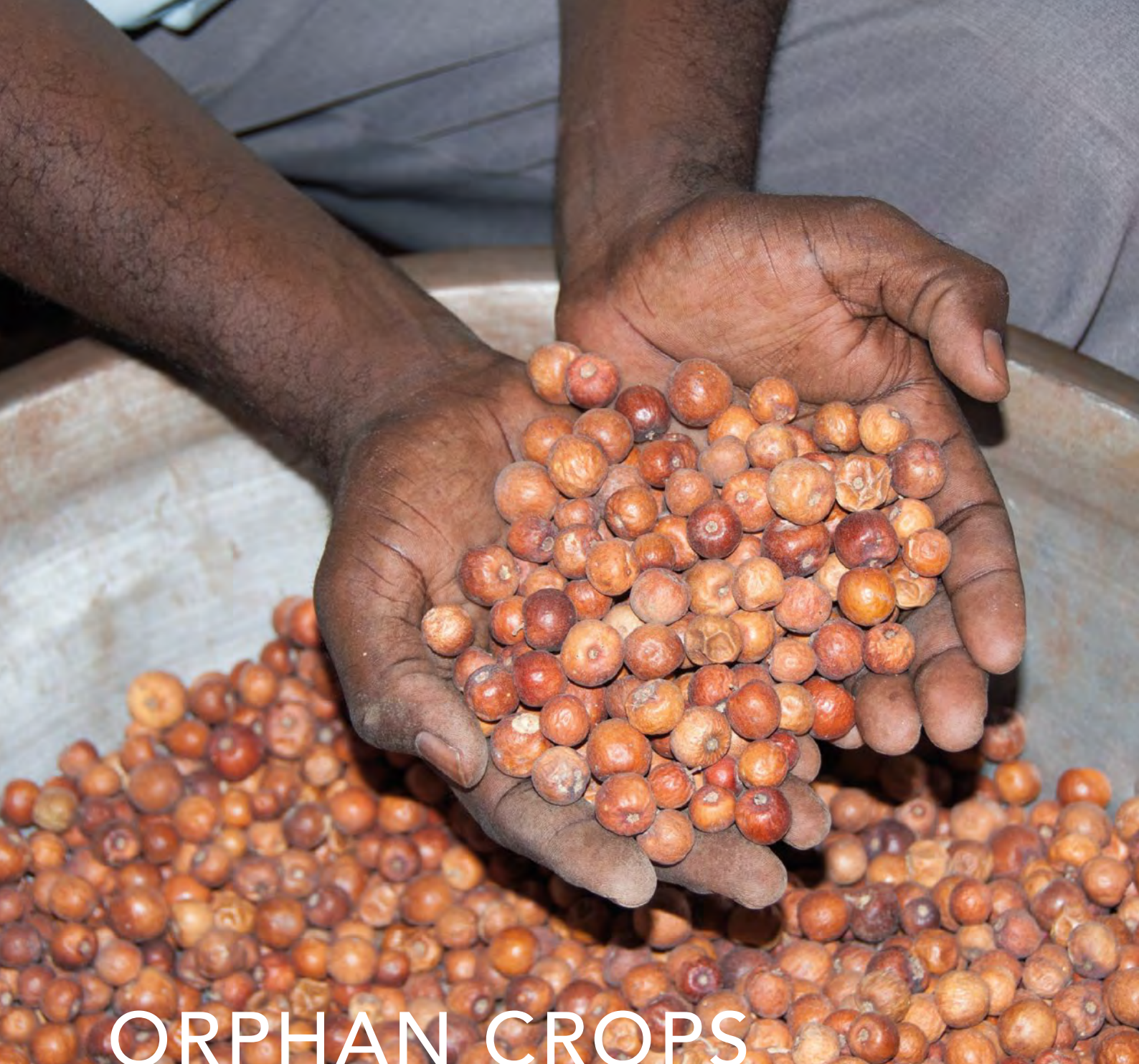
The World Food Prize instituted by Norman Borlaug and Johan Ruan has become the world's foremost award in the field of eradication of hunger. The 2015 award went to Sir Fazle Hasan Abed, founder of BRAC, Bangladesh, for his contributions to putting the poorest, and women in particular, in charge of their own lives and destinies. The occasion provided by the award is also used for organizing an in-depth discussion on issues relating to poverty and hunger. This year's theme for discussion was "Fundamentals of Global Food Security". I made one of the keynote presentations and explained the paradigm shift needed from food to nutrition security in order to achieve Goal 2 of the UN Sustainable Development Goals. This goal calls to "end hunger [and] achieve food security and improved nutrition and promote sustainable agriculture".

To achieve this goal, it is important that in the field of social protection as well as the scientific measures needed for achieving food and nutrition security, we should move from the green to an evergreen revolution approach. Also, agriculture, nutrition and health should be brought together in terms of design and delivery systems relating to public health and agriculture production.

Ultimately, the problem of malnutrition can be solved in predominantly agricultural countries like India only by bringing together agriculture, nutrition and health. For this purpose I designed a Farming System for Nutrition program (FSN) for a project titled Leveraging Agriculture for Nutrition in South Asia (LANSA), sponsored and funded by the Department for International Development (DFID), UK. The FSN consists of the following three components:

- Mainstreaming nutritional considerations in the choice of the crops and farm animals included in a farming system, so as to provide agricultural remedies to nutritional maladies
- Establishment of nutrition gardens containing biofortified plants which can provide the missing nutrients. Examples are moringa, sweet potato, quality protein maize, etc.
- Organizing a cadre of Community Hunger Fighters who are conversant with the malnutrition problems of their area and are able to guide the community on methods of overcoming endemic malnutrition.

All the three components of malnutrition namely—undernutrition, protein hunger and hidden hunger (caused by micronutrient deficiencies)—can be handled in an integrated manner. The nutrition-lead agricultural pathway is the most economical and efficient method of achieving the zero hunger challenge.



ORPHAN CROPS

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THE POTENTIAL OF ORPHAN CROPS

The term *orphan crops* has an exotic ring to it, but in fact all crops were at one time “orphans”, that is, totally outside of the scientific efforts of investigation and discovery. The history of agriculture then is to some extent the history of orphan species being adopted by the global family that is science.

Much of this science has been undocumented. The people of Mesoamerica made great improvements to the scrawny plant that was *teosinte* several thousand years ago, turning it into something resembling the maize of today.

More recently, African American scientist George Washington Carver found in the 19th century many

uses and preparations for the humble “goober pea”, which is now providing nutrition worldwide under the better-known names “peanut” and “groundnut”.

Today many healthy crops are grown in the back gardens of Africa, where 600 million people live in the rural areas. If we could breed these crops to be more nutritious, more productive, and more drought- and pest-resistant, they could play a big role in reducing the chronic hunger, malnutrition and stunting so prevalent in rural Africa.

In 2010, Mars, Incorporated led a group of companies and government bodies that sequenced the reference genome of cacao (*Theobroma cacao*) to help guarantee a global supply of chocolate. This gave me the idea of turning the powerful new tool of genetic sequencing to Africa’s orphan crops. The New Partnership for Africa’s Development quickly joined in to make this “African Orphan Crops Consortium” (AOCC) an African project.

We sent out a questionnaire to over 100 scientists, mainly African, to choose the crop varieties we wanted to examine. Such was the enthusiasm of the scientists involved that we got back many more questionnaires than we sent out, as researchers copied them to their colleagues. 101 key food crops of Africa made the list.

As we focused on the varieties, we also established, at the World Agroforestry Centre (ICRAF) in Nairobi, the African Plant Breeding Academy, to train 250 African scientists and technicians. The first class, 21 African plant breeders from 11 countries and 19 institutions, graduated December 2014.

Renowned plant breeders from U.S. universities taught the course: Rita Mumm, Bruce Walsh, Iago Hale and Allen Van Deynze of University of California at Davis, who also developed the course curriculum. The academy contains a state-of-the-art sequencing and genotyping lab fully calibrated and staffed professionally.

At the graduation ceremony, Dr. Wonder Nunekepeka from Ghana, working on *Hibiscus sabdariffa*, said, “My crop has been an orphan but is not any more! I will be a father for it.” It produces iron-rich leaves when other vegetables are in scarcity. Dr. Nunekepeka is trying to breed it to improve yields.

Globally, at this writing, only 57 plants have been genetically sequenced. We are adding another 101. China’s BGI is doing much of the initial sequencing, but Africa’s own scientists have chosen the crops, are doing the re-sequencing, and these professors and heads of research institutes at the top of their game are going back to their own countries to do the breeding.

AOCC has filled its second class, choosing 30 students from 19 countries and 28 institutions out

of 252 applicants. The consortium will invite select students from the first class to begin to teach the curriculum, with the goal of completely transferring teaching to African instructors by the end of the program. The goal is to train 250 plant breeders and support personnel in five years.

We have raised the equivalent of \$32 million toward a goal of \$50 million needed to achieve Phase One, which involves sequencing the crops and training the scientists. In Phase Two we will integrate genomic tools and strategies to develop new orphan crop varieties for Africa, and in Phase Three we will work with seed companies and smallholder farmers to adopt and deliver diverse and nutritious crop varieties for African farmers and consumers.

Meanwhile, the effort has grown to include other key partners beside NEPAD, BGI, ICRAF, WWF and UC Davis: Life Technologies (donating sequencers and equipment); LGC (genotyping services for plant breeders); iPlant Collaborative (analysis and curation of sequence and genotype data); BIG N2N (Bioinformatics Institute, University of Gent, from Nucleotides to Networks, bioinformatics and annotation of plant genomes); Google (pipelines for data); and BECA (Biosciences Eastern and Central Africa).

But these are only a few of our partners. Currently, 24 major crop consortiums, CGIAR centres, universities, government institutions and foundations are working with AOCC. The network serves as the connection to plant breeders, seed production specialists and farmers to deliver the products of the AOCC. They also serve as an advisory group for input and feedback for AOCC.

Our focus has been on Africa, but our hope is that efforts to bring orphan crops into the family of science spread throughout the world. Government agencies and scientists in India have asked for our help in setting up a similar consortium there, and we are in the process of doing so. Success would doubtless look different from the AOCC, in that India has more well-established plant breeding institutions. China has also expressed interest.

A short time ago, quinoa was an Andean orphan crop. Now it is a high-protein addition to meals across the developed world. Given that we must roughly double food production by 2050 to feed the planetary population, we shall need all the orphan crops we can get.



UNTAPPED TREASURES

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BANANAS: AN UNTAPPED TREASURE

The industrialized world started to consume dessert bananas around the 1870s, but the tropical world discovered bananas much earlier, about 7,000 years ago, in their centre of origin in Southeast Asia and the Pacific. The value of bananas in the industrialized world is about US \$8.9 billion. However in the tropical world, where 87% of all kinds of bananas are consumed, production value is estimated at US \$35.2 billion. With 145 million tons produced annually, bananas are the eighth most important food crop in the world and the fourth most important crop among the least-developed countries. Bananas are consumed in 120 different countries, providing a staple food for nearly 400 million people. While the export industry relies on cultivars of one genetically narrow group

(the Cavendish group), over 400 varieties are estimated to be cultivated by smallholders. These farmers grow up to 30 varieties simultaneously in their fields, including a range of starchy bananas that are either cooked (cooking bananas), fermented (beer bananas) or fried and/or roasted (plantain). The flowers are also consumed as a vegetable, and the fibres extracted from the plant can be used as a source for textiles.

Bananas are giant herbs—not trees—hence they grow very fast and decompose rapidly after harvest. They produce year round, thus providing food during the hunger gap when other crops are less available. If maintained properly, backyards where bananas are grown around the house remain productive for 30-100 years. These giant plants reaching a height of three to four meters create a micro-environment, allowing intercropping with up to 60 other food crops. As such, they form the backbone of complex farming systems supporting farmers to obtain a diverse menu under low-risk conditions, while protecting the soil and supporting sustainable production.

Despite increasing global banana production, yields of banana—used here in the broad sense to encompass all dessert and cooking types—are far below their potential. For example, in Uganda where nearly 10% of all bananas in the world are consumed (with an average consumption of 0.5-1 kg per person per day) average yield is at 9% of the yield potential. Production suffers from many biotic and abiotic stresses, such as *Fusarium wilt*, bacterial wilts, nematodes, weevils, black leaf streak, bunchy top, drought and declining soil fertility.

IITA (International Institute of Tropical Agriculture) and NARO (National Agricultural Research Organization, Uganda) have developed a range of 26 high-yielding cooking hybrids (dubbed NARITAs) with the best ones producing five times more than the local cooking banana varieties. Previously IITA already developed 14 superior plantain varieties with a yield increase of 225%. With the release of the genetic code of banana and a better knowledge of diseases and pests, breeding is expected to go faster despite the low seed set after pollinations.

Plantains are rich in provitamin A and hence any new hybrid should at least provide the same levels. Also the natural diversity in the crop can be better exploited. Large-scale screening of over 400 banana varieties by Bioversity International, IITA and their partners has shown that there is substantial variability in the levels of vitamin A precursors in banana varieties, and that the levels in some cultivars are so high that they can contribute to improving the vitamin A nutritional status of banana-dependent populations at modest and realistic fruit consumption levels.

The discovery of provitamin-A-rich bananas, and the use of varieties and wild types with high levels of resistance to pests and diseases in breeding, underlines the importance of diversity. This diversity is being safeguarded for future generations in a global banana collection. The Bioversity International Musa Germplasm Transit Centre (ITC) was established 30 years ago and is hosted at the Catholic University of Leuven (KU Leuven), Belgium. It stores nearly 1,500 accessions in vitro (in test tubes) at 15°C, and 65% of the collection is kept frozen at -196°C. All banana accessions have been indexed for viruses; infected accessions are cleaned and clean materials are made available at a rate of three to five accessions per day. So far more than 80% of the collection has been distributed to more than 100 countries. Users provide feedback on the accessions' performance, thereby providing more and better documentation of the accessions for future applicants.

Documented accessions are also mass multiplied by commercial in vitro laboratories or government institutions and sold or distributed to farmers. For example, in Northwest Tanzania, 24 new varieties were introduced and farmers selected four varieties. These were mass multiplied to six million plants. Yields in the region increased drastically (from <20 kg to >100 kg) and income was raised three times for 0.5 million people. The staple banana crop has now also become a commercial crop, generating income for smallholders. The introduction and use of the top four new varieties also increased the stability of the banana-based farming system. This is in sharp contrast with the monocultures of the export industry, which are now threatened by a new strain of a soil-borne fungal disease of *Fusarium wilt*, causing Panama disease, in Southeast Asia and recently also in Mozambique. This illustrates the importance of quarantine and controlled movement of plant material and people.



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THE FUTURE OF BIOFORTIFICATION: LET FOOD BE THY MEDICINE

Most nutritionists will agree with the famous declaration attributed to Hippocrates: "Let food be thy medicine". Biofortification has long been seen merely as a promising intervention to improve the nutritional status of vulnerable populations by breeding staple foods that are rich in vitamins and minerals. Dr. Christine Hotz, who used to head the nutrition program at HarvestPlus, wrote in the Nestlé Foundation's 2007 annual report that we need to "demonstrate the ability of biofortified crops to have a positive impact on the nutritional and health status of target populations." Eight years later, there is, indeed, ample evidence demonstrating that biofortified foods are one step closer to fulfilling Hippocrates' adage. For example:

- Maize biofortified with provitamin A has been shown to increase vitamin A stores in young children as effectively as supplements (1).

- Iron-biofortified pearl millet is enough to provide Beninese women aged 18-45 with more than 70 per cent of their daily iron needs (2). This iron pearl millet was able to reverse iron deficiency in school-aged Indian children in four months (3).
- In addition to increasing vitamin A intakes for women and children, provitamin A-rich orange sweet potato has been found to reduce both the incidence and duration of diarrhoea in young children in Mozambique (4).

The World Health Organization is leading a review of scientific evidence to develop guidelines on biofortification as a nutrition intervention. As part of this, a systematic review of evidence by The Cochrane Collaboration is underway. The Codex Alimentarius approved new work on biofortification—work that will begin this year with a definition under the auspices of the Codex Committee on Nutrition and Foods of Special Dietary Use. Furthermore, members of the Codex Coordinating Committee for Africa have now officially recognized biofortification as one nutritional intervention to address hidden hunger.

Dr. Hotz also wrote: “Unlike traditional fortification, biofortification does not require that the food vehicle be centrally processed [...] and has the potential to fill the gap in coverage left by fortification, as it can be more accessible to those who consume staple foods from local or self-production, especially in underserved rural populations.” This gap, even today, is enormous, so we need to rethink our strategies.



Biofortification can, and should, be a cornerstone of any food-based strategy that seeks to provide a foundation of iron, zinc, or vitamin A in the diets to reduce hidden hunger. Biofortified crop varieties released thus far can provide 25-100 per cent of

estimated average requirements (EARs) for women and children, depending on the crop and nutrient. Scientists are applying new techniques to increase the amount of nutrients that crops can provide. But even now, on any given day, if a biofortified staple food is substituted one-for-one for a non-biofortified staple food, an extra 50 per cent of the EAR for iron, zinc or vitamin A could be realized on average across all crops, provided sufficient amounts of the staple are consumed on a daily basis. There are, of course, many other factors to consider in this calculus, but it does give an idea of the potential of biofortified crops that are available now.

The goal is not to increase consumption of staples, but rather to make them healthier. Efforts must also continue to ensure that vulnerable populations have greater access to other nutritious foods such as leafy greens, vegetables, fruits and animal-source foods that are rich sources of nutrients that, together with biofortified foods, can provide people with adequate nutritious diets.

Our research and experience have shown that when caregivers are educated on the benefits of nutrients, they are willing to incorporate more nutritious foods into their diets. For example, in the case of vitamin A, that means exchanging white sweet potato, maize or cassava for orange varieties, and eating other vitamin A-rich foods (such as mangoes) when they are in season or through local production or purchase. Because biofortified crop varieties are as high-yielding as non-biofortified varieties, they should not cost any more to farming and consuming households. Thus, extra iron, zinc or vitamin A is provided at no extra cost to the family food budget. Biofortified seeds, thus, empower women farmers and other caregivers to better meet their family's nutritional needs. On the ground, biofortified crops are already being integrated into agricultural and nutritional strategies in countries. Biofortified staple crops have been released in close to 30 countries and are being tested in more than 40 countries. Conservatively, it is estimated that two million farming households are now growing biofortified crops. HarvestPlus is working with partners from government, civil society and the private sector to scale up these crops to reach 15 million farming households in these regions by 2020, and providing up to 100 million people with access to these foods.

Mahatma Gandhi once stated: “I submit to you that scientists have not yet explored the hidden possibilities of the numerous seeds, leaves and fruits for giving the fullest possible nutrition to [humanity].” In this spirit, we need to invest in agricultural approaches such as biofortification and combine them with efforts to increase dietary diversity. After decades of focusing on reducing caloric deficits through agriculture, the “hidden possibilities” of the plant kingdom in improving nutrition are only beginning to be unlocked.



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YEARS

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ACTIVITIES DURING 2015



THE NEXT 50 YEARS

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A VIEW FROM THE FOUNDATION'S NEW PRESIDENT

Over the past years, the Nestlé Foundation has initiated and supported research on human nutrition in low-income and lower middle-income countries (LMICs), mainly in Latin America, Africa, and Asia, with an emphasis on sustainable effects in the studied populations, capacity building, and institution strengthening. It has prioritized research projects primarily led by local researchers from the developing countries. Projects jointly organized by scientists from developed countries and developing countries were funded if they were thought to promote capacity building in the latter, and the bulk of the budget was used in the developing country.

What are the challenges for the next decades?

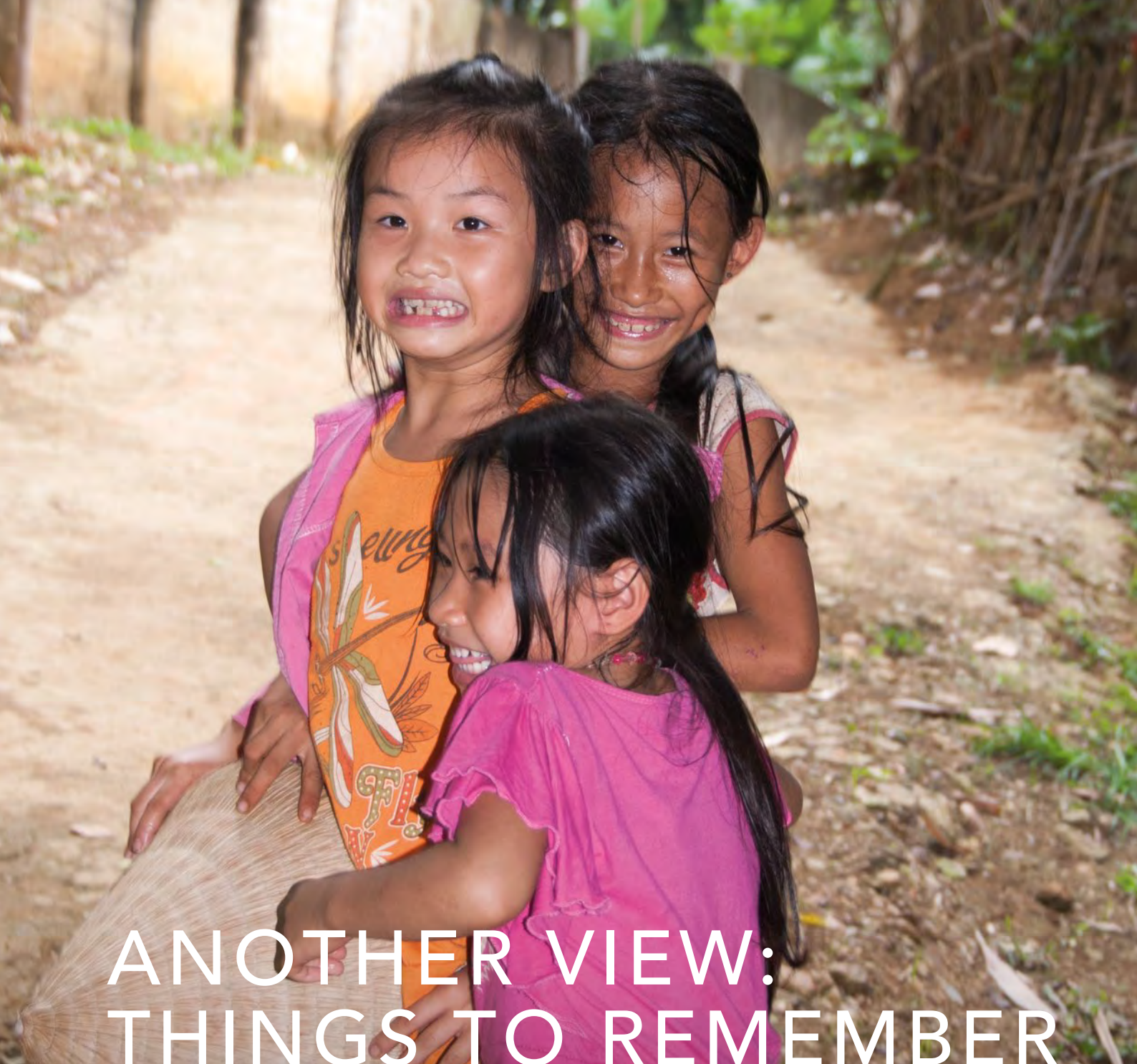
Unfortunately, the consequences of hunger and malnutrition will remain devastating and multifaceted—from Peru to Sudan to Indonesia. Although the world has made significant progress toward eradicating extreme hunger, communities, countries and companies will have to join forces, more than ever, to determine how to feed the world growing population. How can more food with enhanced nutritional value be produced? How can agriculture sustainability, food safety, extended food freshness, and reduced waste be improved? Short-term trends, such as local and regional conflicts, drought, flooding and fluctuations in food prices, will have effects on human nutrition and health. It has been estimated by the World Bank that the higher food prices during 2008 promoted malnutrition and increased the number of children suffering permanent cognitive and physical injury by 44% (1). Long-term considerations include: water scarcity, especially of potable water; reduction of land for agriculture due to competition for crops for biofuels and food production; and, most importantly, the global climate change. These factors will threaten the availability of sufficient food supplies needed to feed the world population, which is projected to increase by 1 billion over the next 12 years, and reach 9.6 billion by 2050. Although economic growth is anticipated, particularly in LMICs, it is unclear how it will contribute to improving nutrition outcomes. In some countries, like India, the benefits of economic development have not yet reached the poorest citizens, as India still has 40% of the world's malnourished children and 35% of the developing world's low-birth-weight infants. Fortunately, there are positive examples, like Brazil, where economic growth and reduction in poverty have resulted in significant improvements in children's health (2, 3).

Malnutrition, in the broad sense of the term, has received more attention recently, due to persisting undernutrition and the growing problem of obesity and its associated metabolic non-transmissible diseases. Evidence shows that the number of overweight individuals is increasing rapidly in countries where undernutrition in both children and mothers is still widespread (4). In many developing countries, there is a concern due to children under five who are overweight. Already in 2010, it was estimated that there were 43 million children (more than 80% of these in LMICs) who were overweight or obese (5).

The rather dark outlook described above identifies present and, more importantly, future nutritional health problems that individuals will encounter in LMICs. These problems will take decades to be solved, even from an optimistic standpoint. Pregnant women and children under the age of 5 years will remain the most vulnerable groups. Many major research themes naturally derive from this situation, which will be the

central focus for the Nestlé Foundation's activities in the future. A major challenge of research activities will be to understand the physiological and molecular basis of the complex nutritional needs, including the micronutrients, of women of reproductive age and of pregnant women, as well as of their progeny during the pre- and post-natal period and up to two years of age. This will promote healthy and productive populations, which are needed to support progress in LMICs. For instance, height-for-age at two years was found to be the best predictor of the abilities and skills of any individual. This definitively links undernutrition to lower intellectual assets. Damage that occurs during the early life period results in permanent impairment, and might also affect future generations (6). It is likely that findings for undernutrition will also apply to overnutrition. Furthermore, adolescent boys and girls should also improve their nutritional status so as to optimize the parenting process, which should result in their children having higher survival rates and cognitive development.

Our knowledge and understanding of the health of women, mothers and children remain very fragmentary. While the subject is not new, the way to address it will change dramatically in the future. New technologies are becoming readily available to address the functioning of whole biological systems, nutrient-gene bidirectional interactions, nutrition-dependent epigenetic modifications, and how the intestinal microbe populations influence the health of their host and therefore, how they may be manipulated to the host's benefit. These technologies allow huge amounts of data to be collected; thus, high-level bioinformatic tools are needed to process and extract this important information. Considerable efforts, accompanied by adequate financial support, will be necessary to educate a generation of researchers able to implement and use these tools in LMICs. Fruitful collaborations with developed countries are a prerequisite, but scientific developments within local institutions are also a must. Each population has its specificities, such as ethnic background, cultural inheritance, and environmental pressures. All these will have to be studied separately to truly understand its needs and solve its problems. It will be of the highest interest to elaborate local solutions that take into account the particular constraints in the chain from farm to fork to improve long-term health. It will be the mission for the next decades of the Nestlé Foundation to promote and support these research developments and their applications to ensure healthy populations globally, better educational achievements and economic prosperity in today's LMICs. Such research programs will require concerted actions and collaborations between all components of society.



ANOTHER VIEW: THINGS TO REMEMBER

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President of the Foundation, 2009-2015

Feeding the world is widely recognized as being one of the big challenges of the 21st century, especially in low-income countries, where malnutrition—undernutrition as well as overnutrition—is widespread and infant mortality is high. In the preceding contribution, Walter Wahli summarizes what the challenges are for the next decades and what future directions of research might be. But even if joint efforts across countries succeed in providing food of high nutritional value accessible in sufficient amounts for populations in low-income countries, there are more obstacles to overcome to bring people to apply knowledge of healthy nutrition. To be successful, efforts to improve the nutritional status of a population must take into account what enables and motivates individuals to adhere to recommendations concerning their health and the health of their children. Women have

a major role in providing and preparing food and in favouring a healthy environment for the family, and in the past decades many research projects have addressed the question of what enables women in low-income countries, who live and work under difficult conditions, to fulfil this task. How important this is will be discussed below.

A majority of the projects supported by the Foundation focus on young women and their infants and children in low-income countries, where efforts to improve the nutritional status in this population have an enormous potential to lower infant mortality, prevent non-communicable diseases in adulthood, and—if they concern women before and during pregnancy—even improve the health of future generations. Beyond the difficulty to provide them with food of high nutritional value, it is mandatory to know the prerequisites for success of interventions targeting nutrition, and in the past years the Foundation has consistently favoured the support of projects which take this into account. Information is of course a crucial part of any intervention and in this report Richard Calland describes how much the right of access to information may help in capacity building and development. But, even if information is available, it must still be understood and the individual person must be motivated to adhere to recommendations. In the context of the family, the overwhelming majority of mothers and fathers are deeply concerned about the well-being of their child, and it is not the motivation which is lacking. In the context of low-income countries, information is often not available, or not in the right moment, and even when it is, mothers may not perceive the problem or be able to see how an appropriate action may translate into an improvement of the health of their child. Access to information means access to education: both are essential prerequisites for the success of programs designed to improve the nutritional status of populations. Especially school education of girls and young women, which is still not accessible for every child in many regions of the world, has an enormous impact on infant mortality, by far more important than commonly thought, as shown by many studies in various regions of the world. In his book *Literacy and mothering* and in this report, Robert Levine reviews three previous studies by other authors: one from Matlab, Bangladesh; another from Cebu in the Philippines; and the INCAP study in Guatemala, which was supported by the Nestlé Foundation. All three of them show that maternal education is an important predictor of infant mortality, care-seeking behaviour by the mother, as well as maternal morbidity and use of contraception. Robert Levine's and his co-workers' own studies have shown that in other regions: in Mexico, Venezuela, Nepal and Zambia even a few years of school for girls can improve infant mortality and lead to a lower fertility rate. They show that literacy acquired during these school years, which are for most girls the first

contact with an unrelated adult person, improves their ability to accede to health information and provides them with what the authors call "health navigation skills", i.e. the ability to seek out and navigate the health-care system when needed. What is striking is that even after a few years of school many of these women continue to improve their literacy and later help their children with schoolwork. They relate in a different way to their children. Rather than behaving as a caretaker only, they reproduce with their children what they experienced in school: an adult "expert" transmitting information to a child. In the study in Venezuela, maternal literacy was a significant positive predictor of maternal communication to the child. In turn, that maternal communication to the child—its quantity as well as its quality—are direct predictors for the acquisition of language and later reading capacity, as has been convincingly shown in American children from different socio-economic backgrounds in remarkable long-term studies by Betty Heart and Todd Risley. They are summarized in their book *Meaningful differences in the everyday experience of young American children*. Furthermore, in the Lancet review series on maternal and child nutrition from 2013, parental schooling is found to be strongly associated with child nutrition and combining child stimulation and nutrition interventions can have complementary effects on nutrition outcomes.

Taken together, all these findings show that the success of nutrition interventions especially in infants and young children very strongly depends on the mother's education, her ability to promote her child's development and to seek health care for herself or her child when needed. These observations must be taken into account in research projects or for any program with nutrition interventions. Their potential to reduce infant mortality, prevent later adult diseases and maternal morbidity will never be fully reached in a society in which primary education is not accessible for all children. Surprisingly, already a few years of school for girls seem sufficient to have an important effect. The scientific evidence accumulated so far suggests that nutrition interventions, in countries where malnutrition is still widespread and infant mortality is high, are best integrated with programs improving the access—especially of girls—to at least primary education. Without this, the fight against malnutrition has little chance to be won.



In 2015 the Council decided to fund nine research projects.

DENTAL HEALTH

VITAMIN A & ANAEMIA

ARSENIC TOXICITY

EPIGENETICS

CHILD GROWTH

NEW RESEARCH PROJECTS

IODINE NUTRITION

FOOD SECURITY

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DENTAL HEALTH

Prevalence of Hypoplasia-associated Severe Early Childhood Caries and Deciduous Molar Hypomineralization amongst 3- to 6-year-old Anganwadi children in Pune, Maharashtra – A cross-sectional study

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USD 1,800

This cross-sectional study will be done amongst 3- to 6-year-old Anganwadi (i.e. preschool for children of low socioeconomic status) children in Pune, Maharashtra. Oral examination will be conducted to assess Hypoplasia-associated Severe Early Childhood Caries (HAS-ECC) (early childhood tooth decay) and Deciduous Molar Hypomineralization (DMH) (developmental enamel defect in the primary second molar). Around 800 children will be examined. A protocol of asepsis will be maintained. Then a questionnaire will be filled out by means of a face-to-face interview of the mothers of the children suffering from the above defects. The questionnaire consists of questions on prenatal factors such as diseases suffered by the mother during pregnancy, perinatal factors like low birth weight or premature birth and postnatal factors like postnatal diseases (e.g., recurrent gastroenteritis, respiratory infections, exanthematous diseases), duration of breastfeeding, etc. Then an association will be made between the presence of HAS-ECC and DMH and the prenatal, perinatal and the postnatal factors. In the end, the mothers, children and the Anganwadi staff will be given oral health and nutritional education. Prior to the start of the study, the examiner will be trained and calibrated for the diagnosis of HAS-ECC and DMH in the clinic of Department of Public Health Dentistry, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune by an expert who is familiar with the diagnosis of children with HAS-ECC and DMH. The inter-examiner and intra-examiner reliability will be checked. Also the questionnaire will be tested for validity and reliability before the start of the study.

VITAMIN A & ANAEMIA

The effect of mixed green leafy vegetables powder on vitamin-A and anaemia status of Ghanaian school children

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USD 24,042

Vitamin-A deficiency (VAD) and anaemia prevalence are nutritional issues of public health concern among Ghanaian schoolchildren. The Ghana School Feeding Program (GSFP) started in 2005 is not yet able to minimize the impact of these two nutritional problems confronting Ghanaian schoolchildren. Pre-formed vitamin-A food sources are not easily affordable for most rural households. Pro-vitamin A (beta-carotene) is converted to vitamin A when blood vitamin A is depleted. Green leafy vegetables (GLVs) are rich sources of pro-vitamin A. These are abundant during the wet season but scarce during the dry season. It implies that most rural household members have inadequate dietary intakes of pro-vitamin A during the dry season, and are often unable to meet their Recommended Dietary Allowance (RDA) for vitamin A. As a result there is always a prevalence of VAD among Ghana's children. Anaemia among Ghanaian schoolchildren has multiple causes. Vitamin A deficiency and poor bioavailability of non-haem iron from plant staples (legumes and cereals) may be the major causes. Studies have shown that vitamin A and beta-carotene could overcome the inhibitory effect of anti-nutritional factors on non-haem iron absorption. The study proposes to investigate the potential of mixed green leafy vegetables powder (MGLVP) to improve vitamin-A and haemoglobin levels of Ghanaian schoolchildren. An adequate amount of MGLVP will be added to the school lunch serving of children who will be randomly selected from schools taking part in the GSFP. A group of children in the selected schools also participating in the GSFP will be randomly selected to serve as controls. They will have the same school lunch serving without MGLVP. The outcome measures will be serum vitamin-A and haemoglobin concentrations at baseline, three months and six months.

ARSENIC TOXICITY

Removing inorganic arsenic from rice

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USD 185,000

Globally, rice is the dominant source of the class-one, non-threshold carcinogen inorganic arsenic (iAs) into the human diet. Rice is naturally elevated in iAs, ~10-fold higher than other foodstuffs. In Bangladesh, which has well documented problems with iAs in drinking water across the country, rice still accounts for a large proportion of iAs intake, even given that drinking water intakes are already highly elevated in a global context. As Bangladesh has one of the highest per capita rice consumption rates (~450g/d) changing from a rice-based diet is not an option; therefore, an effective and simple way is needed to get iAs removed from rice. While breeding for low-iAs rice and altering field management practices may be options medium to long-term, there are significant hurdles to cross before these two options are viable. We propose a direct, centralisable and readily implemental rice-processing solution. Parboiling is a procedure that drives bran nutrients into the rice kernel and causes starches to beneficially alter, increases milling yield, and removes pests such as weevils and fungal contaminants. Traditionally parboiling is conducted on unhusked grain (rough rice) that is then soaked, steamed/boiled and milled. All of these steps offer opportunities to remove iAs. It has been shown that cooking rice in large volumes of water reduces the iAs content, and research shows that if iAs-free cooking water is percolated through the rice that very high removal rates (up to 90%) are achievable, being very effective for wholegrain (de-husked rice). Soaking rough rice or wholegrain in percolating water may remove iAs, while the cooking stage in percolating boiling water would remove iAs. This grant application proposes to optimize parboiling procedures not only to remove grain iAs, but also with the aim to ensure the high retention of other nutrients.

EPIGENETICS

Maternal folate supplementation and epigenetic changes in the offspring

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USD 43,015

Recent animal studies show that maternal folate supplementation alters the offspring's DNA methylation and influences growth and metabolism. This study proposes to leverage the ongoing study of pre-conceptional micronutrient supplementation in Vietnam to evaluate the effect of pre-conceptional folate supplementation on DNA methylation in the offspring and subsequent epigenetic changes that may alter child growth and development. Using a combination of genome-wide measures of DNA methylation, it is planned to test the hypothesis that maternal FA supplementation influences the methylation of key genes regulating growth and metabolism, which influence the child's growth and development at two years. In the parent study, 5,011 women were randomized to one of three groups that received pre-pregnancy weekly supplements containing: 1) 2800 µg FA; 2) 60 mg iron + 2800 µg FA or 3) multiple micronutrients. Of those, 1,658 women conceived and were followed through delivery, and the team has already collected 1,248 cord blood samples. In addition they obtained birth information and cord blood samples from a concurrent sample of 450 mother-infant pairs from randomly selected non-intervention communes. In 2013, a Nestlé Foundation grant was given to the research team to assess the effects of the pre-pregnancy micronutrient interventions on offspring growth and development through age two years. In this proposal, it is planned to follow up on the children in the non-intervention communes and obtain similar data at age two. These additional data will allow a comparison of the effect of maternal folate supplementation on epigenetic changes in the offspring at birth and how they relate to child growth and body composition at two years of age.

CHILD GROWTH

Analysis of global variations in child growth and validity of the universality of the WHO 2006 growth standard

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USD 50,000

The scientific objectives of this study are: 1) to analyse and characterise the global relationship between child growth (<5 years) and income, parental stature and other factors and 2) to assess whether the growth centiles defined by the WHO 2006 growth standards define a norm or standard to which growth of healthy children in ideal circumstances converges to. This study innovates beyond previous research in this area since it is planned to uniquely combine child growth data from developing countries with DHS surveys with non-DHS data from developed and other nations (e.g. China and the Netherlands). This crucially incorporates observations on children whose socioeconomic circumstances and parental heights span and bound on both sides the children in the WHO multi-country growth reference study (MGRS). Novel methods from the poverty literature are applied to estimate living standards of our children in a common monetary metric. Finally, multilevel or mixed-model methods will be used to estimate parametric growth functions to characterize the relationship between covariates such as living standards and parental height (which proxies for genetic and epigenetic inheritance) and growth trajectories, and to address the statistical problems of unbalanced samples and differences between constituent survey designs and populations. In a scoping study, the research team has assembled the largest data set of its kind, with data on 650,000 children from 70 countries, including Euro-Growth Study. Preliminary analysis confirms the hypothesis that WHO standards represent only one, non-unique point on a continuous variation in child growth patterned by the two key covariates. It is proposed to: (i) make the analysis robust and generalizable by filling analytically critical gaps in coverage by incorporating an additional 450,000 children from other identified studies; (ii) utilize global expertise to apply multilevel model techniques to a highly challenging estimation problem; and (iii) ground and package our interpretation in current nutrition research.

IODINE NUTRITION

Nutrition promotion for improving iodine status of children in an iodine-endemic area in West Java, Indonesia

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USD 49,830

The Indonesian government implemented an iodized salt program to eliminate iodine deficiency among the people in 1994. However, the program is still less than successful, indicated by the fact that only 77.1% at the national level and 68.6% of the households in West Java Province usually consume salt with an adequate amount of iodine (MOH, 2013). The subjects of this study will consist of schoolchildren, their mothers and teachers, salt traders, salt producers and the staffs of local offices related to iodized salt policy and implementation, i.e. Offices of Industry, Trade, Education, and Health of Bogor District. The general objective of this study is to analyse the effectiveness of nutrition promotion in improving iodine status of children in an iodine-endemic area. Specifically, the objectives of this study are: 1) to analyse the iodine content of salt circulated in markets and consumed by households; 2) to identify the root problems of unstandardized iodized salt circulated in markets; 3) to analyse the nutritional knowledge, attitude, and practice of schoolchildren, mothers, and teachers, especially related to iodine; 4) to analyse iodine and other nutrients intake of children; 5) to conduct nutrition promotion to children and the mothers, teachers, and related stakeholders (salt traders, salt producers, and staffs of local offices of trade, industry, health, and education); and 6) to analyse the effects of nutrition promotion on iodine status of children, nutritional knowledge, attitude and practice related to iodine of children, mothers, and teachers. The steps of the study are: 1) selecting the study area and schools of four sub-districts with high IDD prevalence or low coverage of iodized salt; 2) developing promotional material; 3) conducting intervention of nutrition education for mothers, teachers, and children and advocating iodized salt to related stakeholders; 4) collecting data on food consumption and urine sample of children; 5) analysing pre- and post-test data on effectiveness of nutrition education and urinary iodine excretion (UIE).





FOOD SECURITY

Participatory prototyping complex agro-ecosystems designs to produce diverse food products in East Java, Indonesia

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and

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USD 17,947

As the fourth most populous country in the world, Indonesia is facing a great pressure to safeguard its food security. Rapid population growth accelerates land conversion and fragmentation has enhanced the number of small rice fields. Boosting production in these small-scale rice monoculture using agro-chemicals has caused yield instability due to recurrent secondary pest outbreaks, resistance and resurgence, threatening human health and increasing vulnerability to climate change, market trends and fluctuating prices. This also limits nutrition diversity for farmers' households, as illustrated by the fact that Indonesia is the fourth-largest rice consumer; more than 50% of their composition diet is rice. This situation leads to undernourished, nutrition-related health problems and vitamin deficiencies. In this study a method is presented to develop prototype designs of complex agro-ecosystems by integrating fish, duck, azolla, legumes, vegetables and fruits into rice systems. Thus, farmers should be able to harvest various food products for their own consumption and for the market. The prototype designs have three steps: The first step is characterising existing rice cropping systems in terms of farm performance, cultivation methods and farming context. The second step is execution of the participatory prototyping through the Farmer Field School (FFS) method to set goals (which include reduction of pollution, external inputs, and operational costs and improving rice yield and dietary diversification) and to arouse wider interest and to generate feedback. Each FFS has seven meetings during one crop season and conducts simple experiments to compare performances of conventional, organic and complex rice systems. The third step is reviewing performance of complex rice systems design in relation to the goals. Evaluation meetings will be held to get feedback from participants whether the prototype designs successfully reached the goals, were compatible to the local situation and reduced present constraints.

MATERNAL NUTRITION

Formative evaluation of an intervention to enhance nutrition and health status of pregnant adolescents in Eastern Uganda using education, cell-phone communication, and income generation

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and

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USD 20,000

Nutritional requirements for pregnant adolescents (10-19 years) are high, yet most pregnant adolescents in Uganda do not meet their nutritional requirements, in part due to food insecurity and low socio-economic status. Moreover, many do not attend antenatal care (ANC) and are therefore at risk of both poor prenatal health and adverse pregnancy outcomes. There is therefore a need for sustainable, comprehensive public health interventions to improve the nutrition and health of adolescent mothers. The proposed formative evaluation will establish community-level needs, approaches and collaborations to support an effective intervention to enhance the nutritional status and health of pregnant adolescents in eastern Uganda. The research is based on the social cognitive theory with an assumption that for pregnant adolescents, individual knowledge and skills; social environmental support like ease of communication (e.g., accessibility and availability of cell phones), family and community engagement; and physical environmental factors that support accessibility and availability of food, gainful employment and prenatal care will enhance nutritional status and health. Moreover, the impacts will extend beyond infant delivery. Participants in the interviews and focus group discussions for the formative evaluation will be recruited from target communities by purposive sampling. Key individuals will include adolescent mothers, school principals, medical centre heads, ANC unit heads, traditional leaders, senior teachers, mothers, grandmothers, husbands, nutrition and health educators, social workers, community midwives and health workers, traditional birth attendants, local council leaders, agricultural officers and leaders of craft and food preparation groups. Interviews and discussions will be analysed based on the social cognitive theory.

VITAMIN B12

Effect of vitamin B12 supplementation during pregnancy and six month postpartum to improve B12 status and child development

Towfida J Siddiqua and Lindsay Allen

International Centre for Diarrhoeal Diseases
Research (Icddr,b)
Dhaka, Bangladesh


and

USDA-ARS Western Human Nutrition
Research Centre
University of California, Davis
Davis, California, USA

USD 100,000

Vitamin B12 intake and status in pregnancy and lactation is potentially insufficient to prevent poor cognition and impaired child development related to inadequate B12 status. In Bangladesh, many women of reproductive age have insufficient B12 status, probably due to low intake of animal source food. Another risk factor for poor B12 is malabsorption associated with gastric diseases and nonspecific gastritis. To evaluate effects of B12 supplementation, a pilot study was conducted in which Bangladeshi women were randomized to 250µg B12/day or placebo through 3-mo postpartum. In this study high prevalence of deficient (26%) and marginal status (40%) of B12 in early pregnancy was found. Supplementation improved maternal and infant B12 status, breast milk B12 and maternal vaccine-specific IgA. However, supplementation up to 3-mo postpartum was not sufficient to reduce tHcy or sustain optimum concentration of all three markers in mothers. Indications from these findings as well as from studies in India and Tanzania are that supplementation starting from early pregnancy throughout the critical window of life just before weaning is important to sustain optimum B12 status. Moreover, B12 intake through food may be more culturally acceptable and bioavailable than pills. Therefore it is planned to conduct a double-blind, randomized trial to investigate the effects of B12-fortified milk on maternal and infant B12 status, immune function and child development. Pregnant women (n=148) will be randomized to receive B12-fortified milk (100 µg/day) or milk without fortification. The daily supplementation beginning at the baseline visit (GW 11-14) will continue until 6 mo-postpartum. Biomarkers of B12 status, immune response and infant development will be studied.





One of the major aims of the Nestlé Foundation is the transfer of sustainable capacity-building knowledge to low-income countries. During 2015 several specific capacity-building activities were supported.



AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT

Local creation and dissemination of nutrition knowledge on the African continent is crucial. The African Journal of Food, Agriculture, Nutrition and Development (AJFAND) (see also <http://www.ajfand.net>) is a nutrition journal made by Africans for Africans, thus creating awareness of the multiplicity of health and nutrition challenges facing Africa. The Foundation supports AJFAND with a regular contribution for the infrastructure as well as for each issue.

PUBLICATION FEES

Publishing research findings might be costly and thus represent another obstacle for many researchers from low-income countries. To enhance nutrition research dissemination, the Foundation paid the publication fees for selected nutrition research projects to assist the researchers from low-income countries in their careers as well as dissemination of their results.



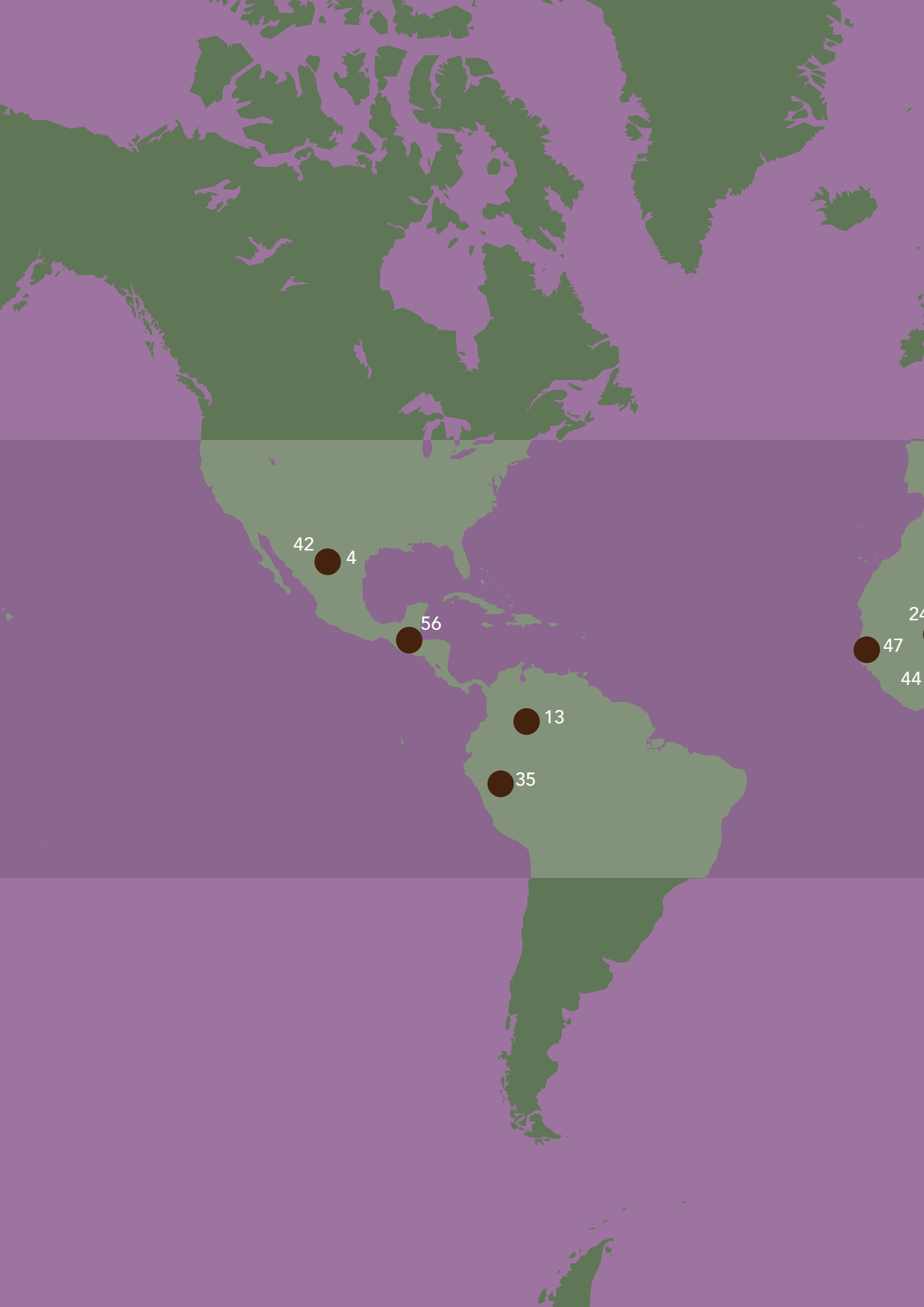
INSTITUTIONAL SUPPORT AND OTHER CAPACITY-BUILDING ACTIVITIES

THE enLINK TRUNK

During this year the last 66 enLINK trunks were shipped (see also page 66 & 214). The trunk shipments will be discontinued for the moment.

A NUTRITION LIBRARY FOR 470 PRIMARY SCHOOLS IN THE CONGO

Nutrition education has to start early in life. Accordingly the Foundation supported the equipment of 470 primary school libraries in the Congo with a book package entitled "Bibliothèque Nutrition pour écoles primaire". This is a small package containing nine books or booklets about the theory and practice of nutrition. This initiative was organized by Dr. Jacques Courtejoie and his team from the Centre de Promotion de Santé (CPS) in Kangu-Mayumbe (Congo). The CPS is one of the major producers of educational materials for medical doctors, nurses and midwives in the Congo. Dr. Courtejoie, head of the CPS, has worked for more than 50 years in the Congo as a medical doctor, and based on his vast experience educational materials in the local language are produced and distributed. The Foundation is proud to support a team which knows about the local needs and the corresponding deeds.





ONGOING PROJECTS

- | | | |
|---|--|---|
| 1 | 2007 / Iodine supplementation in mild-to-moderately iodine-deficient pregnant women: Effects on pregnancy outcome and infant development | Sumitra Muthayya
St John's National Academy of Health Sciences,
Institute of Population Health and Clinical Research,
Bangalore, India |
| 2 | 2008 / Improving micronutrient status of Chinese children using dietary spirulina | Shi-an Yin
National Institute of Nutrition and Food Safety,
Beijing, China |
| 3 | 2008 / Effects of vitamin-A supplementation during lactation on infants' antibody response to hepatitis-B vaccine in China | Zhxiu Wang
Nanjing Medical University, School of Public Health,
Nanjing, China |
| 4 | 2008 / Impact of vitamin-A and zinc supplementation on pathogen-specific diarrheal disease in Mexican children | Kurt Long
University of Queensland, Division of International
and Indigenous Health, Brisbane, Australia |
| 5 | 2009 / Effect of maternal zinc supplementation during pregnancy and lactation on infants' immunity | Mohammad Bakhtiar Hossain
ICDDR, B, Clinical Research Division, Mohakhali-
Dhaka, Bangladesh |
| 6 | 2011 / Effect of soybean supplementation, parasite control and nutrition education on iron status of adolescent girls in rural China | Lei Li
Medical College of Xiamen University, Siming District,
Xiamen, China |
| 7 | 2014 / Minimizing the negative effect of iron supplementation and fortification on gut microbiota using local resources | Siti Helmyati
Gadjah Mada University, School of Health and
Nutrition, Faculty of Medicine, Yogyakarta, Indonesia |
| 8 | 2015 / The effect of mixed green leafy vegetable powder on vitamin A and anaemia status of Ghanaian schoolchildren | Godfred Egbi
University of Ghana, Noguchi Memorial Institute for
Medical Research, Legon, Ghana |
| 9 | 2015 / Nutrition promotion for improving iodine status of children in an iodine-endemic area in West Java, Indonesia | Leily Amalia Furkon
Bogor Agricultural University, Bogor, Indonesia |

BREASTFEEDING

INFANT AND CHILD NUTRITION

- | | | |
|----|---|--|
| 10 | 2008 / Information and education to support and promote exclusive breastfeeding | Ada C Uwaegbute
Michael Okpara University of Agriculture, Umuahia, Nigeria |
| 11 | 2007 / Potential of amaranth grain seeds to improve the nutrition and health status of schoolchildren | John Muyonga
Makerere University, Department of Food Science and Technology, Kampala, Uganda |
| 12 | 2007 / Improving nutritional status of children aged 6-18 months in a semi-arid area in Kenya: The potential of amaranth seed flour | Alice Mboganie Mwangi
University of Nairobi, Applied Nutrition Programme, Uthiru-Nairobi, Kenya |
| 13 | 2008 / Nutrition, anaemia, growth and oxygen weaning in low-birth-weight oxygen-dependent infants in a Kangaroo Clinic | Nathalie Charpak
The Kangaroo Foundation, Bogota, Colombia |
| 14 | 2010 / Effect of fish meal and Vitamin C on the iron status of Ghanaian children consuming cow-pea-based food | Godfred Egbi
University of Ghana, Noguchi Memorial Institute for Medical Research, Legon, Ghana |
| 15 | 2010 / Intensive nutrition and hygiene education for improving nutrient intake of children (6-11 months) | Dwi Nastiti Iswarawanti
SEAMEO Regional Centre for Food and Nutrition, Jakarta, Indonesia |
| 16 | 2010 / Testing the efficacy of an audio program and discussion guide in promoting exclusive breastfeeding in Cameroon, Africa | Susanne Montgomery
Loma Linda University, School of Public Health, Loma Linda, California, USA |
| 17 | 2010 / Efficacy of combined selenium and iron supplementation on micronutrient status of school-children | Nguyen Van Nhien
National Institute for Food Control, Hanoi, Vietnam |

TITLE

PRINCIPAL INVESTIGATOR





TITLE

PRINCIPAL INVESTIGATOR

INFANT AND CHILD
NUTRITION

- | | | |
|----|---|--|
| 18 | 2011 / Effect of hookworm elimination and vitamin-A intervention on anaemic status of preschool children in Sichuan, China (resubmission) | Ke Chen
Chengdu Maternal and Children's Health Care Hospital, Chengdu, Sichuan, China |
| 19 | 2012 / Food-based approaches to reduce childhood nutrient-energy malnutrition in Bangang community, Cameroon | Marie Modestine Kana Sop
University of Douala, Faculty of Science, Douala, Cameroon |
| 20 | 2012 / Drama for behaviour-change communication about breastfeeding and complementary feeding practices in rural areas of Osun State, Nigeria | Beatrice Olubukola Ogunba
Obafemi Awolowo University, Department of Family, Nutrition and Consumer Sciences, Ile ife, Nigeria |
| 21 | 2013 / Infant and young child feeding and care practices of caregivers in the province of Albay, Philippines | Joyce Louise Cruz Ignacio
University of The Philippines Los Banos, College of Economics and Management, Laguna, Philippines |
| 22 | 2013 / Formulation and characterization of infant flours using spirulina powder in replacement of multivitamin-mineral complex | Evariste Mitchikpe
University of Abomey Calavi, Department of Nutrition and Food Sciences, Cotonou, Benin |
| 23 | 2014 / Effects of feeding style and fibre content of complementary foods on the appetite of Ethiopian infants | Kaleab Baye
Addis Ababa University, Centre for Food Science and Nutrition, Addis Ababa, Ethiopia |
| 24 | 2014 / Effect of personalized nutritional counselling on child growth and feeding practices in Burkina Faso | Yassinme Elysee Somasse
Polytechnic University of Bobo-Dioulasso, Department of Public Health, Bobo-Dioulasso, Burkina Faso |

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| 25 | 2008 / The development of new norms for indicators of iodine status during pregnancy and its impact on the prevalence of mental retardation in children | Chen Zupei
Tianjin Medical University, Institute of Endocrinology, Tianjin, China |
| 26 | 2009 / Impact of daily consumption of vitamin-A-fortified oil on breast milk vitamin-A concentration and vitamin-A status of lactating Moroccan women | Najat Mokhtar
Ibn Tofail University, Nutrition Unit, Kenitra, Morocco |
| 27 | 2009 / Role of vitamin-B12 supplementation during pregnancy and postpartum to alleviate nutritional anaemia in Bangladeshi women and their infants | Towfida Jahan Siddiqua
ICDDR, B, Nutritional Biochemistry Lab, Dhaka, Bangladesh |
| 28 | 2010 / SMS and web-based support for appropriate infant feeding to prevent childhood obesity in urban China | Hong Jiang
Fudan University, School of Public Health, Shanghai, China |
| 29 | 2010 / Urinary iodine concentration of pregnant women in Zambia as an indicator of their iodine nutrition status | Cyprian Katongo
Copperbelt University, School of Mathematics and Natural Sciences, Kitwe, Zambia |
| 30 | 2010 / Pre-conceptional vs gestational food supplements and pregnancy outcomes in rural Vietnam | Tu Ngu
National Institute of Nutrition, Department of Applied Nutrition and Nutritional Surveillance at the National Institute of Nutrition, Hanoi, Vietnam |
| 31 | 2011 / Assessment of iodine status in pregnant women and weaning infants in eastern region of Nepal | AK Nepal
Koirala Institute of Health Sciences, Department of Biochemistry, Kathmandu, Nepal |
| 32 | 2013 / Impact of pre-pregnancy micronutrient supplementation on infant growth and development | Phuong Hong Nguyen
Thainguyen Medical School, Thainguyen, Vietnam |



TITLE

PRINCIPAL INVESTIGATOR

33 2009 / Food-based intervention and psychosocial stimulation to improve growth and development of <24mo Indonesian children

Umi Fahmida
University of Indonesia, SEAMEO RECFON, Jakarta, Indonesia

34 2011 / Effects of maternal iodine supplementation in an area of mild iodine deficiency on infant development to 2 years (a follow-on study to our previous Nestlé Foundation grant)

K Srinivasan
St. John's Research Institute, Bangalore, India

35 2012 / Maternal zinc nutrition: Its influence on human health and development in Peruvian children

Nelly Zavaleta
Instituto de Investigacion Nutricional, Lima, Peru

36 2013 / Food-based intervention and psychosocial stimulation to improve child growth and development: First follow-up study

Umi Fahmida
University of Indonesia, SEAMEO RECFON, Jakarta, Indonesia

37 2010 / The role of sub-clinical inflammation on micronutrient status of Myanmar adolescent girls during micronutrient supplementation

Min Kyaw Htet
SEAMEO TROPED Network, Jakarta, Indonesia

38 2011 / Exploration of Myanmar rural caregivers' concepts of childhood diarrheal disease (6 -24 months) and its management related to ORS use and feeding

Khaing Mar Zaw
University of Indonesia, SEAMEO RECFON, Jakarta, Indonesia

EPIDEMIOLOGIC TRANSITION

39 2009 / A pilot study of school-based peer education and obesity-related behaviours in adolescents in Beijing, China

Zhaohui Cui
University of Sydney, The George Institute for International Health, Sydney, Australia

NUTRITION EDUCATION

40 2011 / A multi-approach intervention to empower posyandu nutrition programs to combat the malnutrition problem in rural areas

Ali Khomsan
Bogor Agricultural University, Department of Community Nutrition, Bogor, Indonesia

FORGOTTEN CROPS / AGRICULTURE

41 2014 / The efficacy of biofortified pearl millet in a randomized controlled trial with children <2y in rural Eastern Kenya

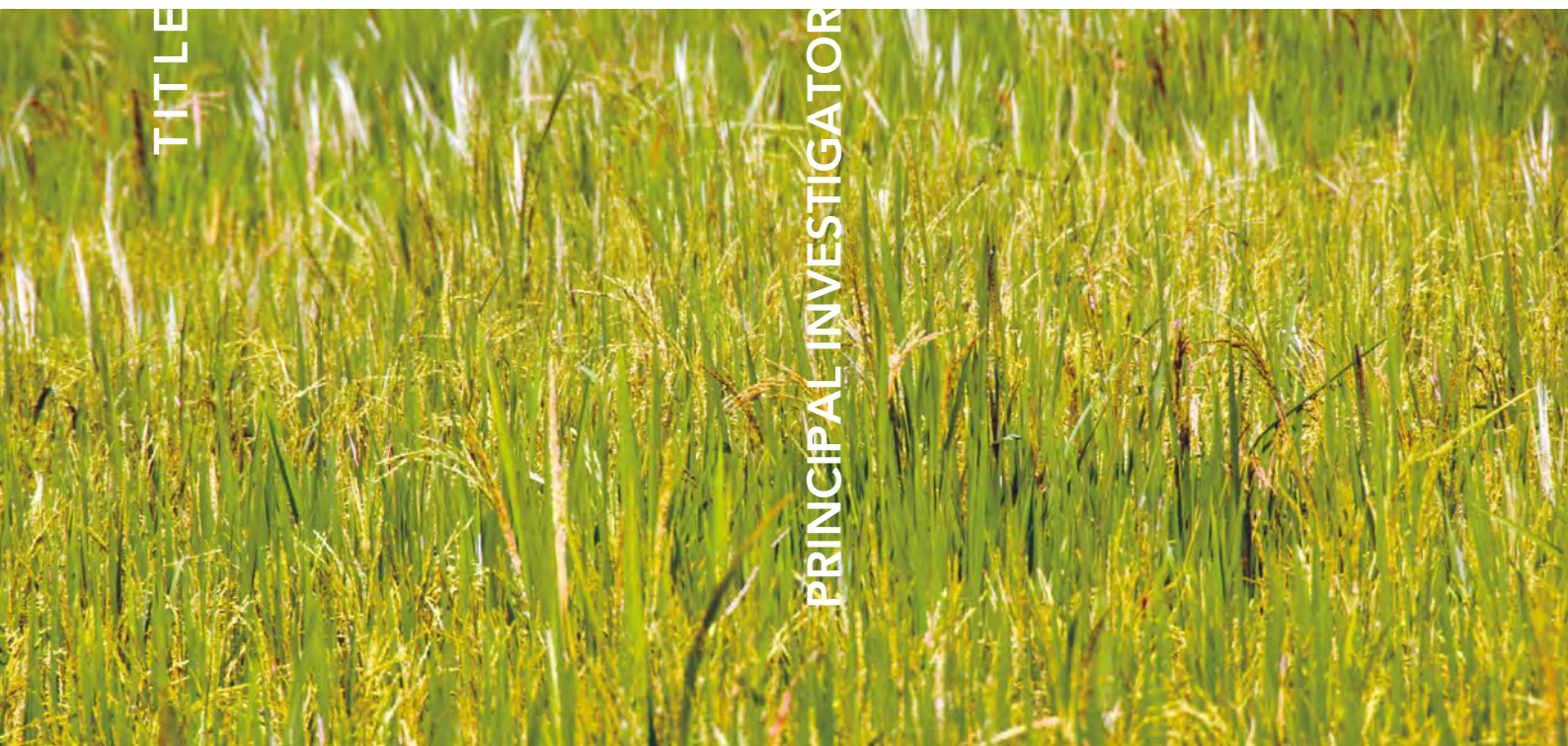
Mueni Hellen Ndiku & Sabaté Joan
University of Eastern Africa, Baraton School of Science and Technology, Eldoret, Kenya
Loma Linda University, School of Public Health, Loma Linda, California, USA

42 2014 / Promoting food sovereignty through a cooperative model for sustainable organic farming in the Mayan Region, Mexico

Cristina Osorio-Vazquez
Universidad Intercultural Maya de Quintana Roo, Quintana Roo, Mexico

TITLE

PRINCIPAL INVESTIGATOR





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|----|---|--|
| 43 | 2008 / Causes and control of food insecurity: A pilot model in the Northwest of Iran | Saeed Dastgiri
Tabriz University of Medical Sciences, Faculty of Medicine, Tabriz, Iran |
| 44 | 2010 / Improving nutritional status of school-children through consumption of cowpea: A food sovereignty perspective | Abdul-Razak Abizari
School of Medicine and Health Sciences, Community Nutrition Department, Tamale, Ghana |
| 45 | 2010 / Pilot study to assess the acceptability of pearl millet grain at macro- and micro-levels in rural Eastern Kenya | Mueni Hellen Ndiku
University of Eastern Africa, Baraton, School of Sciences and Technology and Department of Public Health, Eldoret, Kenya |
| 46 | 2011 / Effectiveness of nutrition package in improving growth of rural children (6-23 months): A cluster randomised trial | Kissa B.M. Kulwa
Sokoine University of Agriculture, Department of Food Science and Technology, Morogoro, Tanzania |
| 47 | 2012 / Prenatal and young child nutritional supplementation and early childhood body composition, growth and development | Momodou K Darboe
MRC International Nutrition Group, Banjul, Gambia |
| 48 | 2012 / Optimized complementary feeding versus iron supplementation on micronutrient status and gut microbiota of children (resubmission) | Lwin Mar Hlaing
University of Indonesia, SEAMEO RECFON, Jakarta, Indonesia |
| 49 | 2012 / Effects of dietary/lifestyle counselling on risk of major cardiovascular events in CAD and non-CAD populations in Indonesia (resubmission) | Iqbal M. Husein
Gadjah Mada University, School of Medicine, Makassar, Indonesia |
| 50 | 2012 / Consumer acceptability of spirulina in Zimbabwe, and effect of cooking on spirulina provitamin A carotenoids | Tawanda Muzhingi
Tufts University, Avondale, Harare, Zimbabwe |
| 51 | 2012 / Sustainable community-based diabetes prevention program by lifestyle modification for at-risk populations in Thailand | Kitti Sranacharoenpong
Mahidol University, Institute of Nutrition, Phuttamonthon, Thailand |
| 52 | 2012 / Community salt iodization and relation of iodine intake to Visual Information Processing (VIP) of Ethiopian infants | G Tafere
Hawassa University, Human Nutrition, Hawassa, Ethiopia |

- | | |
|---|---|
| 53 2012 / Effect of nutrient-dense complementary food on catch-up growth of Indonesian moderately stunted children | Duma Octavia Fransisca
University of Indonesia, SEAMEO RECFON, Jakarta, Indonesia |
| 54 2013 / Child-centred counselling and home-based food production to improve dietary adequacy and growth of young children in south-western Ethiopia | Abebe Gebremariam
Jimma University, Department of Population And Family Health, Jimma, Ethiopia |
| 55 2013 / Assess the impact of public health services distribution of vitamin A in the under-five children in remote rural Zambia | Frederick D Kaona
University of Zambia, Mwengu Social and Health Research Centre, Ndola, Zambia |
| 56 2013 / Behaviour change and nutrition associated with integrated maternal/child health, nutrition and agriculture program | Manolo Mazariegos
Institute of Nutrition of Central America and Panama (INCAP), Guatemala City, Guatemala |
| 57 2013 / Healthy kitchens, healthy children: A school-based cluster randomized controlled trial | Nadine Sahyoun & Hala Ghattas
University of Maryland, Department of Nutrition and Food Science, College Park, Maryland, USA and American University of Beirut, Centre for Research on Population and Health, Beirut, Lebanon |
| 58 2013 / Nutrition and food security: Impact of soil fertility and productivity of home gardens on family nutrition (resubmission) | U R Sangakkara †, continued by Janaki Mohotti
University of Peradeniya, Faculty of Agriculture, Peradeniya, Sri Lanka |
| 59 2013 / Study on effects of excess iodine and the tolerable upper intake level of iodine for children (Pilot study) | Wanqi Zhang
Tianjin Medical University, Public Health College, Tianjin, China |
| 60 2014 / Nutrition gap map: A comprehensive mapping, quality assessment and summary of nutrition-relevant systematic reviews | Zulfiqar Ahmed Bhutta
Aga Khan University Hospital, Centre of Excellence in Women and Child Health, Karachi, Pakistan |
| 61 2014 / A cohort analysis of the sustainability of food insecurity control programs in the northwest of Iran | Saeed Dastgiri
Tabriz University of Medical Sciences, Faculty of Medicine, Tabriz, Iran |
| 62 2015 / Participatory prototyping of complex agro-ecosystems designs to produce diverse food products in East Java, Indonesia | Uma Khumairoh
University of Brawijaya, Faculty of Agriculture, Malang, East Java, Indonesia |
| 63 2015 / Removing inorganic arsenic from rice | Andrew A. Meharg & Habibur Rhaman
Queens University Belfast, Plant and Soil Science, Belfast, Northern Ireland and Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh |
| 64 2015 / Formative evaluation of an intervention to enhance nutrition and health status of pregnant adolescents in eastern Uganda using education, cell phone communication, and income generation | Josephine Nabugoomu
School of Public Health and Health Systems, Waterloo, Canada |
| 65 2015 / Maternal folate supplementation and epigenetic changes in the offspring | Phuong Hong Nguyen
Thainguyen Medical School, Thainguyen, Vietnam |
| 66 2015 / Analysis of global variations on child growth and validity of the universality of the WHO 2006 growth standard | P. Rannan-Eliya Ravindra
University Colombo, Institute for Health Policy, Colombo, Sri Lanka |



THE DIGITAL enLINK LIBRARY

Also during 2015 the digital enLINK library continued to grow, both in terms of number of books offered (at present 39 e-books) as well as registered users and usage:

enLINK user statistics (as of December 31, 2015):

- 378 registered users
- Registrations from 48 countries
- Doubling of full-text views during the last year
- Regular access from users living in **Togo, Ghana, Nigeria, Sudan, Zambia, Vietnam, Ethiopia, Cameroon, Indonesia**
- Most frequently accessed journals:
Current Opinion in Clinical Nutrition
Metabolic Care and Nutrition Today
- Most frequently accessed books:
Oxford Handbook of Nutrition and Dietetics
Essentials in Human Nutrition
Modern Nutrition in Health and Disease

The enLINK trunks

In 2015, 66 enLINK trunks were shipped. In late fall the very last English trunks were mailed to Asmara (Eritrea). During the year twelve small Spanish trunks were delivered to Guatemala. For the moment no new trunks will be built. Despite the progress in digital publishing and digital libraries, books will most likely not disappear and will contribute to capacity building in many years to come.

Anyone from a low-income country can apply to become a registered user. The detailed registration information is available at www.enlink.org. Registration and use of the enLINK library are both free of charge.



www.enLINK.org



enLINK LIBRARY

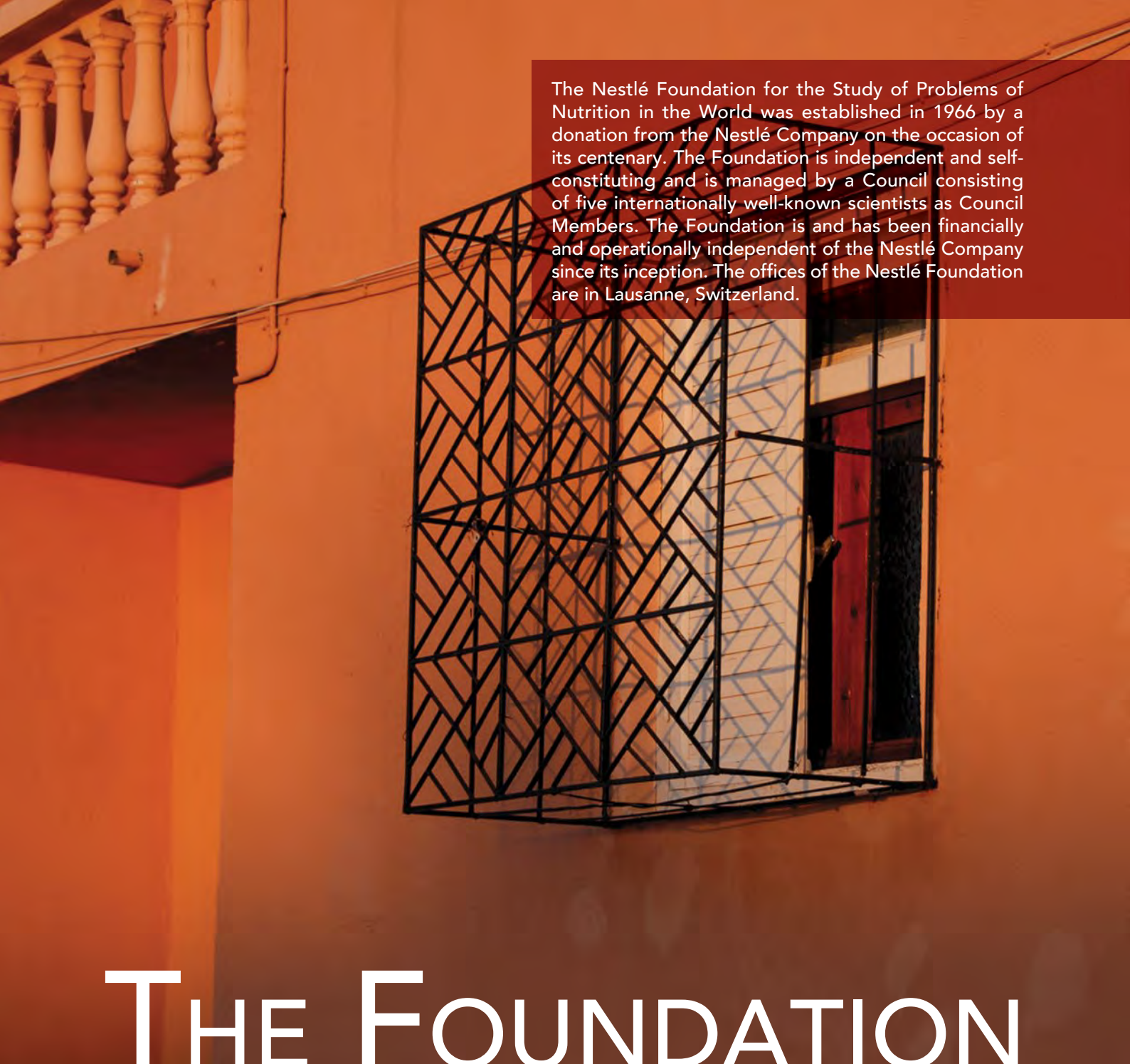
PUBLICATIONS

- Ahmad SM, Hossain MB, Monirujjaman M, Islam S, Huda MN, Kabir Y, Raqib R, Lönnerdal BL. Maternal zinc supplementation improves hepatitis B antibody responses in infants but decreases plasma zinc level. *Eur J Nutr* (published online 25 July 2015) doi: 10.1007/s00394-015-0999-6.
- Egbi G, Ayi I, Saalia FK, Zotor F, Adom T, Harrison E, Ahorlu CK, Steiner-Asiedu M. Impact of cowpea-based food containing fish meal served with vitamin C-rich drink on iron stores and hemoglobin concentrations in Ghanaian schoolchildren in a malaria endemic area. *Food Nutr Bull* 2015;36:264-275.
- Helmyati S, Juffrie M, Rahayu ES, Isti Kandarina BJ. A comparative study of gut microbiota profiles of children living in Kulon Progo and West Lombok. *Pakistan J Nutr* 2015;14:762-4.
- Helmyati S, Rahayu ES, Kandarina BJ, Juffrie M. Sensory evaluation comparison of formulated fermented milk and commercial fermented milk: a new formulated fermented milk as food supplement for iron-deficiency anemia elimination program. *Int J Curr Microbiol App Sci* 2015;4:657-65.
- Htet MK, Fahmida U, Thurnham DI, Hlaing LM, Akib A, Utomo B, Houghton LA. Folate and vitamin B12 status and dietary intake of anaemic adolescent schoolgirls in the delta region of Myanmar. *Br J Nutr* 2015;1-6 (doi:10.1017/S0007114515001609).
- Jaikrishna N. Effect of iodine supplementation in Indian pregnant women on maternal and newborn thyroid function and cognitive development. Published Thesis, Wageningen University, The Netherlands; 2015:241pp (ISBN 978-94-6257-333-8).
- Kana Sop MM, Mananga MJ, Tetanye E, Goudao I. Risk factors of anemia among young children in rural Cameroon. *Int J Curr Microbiol App Sci* 2015;4:925-35.
- Kana Sop MM, Namadi M, Tetanye E, Goudao I. Effect of *Spirulina platensis* supplementation on nutritional and biochemical parameters of under five years malnourished children from an orphanage in Douala, Cameroon. *J Pharm Nutr Sci* 2015;5:5-13.
- Li M, Jiang H, Hu QZ, He GS, Wen LM, Dibley MJ, Baur L, Qian X. Text message to promote breastfeeding and obesity-protective eating behaviours in young children: 12 and 24 months BMI results. *Obes Res Clin Pract* 2014; 8 (Suppl. 1):58 (dx.doi.org/10.1016/j.orcp.2014.10.107).
- Mangani C, Maleta K, Phuka J, Cheung YB, Thakwalakwa C, Dewey K, Manary M, Puumalainen T, Ashorn P. Effect of complementary feeding with lipid-based nutrient supplements and corn-soy blend on the incidence of stunting and linear growth among 6- to 18-month-old infants and children in rural Malawi. *Matern Child Nutr* 2015;11:132-43.
- Nepal AK, Suwal R, Gautam S, Shah GS, Baral N, Andersson M, Zimmermann MB. Subclinical hypothyroidism and elevated thyroglobulin in infants with chronic excess iodine intake. *Thyroid* 2015;25:851-9.
- Nguyen P, DiGirolamo A, Gonzalez-Casanova I, Pham H, Truong T, Nguyen S, Martorell R, Ramakrishnan U. Breastfeeding practices are associated with child development in Vietnamese children. *The FASEB J* 2015;29:1 (suppl 899.4) (abstract).
- Rahmawati W, Muslimatun S, Wijaya-Erhardt M, Erhardt JG, Kurniawan A. Helminth infection and iron status of pregnant women in two geo-climatic areas in Indonesia. *Malaysian J Nutr* 2015;21:155-66.
- Reinsma K, Bolima N, Fonteh F, Okwen P, Siapco G, Yota D, Montgomery S. Bobbi Be Best: the development and evaluation of an audio program and discussion guide to promote exclusive breastfeeding in Cameroon, Central Africa. *Glob Health Promot* 2015;1-13 (doi: 10.1177/17579759145567869) [Epub ahead of print].
- Siddiqua TJ, Ahmad SM, Ahsan KB, Rashid M, Roy A, Rahman SM, Shahab-Ferdows S, Hampel D, Ahmed T, Allen LH, Raqib R. Vitamin B12 supplementation during pregnancy and postpartum improves B12 status of both mothers and infants but vaccine response in mothers only: a randomized clinical trial in Bangladesh. *Eur J Nutr* 2015 (published online February 2015) (doi: 10.1007/s00394-015-0845-x).
- Sukandar D, Khomsan A, Anwar F, Riyadi H, Mudjajanto ES. Nutrition knowledge, attitude, and practice of mothers and children nutritional status improved after five months nutrition education intervention. *Int J Sci: Basic Appl Res (IJSBAR)* 2015;1-19.
- Tafere G, Peterson S, Stoecker B. High variability of urinary iodine concentrations (UIC) and iodine in salt from rural households in Sidama zone, Southern Ethiopia. *Eur J Nutr & Food Safety* 2015;5:914-5 (abstract).
- Ukegbu PO, Uwaegbute AC, Anyika JU, Echendu CA, Nkwoala CC. Assessment of lactation performance of mothers practicing exclusive breastfeeding in Abia State, Nigeria using test weighing technique. *Pioneer Medical J* 2015;5:16-24.

The publications are available free of charge upon request.







The Nestlé Foundation for the Study of Problems of Nutrition in the World was established in 1966 by a donation from the Nestlé Company on the occasion of its centenary. The Foundation is independent and self-constituting and is managed by a Council consisting of five internationally well-known scientists as Council Members. The Foundation is and has been financially and operationally independent of the Nestlé Company since its inception. The offices of the Nestlé Foundation are in Lausanne, Switzerland.

THE FOUNDATION

GUIDELINES FOR GRANT APPLICATIONS TO THE NESTLÉ FOUNDATION

PURPOSE

The Nestlé Foundation initiates and supports research in human nutrition with public-health relevance in low-income and lower-middle-income countries according to the World Bank classification (see <http://www.worldbank.org>). The results of the research projects should ideally provide a basis for implementation and action which will lead to sustainable effects in the studied populations as generally applicable to the population at large. They

should also enable institution strengthening and capacity building in a sustainable manner in the host country, and further cooperation and collaboration between institutions in developed and developing countries.

The Foundation expects research proposals to be primarily the initiative of local researchers from the developing countries. However, the Foundation will

be inclined to consider favourably those applications made jointly by scientists from developed countries with those from developing countries provided it is clear that the initiative will result in capacity building and human-resource development in the latter and that the bulk of the budget is spent in the developing country.

CURRENT POLICY

Sustainable improvement in human nutrition is one of the major issues in the portfolio of the Foundation. During more than 40 years, basic and applied research in nutrition has been supported by the Foundation in over 50 developing countries. In view of the past activities of the Foundation as well as the world's situation at the turn of the millennium, it was recognized that the public-health relevance of the supported research as well as aspects of sustainability, capacity building and educational issues should have a higher priority. Thus, priority is given to projects which lead to sustainable developments with strong elements of capacity building, and the implementation of the results of a research project should be immediate and sustainable. Highly sophisticated nutrition research of mainly academic interest without public-health relevance has lower priority for support, as do solely laboratory-based studies or animal experimentation.

RESEARCH TOPICS

At present the Foundation's work is primarily concerned with human nutrition research issues dealing with:

- (1) maternal and child nutrition, including breastfeeding and complementary feeding,
- (2) macro- and micronutrient deficiencies and imbalances,
- (3) interactions between infection and nutrition, and
- (4) nutrition education and health promotion.

The precise priorities and goals of the Foundation are modified from time to time to meet emerging public-health and nutritional needs in the developing world.

Studies in other areas of human nutrition research might also be considered, as long as they are dealing with problems of malnutrition in eligible countries (see above). Other areas of research may possibly be considered for support if the applicant can offer

specific and convincing evidence and justification for the choice of the research topic.

Funded projects are usually of one- to three-year duration. Projects with a high potential for effective and sustainable improvement of the nutritional status as well as a high capacity-building component will be funded preferentially. The budget of the projects must be appropriate and reasonable and has to be justified in detail.

One of the Foundation's main aims is the transfer of scientific and technological knowledge to target countries. In cases where Foundation-sponsored research projects are realized in collaboration with scientists at universities and research institutes in high-income countries, at least 75% of the budget has to be earmarked for use within the low-income country.

The Foundation does not normally fund:

- (1) projects with low public-health relevance
- (2) projects with doubtful sustainability
- (3) projects lacking transfer of scientific, technical and educational knowledge, i.e. lacking a capacity-building component
- (4) large-budget projects, meaning projects that exceed USD 100,000 per year or USD 300,000 over the total duration of a 3-year project
- (5) nutrition surveys or surveillance studies
- (6) research on food policy, food production and food technology except when linked to an intervention with high potential for sustainable improvement of the nutritional status
- (7) in vitro and/or animal experiments.

ELIGIBLE INSTITUTIONS

Eligible institutions are departments or institutes from universities, hospitals, and other institutions of higher education in low- or lower-middle-income countries. Joint applications from more than one institution (especially South-South) are welcomed. Joint applications from more than one institution involving a North-South collaboration may also be considered. For project applications demonstrating North-South collaboration, it is important that the following criteria are fulfilled: (i) the Principal Investigator is from the South and the proposal has relevance to nutritional problems of the South; (ii) the majority of the budget is earmarked for the South; and (iii) demonstration upon completion of the project of institution- and capacity building in a sustainable manner in the South.

The capacity-building component represents a core issue for all applications to the Foundation. This means that every application needs to demonstrate a training and human-resource and capacity-building component for the developing world. Ideally graduate students or young investigators should play a key role and, where possible, be designated as the Principal Investigator (PI), i.e. be the primary grant applicant, or Co-PI. Established researchers can nevertheless apply but need to clearly indicate the capacity-building component and the designated beneficiaries. All applications need to clearly state the capacity- and human-resource-building components in the host country as well as the long-term sustainability of research in the host institution. Applications from individuals who are non-affiliated researchers and not attached to research or academic institutions can be considered only in very special cases.



TYPES OF AWARDS

The Nestlé Foundation offers different award and grant categories, some of them using a modular approach; for example, the Pilot Grant Program represents the starting grant module for a later Full Grant Research application. The eligibility criteria as well as the research objectives and topics have to be fulfilled no matter what the award category (for further details see www.nestlefoundation.org):

A. Research Grants

Grant type	Description	Budget (in USD)
Training Grant (TG)	The Training Grant (TG) Program supports a small research project such as a MSc or PhD thesis project or another training endeavour.	up to 20,000 in total
Pilot Grant (PG)	The Pilot Grant (PG) Program of the Foundation provides support for pilot research that has a high potential to lead to a subsequent full research project grant. Usually the Foundation does not support nutritional survey research, but often to be able to identify areas of problems for potential intervention one has to collect baseline data. If a pilot study (pre-study or baseline study) will create the needed data for a larger research project, the PG program may assist this. The pilot study and PG usually represent the starting point for a later full research grant application (i.e., a SG or LG) to the Foundation.	up to 20,000 in total
Small Research Grant (SG)	The Small Research Grant (SG) provides support for a small research study. This may represent a continuation of a TG or a PG.	up to 50,000 in total
Large Research Grant (LG)	Full grant application of a complete research proposal according to the guidelines.	up to 100,000 per year to a maximum of 300,000 for 3 years
Re-Entry Grants	To encourage post-graduate students to return to their own countries and to aid them in establishing their careers, the Foundation will support a research programme for eligible candidates. The host institution will need to guarantee a post for the returnee and ensure career development within the host institution. Contribution of support to the eligible candidate from the host institution is essential, while support and collaboration from the overseas institution where the candidate trained is helpful.	up to 50,000 in total

B. Institutional Support

Institutional support involves the support of research or educational projects in specific institutions in low- or lower-middle-income countries which contribute to a focused development of capacity and know-how and human-resource development in the corresponding institution.

HOW TO APPLY

Interested scientists should first submit a letter of intent in which they describe very briefly the kind of project they would like to undertake, including an estimated budget. Instructions for the letter of intent are available on the Foundation website at www.nestlefoundation.org. For a submission of a letter of intent only the downloadable form on our website should be used. If the suggested project is compatible with the Foundation's current funding policy, applicants will receive an invitation to submit a full grant proposal. The guidelines for the submission of a full grant proposal are also available on our website. Other formats will not be accepted, neither for the letter of intent nor for the full grant applications.

In the letter of intent and in the grant application, detailed, evidence-based information about the public-health relevance of the project as well as its immediate impact and sustainability have to be reported. This part of the application is as important as the scientific section of the application.

Research grant applications are evaluated twice a year by the Foundation's Council, a group of independent international scientists. The funding of projects is primarily based on the scientific quality, public-health relevance in the short and long term, sustainability, capacity-building component and, last but not least, budget considerations.

Applications are accepted throughout the year, and the Foundation encourages applicants to submit their proposals early to allow sufficient time for internal as well as external reviews. All submissions should be made electronically by e-mail. Final deadlines for submission are January 10 and May 10 for the Spring and Fall Council Meetings, respectively.

**For more information consult
www.nestlefoundation.org**



The Council of the Foundation consists of five Council Members and Advisors. All Council Members and Advisors are internationally well-known scientists with a specific expertise in different fields of nutrition. The Council is self-constituting and operates independently. The Foundation is directed jointly by the Director and the President of the Foundation.

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The literature references for the different contributions are available on the website of the Foundation at www.nestlefoundation.org.

A list of all research publications of projects supported by the Foundation is also available for downloading.

Nestlé Foundation

for the study of problems of nutrition in the world



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