

Combating Micronutrient Deficiencies: Food-based Approaches



Edited by

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Introduction

The importance of food-based approaches for the prevention and control of micronutrient deficiencies as well as for the improvement of nutrition in general is fully recognized by the Food and Agriculture Organization of the United Nations (FAO). FAO, a specialized UN agency, has as its mandate the raising of levels of nutrition and ensuring humanity's freedom from hunger by promoting sustainable agricultural and rural development. Focusing on the unique relationship between agriculture, food and nutrition, FAO works actively to protect, promote and improve established food-based systems as the sustainable solution to ensure food and nutrition security and, by doing so, to achieve the nutrition-related Millennium Development Goals (MDGs). FAO is committed to supporting the promotion of the production and adequate consumption of micronutrient-rich foods as the sustainable solution to micronutrient malnutrition.

This booklet provides a summary of the publication *Combating Micronutrient Deficiencies: Food-based Approaches*, published jointly by FAO and CAB International and contains the abstracts and the list of key words for each chapter. The publication has 19 chapters, each of which shows the benefits – and in some cases the limitations – of food-based approaches for preventing and controlling micronutrient malnutrition. One hundred authors with different backgrounds have contributed to the book which brings together for the first time under one cover the available knowledge, success stories and lessons learned on country-level activities to demonstrate that food-based approaches are viable, sustainable, and long-term solutions to overcoming micronutrient malnutrition. Many different views and analyses have been captured providing a rich collection of knowledge and experience. Furthermore, the publication is an exceptionally rich source of references on the subject.

The purpose of *Combating Micronutrient Deficiencies: Food-based Approaches* is to provide policy makers, agronomists, food and nutrition security planners, programme implementers and health workers with the information needed to better understand, promote, support and implement food-based strategies to combat micronutrient deficiencies in their respective countries. The publication will appeal to professionals in the sectors of food security, nutrition, public health, horticulture, agronomy, animal science, food marketing, information, education, communication, food technology (preservation, processing and fortification) and development.

Although the most severe problems of micronutrient malnutrition are found in developing countries, people of all population groups in all regions of the world can be affected by micronutrient deficiencies. Approximately two billion people – about a third of the world's population – are today deficient in one or more micronutrients. This is one of the most serious impediments to socio-economic development, contributing to the vicious cycle of malnutrition, underdevelopment and poverty. Micronutrient malnutrition has long-ranging effects on health, learning ability

and productivity, leading to high social and public costs, reduced work capacity in populations due to high rates of illness and disability and tragic loss of human potential. Therefore, overcoming micronutrient deficiencies is a precondition for ensuring rapid and appropriate development.

FAO strongly emphasizes that food-based approaches, which include food production, dietary diversification and food fortification, are sustainable strategies for improving the micronutrient status of populations. Increasing access to and availability and consumption of a variety of micronutrient-rich foods not only have a positive effect on micronutrient status but also contribute to improved nutrition in general. In addition to its intrinsic nutritional value, food has social and economic significance which, for many people, especially those living in developing countries, is commonly mediated through agriculture and agriculture-related activities that sustain rural livelihoods. The multiple social, economic and health benefits associated with successful food-based approaches that lead to year-round availability, access and consumption of nutritionally adequate amounts and varieties of foods are clear. The nutritional well-being and health of individuals is promoted, incomes and livelihoods supported, and community and national wealth created and protected.

However, progress in promoting and implementing food-based strategies to achieve sustainable improvements in micronutrient status has been slow. They were often overlooked as governments, researchers, the donor community and health-oriented international agencies sought approaches for overcoming micronutrient malnutrition that had rapid start-up times and produced quick and measurable results. Although many lives have been saved and much suffering has been avoided as a result of these efforts many developing countries, international agencies, non-governmental organizations (NGOs) and donors are now realizing that food-based strategies that promote diet diversity are a viable, cost-effective and sustainable solution for controlling and preventing micronutrient malnutrition.

Currently, the combined effects of prolonged underinvestment in nutrition, food and agriculture, the recent food price crisis and the economic downturn have led to increased hunger and poverty, jeopardizing the progress achieved so far in meeting the MDGs. FAO estimates that a total of 925 million people are undernourished in 2010. This book shows how food-based approaches not only reduce the prevalence of micronutrient malnutrition, but can also improve the nutritional status of all populations and mitigate one of today's greatest public health problems.

We hope that *Combating Micronutrient Deficiencies: Food-based Approaches* will serve as the basis and catalyst for future dialogue, debate and information exchange and facilitate wider support for an international movement committed to the implementation of effective, long-term food-based solutions to undernutrition and for combating micronutrient deficiencies, thus allowing the world population to achieve its full human and socio-economic potential.

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Strategies for Preventing Multi-micronutrient Deficiencies: a Review of Experiences with Food-based Approaches in Developing Countries

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Abstract

The importance of coexisting micronutrient deficiencies in developing countries is gaining recognition, prompted by the disappointing responses often observed with single micronutrient supplements. Further, of concern is the feasibility and sustainability of supplementation as a mode of delivery in poor resource settings. Consequently, there is increasing emphasis on food-based approaches: fortification, dietary diversification and modification, and biofortification. Novel delivery approaches exist for fortifying complementary foods in the household using tablets, sprinkles and fat-based spreads. These are all designed to supply micronutrients without any changes in feeding practices, and irrespective of the amount of food consumed. A version of the fortified spread is also used as a ready-to-use therapeutic food for treating malnourished children. Dietary diversification and modification, in conjunction with nutrition education, focuses on improving the availability, access to and utilization of foods with a high content and bioavailability of micronutrients throughout the year. The strategies are designed to enhance the energy and nutrient density of cereal-based porridges; increase the production and consumption of micronutrient-dense foods (especially animal-source foods); incorporate enhancers of micronutrient absorption; and reduce the phytate content of cereals and legumes through germination, fermentation and soaking.

In the future, biofortification via processes such as agronomic practices, conventional plant breeding or genetic modification holds promise as a sustainable approach to improve micronutrient adequacy in the diets of entire households and across generations in developing countries. This review summarizes new developments in food-based approaches, their advantages and limitations, and examines some of the efficacy studies and programmes utilizing food-based strategies to alleviate micronutrient deficiencies.

Key words: complementary food supplements, fortification, household dietary strategies, biofortification

Addressing Micronutrient Malnutrition to Achieve Nutrition Security

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Abstract

The poor quality of the habitual diet and the lack of dietary diversity in much of the developing world contribute to deficiencies of micronutrients. Micronutrient malnutrition is a global problem much bigger than hunger and imposes enormous costs on societies in terms of ill health, lives lost, reduced economic productivity and poor quality of life. Addressing the global challenge of micronutrient malnutrition requires the need for many strategies – both short- and intermediate-term and long-term sustainable approaches. In addition to the conventional approaches of micronutrient supplementation and fortification, promoting sustainable food-based approaches to enable adequate intakes of micronutrients by much of the population includes dietary diversification strategies and agriculture-based approaches. Dietary diversification is possible by the promotion of homestead food production, which includes home gardening, small livestock rearing and fishing as well as the processing and preservation of food. Agriculture and agricultural biotechnology offer the opportunity of increasing crop yields and have the potential to improve the micronutrient content of staple foods and cereal crops, thus contributing to better nutrition of populations and thereby helping to achieve nutrition security. By ensuring food and nutrition security and by reducing the widespread problem of micronutrient malnutrition we may hope to achieve the targets set for the Millennium Development Goals.

Key words: nutrition security, food security, micronutrient deficiencies, dietary diversification, home gardening, homestead food production, agricultural biotechnology

Agricultural Interventions and Nutrition: Lessons from the Past and New Evidence

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Abstract

Globally, many poor households rely on agriculture for their livelihoods, and this remains true even when livelihoods are diversified. Poor households are also most vulnerable to undernutrition, including lack of micronutrients. Over the last decades, a variety of organizations have aimed to harness agriculture for nutrition. Agricultural approaches have the potential to substantially impact nutritional outcomes in a sustainable way, but there is insufficient understanding of the evidence base for this potential impact and of how best to achieve this potential. This chapter aims to consolidate the available evidence linking agricultural interventions to nutrition outcomes. First, the chapter describes five pathways through which agricultural interventions can impact nutrition: consumption of own production; increases in income; reductions in market prices; shifts in consumer preferences; and shifts in control of resources. Second, we review four types of studies that provide insights about links between agriculture and nutrition: early studies of agricultural commercialization; studies of women in agriculture; studies of horticultural interventions; and studies of livestock and aquaculture interventions. Consistent themes include the importance of integrating well-designed behaviour-change communications and careful consideration of gender dimensions. Third, we present two case studies that show how well-designed interventions can successfully diversify diets and/or impact micronutrient intakes and nutritional status outcomes; the second case study illustrates impact at scale. The review yields lessons for design of future interventions and for evaluation design, and identifies critical areas for future work, which include investigations of cost-effectiveness, scaling up processes and sustainability.

Key words: nutrition, agriculture, micronutrients, gender, interventions

A 3-year Cohort Study to Assess the Impact of an Integrated Food- and Livelihood-based Model on Undernutrition in Rural Western Kenya

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Abstract

Reducing extreme poverty and hunger is the first Millennium Development Goal (MDG). With undernutrition contributing to one third of all child deaths, improving nutrition is a precondition for accelerating progress towards other MDG targets. While the role of technical interventions such as micronutrient fortification and supplementation in reducing morbidity and mortality has been well documented, evidence to support more comprehensive multi-sectoral approaches remains inconclusive. This chapter aims to evaluate the impact of an integrated food- and livelihood-based model on nutrition-related outcomes in rural western Kenya.

A 3-year prospective cohort study was undertaken among 300 randomly selected wealth-stratified households. Detailed socio-economic and health surveys were conducted. A nutrition module assessed household levels of food security, food consumption frequency and diet diversity. This was complemented by anthropometric measurement and assessments of serum levels of vitamin A among children under 5 years old.

The average food insecurity score decreased from 5.21 at baseline to 4.13 at follow-up ($P < 0.0001$). Average diet diversity scores for daily, weekly and monthly time periods increased from 6.7 to 7.3; from 10.7 to 11.2; and from 12.4 to 12.6 respectively ($P < 0.0001$). Daily consumption for 14 out of 16 food groups increased significantly. For children under 2 years of age, underweight and stunting decreased from 26.2% to 3.9% ($P = 0.002$) and from 62.3% to 38.3% ($P = 0.014$) respectively. Vitamin A deficiency as measured by serum Vitamin A levels decreased from 70.0% to 33.3% ($P = 0.007$) for children under 5 years old.

This study presents encouraging evidence that a multi-sectoral food- and livelihood-based model can improve diet quality, enhance food security and positively affect childhood nutritional outcomes. The wider application of this approach to a diversity of agro-ecological zones in sub-Saharan Africa is currently being assessed.

Key words: diet diversity, multi-sectoral, food security, vitamin A, stunting, food-based

Food-based, Low-cost Strategies to Combat Micronutrient Deficiencies: Evidence-based Interventions in Lesotho and Malawi

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Abstract

The combined effects of HIV infection, food insecurity and malnutrition have fuelled adult death rates across southern Africa, causing an alarming increase in the number of orphans. The long illness commonly associated with HIV infection affects productivity, drains family resources and erodes livelihoods, leaving households and communities stressed, both nutritionally and socio-economically, and vulnerable to further deterioration. Regular intake of nutritionally adequate diets, including micronutrient-rich foods, is essential for boosting the immune system and maintaining good health. Lesotho and Malawi were piloted for a food security and nutrition project that included dietary diversification, aimed at improving micronutrient intakes among HIV-affected communities.

The project's overall objectives included: protecting and promoting the nutritional well-being of HIV/AIDS-affected children; improving livelihoods and food and nutrition security among HIV-affected households; and strengthening the capacity of communities to provide support to HIV-affected households and children. This chapter restricts itself to showing it is possible to enable resource-poor, HIV- and drought-affected communities to combat micronutrient deficiencies through food-based approaches.

Multiple strategies – including institution-building, human resource development, use of participatory approaches, promoting bio-intensive methods of agriculture – and crop and diet diversification, were used in the implementation process.

These strategies and technologies enabled communities to produce and access greater amounts and variety of micronutrient-rich foods all year round. Effective nutrition education and improved techniques in food processing, preservation and preparation increased the consumption of micronutrient-rich foods among target populations.

Through appropriate strategies and technologies the capacity of resource-poor, HIV-affected communities to combat micronutrient deficiencies can be strengthened.

Key words: capacity building, strengthened institutional framework, crop and diet diversification, bio-intensive agricultural methods, participatory approaches, food-based approaches, orphans and vulnerable children, HIV-affected communities, micronutrient deficiencies

Animal-source Foods as a Food-based Approach to Address Nutrient Deficiencies and Functional Outcomes: a Study among Kenyan Schoolchildren

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Abstract

The importance of micronutrients in growth, cognitive development and combating infection is becoming more evident. The main approaches to ameliorating micronutrient deficiencies have been non-food-based approaches. This chapter describes a randomized, controlled school feeding study that tested for a causal link between animal-source food intake and micronutrient nutrition, growth, cognitive and behavioural outcomes. Twelve rural Kenyan primary schools were randomized to one of four groups. Standard I children received the local plant-based dish *githeri* (maize, beans and greens) as a school snack with added meat, milk or fat (the latter to equalize energy content). Control children received no feedings but participated in data collection. Outcome measures at baseline and longitudinally were 24-h food intake recall, anthropometry, cognitive function, physical activity and behaviours during school free play. The meat group showed the steepest rate of increase in Raven's Progressive Matrices scores and in zone-wide school end-of-term total and arithmetic test scores. The meat group showed the greatest increase in percentage time in high levels of physical activity, initiative and leadership behaviours compared with all other groups. For growth, in the milk group only younger and stunted children showed a greater rate of gain in height. The meat group showed near doubling of upper mid-arm muscle area and the milk group a smaller increase. Serum vitamin B₁₂ showed significant improvement. This is the first randomized controlled feeding study to show the effect of meat- versus milk- versus plant-based snacks on children's functional outcomes. Food-based approaches, particularly utilizing animal-source foods, offer potentially sustainable solutions to multiple deficiencies.

Key words: animal-source foods, meat, milk, growth, development, micronutrients, Kenya

Small-animal Revolving Funds: an Innovative Programming Model to Increase Access to and Consumption of Animal-source Foods by Rural Households in Malawi

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Abstract

Increased intake of animal-source foods is a key means to improve nutritional status in populations with high levels of nutrient deficiencies. However, there are few examples of programming models that have successfully improved both access to and consumption of animal products in resource-poor settings. This chapter presents a case study of a community-based intervention to increase household access to and consumption of animal-source foods, implemented as part of a comprehensive, 9-year nutrition and health programme in Malawi.

A community-managed revolving fund scheme was used to distribute small animals to rural households, accompanied by training on animal husbandry and intensive nutrition education to promote consumption of the animal products. This was integrated into a broader anaemia control strategy, which included iron supplementation and malaria control. Cross-sectional surveys were used to evaluate programme effectiveness, including comparison of beneficiary communities with non-programme areas.

Household rearing of all small animals increased from 43% to 65% in programme areas. Significantly more households in the programme area both raised and consumed the target animals at the final evaluation. Anaemia prevalence in pregnant women decreased from 59% to 48% in the programme area, but increased to 68% in the comparison group. In pre-school children, anaemia prevalence decreased similarly in both groups.

The revolving fund scheme successfully increased access to and consumption of small animals in programme communities. Anaemia prevalence decreased in women, but the specific contribution of the animals to this cannot be separated from the combined impact of the integrated programme.

Key words: animal-source foods, anaemia, revolving fund

Aquaculture's Role in Improving Food and Nutrition Security

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Abstract

This chapter provides an overview of aquaculture and discusses the significant nutritional value of its products and its role in rural development. Nearly half of the total global food fish supply comes from aquaculture, making it not only an important source of nutrition, but also a key sector that can reduce poverty through improving livelihoods and well-being at global and community levels. Fish is the primary source of animal protein in developing countries, contributing about 20% of total animal protein supply. Aquaculture has the potential to improve the diets of even the poor segments of the world's population through increased consumption of protein, fatty acids (*n-3*), vitamins and minerals (calcium, phosphorous, iron, selenium and iodine). The main aquaculture-producing countries are in Asia. Employment in aquaculture is highest in China, where 13 million people worked in this sector in 2006. Aquaculture is growing faster than all other animal food-producing sectors with an average of 7.0% per annum since 1970. As growth in this sector is expected to continue, aquaculture infrastructure needs to be improved to ensure the success of this thriving industry. There is a need to strengthen aquaculture planning and policies that support the small-scale fisheries sector in developing countries as it is often overlooked by governments when designing policies and strategies for rural development. Small-scale aquaculture has to be developed as a responsible and sustainable entrepreneurial activity that is financially viable so as to assure its efficacy in poverty reduction and nutrition improvement.

Key words: aquaculture, fish, nutrition, food and nutrition security, rural livelihoods

A Home Gardening Approach Developed in South Africa to Address Vitamin A Deficiency

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Abstract

Home gardening, focusing on provitamin A-rich vegetables, is a long-term strategy that can contribute to combating vitamin A and other nutritional deficiencies which are of public health significance in developing countries. The provitamin A carotenoid content of foods and their potential contribution towards meeting the vitamin A requirements of the target population are predominant considerations in the selection of crops to be planted. This chapter describes a home garden approach that integrates gardening activities with nutrition education, using community-based growth monitoring as entry point. Studies using this approach in South Africa showed a favourable affect on maternal knowledge of vitamin A nutrition, dietary intake of provitamin A-rich vegetables, caregiver-reported child morbidity and children's vitamin A status. Provitamin A-rich vegetables and fruits contributed significantly towards achieving the recommended dietary intake of vitamin A and various other micronutrients. Seasonal availability of provitamin A-rich vegetables and fruits needs to be taken into consideration to ensure year-round availability of provitamin A-rich foods.

The approach is flexible and entry points other than community-based growth monitoring can be used to promote production and consumption of provitamin A-rich vegetables and fruits. Demonstration gardens to serve as training centres, community-based nurseries for orange-fleshed sweet potato cuttings and a seed distribution system are important components of the home garden projects. Various constraints experienced with vegetable gardens and possible solutions are highlighted. Participation in gardening projects is self-selective. Non-participating households within the project areas are, however, exposed to the promotion activities, resulting in a spill-over affect to non-participating households.

Key words: food-based approach, home gardens, vitamin A, provitamin A carotenoids, vegetables and fruits, South Africa

AVRDC – The World Vegetable Center’s Approach to Alleviate Malnutrition

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Abstract

AVRDC - The World Vegetable Center¹ conducts research and development activities to increase access to and improve consumption of diverse and nutrient-rich vegetables, particularly in areas where malnutrition is prevalent. AVRDC aims to improve human nutrition through increasing vegetable productivity, availability and consumption; improving the nutrient content and phytochemical density of vegetables; enhancing the bioavailability of nutrients from vegetables; and improving the health and economic status of the poor in developing countries. Activities to increase vegetable productivity, availability and consumption include the genetic improvement of vegetables (biotic and abiotic resistance and tolerance), development of production systems to increase year-round availability of vegetables, good crop management practices to improve yield and reduce chemical inputs, development of post-harvest technologies to reduce losses, and the promotion of vegetable consumption through information technology, school and home gardening, nutrition education and designing nutrition seed kits for home gardens. Activities to improve the nutrient content and phytochemical density of vegetables include collection and evaluation of vegetable genetic resources, identification and promotion of underutilized indigenous vegetables high in nutrients and bioactive compounds, and selection and/or breeding to increase content of nutrients and bioactive compounds. To enhance the bioavailability of nutrients, optimum food preparation methods and recipes are developed and promoted. Finally, the impact of vegetable consumption on health and economic development, as well as the health benefits of consuming vegetables high in bioactive compounds, is discussed.

Key words: vegetables, indigenous vegetables, micronutrients, bioavailability, breeding, germplasm, school and home gardens, nutrition seed kits, phytochemicals

¹ AVRDC – The World Vegetable Center was formerly known as the Asian Vegetable Research and Development Center (AVRDC). Since 2007, AVRDC expanded its regional mandate worldwide to become AVRDC – The World Vegetable Center, abbreviated as AVRDC throughout the paper.

Introducing Vegetables into the India Mid-day Meal (MDM) Programme: the Potential for Dietary Change

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Abstract

Adequate nutrition is crucial during childhood and a diet rich in micronutrients is vital for good physical growth and mental development and prevention of infectious diseases. Fruits and vegetables are a vital part of a balanced diet and a good source of vitamins and minerals, including vitamin A. Schools are increasingly recognised as important settings for promoting healthy nutrition and eating practices in children.

This chapter reviews recent research from Africa and Asia on the effectiveness of food-based interventions to combat vitamin A deficiency. A few recent studies suggest that schools in developing countries can effectively channel nutrition support to a critical target group of children, using dietary solutions to improve vitamin A status. An outstanding question remains how such potentially life-giving dietary changes can most effectively be promoted and maintained on a larger scale.

To respond to this question, this chapter also reviews current literature on school-based fruit and vegetable initiatives in developed and developing countries. Using country-based data, it then outlines the process and the results of a pilot intervention carried out in urban Indian schools in the Municipal Corporation of Delhi to promote increased vegetable consumption through the Mid-day Meal (MDM) programme and create awareness among teachers and children on the health benefits of vegetables. Despite limitations in the intervention design, many lessons can be learnt from this pilot intervention. It shows that the introduction of vegetables into MDM is feasible and sustainable, provided that adequate funds are allocated. If used effectively, the MDM can become a major tool for improving vegetable consumption among school-aged children in urban and rural India.

Key words: India, schoolchildren, Mid-day Meal, vegetables, vitamin A, nutrition education

Developing Micronutrient-rich Snacks for Pre-conception and Antenatal Health: the Mumbai Maternal Nutrition Project (MMNP)

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Abstract

Observational and trial data suggest that poor maternal micronutrient status as a result of poor dietary quality before and during pregnancy impairs foetal growth and development.

This chapter describes the development of palatable food supplements produced from locally available vegetarian foods that improve the quality of the diet of young Indian women living in Mumbai slums.

A vehicle in the form of a cooked snack food that could be distributed daily was developed to provide the women with supplementary green leafy vegetables (GLV), fruit and milk. The target nutrient content of the snack was defined based on intake data from the study population and the UK Estimated Average Requirement (EAR). The snack was analyzed to measure these target nutrient levels and palatability was assessed.

Several approaches were used to deliver the amount of GLVs, fruit and milk that were considered sufficient to have an impact on the women's nutritional status. A vehicle was developed that contained these micronutrient-rich foods and was palatable and acceptable to the women. Some of the target micronutrient levels were achieved using combinations of fresh GLVs, dried fruits and milk powder. Mean micronutrient levels of the final product (per serving) were: β -carotene 123 retinol equivalents; folate 68 μ g; riboflavin 0.14 mg; iron 4.9 mg; calcium 195 mg; vitamin B₁₂ 0.24 μ g. These values are between 12% and 43% of the UK EAR. To date, target vitamin C levels have not been achieved.

It is possible to develop palatable, culturally acceptable and safe micronutrient-rich food supplements using a low-tech approach and locally available fresh and dehydrated ingredients.

Key words: micronutrient, food supplement, green leafy vegetables, fruit, milk, India

Approaches and Lessons Learned for Promoting Dietary Improvement in Pohnpei, Micronesia

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Abstract

The island state of Pohnpei, Micronesia, has experienced much change in diet and lifestyle since the 1970s. Serious problems of micronutrient deficiencies and non-communicable disease such as diabetes, heart disease and cancer have emerged, following the neglect of traditional local foods and the shift to rice and imported processed foods. An awareness campaign on the benefits of local food, especially carotenoid-rich bananas for nutrition, is the subject of this paper. A community, inter-agency, participatory programme was implemented focused on raising awareness on island food production and consumption. Messages were shared on horticulture, cooking, food processing and conservation through mass media, posters, print materials, photography, national postal stamps, workshops, displays, youth clubs, farmers' fairs, competitions, email and slogans: 'Go Yellow' and 'Let's Go Local'. Research was undertaken in food analysis, genebank collections and community case studies as part of a global health project.

As yellow-fleshed carotenoid-rich foods (banana, taro, pandanus and breadfruit varieties) were identified and promoted, banana and taro consumption increased as did the number of the varieties consumed. Carotenoid-rich banana varieties not previously marketed such as *Karat*, *Utin Iap* and *Daiwang*, became popular. Foods ready for consumption using local banana and taro varieties appeared in the markets where these had not been sold previously. The awareness campaign stimulated great interest in Pohnpei and throughout the region with invitations to present at international meetings and 'Go Local' workshops outside Pohnpei. It was proclaimed as an awareness success and consideration should be given to applying this approach to other Pacific Islands.

Key words: local food, provitamin A carotenoid, food composition, inter-agency, participatory, community

A Food Systems Approach to Increase Dietary Zinc Intake in Bangladesh based on an Analysis of Diet, Rice Production and Processing

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Abstract

The potential to increase the zinc content of rice in communities has been under-exploited. An understanding of the zinc content of rice in communities may be used to plan programmes by identifying and plugging the 'nutrient leaks' in the food system from soil to plate.

This chapter describes a study that aimed to measure the zinc content of rice at different stages from production to consumption in communities and determine the potential for intervention based on the magnitude of differences observed. A second objective was to demonstrate the potential impact of these interventions on zinc intake of children.

The study took the form of a cross-sectional observational study of the usual practice of growing, processing and cooking rice, with measurements of the zinc content of rice using inductively coupled plasma-atomic emission spectroscopy. Dietary assessments were undertaken on children in rice producing communities in four districts of Bangladesh.

Comparison of the four villages suggests the potential for improvements of 11% if the soil zinc is increased from below to above the critical level (0.8 ppm DTPA-available), of 15% with adjustments to milling, of 16% with changes in cooking and up to 38% with a change in locally available rice varieties. If all these changes were implemented, the zinc content of a low-zinc rice would potentially double and children's total dietary zinc would increase by 64%.

Local information on the variability in the zinc content of rice may be used to improve zinc nutrition. This would be most effective as part of an integrated, community-based nutrition strategy that addresses constraints and opportunities to improve multiple nutrient malnutrition.

Key words: *Oryza sativa*, zinc, soil, food processing, diet surveys, food-based approach, food system, Bangladesh

Combating Iron Deficiency: Food-based Approaches

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Abstract

Iron deficiency is the most widespread dietary deficiency in the world affecting close to two billion people or one-third of the world's population. Its most visible impact is iron-deficiency anaemia (IDA) which contributes significantly to high levels of maternal and neonatal deaths in poor, vulnerable populations, while the 'hidden' impact of iron deficiency extends to all areas of individual growth and development. Anaemia is most prevalent in pregnant women and pre-school children. The insidious nature of IDA has made it a difficult challenge for the international community to address effectively as its scale and impact is often overlooked. The chapter presents requirements for iron and related micronutrients and describes the prevalence and geographic and socio-economic distribution of anaemia. The public health consequences of anaemia on both the individual and on society are outlined and the determining or contributing factors that can lead to or hinder their alleviation are discussed.

The chapter concludes that increasing the availability and consumption of a nutritionally adequate diet is the only sustainable and long-term solution, not just for overcoming IDA, but for overcoming other micronutrient deficiencies as well. Policies and intervention programmes that effectively alleviate micronutrient deficiencies are described, including increasing overall food intake, increasing consumption of micronutrient-rich foods, modifying intake of dietary inhibitors and enhancers, using improved processing, preservation and preparation techniques, consumer education for behaviour change, improving food quality and safety and public health, and food fortification and supplementation. The Food and Agriculture Organization of the United Nations is committed to placing food-based strategies for preventing micronutrient deficiencies high on the development policy agenda and urges all parties to speed up their wider implementation if the Millennium Development Goals are to be achieved on time.

Key words: iron deficiency, iron deficiency anaemia, bioavailability, micronutrients, food-based strategies, dietary diversification, nutrition education, food and nutrition security, food fortification

Human Micronutrient Deficiencies: Linkages with Micronutrient Deficiencies in Soils, Crops and Animal Nutrition

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Abstract

Micronutrient contents (trace elements and minerals) of foods are partially determined by the micronutrient content and availability in soils on which the foods are grown. In principle, under conditions of soil micronutrient deficiency, micronutrient contents of food crops can be increased by application of micronutrients as fertilizer.

The first objective of this chapter is to analyse and document the occurrences and the strengths of the linkages between micronutrient deficiencies in soils, crops, animal and human nutrition. The second objective is to assess whether micronutrient application as fertilizer can be a realistic and feasible approach in addressing human micronutrient deficiencies.

Literature in the fields of soil science, agriculture, ecology, animal nutrition and human nutrition has been searched in order to document and analyse, as completely as possible, the relationships between micronutrients in soils, food crops, animal and human nutrition.

Evidence for direct quantitative relationships between micronutrient deficiency in soils and in human nutrition is most clearly available for iodine and selenium, and possibly also for zinc. For zinc and selenium, addition of these micronutrients to soils can substantially increase crop micronutrient content, and thus contribute to ameliorating human micronutrient deficiency.

When considering various approaches in addressing human micronutrient deficiencies, such as dietary diversification, micronutrient supplementation, micronutrient fortification of foods, developing new varieties through plant breeding and genetic manipulation, there appears to be, for some micronutrients, sufficient evidence to consider micronutrient fertilization as an alternative approach, with its own specific advantages. Currently, the most promising candidate for this approach is zinc.

Key words: micronutrient deficiencies, soils, agriculture, fertilizer, human nutrition, iodine, zinc, selenium, iron

Nationwide Supplementation of Sodium Selenate to Commercial Fertilizers: History and 25-year Results from the Finnish Selenium Monitoring Programme

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Abstract

Selenium is unevenly distributed in soils worldwide. For climatic and geochemical reasons, Finland is one of the low-selenium regions in the world. To improve the quality of Finnish foods and animal health and to increase the selenium intake of the population, an official decision was made in 1984 to supplement compound fertilizers with selenium. Since 1985, practically all fertilizers used in Finland have contained selenium. The objective of this chapter is to report the effects of the supplementation of selenium to commercial fertilizers on soils, feeds, basic foodstuffs, dietary selenium intake, human tissues and the environment.

Within a monitoring programme, sampling of cereals, basic foodstuffs, feeds, fertilizers, soils and human tissues has been carried out at least annually since 1985. The systematic error in selenium analyses has been followed annually by a quality assessment scheme involving seven participating laboratories.

The selenium concentration of spring cereals increased on average 15-fold compared with the level before the selenium fertilization practice. The mean selenium concentration in beef and pork increased six- and twofold, respectively, and in milk threefold, compared with levels before selenium fertilization. The average dietary intake increased from 0.04 mg Se/day to a plateau of 0.07 mg Se/day in the mid-2000s. Foods of animal origin in 2006 contributed over 75% of the total daily intake of selenium. The mean human plasma selenium concentration increased by 60% and the selenium status is optimal. Evident signs of selenium transport into natural waters have not been found.

In Finland, where the geochemical conditions are relatively uniform, the nationwide supplementation of fertilizers with selenium has proved to be an effective, safe and controlled way of bringing the selenium intake of the whole population to the recommended level. Moreover the well-being of animals has been secured.

Key words: selenium fertilizers, selenate, monitoring programme, soil, feeds, foods, dietary intake, human selenium status, environment, Finland

Leaf Concentrate and Other Benefits of Leaf Fractionation

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Abstract

Leaf concentrate is an extremely nutritious human food, containing approximately 50% (dry weight) high-quality protein, together with numerous micronutrients, principally β -carotene, vitamins B₆, B₉, E and K, plus iron, calcium and magnesium. Many studies have shown that those consuming it recover quickly from nutritional anaemia and have a significantly improved general state of health. Today, over 40,000 people receive a daily serving of 10 g of dried lucerne leaf concentrate.

The fractionation of leaves was first reported over 200 years ago and has been the subject of extensive research and application since the 1940s. The process breaks down the original leaves into three products: residual fibre, 'whey' and leaf concentrate. The whey and the fibre are effective fertilizers, substrates for fermentation and/or animal feed. Through the use of all three products, leaf fractionation can be more productive, in terms of edible protein per hectare of land, than any other known agricultural method.

This chapter presents the history and nutritional qualities of leaf concentrate, provides technical details of leaf fractionation at domestic and intermediate (community/semi-industrial) scales of production, and reviews studies that provide evidence for the effectiveness of leaf concentrate in improving human nutritional status. It concludes by reviewing the factors that have hitherto hindered the widespread adoption of leaf concentrate and leaf fractionation. The authors suggest how these may be overcome, and discuss the potentially wider role of leaf concentrate in alleviating human malnutrition, including its use in locally-produced ready-to-use therapeutic food.

Key words: leaf concentrate, leaf fractionation, food security, nutrition, micronutrient deficiency, β -carotene, vitamin A, iron, anaemia, child and maternal health, HIV/AIDS

Disability-adjusted Life Years (DALYs): a Methodology for Conducting Economic Studies of Food-based Interventions such as Biofortification

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Abstract

Micronutrient deficiency is a public health problem in many developing countries despite the food-based approaches such as conventional supplementation and fortification programmes to combat it. Therein lies the importance of programmes such as biofortification, which could complement these efforts; but their applicability and continued development would be strengthened with an accurate assessment of cost effectiveness and economic impact. The disability-adjusted life years (DALYs) methodology could be a good approach for such a purpose.

The objective of this chapter is to explain the DALYs methodology used to evaluate interventions in health and nutrition (e.g. biofortification) in economic terms and then apply it to the case of iron-biofortified beans in Nicaragua.

Based on the relationship between micronutrient deficiency and health, the impact and cost of biofortification are estimated in economic terms based on the years of productive life lost (DALYs) as related to the biofortification of beans with iron in Nicaragua. The introduction of iron-biofortified beans in Nicaragua may save 252 to 989 years of productive lives in that country, at a unit cost ranging from US\$96 to US\$379 (cost-effectiveness). In monetary terms this represents a saving of US\$246,000-969,000 (economic impact).

The DALYs could be a useful approach for the economic assessments of nutritional interventions such as biofortification as it considers the interrelationships existing among nutrition, health and wellbeing. The principal constraint is the availability and quality of the information required for its application.

Key words: disability-adjusted life years, iron deficiency, biofortification, cost effectiveness, economic impact, Nicaragua

Combating Micronutrient Deficiencies: Food-based Approaches

Edited by

Brian Thompson and Leslie Amoroso

Food and Agriculture Organization of the United Nations

Micronutrient deficiencies affect more than two billion people in the world today. With long-ranging effects on health, learning ability and productivity they contribute to the vicious cycle of malnutrition, underdevelopment and poverty. Food-based approaches, which include food production, dietary diversification and food fortification, are sustainable strategies for improving the micronutrient status of populations and raising levels of nutrition. *Combating Micronutrient Deficiencies: Food-based Approaches* focuses on practical, sustainable actions for overcoming micronutrient deficiencies through increased availability, access to and consumption of adequate quantities and appropriate varieties of safe, good quality food. The volume brings together the available knowledge, success stories and lessons learned to demonstrate that food-based approaches are viable, sustainable and long-term solutions to overcoming micronutrient malnutrition. This booklet is a summary of the publication and contains the abstracts and the list of key words for each chapter.

Combating Micronutrient Deficiencies: Food-based Approaches is a useful resource for policymakers, agronomists, food and nutrition security planners, programme implementers and health workers.

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World Health Organization and Food and Agriculture Organization of the United Nations
France, 2006, 341 pp with 1 CD-ROM
ISBN 92 4 159401 2

English only:
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Preventing Micronutrient Malnutrition: A Guide to Food-based Approaches

A manual for policy makers and programme planners
Food and Agriculture Organization of the United Nations and International Life Sciences Institute
International Life Sciences Institute, Washington DC, USA, 1997, 105 pp
ISBN 0-944398-89-8

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Food and Agriculture Organization of the United Nations and The World Vegetable Center- AVRDC
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