



# **Improving Human Nutrition Through Agriculture: The Role of International Agricultural Research**

October 5-7, 1999

## **Micronutrient Deficiencies as a Public Health Problem in Developing Countries and Effectiveness of Supplementation, Fortification, and Nutrition Education Programs: Is There a Role for Agriculture?**

Barbara A. Underwood, Ph.D.

President, International Union Nutritional Sciences

Scholar-in-Residence, Institute of Medicine

National Academy Sciences

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A Workshop hosted by the International Rice Research Institute, Los Banos, Philippines organized by the  
International Food Policy Research Institute



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## **Some Historic Landmarks**

Five decades ago international agencies and public health officials recognized severe energy and protein malnutrition as problems worthy of attention and expenditure of resources. Four decades ago, classic signs of vitamin deficiencies, such as vitamin A, and mineral deficiencies, such as iron and iodine deficiencies, were added to the list of scourges frequently associated with PEM and deserving special medical attention. Three decades ago, a “dooms-day” mentality gripped the world because pundits predicted that global food shortage were inevitable given the explosive growth in population that was occurring, primarily in the developing world. Two decades ago, perception began to change as evidence accumulated that some interventions were having positive impacts. In 1990, just one decade ago, commitments to accelerated actions were initiated at several UN-Agency initiated conferences (IMPT COMMITMENTS):

- 1990 UNICEF-sponsored World Summit for Children with a call for “a reduction in severe and moderate malnutrition among children under 5 by half the 1990 rate by the year 2000”, including elimination goals for micronutrient malnutrition.
- 1992 WHO/FAO International Conference on Nutrition in 1992 that reinforced earlier goals and extended to “elimination of death from famine”
- 1996 FAO-sponsored World Food Summit that endorsed earlier goals and declared “the commitment to achieving food security for all, and to an ongoing effort to eradicate hunger in all countries, with an immediate view to reducing the number of under-nourished people to half its present level no later than 2015.”

## **Changing Perceptions**

Progress through the last half-century in addressing global food , nutrition and health problems obviously has engaged planning by agriculturists and nutritionists, as well as those concerned with population growth, but not always from a consensus view. Indeed, some confusion occurred among nutritionists, whose debate shifted from stressing calories, to protein quality, and back to calories as the primary global nutrition problem to combat. This confusion spilled over to the agriculture sector as to appropriate agriculture policies to serve both human nutrition and national production and development needs. For example, would simply producing more low-cost, energy-dense food, i.e. rice, wheat, corn or even cassava, which are widely consumed by the poor, solve the problem, or should crops qualitatively more balanced in their amino acid content, such as legumes, or livestock receive major emphasis, even though somewhat more costly? The population

sector also debated the best approach to curb the rate at which population growth was out-stripping per capita food availability.

Each sector responded by changing their perceptions of the problem:

- the population control sector from only distribution of contraceptives to promoting the status of women in society;
- the agriculture community by investing in the “Green Revolution”, for which the CGIAR-system can take a large share of the credit;
- the nutritionists by a change from focus on medically managing only 3<sup>rd</sup> degree malnutrition to controlling less severe undernutrition affecting vastly larger populations with consequences not only for physical, but also for cognitive and immunological development.

Dividends from these investments by agriculture and changed perceptions by nutritionist and family planners are reflected in the soon to be released 4th World Nutrition Report of the Sub-Committee on Nutrition—assisted by IFPRI—in which a progressive improvement from 1980 to the present is charted (TRENDS). In most countries today mortality rates among infant and young children are at historic lows and life expectancy is at historic highs. Severe forms of PEM still occur, but are associated most commonly with devastating natural disasters and civil unrest that have lead to displacement of persons, prolonged crop failures, or lasting economic crises. And, with the exception of sub-Saharan Africa, progress in combating chronic undernutrition is occurring.

The prevalence of classic clinically evident vitamin and mineral deficiencies has also declined in nearly all countries and (ELIMINATION) dramatic progress toward elimination as public health problems has occurred, although the pace is slow for some micronutrients, particularly iron-deficiency anemia. Progress in child survival and development are attributed to (PIE CHART) gains in underlying factors of reduction in social disparities, health care access, and food availability. (NATIONAL FACTORS) Improvements in national economics and equity also have had spin-off for households and community development as well as child survival and development (UNICEF MODEL).

### **World Situation at the Dawn of a New Millennium**

(YEAR 2000) Nonetheless, at the dawn of a new millennium, the SCN estimates that the developing world will produce 30 million babies annually born undernourished, be plagued by over one-fourth of their preschool-age children being underweight and one-third stunted, and be burdened by reduced productivity of about 15 % of the adult population who also are underweight. Hence, the quantity of food available to the vulnerable is a persistent problem with which agriculture must continue to be concerned into the next century. Also, however, are issues of dietary quality, particularly with respect to micronutrients that are of equivalent concern and will need to capture sustained investment by agriculture. (I will return to the magnitude of the micronutrient deficiency problem later in my talk.)

### **Dietary Quality Issues**

Dietary quality relates to the essential nutrient content, particularly essential micronutrients. (DIETARY QUALITY) Micronutrients are those vitamins and minerals needed in small amounts to support physiological functions that must be provided in

foods or as supplements because they cannot be made by the body in amounts sufficient to meet needs. (MN PH CONCERNS) Currently three micronutrients have captured attention as being of public health concern, i.e., iron, vitamin A and iodine. Because zinc nutrition shares many traits similar to iron, and because there is increasing evidence of the impact of zinc deficiency on growth, diarrheal disease and other health-related parameters, it can be assumed that it is already a problem of public health concern. There are others micronutrients that are likely to be recognized as public health concerns as more is learned of their prevalence and health consequences.

### **Size and Consequences of the Micronutrient Problem and Progress in Control**

(MAG AND CONSEQUENCES) As with PEM in the latter part of the century, perceptions with respect to micronutrients have changed from a focus on clinical deficiencies of micronutrients, i.e. anemia, goiter and eye health, to that of the hidden consequences of inadequate nutrition that compromise immune functions, cognitive development, growth, reproductive performance and work productivity. Indeed, estimates are that 3.5-5 billion are iron deficient (ID), 2.2 billion deficient in iodine (IDD) and 140-250 million deficient in vitamin A (VAD). You will recall that these numbers exceed those projected to be stunted and wasted by the end of the century (150-180 million children).

Progress is being made (PROGRESS), particularly with respect to IDD. (I will not pursue this issue further because an effective solution through the universal iodization of salt is in hand.) But much remains to be done, particularly in reducing iron, zinc and vitamin A deficiencies, which to the present have largely been attacked using a medical model of distributing supplements. Most agree that sustaining the progress that has been achieved will depend on underpinning the medical model with food-based approaches. Agriculture by investing in the green revolution can rightly be credited for its contribution to reducing food shortages and the PEM problem. A similar opportunity exists now for agriculture to invest in developing more micronutrient-dense staple crops, while not neglecting continued research on livestock and small animals, fish, vegetables and legume production. Investments in food-based approaches potential addresses multiple nutrient and phytochemical needs for optimal health as well as facilitating sustaining the gains being made by short-term micronutrient control measures now being implemented by periodically distributing medicinal supplements, or in a few instances through fortification of food products.

Supplements are effective. The medicinal approach, which is cheap in terms of cost of the pills, but expensive in terms of the support devoted to repetitive use of scarce health-manpower, has been successful in reducing clinical deficiency signs. Indonesia as well as Vietnam declared themselves to be free of clinical vitamin A deficiency (xerophthalmia) in part because of the successful broad coverage achieved through periodic delivery of high-dose vitamin A supplements. The current economic crisis in Indonesia, however, has seen the reoccurrence of clinical deficiency, suggesting that dependence on this solution is vulnerable to economic and political instability.

Fortification can work some places. In developed countries, fortification of a variety of food products has underpinned control of micronutrient deficiencies. I am aware of efforts in the Philippines to fortify several products, and of the evidence that this strategy may prove effective, at least in urban areas. The fortification of sugar has successfully raised the level of vitamin A nutrition in some Latin American countries, but

fortification is not feasible in much of Africa and parts of Asia where the food industry is in rudimentary stages of development and there is no structure for quality assurance of fortified products. Fortification of rice, wheat, maize and of other food vehicles has been successful in advanced countries where central processing and strict quality control is assured. This is not the case for many of those countries where micronutrient deficiencies are most prevalent. The place of fortification for micronutrient deficiency control, therefore, is one important weapon in the mix of strategies needed, but is not alone sufficient and not currently feasible in many situations.

Education and awareness of the public is crucial. There is no question that social marketing of micronutrient strategies for social good, from individual to national level, is a critical need in all approaches to the control of micronutrient malnutrition. The public must not be considered only the “target” of imposed interventions. Civil society must become engaged in the process with the goal of their becoming demanding consumers participating in the action to achieve micronutrient adequacy—with the resultant health benefits—by whatever means progressively leads toward self-sufficiency in attaining adequate food and nutrition security for their household, which is their basic human right.

### **Is it Worth the Investment?**

Let me illustrate what the payoffs could be using the example of vitamin A. (TRIALS) The lethal consequences of vitamin A deficiency have been convincingly demonstrated in large scale clinical trials in which vitamin A nutriture was restored in inadequately nourished populations of children, and more recently, pregnant women. Meta analysis of all the data from seven community trials conducted in five countries revealed that child mortality was reduced on average by 23%. In two of these trials, the two with the greatest efficacy, this was achieved at levels attainable through diets if only the RDA were met. This is possible, therefore, without relying on medicinal supplements through providing food with appropriately quantity and bioavailability of micronutrients.

(NEPAL) A recent trial in Nepal demonstrated that gains are not limited to child survival. Maternal mortality among a deficient Nepalese population of pregnant women was reduced by 50% when the RDA was met on a weekly basis by providing either vitamin A or beta-carotene. (CONTROL MEASURES) Although these findings need to be confirmed by studies that recognize in their design the appropriate ethical considerations, surely, the findings provide a real incentive for agriculture to join other sectors in developing the arsenal of control measures by investing in improving micronutrient nutriture through improved content and bioavailability of staple foods—and other affordable food sources—for the survival of children and mothers, and thus, the health of nations.

### **Sustainable Food-based Solutions**

(SUSTAINABLE SOLUTIONS) Sustainable solutions for iron/zinc, vitamin A and other micronutrient deficiencies lie in food-based approaches, for which agriculture will play a key role. I am aware of the progress being made in some research centers through germplasm screening of traditional varieties of cassava, sweet potato and other vegetables for their higher content of beta-carotene. These varieties can make a substantial contribution in selected populations. (IMPORTANCE OF CEREALS) I understand that that more than 50 per cent of the world’s cultivated land is devoted to wheat, rice and maize and that by 2020, almost 96% of the world’s rice consumption, 2/3

of the world's wheat consumption, and almost 60% of the world's maize consumption will be in developing countries. Clearly, cereals are critical now and in the future to human nutrition and there is an unusual opportunity for agriculture through plant breeding to make a difference.

I am anxious to learn more at this meeting about the potential for new varieties of cereals with enhanced micronutrient content and bioavailability. For example, the new transgenic strain of rice developed by a group in Switzerland working with scientists here at IRRI. I am told that this rice has potential in 300 grams of the cooked product for meeting the recommended level of vitamin A. (MAP VAD) The global distribution of vitamin A deficiency shows how such a crop could impact among rice-eating cultures. I am told that this same strain of transgenic rice contains several fold more iron, and by introducing a gene for phytase to reduce the phytic acid content, has potentially improved the bioavailability of iron several fold. Earlier studies of genetically modified, low-phytic acid maize used for preparing tortillas already have demonstrated the potential for improving iron nutrition in maize-consuming populations. Virtually all the populations affected by vitamin A deficiency and many more suffer the consequences of iron deficiency as well, i.e. increased mortality, decreased cognitive development and reduced work productivity. It should be obvious how investments in improving the micronutrient content of staple crops could reduce constraints to human and national development.

### **Does Agriculture have a role? Strategic partnerships are needed**

To conclude, (MN ADEQUACY DIETS) I hope that the answer to that question is obvious. Strategies are possible to enhance the micronutrient content and bioavailability of plant-based staple and other micronutrient-containing foods in whole diets. (STRATEGIC PARTNERS) Maximum efficacy will occur when alliances are formed between agriculturists whose expertise lies in improving the micronutrient content in staple and other crops, and altering the ratio of enhancers to inhibitors of bioavailability in field crops, and nutritionists whose expertise lies in diversifying and modifying menus along similar lines that enhance micronutrient availability in households. I am particularly pleased to be at this meeting that brings the two strategic partners together and anticipate productive dialogue over the next few days as these few suggestions for (AGs ROLE) roles of the CGIAR and (NUTs ROLE) the roles of nutritionists are elaborated. (ADVOCACY PARTNERS) I hope that we can join hands in advocacy for the feasibility and long-term sustainability of combating micronutrient deficiencies through food-based approaches. Increased investment by agriculture in quantitative and qualitative improvement in the nutrition of populations is crucial to accelerating global economic growth and national development. The spin-off for the health and quality of life for millions of individuals and communities now trapped in poverty and deprivation is obvious. It is fundamental to achieving the increasingly recognized human right to adequate food and nutrition.