# Priorities for Public Sector Research on Food Security and Nutrition

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Executive Summary

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Good nutrition is the foundation for human health and well-being, physical and cognitive development, and economic productivity. Nutritional status is a critical indicator of overall human and economic development, as well as an essential social benefit in its own right. Integrated actions are needed across the health, education, and agricultural sectors to shape dynamic food systems to promote better nutrition.

Agriculture and food systems will always provide most of the nutrients and compounds that humans require to sustain healthy and productive lives. It is clear that, in the face of rapidly growing populations and land, environmental, human capacity, and institutional constraints, agriculture has not performed this function well in developing countries.

**Evidence on under and over nutrition**

Although the prevalence of undernourishment in developing countries has declined from 23 percent in 1990 to 15 percent in 2012, stunting (low height for age) continues to affect 28 percent of children, causing permanent impairment to their cognitive and physical development (FAO, 2012a). Micronutrient deficiency, defined as being deficient in one or more vitamin and minerals important for human health, is another form of malnutrition. Prevalence of the more commonly measured deficiencies – vitamin A, iron, zinc, and iodine – remains around 30 percent for populations in developing countries. Prevalence rates are higher are for preschool children and women of reproductive age, who are more at risk due to higher requirements for growth and reproduction.

As rates of undernutrition have decreased, however, the prevalence of overnutrition is increasing in nearly all countries, including low-income countries where it coexists with high rates of undernutrition (Stevens et al. 2012).

The social and economic costs of undernutrition, micronutrient deficiencies, and obesity are high. Measured in terms of Disability Adjusted Life Years (DALYs), child and maternal undernutrition continue to pose the largest nutrition-related health burden globally, with more than 166 million DALYs lost per year in 2012 compared with 94 million DALYs lost to adult overweight and obesity. The economic cost of undernutrition may reach as high as 2-3 percent of GDP in developing countries, and undernutrition is a pathway through which intergenerational poverty is transmitted.

**Effects of Incomes and Food Prices on Diets**

Food prices and income levels have a strongly determinative effect on dietary quality. Studies have shown that at low income levels, the poor give priority to purchasing food staples, the most inexpensive sources of energy. As incomes increase, they buy non-staple plant foods (lentils, fruits, vegetables) and animal products, which are denser in bioavailable vitamins and minerals than staple foods. Nutritionists consider dietary diversity – the number of different foods or food groups consumed over a given reference period – a key indicator of a high quality diet (Ruel, 2003). Evidence indicates that dietary diversity is strongly and positively associated with child nutritional status and growth, even after social economic factors have been controlled (Arimond and Ruel, 2004; Arimond et al., 2010).

Between 1965 and 1999, developing country population doubled but cereal production more than doubled due to Green Revolution production technologies. After adjusting for inflation, real cereal prices fell over time, despite population growth. Because the poor spend a high percentage of their incomes on food staples, lower cereal prices freed up income that could be spent on a range of necessities, including better quality food. Production of non-staple plant and animal foods did not keep pace with demand and inflation-adjusted prices of many non-staple foods increased. Energy (food staples) became more affordable, but dietary quality (non-staples) became more expensive, shifting price incentives toward reliance on food staples, particularly for those poor whose incomes have remained constant. This reliance on staple foods has led to a worsening of mineral and vitamin intakes, micronutrient deficiency, and poor health for many segments of developing country populations.

Due to decreasing investments in public sector agricultural research, high growth rates in cereal yields in developing countries were not sustained, but population continued to grow. Food staple prices began to rise with price spikes in 2008, 2010, and 2011. Because the poor must protect their consumption of food staples to keep from going hungry, higher staple prices left less money for non-staple foods and other expenses. When faced with rising food prices and no change in income, the poor reduce expenditures on non-staple foods and non-foods. While energy intakes may decline in this scenario, vitamin and mineral intakes decline more drastically, leading to worsening mineral and vitamin deficiencies.

**Interventions to enhance nutritional content of staple foods**

Because achieving dietary diversity is not always possible for vulnerable populations, fortification and biofortification become important alternatives. Most efforts at food fortification involve key micronutrients such as vitamin A, vitamin D, iodine, iron, and zinc. Salt, maize and wheat flours, and vegetable oils are common candidates for fortification, because they are widely consumed and can be fortified at low cost. Micronutrient fortification is considered highly cost-effective; salt iodization can reach 80-90 percent of the target population at a cost of approximately $0.05/person/year. Flour fortification with iron can reach up to 70 percent of the target population for about $0.12/person/year.

Fortified products reach micronutrient-deficient consumers through existing or newly established distribution channels. The companies involved in fortifying foods generally have well-established distribution and marketing channels that are strongest in urban areas. Some countries have implemented mandatory fortification standards, which improve coverage and impact. Successful fortification programs mobilize political will to mandate and enforce standards, form partnerships with international organizations, food producers, and governments, and provide technical support and monitoring.

Biofortification, the process of breeding nutrients into food crops, is a sustainable, longer-term strategy for delivering micronutrients to rural populations in developing countries. Crops are being bred for higher levels of micronutrients using both conventional and transgenic breeding methods; several conventional varieties have been released, while additional conventional and transgenic varieties are in the breeding pipeline. The results of efficacy and effectiveness studies, as well as recent successes in delivery, provide evidence that biofortification is a promising strategy for combating micronutrient deficiency.

The first biofortified crops are currently being disseminated, including provitamin A-rich orange sweet potato in Uganda, high-iron bean in Rwanda and DRC, and high-iron pearl millet in India. Additional research on consumer acceptance and varietal adoption are being carried out. Current progress is discussed in greater detail in Saltzman et al. (2013).

**Enhancing supply chains to deliver more diverse and nutritious foods**

Dietary diversity is determined by relative prices, incomes, and tastes of individuals and households, which are affected by changes in food systems. Apart from increasing incomes and lowering food prices, several specific actions can be taken through agriculture to promote dietary diversity: improving nutrition in food supply chains and making food more diverse through homestead production.

Agricultural products reach consumers through food supply chains, each link of which affects the availability, affordability, and nutritional quality of foods. Technologies and management practices to preserve nutrients and reduce food losses include proper household storage, and nutrient-preserving techniques during storage and transport, as well as food fortification. As modern food supply chains led by large processors, distributors, and retailers expand in developing countries and complement traditional supply chains, the great diversity in the way food is supplied to consumers will require even greater efforts and coordination to reduce nutrient and food loss, from the field to post-harvest storage to transport to consumption.

Specific interventions aimed at diversifying what farmers produce can also contribute to better nutrition. This diversification can occur at a national level (for example, through targeted government investments in particular crops) or at a household level (such as with homestead gardening). Small-scale home gardens have been found to increase consumption of fruit and vegetables (Masset et al. 2011). Strengthening animal husbandry may have a greater effect on the availability of macro and micronutrients at the household level (Ayele and Peacock, 2003).

**Food safety and agriculture-associated diseases**

Nutrition and health interactions are important; the full benefits of improved nutrition cannot be realized without control of diarrheal and other diseases. In poor countries, diseases associated with agriculture have important health impacts. These diseases can be categorized as zoonoses and emerging infectious disease (accounting for at least 7% of the total disease burden in least-developed countries), food-associated disease (5% of the disease burden), water-associated disease (6%), and occupational disease and drug resistance (contribution to disease burden has not been comprehensively assessed)(McDermott and Grace, 2012).

Managing and mitigating these disease risks requires comprehensive assessment of the health, environment, and environmental costs of a particular disease. Existing food safety policies, procedures, and regulations often exclude small-scale value-chain actors. For example, in Kenya, in light of research assessing public health risks, policymakers shifted the focus to support and training for the informal dairy sector, resulting in safer and better quality milk as well as economic benefits (Kaitibie et al. 2008). Multidisciplinary approaches and new institutional arrangements are often required to best control these agriculture-associated diseases.

**Gender is a cross-cutting issue in nutrition interventions**

Men and women typically play differentiated roles in food systems and within the household, although these differences vary widely by region and are changing rapidly (FAO, 2011 [SOFA 2010-11]). Production projects are more likely to succeed when gender roles are taken into account in project design and implementation (Berti et al., 2004; Quisumbing and Pandolfelli, 2010). Gender-specific time constraints are particularly important.

Significant inequalities in distribution of food may exist at the intra-household level. In particular, adult women and female children may receive a disproportionately low share of non-staple plant and animal/fish foods, resulting over the long term in poor micronutrient status. The severity of these distribution effects varies by country.

**Integrating program and policy efforts across agriculture, nutrition, and health**

The evidence of nutrition-sensitive interventions, either agriculture or food (see Webb and Kennedy 2012 for a review of reviews) remains unconvincing. Reviews consistently note the problems of inadequate study design including weak or absent counterfactuals and low power. At present, numerous agriculture and public health actors are working together to deliver and evaluate, through randomized trials or other longitudinal cohort designs, different integrated programs for diet, nutrition, and health impacts. It is expected that over the next 3-5 years, there will be an increasing body of evidence, both statistical and economic (cost-effectiveness), to guide integrated program design and implementation to improve diet quality in the short-term and stunting in the medium term.

**Conclusions for Research Priorities for Nutrition-Sensitive Agriculture**

This paper discusses several ways in which agriculture can be transformed to provide the dietary quality which is required for good health. Ultimately, more knowledge and consensus-building is required to identify the best, most cost-effective agriculture-related pathways to reduce malnutrition. Such knowledge will improve the efficiency of nutrition-sensitive interventions, but is certainly no barrier to taking immediate actions.

First, there must be a better understanding of the relationship between diets and better nutrition outcomes. Are additions of single minerals and vitamins effective, and at what levels? What combinations of minerals and vitamins are effective, and at what levels? And which food groups are most important, and at what levels? Additional research is also needed to determine at which lifecycle stages such dietary improvements are effective. The first 1,000 days is a highly critical period, but can foods alone provide useful levels of nutrients and other compounds? What nutritional outcomes are associated with better diets (single nutrients, multiple nutrients, dietary diversity) for preschoolers, female and male adolescents and adults, and the elderly?

Once the efficacy of dietary of interventions is better understood, the specific programs and policies that can be scaled up most cost effectively can be more thoroughly analyzed. All types of interventions, from sector-wide policies (to improve dietary diversity and reduce the rising prices of non-staple foods), to interventions focused on specific food markets (fortification and biofortification) or populations (home gardening, nutrition education), must be assessed, first through ex-ante benefit-cost analyses and then in practice.

**Implications for CGIAR and FAO Activities**

The Green Revolution was highly successful in raising cereal yields and, in so doing, lowered the cost of calories for the poor, broadly and successfully reducing hunger. However, due to the rising prices of foods rich in vitamins and minerals over the last decades, deficiency rates, in particular for preschool children and women of reproductive age, remain at high levels – with devastating consequences for their quality of life and economic productivity.

The world once again faces the prospect of rising cereal prices, exacerbating the limitations of food budgets of the poor to address dietary quality. No doubt the global community will find the political will to invest in more rapid growth of cereal yields, to once again lower cereal prices and to keep them relatively low. This, to be sure, is a critical objective. The hope, however, is that **the CGIAR and FAO will give just as high a priority to dietary quality in the required new round of increased investments in agriculture.**

The following provide examples of what can be done:

- Invest at higher rates in sustained productivity increases (including extension to farmers) for a range of non-staple foods – vegetables, fruits, pulses, animal products.

- Make the mineral and vitamin content of the edible portions of new crop varieties as core breeding objectives, not just yields and other agronomic characteristics that contribute to farm profits; scientific breakthroughs are reducing the cost of including these additional nutrition breeding objectives.
- Consider dietary quality in economic policy analysis related to food security, not just energy intake.

The world is evermore inter-dependent as environmental resources become scarcer. The CGIAR and FAO must learn to work cooperatively across disciplinary and institutional boundaries to make agriculture more nutrition-sensitive, for example by:

- Expanding the number of nutrition and health professionals on their staffs, and investing in and rewarding efforts to work collaboratively across disciplinary divisions – for example, by investigating how new methods of storage, processing, and cooking could preserve valuable nutrients and compounds that are otherwise lost, or could reduce undesirable compounds; breeding strategies could complement these efforts, for example by discovering key genes that slow down provitamin A degradation.
- Engaging with NGOs who focus on improved nutrition and health in rural areas, in developing and implementing food-based strategies to achieve their goals – for example in the area of home gardening and livestock production.
- Engaging with health ministries to achieve a joint understanding of how agricultural policies can either hinder or help achieve nutrition and health goals – for example, by discussing cost-effective safety improvements for particular food value chains.

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