Maternal and Child Nutrition 3

Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition?

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Acceleration of progress in nutrition will require effective, large-scale nutrition-sensitive programmes that address key underlying determinants of nutrition and enhance the coverage and effectiveness of nutrition-specific interventions. We reviewed evidence of nutritional effects of programmes in four sectors—agriculture, social safety nets, early child development, and schooling. The need for investments to boost agricultural production, keep prices low, and increase incomes is undisputable; targeted agricultural programmes can complement these investments by supporting livelihoods, enhancing access to diverse diets in poor populations, and fostering women's empowerment. However, evidence of the nutritional effect of agricultural programmes is inconclusive—except for vitamin A from biofortification of orange sweet potatoes—largely because of poor quality evaluations. Social safety nets currently provide cash or food transfers to a billion poor people and victims of shocks (eg, natural disasters). Individual studies show some effects on younger children exposed for longer durations, but weaknesses in nutrition goals and actions, and poor service quality probably explain the scarcity of overall nutritional benefits. Combined early child development and nutrition interventions show promising additive or synergistic effects on child development—and in some cases nutrition—and could lead to substantial gains in cost, efficiency, and effectiveness, but these programmes have yet to be tested at scale. Parental schooling is strongly associated with child nutrition, and the effectiveness of emerging school nutrition education programmes needs to be tested. Many of the programmes reviewed were not originally designed to improve nutrition yet have great potential to do so. Ways to enhance programme nutrition-sensitivity include: improve targeting; use conditions to stimulate participation; strengthen nutrition goals and actions; and optimise women's nutrition, time, physical and mental health, and empowerment. Nutrition-sensitive programmes can help scale up nutrition-specific interventions and create a stimulating environment in which young children can grow and develop to their full potential.

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Introduction

The food system is threatened by food and oil price volatility, diversion of resources from production of food to biofuels, climate change and related water shortages, persistent conflicts and emergencies, and natural disasters affecting agriculture production and yields.[1–4] These challenges are compounded by changes in demand for food that are brought about by growing populations, increasing incomes, and urbanisation—shifts that raise concerns about diet quality and food safety, while threatening water, land, and other finite natural resources.[5–8] In view of these challenges, protection of nutrition, let alone acceleration of progress, will entail more than bringing nutrition-specific interventions to scale. It will require a new and more aggressive focus on coupling effective nutrition-specific interventions (ie, those that address the immediate determinants of nutrition) with nutrition-sensitive programmes that address the underlying causes of undernutrition (panel 1[9,10]).

Nutrition-sensitive programmes draw on complementary sectors such as agriculture, health, social protection, early child development, education, and water and sanitation to affect the underlying determinants of nutrition, including poverty; food insecurity; scarcity of access to adequate care resources; and to health, water, and sanitation services.[11] Key features that make programmes in these sectors potentially nutrition-sensitive are: they address crucial underlying determinants of nutrition; they are often implemented at large scale and can be effective at reaching poor populations[12] who have high malnutrition rates; and they can be leveraged to serve as delivery platforms for nutrition-specific

Key messages

- Nutrition-sensitive interventions and programmes in agriculture, social safety nets, early child development, and education have enormous potential to enhance the scale and effectiveness of nutrition-specific interventions; improving nutrition can also help nutrition-sensitive programmes achieve their own goals.
- Targeted agricultural programmes and social safety nets can have a large role in mitigation of potentially negative effects of global changes and man-made and environmental shocks, in supporting livelihoods, food security, diet quality, and women's empowerment, and in achieving scale and high coverage of nutritionally at-risk households and individuals.
- Evidence of the effectiveness of targeted agricultural programmes on maternal and child nutrition, with the exception of vitamin A, is limited; strengthening of nutrition goals and actions and rigorous effectiveness assessments are needed.

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- The feasibility and effectiveness of biofortified vitamin A-rich orange sweet potato for increasing maternal and child vitamin A intake and status has been shown; evidence of the effectiveness of biofortification continues to grow for other micronutrient and crop combinations.
- Social safety nets are a powerful poverty reduction instrument, but their potential to benefit maternal and child nutrition and development is yet to be unleashed; to do so, programme nutrition goals and interventions, and quality of services need to be strengthened.
- Combinations of nutrition and early child development interventions can have additive or synergistic effects on child development, and in some cases, nutrition outcomes. Integration of stimulation and nutrition interventions makes sense programmatically and could save cost and enhance benefits for both nutrition and development outcomes.
- Parental schooling is consistently associated with improved nutrition outcomes and schools provide an opportunity, so far untapped, to include nutrition in school curricula for prevention and treatment of undernutrition or obesity.
- Maternal depression is an important determinant of suboptimum caregiving and health-seeking behaviours and is associated with poor nutrition and child development outcomes; interventions to address this problem should be integrated in nutrition-sensitive programmes.
- Nutrition-sensitive programmes offer a unique opportunity to reach girls during preconception and possibly to achieve scale, either through school-linked conditions and interventions or home-based programmes.
- The nutrition-sensitivity of programmes can be enhanced by improving targeting; using conditions; integrating strong nutrition goals and actions; and focusing on improving women's physical and mental health, nutrition, time allocation, and empowerment.

See Online for appendix

Panel 1: Definition of nutrition-specific and nutrition-sensitive interventions and programmes

Nutrition-specific interventions and programmes

- Interventions or programmes that address the immediate determinants of fetal and child nutrition and development—adequate food and nutrient intake, feeding, caregiving and parenting practices, and low burden of infectious diseases
- Examples: adolescent, preconception, and maternal health and nutrition; maternal dietary or micronutrient supplementation; promotion of optimum breastfeeding; complementary feeding and responsive feeding practices and stimulation; dietary supplementation; diversification and micronutrient supplementation or fortification for children; treatment of severe acute malnutrition; disease prevention and management; nutrition in emergencies

Nutrition-sensitive interventions and programmes

- Interventions or programmes that address the underlying determinants of fetal and child nutrition and development—food security; adequate caregiving resources at the maternal, household and community levels; and access to health services and a safe and hygienic environment—and incorporate specific nutrition goals and actions
- Nutrition-sensitive programmes can serve as delivery platforms for nutrition-specific interventions, potentially increasing their scale, coverage, and effectiveness
- Examples: agriculture and food security; social safety nets; early child development; maternal mental health; women's empowerment; child protection; schooling; water, sanitation, and hygiene; health and family planning services

Adapted from Scaling Up Nutrition[9] and Shekar and colleagues, 2013.[10]

interventions. Nutrition-sensitive programmes might therefore help to accelerate progress in improving nutrition by enhancing the household and community environment in which children develop and grow, and by increasing the effectiveness, coverage, and scale of nutrition-specific interventions.

Nutrition-sensitive programmes can help protect poor populations from the negative consequences of global food security threats and mitigate the effects of financial, weather-related, and man-made shocks (eg, conflicts). Such shocks make poor populations increasingly vulnerable to undernutrition, as shown by food and fuel price crises in the past 6 years,[4] and documented effects of conflicts on morbidity and mortality among affected populations.[13,14] Climate change and the expected increased frequency of droughts and flooding are likely to reduce food availability and dietary diversity, and increase rates of infectious diseases such as diarrhoea or malaria.[15] Under these circumstances, nutrition-sensitive programmes can help to protect the assets and welfare of poor people and their investments in the health, nutrition, and development of their children.

Nutrition-sensitive programmes are likely to affect nutrition through changes in food and non-food prices and income, and through women's empowerment. Panel 2[16,17] and figures 1[18,19] and 2[18,19] show results of analyses of the links between income growth and maternal and child anthropometry and anaemia (appendix p 1). Appendix p 2 summarises evidence regarding the association between women's empowerment and child nutrition.

We review evidence of the nutritional effect of programmes from different sectors, and discuss how such investments could be made more nutrition-sensitive. We selected sectors on the basis of: relevance for nutrition (eg, address crucial underlying determinants of nutrition); availability of assessments of their nutritional effect; high coverage of poor populations; and targeting (programmes are, or could be, targeted to reach nutritionally vulnerable groups). The two sectors that most closely meet these criteria are agriculture and social safety nets. Early child development programmes do not meet the high coverage criteria but they are included because child development and nutrition outcomes share many of the same risk factors, and there is a growing interest in examination of potential integration and synergies in programming and outcomes.[20,21] Schooling is also included, despite failing to meet all criteria, because of the importance of parental education for child nutrition and development. Health, water and sanitation, and family planning are covered in the accompanying report by Zulfiqar Bhutta and colleagues.[22] Investments and policies in several other sectors (eg, transportation; communication and information technology; and global food, agriculture, and trade) have the potential to affect nutrition, as do more targeted policies (eg, maternity leave); however,

we excluded these sectors because of the absence of assessments of nutritional effects.

Consistent with the Maternal and Child Nutrition Series, we focus on adolescent girls and women, infants, and young children during the first 1000 days of life (period from conception to a child's second birthday). Interventions to improve nutrition and child development during this period have high rates of return because of their importance in enhancing economic productivity later in life[23] fostered by a combination of improved health, nutrition, and cognition, which lead to more schooling, higher-paying jobs, and overall enhancement of physical, cognitive, and reproductive performance.[24]

The programmes we reviewed generally have several objectives, including improving income, food security, women's empowerment, and nutrition. For this reason cost effectiveness studies cannot be easily applied to assess or rank these programmes. Similarly, although cost–benefit analysis can be used in principle, this analysis needs a common metric for all outputs, generally in monetary terms. However, a conversion of a death averted into monetary values requires an arbitrary assessment of the value of premature deaths averted. Similarly, although equity is usually deemed socially desirable, its value cannot be easily quantified.[25] Therefore, the nutrition outcomes in the programmes we discuss cannot be directly compared with those in the accompanying report by Zulfiqar Bhutta and colleagues.[22] However, as we explain, the programmes we review are an integral component of an overall strategy to improve global nutrition.

Agriculture

Agriculture systems have a crucial role in provision of food, livelihoods, and income.[1] Agriculture is the main occupation of 80% of poor populations in rural areas, including women. In Africa, women account for 70% of agricultural labour and 80% of food processing labour.[26,27] Growing concerns about how to meet the food needs of an estimated global population of 9 billion by 2050 have spurred renewed efforts to boost agriculture production and productivity in the face of increasing threats that affect the global food system. Agriculture growth has been shown to reduce undernutrition;[28] an additional investment of US$8 billion per year globally would reduce the number of underweight children by 10 million and of hungry people by 201 million by 2050, and raise the income of many of the world's poorest people.[28] Moreover, the economic returns to investments in agriculture are high compared with many other economic investments.[29]

Although investments to enhance agriculture productivity and boost global food supply are crucial for long-term reductions in poverty, hunger, and malnutrition, they might not solve the problem of scarcity of access to nutritious and diverse diets (as opposed to scarcity of calories) that poor people face. A new emphasis on making agricultural systems and food and agriculture policies more nutrition-sensitive is called for and several reports discuss approaches and instruments to do so.[1,30–33] An approach that can complement efforts to raise agricultural productivity and food supply globally is targeted agricultural programmes aimed at enhancing poor households' income and access to high-quality diets. Our review focuses on these types of programmes, most specifically homestead food production systems, and the biofortification of staple crops, because they both meet our selection criteria, with the exception of scale.

Targeted agricultural programmes can affect nutrition through several pathways (panel 3[34,35]). Despite variations in the way researchers use these pathways, all concur that women—their social status, empowerment, control over resources, time allocation, and health and nutritional status—are key mediators in the pathways

Panel 2: How responsive is nutrition to income growth?

As economies grow, stunting rates typically decrease, but the predicted decrease is far slower than the corresponding poverty reduction associated with economic growth (figure 1). Country fixed-effects regressions show that a 10·0% increase in gross domestic production (GDP) per person predicts a 5·9% (95% CI 4·1–7·6) reduction in stunting and an 11·0% (8·6–13·4) decrease in the World Bank's poverty measure of individuals living on $1·25 per person, per day. The effect of growth in gross national product on nutrition comes from a combination of increased household resources, and improved infrastructure and nutrition-relevant services. Much unexplained variability exists in the effect of national income on stunting. As shown in figure 1, countries such as Guatemala, South Africa, and India have higher stunting rates than expected for their income levels. By contrast, the Dominican Republic, Senegal, Ghana, China, and Sri Lanka are among the best performers.

The association between prevalence of child underweight and GDP growth is stronger than for stunting, with the rate of decrease with 10·0% GDP growth being 7·0% (95% CI 5·3–8·8; appendix p 1). This estimate is larger than reported with earlier datasets.[16] Anaemia—defined as haemoglobin concentrations below 109 g/L—decreases at a slower rate; a 10·0% improvement in income would decrease child anaemia by only 2·4% (1·3–3·6) and maternal anaemia by 1·8% (0·4–3·1). However, severe anaemia—defined as haemoglobin below 70 g/L—decreases at a much higher rate with income growth for both mothers (6·5%; 95% CI 4·2–8·8) and children (9·0%; 5·1–12·9).[17] Although data for low birthweights are not as reliable as those for other nutritional indicators, estimates using World Bank data suggest that a 10·0% increase in GDP per person typically reduces low birthweight prevalence by only 2·3% (95% CI 0·8–4·1). Bangladesh, India, Sudan, and Haiti have particularly high rates of low birthweight prevalence relative to their national levels of income. For women underweight (body-mass index <18·5 kg/m^2), a 10·0% growth in national income results in a 4·0% (95% CI 1·7–5·8) decrease in underweight prevalence, a rate substantially lower than the reduction in child underweight.

The association between national income growth and women overweight and obesity is much stronger than for women underweight: a 10·0% increase in GDP per person is estimated to increase prevalence of overweight and obesity in women by 7·0% (95% CI 4·0–10·0; figure 2). These findings show that when GDP per person increases, prevalence of women's overweight or obesity increases faster than prevalence of women underweight decreases. Again, some countries are clear outliers, with Egypt and several Latin American countries having very high levels and several Asian countries (eg, Vietnam, India, China, Thailand) having lower than expected levels of overweight and obesity in view of their GDP per person.

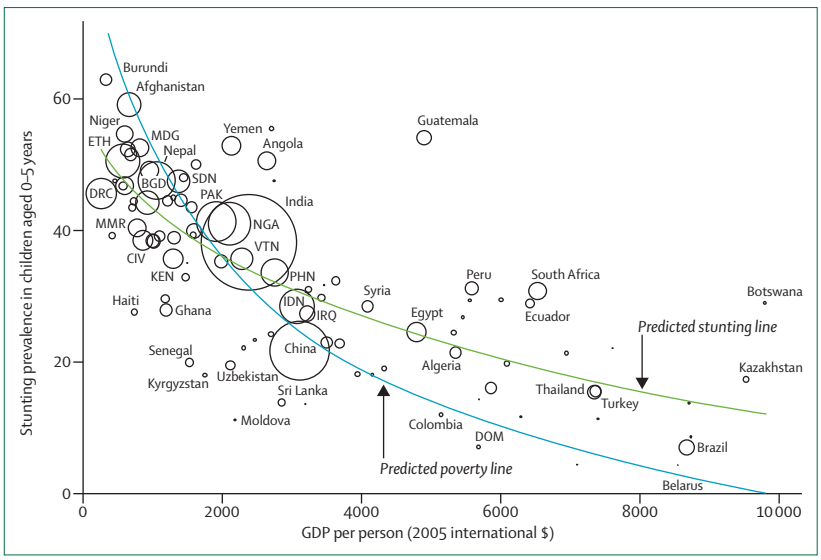

Figure 1: **Prevalence of stunting in children aged 0–5 years and GDP per person**
Most observations for prevalence of stunting are from 2000–08. The fitted curves are locally weighted regressions of prevalence of stunting in children aged 0–5 years and poverty (<$1·25 per person, per day), against GDP per person. The adjustment to international dollar units converts income expressed in nominal dollars to one that is expressed in terms of international dollars, which have the same estimated purchasing power as a dollar in the USA, accounting for local prices. The size of the circles represents the estimated population of stunted children aged 0–5 years, in about 2005, on the basis of multiplication of stunting prevalence by UN estimates of the population of children aged 0–5 years. Data are sourced principally from the Demographic and Health Surveys,[18] with observations for some countries sourced from WHO.[19] GDP=gross domestic product. BGD=Bangladesh. CIV=Côte d'Ivoire. DOM=Dominican Republic. DRC=Democratic Republic of the Congo. ETH=Ethiopia. IDN=Indonesia. IRQ=Iraq. MDG=Madagascar. MMR=Myanmar (Burma). KEN=Kenya. NGA=Nigeria. PAK=Pakistan. PHN=Philippines. SDN=Sudan. VTN=Vietnam.

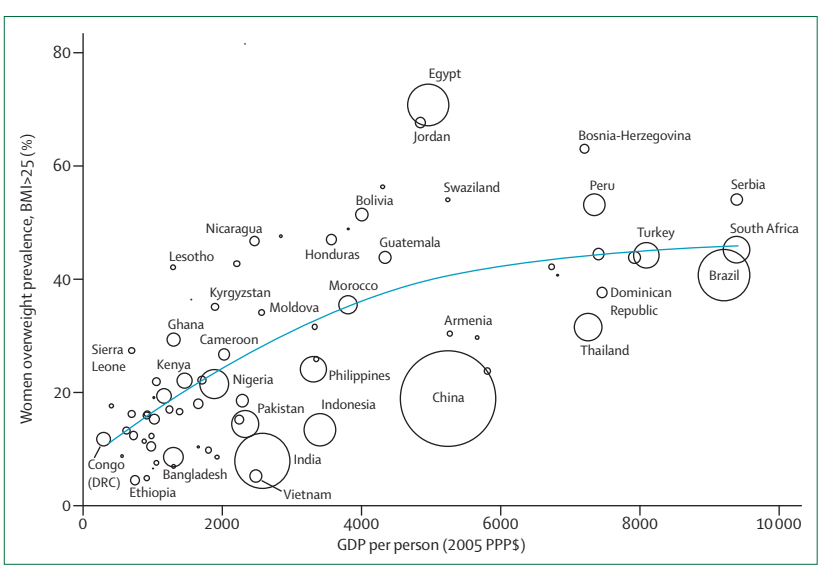

Figure 2: **Prevalence of women overweight (BMI>25) and GDP per person, for low-income and middle-income countries**
Most observations for prevalence of women overweight are from 2000–10. The fitted curve is a locally weighted regression of prevalence of women overweight against GDP per person. The correlation between prevalence of women underweight and the log of GDP per person is 0·71 and is significant at the 1% level. The size of the circles represents the estimated population of overweight women aged 15–49 years, in about 2005, on the basis of multiplication of prevalence of women overweight by the UN population estimates of the female population aged 15–49 years. Data are sourced principally from the Demographic and Health Surveys[18] and WHO.[19] DRC=Democratic Republic of the Congo. GDP=gross domestic product. PPP=purchasing power parity.

between agriculture inputs, intra-household resource allocation, and child nutrition.[26,30,34–38]

The recognised importance of development of new approaches to stimulate agriculture's contribution to nutrition has led to an increased interest in examination of the so far untapped potential of leveraging value chains to improve nutrition. Since this approach is still at a nascent stage, experience and evidence of effectiveness are scarce. Panel 4[39–46] provides a brief overview of the approach.

Home gardens and homestead food production systems

Several scientific literature reviews of homestead food production systems have been done in the past decade.[34,38,47–52] These reviews focused on different types of programmes and nutritional outcomes and used different search strategies and inclusion and exclusion criteria. Despite these differences, key conclusions were largely consistent across all reviews (appendix pp 3–4). First, these reviews note that there is little evidence of effectiveness of homestead food production programmes on maternal or child nutritional status (anthropometry or micronutrient status), with the possible exception of vitamin A status. For child anthropometry, a few studies reported an effect on at least one indicator,[53–57] but effects were generally small. Although meta-analysis might not be the method of choice for synthesis of evidence from such diverse programmes, the results of a four-study meta-analysis[52] showed no overall effect of targeted agricultural programmes on underweight, wasting, or stunting. Another four-study meta-analysis[51] for vitamin A status, however, reports a small overall difference in serum retinol between intervention and control areas (0·08 μmol/L); a cluster-randomised effectiveness assessment of a biofortified orange sweet potato intervention in Uganda also showed a 9·5 percentage point reduction in the prevalence of low serum retinol (<1·05 μmol/L) in intervention compared with control children aged 3–5 years at baseline.[58] The second consistent message is that nutritional effect is more likely when agriculture interventions target women and include women's empowerment activities, such as improvement in their knowledge and skills through behaviour-change communications or promotion of their increased control over income from the sale of targeted commodities. No studies, however, have specifically compared targeting of men versus women, or mainstreaming gender versus not doing so in the programmes reviewed. The third key message is that, with the exception of two studies of biofortified orange sweet potato,[58,59] impact evaluation studies have generally been too poor and sample sizes often too small to draw definite conclusions about effects on nutritional status.

One review,[38] which specifically looked at effects of homestead food production systems on intermediary outcomes along the impact pathway, concluded that, when measured, positive effects are shown for several underlying determinants of nutrition, including household production and consumption, maternal and child

intake of target foods and micronutrients, and overall dietary diversity. This finding is consistent with results from an impact-pathway focused assessment of a homestead food production system in Cambodia, which showed no effect on child anthropometry or anaemia despite effects on household production, consumption, and dietary diversity.[60]

Despite explicit targeting of women in many agricultural programmes, few studies have measured specific aspects of women's empowerment as a pathway to improved nutrition, and results are mixed. Assessments of homestead food production systems in Bangladesh and Nepal report positive effects on women's income, control over resources, or influence in decision making on a range of issues.[53,61–63] In Kenya, a project promoting orange sweet potato production among women farmers showed that women gained control over selling the product, whereas men maintained control over income.[64] Livestock and dairy projects in Kenya and Bangladesh report increases in women's income or influence in decision making,[65,66] whereas in India, men's but not women's income improved as a result of a dairy project.[67] Very few studies have measured the effect of agriculture interventions on women's time, knowledge, practices, health, or nutritional status and none have modelled the potential mediating role of these maternal resources on child nutrition.[38]

Biofortification

Biofortification is a uniquely nutrition-sensitive agriculture intervention because it focuses on breeding of staple crops that are rich in essential micronutrients.[68] The many advantages of the approach are well documented.[68,69] Biofortification, however, cannot achieve the high concentrations of micronutrients needed to treat severe deficiencies or to fulfil the high requirements (eg, for iron and zinc) of pregnant and lactating women and infants; it is more suited for provision of a daily dose of micronutrients (about 50% or more of daily needs) to help prevent deficiencies in individuals throughout the lifecycle, outside of the 1000 days window. As is true for all approaches, biofortification should be considered as one component of a larger strategy to eliminate micronutrient deficiencies, and the optimum mix of supplementation, dietary diversification, fortification, biofortification, and health services should be defined depending on local context.

Three broad milestones need to be achieved for biofortification to succeed: 1) breeding objectives (minimum target concentration for each micronutrient) must be met; 2) retention and bioavailability of micronutrients must be satisfactory so that intake leads to expected improvements in status; and 3) farmer adoption rates and intakes by target populations must be adequate. HarvestPlus, a programme that has led a global effort to breed and disseminate biofortified staple food crops since 2003, has made substantial progress in research to test these three steps for vitamin A, zinc, and iron in seven crops: cassava,

Panel 3: Pathways by which agriculture can affect nutrition outcomes

- As a source of food: increases household availability and access to food from own production
- As a source of income: increases income from wages earned by agricultural workers or through the marketing of agriculture commodities produced
- Food prices: agricultural policies (national and global) affect a range of supply and demand factors that establish the price of marketed food and non-food crops; this price in turn, affects the income of net seller households, the purchasing power of net buyers, and the budget choices of both
- Women's social status and empowerment: women's participation in agriculture can affect their access to, or control over, resources and assets, and increase their decision-making power regarding intra-household allocation of food, health, and care
- Women's time: women's participation in agriculture can affect their time allocation and the balance between time spent in income generating activities and time allocated to household management and maintenance, caregiving, and leisure
- Women's own health and nutritional status: women's participation in agriculture can affect their health (eg, through exposure to agriculture-associated diseases) and nutritional requirements (eg, through increased energy expenditure); their health and nutritional status can, in turn, affect their agricultural productivity and hence their income from agriculture

Adapted from the World Bank[34] and Gillespie and colleagues, 2012[35]

Panel 4: Value chains for nutrition

Food supply chains are defined as the series of processes and actors that take a food from its production—including inputs into production—to consumption and disposal as waste.[41] Broadly defined steps along the supply chain include production, processing, distribution, retailing, promotion, labelling, and consumption. The concept of value chain refers to the addition of value (usually economic) for chain actors at different steps along the chain.

In the past 5 years, value chains have been singled out as one potential strategy to leverage agriculture to improve nutrition.[39–41] The approach could be particularly relevant for traditional value chains for micronutrient-rich foods such as dairy, meat, fish, poultry, and fruits and vegetables, which are generally lacking in the diets of low-income households because of scarce availability, perishability, and high prices often compounded by a scarcity of information and knowledge about their health and nutritional benefits. Food value chains are therefore a possible entry point to stimulate both supply and demand (especially among poor populations) for micronutrient-rich foods.

Value chain concepts and analysis have unique features that make them a promising approach for tackling both undernutrition and overnutrition: 1) they focus on coordination between actors, because all value chain processes and actors are tightly linked by each action affecting the others along the chain; 2) they are analytical, versatile, and solution-oriented and can therefore be used to assess the constraints that affect availability, affordability, acceptability, or quality of nutritious foods in a given context, and identify and test solutions that can be implemented at specific leverage points along the chain; 3) they focus on addition of economic value, and could therefore be used to identify points before, during, and after production at which nutritional (and economic) value could be added, or losses in nutrients prevented. In view of the importance of coordination across sectors and of development of joint solutions to stimulate agriculture and nutrition linkages, value chain concepts and analysis might provide a useful framework and platform to achieve these goals.

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Value chains also have important limitations. First, they focus on one food at a time, as opposed to the whole diet and the many nutrients required for healthy living. Efforts to integrate nutrition into value chains should therefore focus on complementary value chains to fill the specific dietary and nutrient gaps identified in target populations. Second, the focus on addition of economic value plus incorporation of nutrition goals might create insurmountable trade-offs for value chains actors. Third, although they might be well-suited to enhance access to micronutrient-rich foods for girls and women during the reproductive period, their role for addressing the special needs of young children might be limited to fortified complementary foods or products, and a few target foods such as dairy products and biofortified crops (eg, biofortified orange sweet potatoes).

Case studies[43–43] and a review of on-going programmes[44] suggest that several research initiatives and value chain actors are currently exploring the potential of value chains to improve nutrition. One such initiative is homegrown school feeding programmes, which use value chains to link agriculture and nutrition, with potential livelihood and income benefits for farmers and nutrition benefits for young children and their families.[45,46] Existing efforts to incorporate nutrition in value chains should also consider addressing food safety issues, especially since most of the micronutrient-rich foods of interest are also highly perishable and susceptible to food safety problems. Tackling of food-borne diseases would improve nutrition.

For more on the **HarvestPlus programme** see http://www.harvestplus.org

maize, sweet potato, bean, pearl millet, rice, and wheat (table). In addition to achieving major progress in breeding and releasing crops, the programme will complete all planned retention and bioavailability studies in 2013, and 11 efficacy trials in 2014. Two effectiveness trials,[58,59] which assessed the rollout of orange sweet potato in Uganda and Mozambique (milestone three), have been completed. They showed high farmer adoption and significant increases in vitamin A intakes in both countries and in child vitamin A status in Uganda.[58,59] Effectiveness trials for the other target crops are expected to be completed by 2018.

Thus, present evidence regarding biofortification is concentrated on the first two milestones—proof of concept that breeding for micronutrient-rich crops is feasible and that micronutrients are retained and bioavailable—and a growing evidence of efficacy. Results on bioconversion of β carotene to retinol in humans and bioavailability of zinc and iron from biofortified compared with common varieties are very encouraging, suggesting that extra minerals will lead to net increases in quantities absorbed. Efficacy studies also confirm that intakes of iron-biofortified rice[70] and beans[71,72] improve iron status, and that all biofortified crops released so far have favourable agronomic qualities, including equal or higher yields than common varieties, and greater disease resistance and drought tolerance. Evidence regarding the effectiveness of biofortification, however, is still confined to vitamin A in orange sweet potato, and the scalability of delivery is yet to be shown.

Social safety nets

Social safety nets are programmes that distribute transfers to low-income households. These programmes raise income among vulnerable groups and enhance resilience by preventing destitution brought about by loss of assets or reduced investment in human capital during times of crises. Transfers can be in the form of cash or food, although with improved technology for tracking income transfers, cash transfers are increasingly the preferred means to support chronically poor households. Between 0·75 and 1·0 billion people in low-income and middle-income countries currently receive cash support.[73] Although many transfer programmes reach only a small share of the vulnerable population, some have extensive coverage, such as Ethiopia's Productive Safety Net Programme, which reaches 10% of the country's population,[74] and transfer programmes in Brazil and Mexico that reach 25%, and in Ecuador 40%, of their populations.[75] The generosity of transfers varies widely, ranging from transfers that increase total income marginally to those that boost income by up to a third for the poorest recipients.[75]

The main goal of social transfers is to augment income, but programmes sometimes include additional interventions or conditions that can enhance their nutrition sensitivity such as: linking of transfers to health and nutrition services (eg, through conditionality); targeting of households with nutritionally vulnerable members, on the basis of age or physiological status; inclusion of nutrition-specific interventions for selected individuals within the household (eg, nutrition behaviour-change communications or distribution of fortified foods or supplements); administration of transfers in a sex-sensitive manner (eg, by directing transfers to women or designing them to accommodate time constraints of caregivers); and targeting of populations facing climatic or economic stress related to seasonality or other shocks, or focusing on emergencies.

Conditional cash transfers

Conditional cash transfers aim to stimulate households to invest in the health, nutrition, and education of their children (enhancing human capital) by promotion of the use of these services as conditions (conditionalities) for receipt of transfer. Most conditional cash transfers target transfers to women, on the premise that increasing women's control over resources will lead to greater investments in children (appendix p 2). Although conditional cash transfers are implemented worldwide, experimental evidence of effectiveness comes mostly from Latin America. In addition to their positive effects on poverty reduction, household food consumption, and dietary diversity,[76,77] almost all programmes assessed increased the use of preventive and curative health and nutrition services.[78,79] The Mexico, Brazil, and Nicaragua programmes[80–83] also showed improvements in women's control over additional resources, enhanced self-esteem, heightened knowledge and awareness of health and nutrition, and increased opportunities for women to strengthen their social networks.

	Country (year of first release)*	Status of nutrition studies†			
		Dietary intake and retention	Bio-availability	Efficacy	Effectiveness
Vitamin A crops (released)					
Cassava	Nigeria, Democratic Republic of Congo (2012)	✓	✓	2013–14	2013–15
Maize	Nigeria, Zambia (2012)	✓	✓	Continuing	2013–15
Orange sweet potato	Uganda (2007), Mozambique (2002)	✓	✓	✓	✓
Iron crops (released)					
Bean	Rwanda (2012)	✓	✓	Continuing	..
Pearl Millet	India (2012)	✓	✓	✓	2013–15
Zinc crops (under development—to be released in 2013)					
Rice	Bangladesh and India (2013)	✓	2013	2013–14	2014–16
Wheat	India and Pakistan (2013)	✓	✓	2013–14	2014–16

References are provided in appendix pp 5–6. *Approved for release by National Governments after intensive multi-location testing for agronomic traits and micronutrient performance. †Completed though not necessarily reported.

Table: **Release schedule for biofortified crops and status of related nutrition studies**

Despite the many benefits of conditional cash transfers for households and women, evidence of effects on nutritional outcomes is mixed.[76,78] A review[77] using pooled estimates shows that, overall, conditional cash transfers have had a small, but not statistically significant, effect on child anthropometry. A forest plot analysis of 15 programmes,[77] combining conditional cash transfers and unconditional cash transfers, shows an average effect of 0·04 in height-for-age *Z* score, an effect size that is neither statistically significant nor biologically meaningful; similarly, no significant effect was identified for conditional cash transfers only. In view of the heterogeneity of populations and programme designs and methods, meta-analyses might not be the most appropriate approach for assessment of effect, but analyses of individual studies are consistent with the findings. Only a few conditional cash transfer studies show effects on anthropometry, and these effects are shown in the youngest or poorest children, or those exposed to the programme for long durations.[76,77,84] Evidence of effects on micronutrient nutrition is equally scant and comes from only a few studies that have looked at these outcomes.[76] The Mexico conditional cash transfer programme, which distributed a micronutrient-fortified food to beneficiary mothers and children, showed a positive effect on child intake of iron, zinc, and vitamin A among those who consumed the product, but only a small effect on mean haemoglobin or anaemia reduction.[76] Two other programmes, in Honduras and Nicaragua, that assessed effect on haemoglobin showed no effect.[76] The Mexico programme showed reductions in low birthweight attributed to changes in women's empowerment, which in turn were attributed to women's increased demand for better quality prenatal care as a result of participation in the programme.[85] Evidence is also emerging of small effects of conditional cash transfers on child development outcomes.[86]

School feeding programmes

School feeding programmes are a type of conditional transfer, albeit in kind. Similar to other transfers, they are mainly a form of social assistance for consumption. The links to nutrition are less direct than transfers targeted to mothers and children during the first 1000 days, but school feeding can reduce hunger and stimulate learning.[87] These programmes, however, are implemented in nearly every country in the world.[88] Results from a meta-analysis show that school feeding programmes have small effects on school-age children's anthropometry, particularly in low-income settings.[89] Major effects on height are not expected in school-age children and weight gains can be either positive (in underweight populations) or negative (when risks of obesity are high). In middle-income countries, school meals might also serve as an opportunity to combat obesity; Brazil and Chile have redesigned their programmes with this risk in mind.[90]

School meals might also benefit other members of the household when the food provided is shared or when the school-aged child's intake at home is reduced.[91,92] Randomised controlled trials in Burkina Faso and Uganda showed effects on weight among preschool-aged boys (ie, <5 years) whose siblings received school meals or take-home rations compared with a control group[93] (Gilligan D, International Food Policy Research Institute, personal communication). Another opportunity offered by school feeding programmes is to affect iron nutrition, especially for adolescent girls. A review[92] of randomised evaluations of iron-rich school meals (fortified or providing animal-source foods) documents that three of four studies improved iron status, irrespective of initial status. The addition of a micronutrient mix to school meals in India improved total body iron, but not anaemia, possibly because of worm loads.[94] Deworming can, however, be included as part of a larger school health programme, although the timing of

Panel 5: Unintended, negative effects of in-kind and cash transfers in Mexico

Social safety nets can reduce poverty and increase use of health and education services.[79] Depending on their target populations, however, these interventions can have unintended negative consequences. The effects of Mexico's *Programa de Apoyo Alimentario* (PAL; Food Support Programme) on excess weight gain in women is one such example. PAL is a dual conditional cash and in-kind transfer programme targeted to poor and remote communities in rural Mexico. An assessment of PAL[99] showed improved household dietary quality, but also increases in total energy consumption in a population that was not energy-deficient and had a high prevalence of overweight and obesity among women at baseline (65%). PAL also increased the already steep annual weight gain in adult women in the control group (425 g, SD 80) by 291 g (111) per year in the food basket group (a 68% increase) and by 222 g (122) per year in the cash group (a 52% increase). The most substantial effect was recorded in adult women who were already obese before the programme started (518g [153] per year in the food basket group and 354 [169] per year in the food basket group; figure 3).[100] The PAL programme's food basket included several energy-dense staple and basic food products including oil, cookies, and whole milk, and provided an additional 450 kcal per day per adult. To avoid negative effects on populations experiencing the double burden of child stunting and adult obesity, transfer programmes should be designed to respond to the identified needs of target populations, and for food transfers, their specific nutrient gaps.

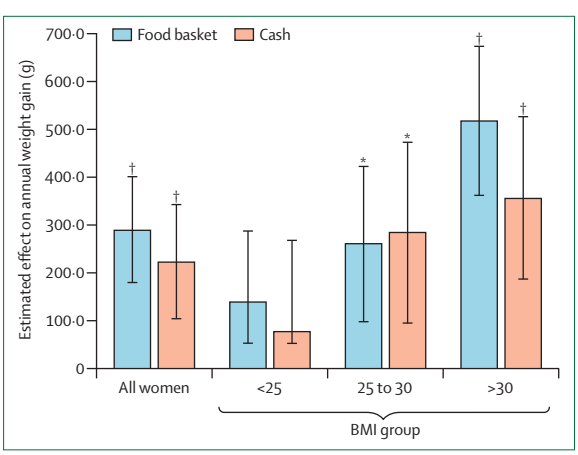

***Figure* 3: Estimated effect of Mexico's *Programa de Apoyo Alimentario* programme on annual weight gain in women, by initial BMI**
BMI=body-mass index. *p<0·05. †p<0·01.

delivery differs from the daily meal programme. Since school-aged children are the main reservoir of worm loads in a population, such an intervention could benefit younger children as well.

Unconditional transfers

Unconditional transfers, either as cash or in kind, have also been popular, particularly outside of Latin America. Households commonly spend more on food and health with cash transfers—even when they are only indirectly linked to nutrition and health—than they spend out of other increases in income.[95,96] Moreover, some unconditional cash transfers use so-called soft conditions in the form of broadly targeted behaviour-change communications or social marketing to encourage health-seeking behaviour. In Africa, soft conditions or unconditional cash transfers are more common than conditional cash transfers.[97] One randomised trial showed that a conditional cash transfer with health conditionality increased clinic visits in Burkina Faso, whereas an unconditional cash transfer did not,[98] showing the importance of the condition for achieving health-seeking behaviour changes in this setting. Evidence, however, shows an absence of overall effect of both unconditional cash transfers and conditional cash transfers on child nutritional status.[77] Costs will differ between the two approaches as will the distribution of benefits for different outcomes; as such, no method dominates in all situations.

In-kind household food distributions

In-kind household food distributions are currently less prominent than they were in previous decades, mostly because of cost considerations. They are now largely used as part of an emergency response or in places where the logistics of cash transfers are constrained. Evidence from Mexico suggests that in-kind food transfer programmes might have unintended effects on overweight and obesity when the energy contribution of the food basket exceeds the energy gap in the targeted population (panel 5,[99,100] figure 3). In addition to general family rations, food distribution programmes often provide micronutrient-fortified foods (eg, corn-soy or wheat-soy blend) to mothers and young children. In Haiti, distribution of such food rations to all mothers and children within the first 1000 days of life had a greater effect on child growth than did targeting of underweight children younger than 5 years.[101] In view of the severity of food insecurity in this population, no unintended effects on overweight or obesity were identified. Complementation of this programme with the distribution of iron-fortified micronutrient powders reduced anaemia prevalence by half in as little as 2 months.[102]

Transfer programmes in emergencies

Transfer programmes in emergencies also usually combine nutritionally enhanced complementary foods for pregnant and lactating women and their young child with family rations or cash. Disasters, particularly sudden onset emergencies such as earthquakes and hurricanes, often disrupt normal market channels, which might dampen the logistical advantages of cash compared with food transfers. Although food aid deliveries overall declined from 15 million metric tonnes (t) in 1999 to 4·1 million t in 2011, emergency deliveries have remained almost constant; they now account for more than 67% of total food aid.[103] Even when targeted towards overall household subsistence, aid during disasters can prevent major deteriorations in child undernutrition.[104,105] Age-based targeting of fortified foods can help prevent undernutrition and complement efforts to tackle cases of severe acute malnutrition with specially formulated products. The nutritional effects of emergency deliveries can be

enhanced by inclusion of lipid-based nutrient supplements in the package of assistance to families.[106–108]

Early child development

Stunting and impaired cognitive development share several of the same risk factors, including deficiencies in protein, energy, and some micronutrients, intrauterine growth retardation, and social and economic conditions, such as maternal depression and poverty.[109] Some of the key phases of brain growth and development also encompass the first 1000 days of life, the period of peak susceptibility to nutritional insults. Therefore, some key interventions can protect children from both nutritional and developmental risks; these include core maternal and child nutrition interventions, psychosocial stimulation and responsive parenting, and interventions to alleviate poverty, food insecurity, maternal depression, and gender inequity.[21]

Evidence of the effect of early child development interventions, with or without a nutrition component, on child development outcomes has been extensively reviewed in two previous series in *The Lancet*.[20,21] We focus on evidence of how child stimulation and nutrition interventions can have complementary effects on nutrition outcomes (appendix pp 7–9). The most comprehensive, long-term study[110] of interventions that provided both child stimulation and food supplementation to stunted children aged 9–24 months in Jamaica showed an additive effect of the two interventions on cognitive development, but not on growth. At adolescence, the additive effects on cognition were not sustained, but the group having received stimulation had long-term benefits, which ranged from improved development outcomes to educational attainment and social behaviour.[111,112] In Bangladesh, addition of stimulation and home visits to standard nutrition and health care for severely malnourished children improved development outcomes and weight-for-age *Z* score (WAZ).[113] Another trial in Bangladesh, which added responsive parenting (including feeding) to an informal nutrition and child development education programme, showed benefits on several feeding and parenting behaviours, child self-feeding, and development outcomes; addition of iron-fortified micronutrient powders to the intervention improved weight gain and WAZ but had no additional effect on development outcomes.[114] A zinc supplementation and responsive stimulation intervention in underweight children in Jamaica showed synergistic effects on child development between the two interventions: greater benefits on development outcomes were identified in the zinc and stimulation group, compared with little or no effect in the groups receiving either.[115] This synergistic effect, however, was not noted for morbidity (reduced only in zinc group) or growth (no effect in either group). A randomised controlled trial of cash transfers to households linked to preschool enrolment in Uganda provides an example of joint benefits on cognition and nutrition; findings showed significant effects of cash transfers on child cognitive development, which were mediated by increased preschool participation, improved diets, and reduced anaemia (Gilligan D, Roy S, International Food Policy Research Institute, personal communication).

Other trials—in India, Pakistan, and Bangladesh[116–118]—although successful at improving child development or nutrition outcomes, or both, failed to show additive or synergistic effects between nutrition and stimulation interventions. In India,[116] beneficiaries of the Integrated Child Development Services (ICDS) programme were allocated to groups receiving breastfeeding and complementary feeding counselling, or this package plus responsive feeding and psychosocial stimulation skills. Compared with ICDS only, both intervention packages improved child dietary intake and haemoglobin and reduced morbidity, but only the nutrition intervention increased length gain, and only the full package including stimulation benefited development outcomes.[116] A factorial design trial in Pakistan[117] showed no evidence of additive or synergistic effects of a nutrition (counselling and micronutrient powders) and stimulation intervention (monthly group meetings and home visits for children aged 0–24 months) on child development or nutrition outcomes. Preliminary results show effects of all three intervention packages on developmental scores compared with control, with larger effect sizes among the two stimulation groups. In Bangladesh,[118] psychosocial stimulation with or without food supplements among severely underweight children aged 6–24 months on discharge from hospital had an effect on mental development and a small effect on WAZ, but no additive or synergistic effects were noted between the two interventions. One intervention that closely ties feeding practices with child stimulation is responsive feeding. Few studies of this approach, however, have been designed to distinguish messaging on complementary feeding from those on psychosocial care[114] and few so far have shown a clear association with nutritional outcomes.[119]

Reduction of maternal depression is another way to address risk factors common to both nutrition and child development.[120,121] Efforts are being made to link basic health services with a wide range of social support for women. Efficacy trials.[122,123] show that the benefits might accrue to both mothers and their newborn babies, justifying ongoing efforts to bring these initiatives to scale.

Schooling

Although children are beyond the crucial 1000 days window when they enter school, their schooling experience might be a strong determinant of the nutrition of the next generation. Parental schooling has been consistently associated with child nutritional status, with maternal education often, but not always, having a larger explanatory power than paternal education, controlling for income and schooling choices.[124,125] The positive global trends in schooling are, therefore, encouraging for

nutrition. Data from developing countries show an average increase in years of schooling from 2·60 to 7·62 for boys and from 1·50 to 6·64 for girls between 1950 and 2010.[126] The girl to boy ratio shows a substantial improvement over this period, from 57·7% to 85·9%. Enrolment data show parity in girls' primary schooling in most countries;[127] moreover, in many countries more girls than boys are now in secondary school. Still, only about a fifth of adolescent girls in sub-Saharan Africa and two fifths of girls in south Asia are enrolled in secondary education.[128]

We assessed the level of parental education necessary for a meaningful reduction in child undernutrition by analysing 19 datasets from the Demographic and Health Survey (collected since 1999) and derived estimates of the risk of child stunting associated with maternal and paternal primary and secondary education, controlling for household wealth, rural versus urban residence, and child age and sex. The analysis showed that the risk of stunting is significantly lower among mothers with at least some primary schooling (odds ratio [OR] 0·89, 95% CI 0·85–0·93), and even lower (p<0·001) among mothers with some secondary schooling (0·75, 0·71–0·79). Paternal education at both the primary and secondary levels also reduced the risk of stunting although the respective ORs (0·96, 0·93–1·01; and 0·85, 0·81–0·89) are smaller than for maternal schooling. Despite this overall association, there is appreciable heterogeneity in effect sizes for both maternal and paternal education in individual countries, probably indicative of differences in both quality of education and quality of data.

For more on the **Scaling Up Nutrition movement** see http://scalingupnutrition.org

Schooling directly increases individual earnings and national income and, through these pathways, can affect nutrition in the long term. Thus, programmes to increase schooling via the supply of inputs or through fee waivers or cash transfers can be expected to reduce the risk of undernutrition for the next generation. There is a lack of clarity, however, about which aspects of schooling, beyond the income effect, benefit nutrition. At least five overlapping pathways have been suggested, but not formally tested. Schooling might: 1) transmit information about health and nutrition directly; 2) teach numeracy and literacy, thereby assisting caregivers in acquiring information and possibly nutrition knowledge;[129,130] 3) expose individuals to new environments, making them receptive to modern medicine; 4) impart self-confidence, which enhances women's roles in decision making, and their interactions with health-care professionals; and 5) provide women with the opportunity to form social networks, which can be of particular importance in isolated rural areas. The question remains as to whether schooling could do even more to directly affect nutrition, both in the short term for school children and in the long term as they transition into their parental role. Although nutrition modules are available in some school health education programmes,[131,132] assessments of the effect of a school health and nutrition curriculum in developing countries on undernutrition or health knowledge, let alone on parenting skills decades later, are absent.

Schools are also suitable venues to introduce programmes to combat obesity. Such programmes can focus on healthy diets and promotion of physical activity. A systematic review[133] of 22 studies in low-income and middle-income countries noted that 82% of such programmes had a favourable effect on physical activity, diet, or both.

Discussion

In 2008, *The Lancet* Maternal and Child Undernutrition Series included conditional cash transfer programmes and dietary diversification approaches as "general nutrition support strategies", and noted small positive effects of conditional cash transfers on child anthropometry in three Latin American countries, and an absence of a statistically significant of effect of dietary diversification strategies on child nutrition outcomes.[134] In the present series, we discuss evidence regarding the nutritional contribution of programmes in four sectors and the potential for enhancing their nutrition-sensitivity. Although the concept of nutrition sensitivity is not new, investments in development and implementation of nutrition-sensitive programmes have intensified in the past few years, prompted by the 2008 series, and spearheaded by the Scaling Up Nutrition movement.[9] It is important to recognise, when interpreting the results of our review, that most of the programmes included were retrofitted and tagged as nutrition sensitive without having been originally designed as such.

Targeted agricultural programmes have an important role in supporting livelihoods, improving household food security and healthy diets, and in fostering women's empowerment. Yet, our review shows inconclusive evidence of effects on child nutritional status, with the possible exception of benefits on vitamin A intake and, to a lesser extent, vitamin A status. These findings are probably the result of a combination of factors, including: weaknesses in programme design and implementation (especially the nutrition, behaviour-change communication, and health components);[60] inclusion of households with children outside of the 1000 days window with little potential to benefit in linear growth; and the fact that other pressing constraints to nutrition—such as infectious diseases, helminths, and environmental enteropathy associated with scarcity of access to appropriate water, sanitation, and hygiene—might not be addressed by the programmes. Additionally, the assessments of most of the programmes we reviewed had crucial weaknesses such as an absence absence of valid comparison and control groups, a possibly too-short duration of intervention, small sample sizes, the inclusion of the wrong age group in effectiveness assessments, and the failure to control for potential confounding factors in the analysis. All these assessment

design flaws reduce the ability to detect an effect even if one exists.

In view of the complexity and diversity of agricultural programmes, their many goals, and their long impact pathways, some argue that impact assessments should focus on outcomes such as food security and diet quality, rather than child nutritional status during the 1000 days window. Although complexity is a valid concern, the many pathways by which agriculture can improve nutrition—and evidence that effects on several indicators along these pathways are achieved—support giving these programmes a fair chance to deliver on child nutrition outcomes. Future work should include testing of programmes with stronger designs, nutrition goals, and interventions; use of rigorous programme-theory based impact and impact pathway assessments; and assessment of cost and cost-effectiveness (panel 6).

Biofortification has made substantial progress by establishing proof of concept for orange sweet potato and showing effects, through rigorous assessments, on maternal and child intake of vitamin A and child vitamin A status. The challenges for biofortification now rest in showing effectiveness of new crops, refining delivery and marketing strategies, scaling up successfully, and integrating new varieties into national agricultural research systems.

Social safety nets are a powerful way to reduce poverty, and currently provide income support to a billion chronically poor individuals and to shock victims. They have been shown to improve household food availability and dietary quality and to foster certain aspects of women's empowerment, and for conditional cash transfers in particular, to stimulate demand for health and education services. Despite these many benefits, pooled evidence shows little effect on nutritional outcomes. By contrast with agriculture programmes, several effectiveness assessments of social safety nets have used rigorous randomised controlled trial designs, although most of these studies were done in middle-income countries and might underestimate the magnitude of effect that could be achieved in poorer settings. Additionally, some aspects of programme design or implementation might have diluted their nutritional effect, including poor timing and short duration of maternal and child exposure, absence of clear nutrition goals, and poor selection or implementation of nutrition interventions in some programmes. Also, the gap between increased use of health and nutrition services and nutrition benefits has been attributed, at least partly, to the poor quality of services provided.[78] Conditional cash transfers are designed to increase health awareness and service demand, but ultimately their nutritional effect rests on the quality of public health services.

Our review of early child development interventions provides little evidence that stimulation alone has a direct effect on nutrition outcomes, but it suggests that combined early child development and nutrition interventions can have additive or synergistic effects on development outcomes, and in some cases on nutrition. The examples of successful joint delivery of these services point to an area in which programmatic synergies, cost savings, and potential benefits for both child development and nutrition might be identified.

Girls' schooling is increasing in many countries, largely as a result of government interventions to change incentives and reduce barriers to girls' school enrolment and participation. Increases in parental schooling have contributed to reductions in stunting, but larger effects could probably be achieved if effective nutrition education programmes were incorporated into school curricula.

***Panel* 6: Research priorities**

- Rigorous, theory-based effectiveness and cost-effectiveness assessments of complex and large scale nutrition-sensitive programmes. These assessments should include:
  - Use of experimental randomised controlled trials, where feasible, to test different methods of delivery and joint packages of interventions.
  - Careful assessment of programme impact pathways and quality of service delivery, use of process evaluation instruments and mixed methods, including assessment of the capacity and efficiency of front-line health workers.
  - Measurement of gender-disaggregated impact indicators; these indicators should be carefully selected on the basis of nutrition goals and interventions included in programmes and could include: anthropometry, micronutrient status biomarkers, child development outcomes, child morbidity.
  - Measurement of intermediary outcomes along the impact pathway (eg, household consumption; food security and dietary diversity; dimensions of women's empowerment, maternal physical, and mental health; detailed dietary intake or simpler measures such as dietary diversity for target individuals).
  - Detailed costing for assessment of cost-effectiveness.
- Development of methods to allow comparison of the social benefits of complex programmes with many objectives and joint outcomes, with the benefits of single-outcome programmes.
- Formative research and focused ethnographic studies to guide selection, design, and implementation of nutrition interventions to be integrated in nutrition-sensitive programmes, and for overall design of nutrition-sensitive programmes.
- Qualitative research to understand barriers to participation, adoption and use of programme inputs and services (eg, agricultural inputs, compliance with conditions in conditional transfers, recommended feeding or caregiving practices).
- Research to rigorously test the feasibility and desirability of integration of interventions from several sectors versus co-location. Such research would establish whether programme implementers should develop new instruments and methods for joint planning, implementation, monitoring, and assessment, or whether investments should focus on effective programme co-location and implementation.
- Research to test and document the scalability of newly released biofortified crops.
- Assessment of effectiveness large-scale programmes combining early child development and nutrition interventions in different contexts and assessment of synergies both in programming and outcomes.
- Research to test different delivery platforms for programmes to reduce maternal depression.
- Research to test different delivery systems for reaching adolescent girls (eg, school programmes, social safety nets with conditions to keep girls in school, agricultural programmes targeting adolescent girls at home).
- Assessments of school nutrition programmes and their short term effect on knowledge of school children and long-term effect on parenting skills.

Our review shows the potential of programmes in the four sectors reviewed to improve the lives of poor households and individuals, both in the short-term and the long-term. It also shows, however, that more needs to be done to increase the nutrition sensitivity of programmes so that their potential to deliver on maternal and child nutrition outcomes is unleashed. The nutrition sensitivity of promising programmes can be enhanced in several ways. First, targeting on the basis of nutritional vulnerability (eg, age, physiological status) in addition to geographic targeting on the basis of poverty, food insecurity, or location can help reach households and individuals most likely to benefit from the programme. Alternatively, targeting of nutritionally vulnerable individuals could be used as a second level of targeting for subgroups of programme beneficiaries who meet pre-established criteria. For example, targeting agricultural programmes to households with pregnant or lactating women or children younger than 2 years might be neither logistically feasible nor optimum for community development; however, geographic community-level targeting could be used as a first targeting criteria, with a second level focusing on reaching mothers and young children with a specific package of preventive nutrition and health interventions. Another key target group for nutrition-sensitive programmes is adolescent girls; conditions or other incentives can be used to keep girls in school, help delay first pregnancy, address HIV risk factors,[135] and improve adolescent girls' nutrition knowledge and micronutrient status to prepare them for motherhood.

Second, evidence shows that nutrition improvements are not automatic even with programmes that are successful at reducing poverty, food insecurity, and sex inequalities. To reach their full potential, programmes such as those reviewed need careful identification of nutrition goals and appropriate design and effective implementation of interventions to achieve them. A third way to enhance the nutrition sensitivity of programmes is to engage women and include interventions to protect and promote their nutritional wellbeing, physical and mental health, social status, decision making, and their overall empowerment and ability to manage their time, resources, and assets. A fourth promising, yet underused approach to enhance the nutrition sensitivity of programmes is to use them as delivery platforms for various nutrition-specific interventions. Nutrition behaviour-change communications, which are incorporated in several agriculture, social safety nets, early child development, and school health programmes are one example of such use. Other opportunities include addition of the distribution of micronutrient-fortified products to nutritionally vulnerable adolescent girls, mothers, and young children,[101,136] or of preventive health inputs to agriculture, social safety net, early child development, or school programmes.

Finally, a crucial question that remains to be addressed when designing nutrition-sensitive programmes is the degree to which programmes should indeed integrate actions from several sectors, or co-locate programmes managed by different sectors so that they reach and saturate the same communities, households, and individuals. In view of the complexity of integration,[33,137,138] especially across many sectors, it is important to carefully assess whether investments should focus on joint planning, implementation, monitoring, and assessment, or on effective programme co-location (panel 6).

Conclusions

Nutrition-sensitive programmes hold great promise for supporting nutrition improvements and boosting the scale, coverage, and benefits of nutrition-specific actions. New incentives are needed to support innovations in nutrition-sensitive programmes and unleash their potential to tackle nutrition while also achieving their own goals. New nutrition-sensitive agriculture[44] and social safety net programme designs, methods, and packages of interventions are being tested and are strengthening links with health services. Rigorous impact evaluations, many of which are based on strong programme-theory and impact pathway analysis, are addressing key weaknesses encountered in previous evaluations and are assessing impacts on a range of nutrition and child development outcomes and several household and gender outcomes along the impact pathway. Evidence generated by these enhanced programmes and assessments in the next 5–10 years will be of crucial importance to inform future investments in agriculture and social safety net programmes to improve nutrition.

The potential benefits of integration of early child development and nutrition programming include cost savings and gains in both child development and nutrition outcomes. Leveraging health, agriculture, or social safety net platforms for joint early child development and nutrition programming during the first 1000 days of life would help focus on the crucial period of peak vulnerability for both nutrition and development. Current work is exploring such approaches. Benefits from psychosocial interventions on cognition, however, extend well beyond the first 2 years, and therefore, continued child development support is required thoughout the entire preschool period. Early child development programmes, possibly linked to conditions in transfer programmes or delivered through preschool or community settings, could offer psychosocial stimulation and parenting interventions, while also providing relevant nutrition interventions for children 2 years and older, focusing on micronutrients, healthy diets, and obesity prevention. With improved guidance and curricula for nutrition education in schools, a new emphasis on using schools to improve nutrition knowledge and practices and preparing school children for their future parenting roles should also emerge.

The immense potential of programmes addressing the underlying determinants of undernutrition to complement and enhance the effectiveness of nutrition-specific interventions is real, but is yet to be unleashed.

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Investments in nutrition-sensitive programmes can have a pivotal role in prevention of the excess stunting, wasting, and impaired child development that the scale-up of nutrition-specific interventions cannot resolve on its own.

Contributors

MTR and HA conceptualised the report, reviewed the literature, and wrote the all drafts of the report.

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Derek Heady, research fellow at IFPRI, did the analysis and prepared the panel on the relation between income and nutrition. Joe Green, independent consultant, did the analysis of the role of education. Mara van den Bold, research analyst at IFPRI, reviewed the literature on women's empowerment, provided background text, and wrote the panel on women's empowerment and nutrition. Jef Leroy, research fellow at IFPRI, did the analysis and wrote the panel on the cash transfer programme in Mexico. Erick Boy, senior research fellow at IFPRI, provided background text and other material for the section on biofortification. Sivan Yosef, programme manager at IFPRI, provided research and editing assistance during all steps of the process.

Conflicts of interest

REB serves on the Boards of the Micronutrient Initiative, Vitamin Angels, the Child Health and Nutrition Research Initiative, and the Nestle Creating Shared Value Advisory Committee. VM serves on the Nestle Creating Shared Value Advisory Committee. All other authors delcare that they have no conflicts of interest. As corresponding author, Marie Ruel states that she has full access to all data and final responsibility for the decision to submit for publication.

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