Micronutrient-sensitive food value chains: A systematic review of intervention strategies and impact pathways to nutritional outcomes

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Received: 18 February 2022
Accepted: 02 March 2022
doi: 10.1079/cabireviews202217012

The electronic version of this article is the definitive one. It is located here: http://www.cabi.org/cabireviews

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Abstract

Knowledge and evidence on how food value chains can deliver nutrition, especially micronutrients, are limited. A deeper understanding of the food value chains as part of agri-food systems approaches addressing hunger and malnutrition through agricultural development may provide pathways for nutrition and health outcomes. This systematic review was undertaken using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to assess the broad topic of value chains and micronutrients, focusing on interventions and their related impact pathways. Impact pathway interventions improving micronutrient delivery and consumption were classified as production, accessibility, marketing, income, knowledge and behavioral, and finally, women’s empowerment pathways. However, the case study evidence on the micronutrient-sensitive value chains for nutritional outcomes is very scant. This review identified that making value chains micronutrient-sensitive requires a multi-stakeholder, integrated approach as a basis for concerted action among various stakeholders in terms of policy, research, strengthening partnerships and coordination, and information sharing. The review illustrates the scarcity of literature with a focus on the micronutrients in the context of food value chains and developing countries. The food value chain approach offers great potential to unpack the complexity of food systems and identify entry points and pathways for improving nutrition outcomes, especially the micronutrients. Additionally, this review identifies multiple entry points and calls for strong advocacy of nutrition-sensitive value chain approaches to combat hidden hunger.

Keywords: food value chains, micronutrients, interventions, impact pathways, malnutrition

Introduction

Developing country food systems have changed dramatically since the Green Revolution period. Despite economic growth and increased agricultural production in South Asia and Sub-Saharan Africa, malnutrition rates remain high due to the complexity of the problem [1]. Therefore, the sustainable development goals (SDGs) have been crafted to achieve food security and improve nutrition while promoting sustainable agriculture. Traditionally, the main focus of agricultural development and food security programmes has been on macronutrients ignoring the critically important micronutrients. The magnitude and profound consequences of micronutrient malnutrition on human health and well-being demand a new “greener” revolution [2]. Micronutrient malnutrition not only affects the health, well-being, and livelihood of all those individuals and families afflicted, but also adversely impacts programmes to control population growth, societal stability, and national development efforts.

Unfortunately, in many nations, the introduction of high-yielding cereal crops and trends towards less heterogeneous farming systems has resulted in reduced diversity of food available to low-income individuals and families, and therefore, decreased access to and increased cost of more diverse food sources in the marketplace especially for the

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poor [3–5] resulting in micronutrient malnutrition. The triple burden of malnutrition–undernutrition, micronutrient deficiencies, and over nutrition coexist in the same households. This review aims to learn from the understanding of intervention strategies and impact pathways to deliver micronutrients along the food value chains. Presently, there are at least 15 trace elements (i.e., micronutrient elements) and 12 vitamins known to be essential for human life [6–9].

Food value chains, being one of the core elements of a food system required to feed a population, comprise diverse drivers (e.g., political, economic, sociocultural, and environmental drivers) that affect all value chain actors, including consumers [10–12]. Building on our existing understanding of how food systems influence dietary patterns and nutrition [13–23], nutrition-sensitive approach to value chain development has been identified as a promising way to shape food systems for improved food security and nutrition outcomes [24–33]. However, changing the food systems at scale for better nutritional outcomes first requires changes in agricultural production among others, as the present composition of production does not provide sufficient quantities of micronutrients [10, 34]. Interventions through agricultural value chains can incorporate a range of value chain actors (input providers, traders, processors, and consumers) critical to providing more nutritious food. Functional value chains are necessary to widely distribute nutrient alternatives such as bio-fortified crops as well [7, 35–49]. Several past studies have suggested that value chain interventions can potentially play an important role in promoting more nutritious foods [15, 25, 50–53]. The research and development stakeholders have recognized that the value chain concepts can be useful in designing and promoting strategies to achieve nutrition goals [54, 55]. Identifying opportunities and incentivizing the chain actors involved in marketing of agricultural products with higher nutritional value would be vital to this approach. However, the value chain development efforts have largely focused on efficiency and economic returns among value chain transactions, and the nutritional content of commodities is generally not considered. The potential for value chain interventions to enhance nutrition though is part of the current food and nutrition security narrative, but so far there has been little documented experience. The evidence on factors that incentivize actors along the value chain to deliver more nutritious food is needed to design enabling policies [56, 57]. Evidence is also important on the potential impacts of the absence of appropriate policies that might lead to food value chains that result in undesirable nutritional outcomes. Moreover, the literature particularly illustrating the role of micronutrient-sensitive value chains and their impact on nutritional outcomes [4, 24, 25, 27–30, 38, 58–62] is further limited. Very few studies are available in the literature on micronutrient-sensitive value chains [15, 28, 29, 50, 63, 64], which are considered important to address the challenge of the hidden hunger both in the developed and developing countries. The use of value chain analysis to identify opportunities for targeted nutrition interventions in food systems is still an emerging method, and very little evidence has been documented for specific nutrients. Therefore, this review was intended to explore the perspective of improved nutrition concerning specific micronutrients in food value chains. The present review seeks a more in-depth exploration of value chains’ role as a useful framework to unpack the complexity of food systems bringing a nutrition lens to the value chains, especially the micronutrients. The review is likely to be helpful to researchers and development stakeholder to develop pathways of nutrition-sensitive value chain interventions and design future studies to fill the critical evidence gaps.

Following this brief introduction, the subsequent section describes the study’s methodology, followed by the next section on the analyzed literature review in the form of impact pathways, intervention analysis, and nutritional outcomes. Finally, the conclusions are presented in the last section.

Methods

Protocol and registration

We conducted this review using the guideline from Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [65, 66].

Search strategy

We systematically searched published studies from the three most visited electronic bibliographic databases such as CABI, PubMed, and Web of Science in two steps. Firstly, we identified three search themes: nutrient, micronutrient, and food system. We then explored various sub-themes, for example, diet general, food general, micronutrient, vitamin, minerals, value chain, food system, and policy. We used different keywords in different themes and sub-themes. We used OR between words for intra-sub-theme search and finally, we used AND for all inter-sub-theme words to accumulate all the relevant results. Secondly, we applied two filters, namely publication time (from the year 2000) and language (English), to get more relevant results. Although this syntax may look complex, it allowed us to deep dive into several related and insightful articles.

Initially, we piloted our search strategy in the CABI database in April 2021 and replicated it in the other databases. All the relevant queries are reflected in Table 1. In total, we found about 8702 articles from these three databases based on our search terms. Apart from these articles, we also included another 55 studies from other sources.

Eligibility criteria and study selection

Our main objective was to find out the interventions that help in the reduction of micronutrient malnutrition or hidden hunger through a better understanding and
Table 1. Search terms in the review of micronutrient-sensitive value chains using electronic bibliographic databases.

<table>
<thead>
<tr>
<th>Query no.</th>
<th>Theme</th>
<th>Sub-theme</th>
<th>Keyword</th>
<th>CABI</th>
<th>PubMed</th>
<th>Web of Science</th>
<th>Others (cross references and web search)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Nutrition</td>
<td>Diet general</td>
<td>Nutrition OR diet OR dietary OR dietary diversity Food OR fruit OR vegetable OR milk OR meat OR egg OR cereals OR Oil OR Pulses OR Fish OR millets OR processed food OR fresh food</td>
<td>1070963</td>
<td>1052128</td>
<td>806747</td>
<td></td>
</tr>
<tr>
<td>#2</td>
<td>Nutrition</td>
<td>Food general</td>
<td></td>
<td>3153520</td>
<td>2491188</td>
<td>2772787</td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td>Nutrition total</td>
<td></td>
<td>#1 OR #2</td>
<td>3638312</td>
<td>3052018</td>
<td>3263625</td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td>Micronutrient</td>
<td>Micronutrient</td>
<td>Micronutrients OR vitamins or minerals</td>
<td>449534</td>
<td>1035238</td>
<td>600012</td>
<td>55</td>
</tr>
<tr>
<td>#5</td>
<td>Micronutrient</td>
<td>Vitamin</td>
<td>Fat soluble vitamin OR water soluble vitamin OR vitamin A OR vitamin D OR vitamin E OR vitamin K OR vitamin B OR vitamin C OR pantothenic acid OR biotin OR folic acid</td>
<td>172687</td>
<td>293064</td>
<td>254804</td>
<td></td>
</tr>
<tr>
<td>#6</td>
<td>Minerals</td>
<td></td>
<td>Macro minerals OR microminerals OR calcium OR magnesium OR phosphorus OR sodium OR potassium OR chloride OR sulfur OR iron OR copper OR iodine OR zinc OR fluoride OR selenium OR manganese OR chromium OR molybdenum</td>
<td>1000993</td>
<td>2209672</td>
<td>3131269</td>
<td></td>
</tr>
<tr>
<td>#7</td>
<td>Food System</td>
<td>Micronutrient total</td>
<td>#4 OR #5 OR #6 Food system OR value chains OR food value chain OR supply chains</td>
<td>1279438</td>
<td>2816023</td>
<td>3593321</td>
<td></td>
</tr>
<tr>
<td>#8</td>
<td>Food System</td>
<td>Value chain</td>
<td></td>
<td>32060</td>
<td>2796</td>
<td>19710</td>
<td></td>
</tr>
<tr>
<td>#9</td>
<td>Policy</td>
<td></td>
<td>Food policy, biofortification, “nutritional intervention”</td>
<td>23065</td>
<td>6194</td>
<td>7007</td>
<td></td>
</tr>
<tr>
<td>#10</td>
<td>Policy</td>
<td>Food system total</td>
<td>#8 OR #9</td>
<td>53593</td>
<td>8891</td>
<td>26516</td>
<td></td>
</tr>
<tr>
<td>#11</td>
<td>Final Search_1</td>
<td>Nutrition + micronutrient + value chains</td>
<td>#3 AND #7 AND #10 From 2000 AND English</td>
<td>4860</td>
<td>2002</td>
<td>2724</td>
<td></td>
</tr>
<tr>
<td>#12</td>
<td>Filter</td>
<td>Publication time, language</td>
<td></td>
<td>4152</td>
<td>1886</td>
<td>2664</td>
<td></td>
</tr>
<tr>
<td>#13</td>
<td>Final</td>
<td></td>
<td>#11 AND #12</td>
<td>4152</td>
<td>1886</td>
<td>2664</td>
<td>55</td>
</tr>
</tbody>
</table>
developing micronutrient-sensitive value chains (MNSVC). As Table 2 shows, we used six criteria to determine the eligibility for inclusion of relevant articles out of 8757 search articles: topic related to MNSVC, publication type, interventions, comparators, inclusion for impact, and pathway analysis.

### Results

The search from three bibliographic databases and web search retrieved 8757 studies, resulting in final inclusion of 98 articles that reported on the impact pathway and intervention analysis (n = 84) and their nutritional outcomes (n = 14). The detailed PRISMA flow diagram (Figure 1) shows step-by-step search terms and queries for undertaking the present study review.

#### Study characteristics

##### Country-wise distribution

Out of 98 relevant literatures, 70 studies were related to 42 different countries for either analyzing impact pathways and/or interventions or case studies. We found that the most studies were from lower middle-income economies (n = 68), followed by upper middle-income economies (n = 20), lower-income economies (n = 15), and high-income economies (n = 12). Figure 2 shows the country-wise detailed map for our selected studies.

##### Year-wise distribution

The concept of MNSVC is relatively new. In the earlier years (2000–2010), we found very few readings (n = 13) relevant to the concept of the present study. However, after 2010, increased interest and significance (n = 102) were observed among the research fraternity in understanding nutrition-sensitive value chains. We found the highest frequency of publications in the year 2018 (n = 17), followed by 2017 (n = 13) and 2016 (n = 11) and 2019 (n = 11). Details of the year-wise publication are shown in Figure 3.

##### Impact pathway-wise distribution

Most food value chain pathways are nonlinear, and there are several interactions among them. Our research includes 84 studies in pathway analysis. Here, we have reported six

### Table 2. Screening process for micronutrient-sensitive value chain.

<table>
<thead>
<tr>
<th>Screening phase</th>
<th>Criterion</th>
<th>Included</th>
<th>Excluded</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title screening</td>
<td>Topic related to MNSVC</td>
<td>Topic relevant to MNSVC, such as nutrition, micronutrient, or nutrition-sensitive interventions</td>
<td>Irrelevant topics, such as disease conditions</td>
<td>Relevance</td>
</tr>
<tr>
<td>Title and abstract</td>
<td>Publication type</td>
<td>Peer-reviewed studies, discussion papers, significant gray literature from highly reputed International Bodies (FAO, UNICEF, USDA)</td>
<td>Meta-analyses and opinion papers, letters and editorials, conference abstracts</td>
<td>Peer-reviewed articles are robust in quality of content and methodology, and therefore, studies without peer review excluded</td>
</tr>
<tr>
<td>Abstract and full text</td>
<td>Interventions</td>
<td>Micronutrient interventions that incorporate specific nutrition objectives and actions and address the following domains of the value chain stakeholders: health, environment, education, and social and financial protection</td>
<td>Nutrition interventions alone, without micronutrient-specific objectives and actions, and that do not go beyond the laboratory</td>
<td>Included studies relevant to nutritional interventions aimed at domains of value chains</td>
</tr>
<tr>
<td>Abstract and full text</td>
<td>Comparators</td>
<td>Studies comparing outcomes between different groups and pre-and post-intervention within a single group</td>
<td>One-time cross-sectional studies not comparing the effects between different groups; or the same group before and after intervention</td>
<td>Excluded the articles that were not able to identify the effect of the intervention</td>
</tr>
<tr>
<td>Full text</td>
<td>Inclusion for impact</td>
<td>The impact analysis included outcomes measured on treatment or intervention effects and also the processes</td>
<td>Studies present proportion only, without studying significant effects and/or differences between groups</td>
<td>Descriptive analysis presenting proportions allows making outlines about the change and better understanding of impact</td>
</tr>
<tr>
<td>Full text</td>
<td>Pathway analysis</td>
<td>Studies reporting entry points of pathways of intervention of MNSVC for nutrition, such as food production, agricultural income, markets, women’s empowerment, and knowledge on nutrition</td>
<td>Studies reporting on intervention only without pathways mainly improving the micronutrient content in the food</td>
<td>Impacts alone do not give insights into the pathways that allow improving value chains to deliver micronutrient-rich foods</td>
</tr>
</tbody>
</table>

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pathways to improve micronutrient consumption. These six pathways were production pathway (n = 38), accessibility pathway (n = 38), markets pathway (n = 21), income pathway (n = 7), knowledge and behavioral pathway (n = 9), and women's empowerment pathway (n = 7). Along with these impact pathways, we found 14 studies on micronutrient nutritional outcomes through interventions. However, multiple combinations of these were often
reported within a single study. The largest number of studies reported only a single pathway (n = 77). The Venn diagram in Figure 4 shows the type of studies and interaction between impact pathways and the nutritional outcome studies.

**Pathway and intervention analysis**

Several recent studies have proposed pathways through which food systems could influence nutrition [24, 63, 68–71]. These seem to agree that food production for own consumption, food availability, incomes, prices, gender-specific time allocation, and consumer behavior provide important links between the food systems and household access to food and nutrition. In this study, we have followed six pathways of value chain interventions for delivering micronutrients, namely production pathway, accessibility pathway, markets pathway, income pathway, knowledge and behavioral pathway, and women empowerment pathway. The interventions introduced through these pathways have been discussed in detail in the following sections.

**Production pathway**

Thirty-eight out of 98 studies mainly relates to the production pathway. This pathway has two sub-pathways. The first sub-pathway discusses the improvement of micronutrient content in food through fortification. Fortification is a feasible and cost-effective means of delivering micronutrients to populations that may have limited access to diverse diets and other micronutrient interventions [7, 35–49, 72, 73]. It can be done through two approaches: bio-fortification and fortification of food during processing. Bio-fortification of staple crops can help improve a poor-quality diet, especially where food choices are limited, and soils may be devoid of bioavailable micronutrients. Over 20 million people worldwide are currently consuming bio-fortified crops [7, 35]. Bio-fortification can be achieved in three ways [49]: (a) conventional bio-fortification—to change the genetic makeup of the plant for higher micronutrient content is the most sustainable bio-fortification approach [17, 37]; (b) agronomic bio-fortification—this approach includes fertilization of crop with micronutrient and exogenous application of micronutrients through the foliar application [17]; (c) transgenic bio-fortification—inserting genes needed for the accumulation of a micronutrient, which would otherwise not exist in that particular crop (either complete form or in a bioavailable form) [17, 74].

Another way of fortification of food is done during food processing either voluntarily through breakfast cereals, yoghurt, and sweet biscuits [59, 60, 73, 75–77] or through policies mandating blending of micronutrients in the flour, oil and salt, etc. [60, 73, 78].

The second sub-pathway is to increase the availability of micronutrient-rich food in communities. The consumption of micronutrient food by producer households either out of their production through home/school/community gardening [24, 79–86] or purchase from the market [29, 39] can be considered the most direct pathway to achieving changes in their micronutrient consumption. However, proper processing by increasing the shelf-life of whole
micronutrient-rich foods can be used year-round and can be distributed in a wider community, increasing the availability of micronutrient-rich food [39, 87]. The overall availability of nutritious foods might also be increased through interventions that increase seasonal availability. This might be achieved through staggered planting systems, or systems of planting in different climatic regions [87], or improved storage systems [81].

**Accessibility pathway**

The availability of micronutrient-rich foods in the local food environment is important; however, this alone does not necessarily translate into high-quality dietary patterns [88]. Economic and regular accessibility of micronutrient-rich food is equally important. An increase in accessibility of micronutrient-rich foods can be explained in two sub-pathways: direct and indirect pathways.

The direct pathway is easy accessibility to the micronutrient-rich foods to the end consumer through government and non-governmental programmes. Providing micronutrient-rich food through school meal programmes is one of the most important interventions of the accessibility pathway [1, 58, 61, 87, 89–92]. Public distribution system (PDS) providing subsidized food is another intervention pathway to increase access to micronutrient-rich foods by vulnerable populations [6, 8, 26, 69, 77, 93]. Subsidies/social transfers to facilitate consumption in lean season can also increase micronutrient-rich food consumption [25]. Community kitchens that provide the main meal at a low cost to impoverished families also influence access to micronutrient-rich foods [94–97].

An indirect pathway enables accessibility through strategic interventions across the food supply chain. In developed countries, significant quantities of food are wasted at the consumption level and lost early in the food value chain. In developing countries, significant quantities of food are lost during the production-to-processing stages of the food value chain; much less food is wasted at the consumer level [27, 98, 99]. Micronutrient-rich foods can be made relatively more affordable by reducing losses and waste [100–103] and through an integrated production process after harvesting [51]. The government’s provision of subsidies also alters the affordability and accessibility of nutritious foods or specific micronutrient-rich foods/agricultural commodities [4]. Household and community production of micronutrient-rich food in the short and long value
chains [29, 71, 79–81, 84, 85, 104–107] also affect the micronutrient consumption. In addition, the packaging and processing enhance the micronutrient consumption by increasing shelf-life and wider distribution [87].

**Markets pathway**

Commercial marketing for micronutrient-rich food not only motivates behavior changes of the potential consumers but can also promote the rate of adoption of micronutrient-rich foods [24, 108]. In some cases, it will benefit maternal and child nutrition and health [41]. promote the production and consumption of indigenous vegetable crops in vulnerable communities, and help meet the recommended intakes of micronutrients like vitamins A and C and iron throughout the year [6]. To ensure that value chain interventions have sustainable impacts on nutrition outcomes, the interventions must engage with the private sector throughout. The private sector may be engaged to integrate goals such as improved nutrition or sustainability; such interventions are more likely to be taken to scale if profit incentives can be aligned with nutritional outcomes [2, 77]. For this pathway, both public and private sectors need to engage to achieve the integrated goals of nutritional outcomes and sustainability.

Government programmes may better adapt the product’s labelling to the local consumers and offer customized products for wider acceptability and utility. Through labelling in the local language, nutrition messaging can facilitate consumer compliance and are more likely to be popularly accepted in the communities [109], but it is also critical that the consumers understand and are aware about food products labelling. A standardized small-packaged food product may fulfills the safety and micronutrient intake at the point of consumption and ensures easy availability for the lower-income populations [75, 77, 110, 111]. Development of convenient packaging sizes is needed that suits a limited budget [1, 70, 75, 90, 109, 112, 113]. Another option, such as supplementation of micronutrients through capsules, needs more evidence base [62, 90] apart from the issues of the supply chain and adherence for Iron Folic Acid Supplementation (IFAS) for pregnant women. The development and promotion of ready-to-eat micronutrient-rich food products may be encouraged through nutritious snacks at any time of day. However, the consumers should have choices to access this through various distribution channels like alternative retail outlets such as petrol stations, convenience stores, and schools [29, 114].

Nowadays, the concept of local food has gained traction in the media, engaged consumers, and offered farmers a new marketing tool [25, 61, 115]. Therefore, nutrient-dense, climate-resilient, economically viable, and locally available or adaptable food can be prioritized as Future Smart Food (FSF) and it can play an important role in combating hunger and malnutrition [115–117].

**Income pathway**

Household income has the high potential effect on nutrition, especially among the most vulnerable population. Changes in consumption patterns in response to price and income changes could impact nutrient intake with related positive or negative consequences [118]. Dietary quality is also associated with income, especially in developing countries. When people are very poor, they rely on dietary staples like cereals that tend to be poor sources of micronutrients [119]. Increasing and, where relevant, diversifying on- and off-farm income throughout the year are essential to improving food and livelihood security and meeting nutritional needs. The most important intervention in this pathway has been the introduction of improved dairy cow breeds resulting in higher milk yields per cow, higher milk sales, and greater market integration, and thereby, these households had higher expenditure on nutritious food [84, 120–122]. Besides that, crop diversification also increases and stabilizes the households’ income and, henceforth, nutrition [123]; in addition, improved coordination and linkages with traders/markets also reduce costs of production and increase revenue and therefore improve the income of the farmers that may influence the nutrition [25].

**Knowledge and behavioral pathway**

Lack of knowledge, beliefs about food, customs, and poverty are the main factors preventing millions of people from eating enough micronutrient-rich foods [124]. Information campaigns and the promotion of nutrient-rich products increase the awareness among the value chain actors [25, 125]. Education on micronutrient-rich food enhances consumers’ awareness on its importance for health and confidence in food safety and food quality [60, 126, 127]. The evidence on interventions to improve the iron content of the meals found community kitchens as a unique opportunity to develop and design nutrition education interventions to improve the consumption of micronutrient-rich foods. Simultaneously, a behavior change communication strategy targeted at women and adolescent girls to enhance awareness and knowledge about micronutrient deficiencies was looked upon as a long-term strategy for improving dietary intake among the communities [15, 94].

**Women’s empowerment pathway**

There is compelling evidence of the fundamental role of women in food value chains [24, 27, 128–130]. Gender relations have been found highly relevant also in determining the effectiveness of food loss reduction strategies and interventions. These types of interventions, which aim for long-term adoption of technologies and shifts in production behaviors, require that gender relations and the different priorities, preferences, and bargaining power of women and men as actors of the food value chain are considered [27]. Gender affects health and nutrition outcomes, which
may lead to micronutrient deficiencies, at least in some cultures, and where there is a difference in priority within the household, it is usually females who are disadvantaged [8]. Evidence suggests that knowledge transfer to women can lead to desirable changes in diets and there is greater potential to enhance nutrition knowledge and practices by targeting women [97]. A study reveals that a combination of strategies and formative research effectively improved women and adolescent girls’ dietary iron intake and thereby improved their iron status [94].

**Nutritional outcome through value chains**

Value chain approach, which use supply chains to add value (usually economic) to products as they move from producers to consumers, can increase access to nutritious foods, especially micronutrient-dense foods, and improve nutritional status. There is an existing knowledge gap specifically, about how the value chains can be shaped to increase incomes and improve diets and nutritional outcomes. The dairy value chain was a successful strategy to distribute micronutrient-fortified yoghurt (MNFY) among pastoralists in Northern Senegal, and increase Hemoglobin concentrations among their children and reduce anemia [60]. Another study described that development, expansion, coalition, and strengthening consumer demand of new products or by modifying existing food products to address specific micronutrient deficiencies such as iodine fortification; vitamin-fortified yoghurt from Grameen Danone Foods for the Asian market; packaged foods rich in micronutrients and vitamin A-fortified cooking oil [59]. In Nigeria, school meals served in three rural schools were provided to meet a third of recommended daily energy and micronutrient intakes [58]. The large-scale interventions using integrated agricultural, demand creation/behavior change, and marketing components to introduce and promote Orange Flesheed Sweet Potato (OSP) were successfully incorporated it into the diets of women and children. It significantly increased the adequacy of vitamin A intake [38].

While in rural Bangladesh, children who participated in a community-based school meal programme using local foods with soybean showed significant improvements in height velocity and hemoglobin concentrations compared with children who did not participate in the school meal programme [61]. In another study, the supplementation method’s delivery of multiple micronutrients through the food route was as efficient as the conventional method of supplementation through tablets among residential school children [62].

In India, a study found a negative effect on micronutrient intake in low-income families upon the exogenous increase in wheat and rice subsidy through a targeted food price subsidy programme [4]. This study reflects the unintended effect of selectively subsidizing certain food items, thereby lowering micronutrient intake among a population that suffers from high levels of micronutrient deficiency.

When adopted and put into practice, nutrition awareness can lead to improvements in nutrition outcomes across the life cycle [24]. Also, a case study that seeks to identify actionable options for leveraging local value chains for improved nutritional outcomes of poor rural consumers in Malawi calls for an integrated approach, starting from consumption to production [25]. The traditional food value chains often still predominate in low- and middle-income countries and can significantly influence nutrition outcomes by facilitating a year-round availability of a wide variety of foods [27]. There is little empirical evidence illustrating how food purchasing patterns and dietary outcomes change when smallholder farmers and rural participants are linked to higher-value market opportunities [28]. Another research focused on the fruit value chain-linking growers, processors, and retailers in South Africa, India, and Australia with its emphasis on identifying implications for end-consumption through nutrition-oriented value chains rather than economic outcomes within the chain [29, 131]. Utilizing locally available small fish has shown considerable potential as a cost-effective food-based strategy to enhance micronutrient intakes in Ghana, Malawi, Uganda [30], and Bangladesh [132, 133].

**Conclusions and implications**

Making food value chains micronutrient-sensitive requires a multi-stakeholder, integrated systemic approach as a basis for concerted action among various stakeholders in terms of policy, research, strengthening partnerships, coordination, and information sharing. To make such a system approach effective and sustainable, there must be specific incentives for every stakeholder involved in the micronutrient-sensitive value chains. The pathways and policies to make food value chains nutrition-sensitive would include (a) moving from a focus on supply opportunities and market demands to one which takes into consideration consumers’ nutrition needs, and which may involve creating demand (e.g., through social marketing or nutrition education campaigns, behavior change communication strategies); (b) shifting from a commodity focus that addresses one value chain at a time to an approach that addresses various value chains including food loss and waste intending to improve diets in a holistic way; (c) transitioning beyond targeting economically active groups in a more inclusive way also to address the needs of nutritionally vulnerable and economically marginalized populations; and (d) broadening the concept of “value” from a purely economic focus on the one encompassing gender, nutrition, health, and environmental dimensions.

In this review, we have presented pathways to enable the delivery of micronutrients across the continuum of the food value chains to address the hidden hunger or triple burden of malnutrition, which is becoming a common problem for both developing and developed economies. However, the available literature has not yet deeply focused
on the micronutrients in the context of the food value chain. More rigorous evidences are needed to identify leverage points for designing context-specific interventions to build (micro) nutrient-sensitive food value chains and enhance consumer awareness to attain improved intakes of nutritious foods, especially micronutrient-dense foods, to combat hidden hunger. The evidences are needed also to build strong narratives on the importance of (micro) nutrient-sensitive food value chains supporting healthy and sustainable food systems.

**References**


12 CABI Reviews


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