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ORIGINAL PAPER

Simple solutions for complex problems? What is missing in agriculture for nutrition interventions

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Abstract

Within the nutritionism paradigm, in this article we critically review the marketization and medicalization logics which aim to address the pressing issue of malnutrition in low- and middle-income countries. Drawing from political economy and food system transformation discourses, we are using the popular intervention types of nutrition-sensitive value chains (marketization logic) and biofortification exemplified through orange-fleshed sweet potato (medicalization logic) to assess their outcomes and underlying logics. We demonstrate that there is insufficient evidence of the positive impact of these interventions on nutritional outcomes, and that their underlying theories of change and impact logics do not deal with the inherent complexity of nutritional challenges. We show that nutrition-sensitive value chain approaches are unable to leverage or enhance the functioning of value chains to improve nutritional outcomes, especially in light of the disproportionate power of some food companies. We further demonstrate that orange-fleshed sweet potato interventions and biofortification more broadly adopt a narrow approach to malnutrition, disregarding the interactions between food components and broader value chain and food system dynamics. We argue that both intervention types focus solely on increasing the intake of specific nutrients without incorporating their embeddedness in the wider food systems and the relevant political-economic and social relations that influence the production and consumption of food. We conclude that the systemic nature of malnutrition requires to be understood and addressed as part of the food system transformation challenge in order to move towards solving it. To do so, new evaluation frameworks along with new approaches to solutions are necessary that support multiple and diverse development pathways, which are able to acknowledge the social, political-economic, and environmental factors and drivers of malnutrition and poverty.

Keywords Food systems · Nutrition-sensitive · Value chains · Biofortification · Orange-fleshed sweet potato · Political economy

1 Introduction

Interest in interventions that address malnutrition in low- and middle-income countries (LMICs) has increased significantly in the past two decades. Despite a range of efforts to combat malnutrition in many LMICs, the triple burden of malnutrition, i.e. the simultaneous existence of under- and overnutrition (Gómez et al., 2013), is well underway in many countries. The share of the population who is undernourished in low-income countries has steadily *increased* since 2014, particularly in Sub-Saharan Africa, where the prevalence of undernourishment increased from 18% in 2014 to 23.2% in 2021 (FAOSTAT, 2022). The increase in Sub-Saharan Africa is to some degree driven by population growth as an increasing number of children under 5 years of age are stunted (Onyango et al., 2019). In addition, vitamin A and zinc deficiencies persist at high levels in Sub-Saharan Africa and South Asia (Christian & Dake, 2021; Popkin et al., 2020), whilst the consumption of unhealthy ultra-processed foods is increasing rapidly across LMICs, further deteriorating micronutrient deficiencies and increasing the incidence of obesity (Pries et al., 2019; Reardon et al., 2021).

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Against the backdrop of worsening nutrition in many LMICs, 'agriculture for nutrition' has become a central focus in the international development agenda as well as in policy-making. However, in line with techno-centric views about the nature of solutions for other agricultural challenges, 'agriculture for nutrition' has focused narrowly on technical and/or market-driven interventions that seek to support both income and nutrition outcomes in LMICs (Gassner et al., 2019; USAID, 2021). Research organizations such as the CGIAR,[1] donors such as the Bill and Melinda Gates Foundation (BMGF) as well as initiatives such as the Alliance for a Green Revolution in Africa (AGRA), the Global Alliance for Improved Nutrition (GAIN), HarvestPlus, and the Scaling Up Nutrition Movement emphasize how technical solutions to nutrition will contribute to achieving the Sustainable Development Goal (SDG) 2 of Zero Hunger. These technical solutions include providing access to improved seeds and food of biofortified crop cultivars. The promise of these solutions is that these improve nutrition outcomes, addressing issues of dietary diversity, overnutrition, stunting, and micronutrient deficiencies. However, there is little evidence that these approaches generate significant and sustainable impact in improving nutrition or broader development aspirations.[2] Just one of many examples of this concern is the most recent review of CGIAR Research Program on Agriculture for Nutrition (A4NH) that finds "no progress has been reported on improving dietary diversity" (CAS, Secretariat (CGIAR Advisory Services Shared Secretariat), 2020, p. 2).

This reductionist trend towards technical and market driven nutritional fixes has been characterized by the literature on the political economy of food as the paradigm of *nutritionism* (Kimura, 2013; Scrinis, 2008, 2013), whereby food and nutrition are merely viewed as being composed of nutrients, ignoring the political-economic and social-cultural environments which determine the economic and cultural value creation of food (see e.g. Mintz & Du Bois, 2002). Within this paradigm, 'marketization' (private sector delivery through wholly marketized food and nutrition systems) and 'medicalization' (increasing nutrient intake) efforts have gained significant popularity (Robinson, 2016; Scrinis, 2008, 2020). These approaches have been critiqued for sidestepping the complexity of nutritional drivers and determinants, thereby depoliticizing the complexity and underlying drivers of malnutrition (Robinson, 2016; Scrinis, 2020). This critique highlights a growing consensus that the underlying causes of the triple burden of malnutrition are not of technical nature per se (i.e. insufficient availability/supply of foods), but instead reflect complex inequities and power relations in food systems (Biovision Foundation for Ecological Development & IPES-Food, 2020; Development Initiatives, 2020).

Similarly, arguments in the sustainable food system discourse suggest that a fundamental reconfiguration or transformation process is required that re-directs agri-food systems towards more environmentally sound, equitable and socially just pathways of development (Anderson & Leach, 2019; Béné, 2022; Caron et al., 2018; IPES-Food & ETC Group, 2021). The transformation is not only a technological change agenda, but more importantly a social and political agenda that needs to open up to wider stakeholder values and aspirations and broaden-out choices and innovation pathways through more democratic and bottom-up approaches (Ely et al., 2014; Stirling, 2008, 2014). Interventions framed in this transformational perspective need to be informed by and embedded in the political-economic and social relations that directly and indirectly affect interventions, including the interests and choices by different actors, such as so-called Big Food (Stuckler & Nestle, 2012), that are currently driving the ongoing nutrition transitions toward unhealthy diets in many LMICs.

Following the nutritionism paradigm (Kimura, 2013; Scrinis, 2008, 2020), we use two popular agriculture-nutrition intervention types, namely nutrition-sensitive value chains (NSVCs) and biofortification and its best documented example orange-fleshed sweet potato (OFSP), to unpack the underlying logics and impacts of marketization and medicalization interventions (Robinson, 2016). By reviewing the most recent evidence of NSVCs and OFSP in light of their underlying theories of change (ToCs), we demonstrate not only that there is insufficient evidence of these interventions on improving nutritional outcomes, but also that the underlying impact logics are inadequate for dealing with the complexity of nutritional challenges. Combining the political economy and food system transformation perspectives with the insights derived from the review of popular intervention types, this paper challenges the current trend of nutritional interventions to narrowly focus on marketization and medicalization pathways. By highlighting that NSVC and OFSP approaches depoliticize societal debates around food production, distribution and consumption patterns, this paper makes a specific contribution to the debates around the politics of nutrition and nutrition interventions (Duncan & Claeys, 2018; Gillespie et al., 2013; Leach et al., 2020; Nisbett et al., 2014). We further underline the need to adopt an approach that allows for multiple and diverse development pathways (such as Scoones et al., 2015), which accounts for the social, political-economic and environmental complexities and realities that drive issues of malnutrition and poverty. The paper argues that nutritional challenges need to be addressed as part of the system transformation

[1] CGIAR is a global research partnership for a food secure future dedicated to reducing poverty, enhancing food and nutrition security, and improving natural resources.

[2] Note that this paper focuses on nutrition and not food security. Separate dynamics exist when examining the impact of interventions on food security, particularly with respect to humanitarian assistance.

challenge, a perspective that is increasingly been argued within the context of grand challenges associated with food systems and concerns about the negative consequences of current trajectories of innovation and change (Conti et al., 2021; El Bilali, 2019).

The paper proceeds as follows. First, we present the intervention types representing the marketization and medicalization paradigms and illustrate the systemic nature of nutritional challenges. Second, we discuss the findings from the review in light of recent thinking on food system transformation and political economy of food to explain and critique the current narrow focus on marketization and medicalization as an artefact of incumbent interests in food systems. We conclude that a reframing of nutritional challenges and solutions is necessary to generate multiple pathways with various directions for improvement.

2 Nutrition-sensitive value chains and orange-fleshed sweet potato: What is the evidence?

The marketization of malnutrition denotes that to achieve the most effective and efficient improvements in malnutrition, market structures, particularly private sector actors, need to be leveraged, for instance through nutrition-sensitive value chain approaches (Robinson, 2016). The nutrition-sensitive value chain (NSVC) approach accurately demonstrates this logic as it aims to work through the value chain, i.e. using market actors and dynamics, to identify entry points and opportunities for improving nutritional outcomes (Hawkes & Ruel, 2011). Building on the value chain framework, the NSVC framework is a market-based approach that focuses on identifying and addressing market failures in both the supply of and demand for nutrient-rich food (Gelli et al., 2015). The NSVC approach differs from other types of agriculture-nutrition interventions in that it focuses on specific segments of the value chain or its entirety (Maestre et al., 2017).

The medicalization of malnutrition understands malnutrition as being the mere consequence of an insufficient intake and retainment of nutrients (Robinson, 2016). The proposed solution to this issue is then of technical nature, namely the increase in nutrient consumption or absorption through, for example, biofortified crops (Kimura, 2013; Robinson, 2016). Biofortification aims to address micronutrient deficiencies, so-called hidden hunger, by increasing nutrient levels in crops during plant growth through conventional plant breeding or genetic modification, commonly in staple crops in LMICs (CGIAR Research Program on Agriculture for Nutrition and Health (A4NH), 2021).

2.1 Methods

For this paper, we have purposefully selected the NSVC and orange-fleshed sweet potato (OFSP) approaches as the focus of the analysis since they both represent popular types of agriculture-nutrition interventions in LMICs (see e.g. CGIAR Research Program on Agriculture for Nutrition and Health (A4NH), 2021; HarvestPlus, 2020; USAID, 2021). OFSP, in particular, serves as an exemplary case of biofortification interventions as it has been widely promoted over many years, particularly in Sub-Saharan Africa, and has been subject to a large body of impact and evaluation studies, resulting in a readily available and relatively large evidence base. It is also a widely known case as the core team behind OFSP was awarded the World Food Prize in 2016. Sweet potato is also identified as a priority crop by HarvestPlus for most countries in Sub-Saharan Africa (except southern Africa) (HarvestPlus, 2022).

The analysis of the intervention types is based on a comprehensive literature review. The following criteria were used to select publications: use of primary or secondary data; published in English; explicit consideration of nutrition or diet-related outcome indicators; all study designs, i.e. impact evaluations, systematic reviews, case studies, and cross-sectional studies. Regarding NSVC interventions only publications that addressed at least two nodes of the value chain(s) were included. Theoretical or conceptual publications about NSVC and OFSP interventions were excluded from the review of impacts. However, some of these publications served to contextualize the approaches in terms of the underlying ToCs and impact pathways (see below). The review was not limited to a geographical area, dates, or (in the case of NSVC) specific commodities or foods. The review includes peer-reviewed journal articles, working papers, book chapters, and project reports which are available online.

We used a two-step procedure to identify relevant publications. First, we used the *Food Systems and Nutrition Evidence Gap Map* (Moore et al., 2021), which is hosted by the International Initiative for Impact Evaluation (3ie) and collects impact evaluations and systematic reviews of food system interventions across various outcome indicators. We decided to use this evidence gap map as it is based on a systematic search of all the impact evaluations and systematic reviews of food system interventions. In the evidence gap map, we identified a total of 18 studies: seven studies on NSVC interventions and 11 studies on OFSP interventions (see supplementary material for an overview). Second, we conducted a complementary literature search on Google Scholar and relevant websites (i.e. CGIAR databases, HarvestPlus, and FAO publications), including backward and forward screening of studies that were cited, to capture more recently published evaluations, reviews, project evaluations and qualitative studies. For an overview of the search strings see supplementary material. We identified additional 21 publications that assessed the impacts of NSVC (10 studies) and OFSP interventions (11 studies). The 39 identified studies cover systematic reviews across Sub-Saharan Africa and Asia as well case studies from Ghana, Kenya, Liberia, Mozambique, Nigeria, Pakistan, Uganda, Senegal, Sierra Leone, Tanzania, and Zambia.

2.2 Marketization: Nutrition-sensitive value chains

2.2.1 Theory of change

NSVC interventions mainly target one or more of the following four dimensions, i.e. the availability, affordability, access and the nutritional quality of foods (Hawkes & Ruel, 2011). The starting point of NSVC interventions is generally the identification of a malnutrition issue for a (specific group of the) population, and then work backwards through the value chain(s) to identify entry points for enhancing the consumption of nutrient-dense foods covering various stakeholders such as the private sector, public sector and civil society. Different types of NSVC approaches exist, ranging from a largely descriptive diagnostic framework (de la Peña & Garrett, 2018; Gelli et al., 2015), a producer-oriented approach (Gómez & Ricketts, 2013), a consumer-oriented approach (Allen & de Brauw, 2018), a conceptual framework incorporating a differentiated view on the role of the private sector (Maestre et al., 2017), and a list of insights for NSVC intervention design (Morgan et al., 2019).

A basic ToC of NSVC interventions (from the perspective of small-scale farming households) is presented in Fig. 1. De la Peña et al. (2018, pp. 18–19) identify three impact pathways for improving nutrition, namely:

- Own production pathway: households increase the consumption of nutritious foods through their own production;
- Income pathway: households increase the consumption of nutritious foods through increases in income; and
- Market pathway: households increase the consumption of nutritious foods as they become more available and affordable through improvements in the efficiency of producing, processing and transporting foods.

In addition, the authors identify two impact mediators for improving nutrition, namely women's empowerment and nutrition awareness, which act across the three impact pathways. The impact pathways operate across three main domains, namely nutrition and health; agricultural production; and business development and value addition (Gelli et al., 2015). One of the key trade-offs in NSVC interventions centers around the price of food. On the one hand, food prices should remain relatively low so that particularly poorer consumers can afford nutritious food (market pathway). On the other hand, food prices should increase so that food producers, particularly smallholders, earn

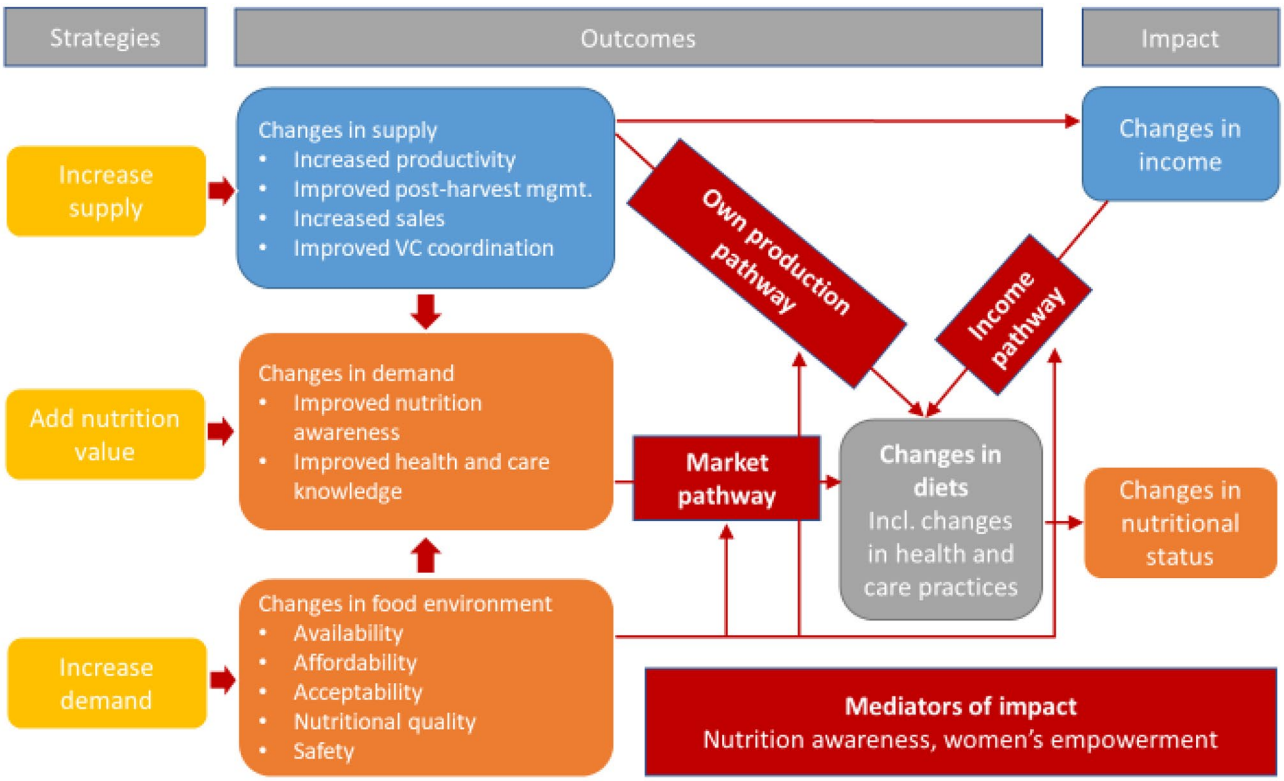

Fig. 1 Theory of change of NSVC interventions. Source: de la Peña et al. (2018)

a higher income to afford to buy more nutritious foods (income pathway) (Mausch et al., 2020).

2.2.2 Systematic evidence

To the best of our knowledge, no systematic review on the impact of NSVC interventions on nutrition outcomes has been conducted at the time of the completion of this review. This is partly due to the complex nature of assessing NSVC interventions as they address two or more nodes of the value chain, rendering the attribution of impact to the value chain intervention an inherently complex task (Ton et al., 2010). While there is evidence on the impact of individual value chain components, particularly production, on nutrition, there is no systematic evidence on multiple nodes of the value chain. In addition, we identified two evidence reviews that examine the impact of interventions along (food) value chains on nutrition outcomes, without classifying these as NSVC interventions.[3]

First, Juillard et al. (2017) provide an evidence synthesis on the impact of market support interventions on food security during humanitarian crises. Market support interventions may be classified as NSVC interventions if they address at least two nodes of the value chain. The authors were unable to conduct the intended meta-analysis due to the overwhelming lack of evidence in terms of the quantity, quality, rigor and diversity of published studies. Second, Nordhagen (2020) carried out a scoping review on the impact of food supply chains on the diets and food accessibility of children and adolescents. The author finds very few studies that examine the value chain in a holistic manner, identifying only six studies that cover more than one node of the value chain (the individual studies are further discussed below). She concludes that there is insufficient evidence on the impact of food value chains on improving nutrition outcomes.

2.2.3 Evidence on leveraging value chain linkages for nutrition and income

Vertical and horizontal coordination Enhancing both the horizontal and vertical coordination in value chains are regarded as critical in addressing challenges faced by increased globalization (Humphrey & Navas-Alemán, 2010). With regards to horizontal coordination, Dumas et al. (2018) conducted an impact evaluation of the short-term impacts of setting up egg production centers on household egg purchases, consumption, and height-for-age of young children. The study finds a positive impact of the production centers on household egg purchases, but no impact on household egg consumption and height-for-age of children. The authors attribute the limited impact of the intervention to the risks faced by households connected to the dependence on external market dynamics, such as the inability of households to increase egg prices despite rising feed prices and barriers to access inputs.

Rutherford et al. (2016) evaluated the impact of a project to enhance the vertical coordination (i.e. the linkages between farming households and input suppliers and buyers) and increase crop volume on household food security and nutrition. The authors find that over the two-year time period food security (measured through an index) decreased for participating households, whilst food security for households in the control group remained stable. However, the authors do not provide an interpretation of the size of the decrease, thereby failing to provide more meaningful implications for people's livelihoods. Despite lower food insecurity and increased access to food, the evaluation finds no impact on children's nutrition. Consequently, the authors argue that the underlying ToC and impact pathway (i.e. increased household income will enhance children's nutrition) is too simplistic. Instead, a systems approach is necessary to understand and address the broader challenges that impact children's nutrition within and outside of households.

Leveraging the private sector The private sector is assumed to be a critical partner in NSVC interventions due to their potential role in providing nutritional benefits beyond the project or program if profitable. However, the evidence reviewed for this study suggests that it is extremely difficult to influence the structural constraints and underlying incentive structure of companies. For example, Anim-Somuah et al. (2013) and Nwuneli et al. (2014) demonstrate that local medium-sized businesses in Ghana and Nigeria, respectively, face significant constraints in realizing business models that are sustainable and profitable, whilst providing nutrient-rich food products to poorer consumers. In particular, these companies struggle to produce affordable and healthy food products due to their high costs in terms of sourcing high quality inputs, demand generation, distribution, and signaling of the nutritional quality. Interestingly, both studies conclude that public sector support is critical since the private sector alone is unable to significantly reduce undernutrition.

Ansari et al. (2018) also closely examine the local business environment, and caution that private sector objectives may be in opposition to objectives of improving nutrition outcomes. The authors use a case study of the dairy value chain in Pakistan to evaluate the success of a nutrition-sensitive innovation in the value chain, i.e. the processing, packaging and retailing of ultra-high temperature (UHT) milk. The innovation did not result in the desired increase in the supply of affordable dairy products, particularly to poor consumers. Instead, the UHT innovation resulted in the development and distribution of non-dairy products of little to no nutritional value and with weak or no linkages with farming households (the introduction of so-called tea creamers is illustrative here). The main driving

[3] While Ton et al. (2017) analyze contract farming as a value chain innovation, they focus on food security as the outcome variable which is beyond the scope of this paper due to its different nature as compared to nutrition.

Fig. 2 Simple theory of change and evidence of impacts of biofortification interventions. Source: Masset et al. (2011)

force of this development was the search of new sources of profits by dairy processors responding to changing consumer demands and price sensitivity. The authors highlight that in the context of weak market regulation, dairy processors were able to market unhealthy food products as healthy dairy products at very affordable prices to low-income consumers.

Finally, Le Port et al. (2017) find that leveraging an existing distribution system of the dairy value chain in Senegal to distribute micronutrient-fortified yoghurt had an insufficient impact on the prevalence of anemia among children of dairy-producing households. The authors find that external factors such as weather conditions are critical in determining the intervention participation of households. Most notably, they record significant decreases in participation in the dry season vis-à-vis the rainy season, with important implications for intended nutritional impacts. In addition, questions around the sustainability and cost-effectiveness of such business arrangements were not addressed in the study, leaving at best an ambiguous business case for such interventions. Instead, the authors state that the intervention critically hinged upon the strong partnership between a non-governmental organization, the government and the private sector. It would be useful to assess this intervention against the background of business requirements outlined in Maestre et al. (2017, p. 37) to examine, for instance, how dairy processors can manage the increased costs and risks associated with the production and distribution of micronutrient-fortified yoghurt.

2.3 Medicalization: Biofortification and orange-fleshed sweet potato

2.3.1 Theory of change

Biofortification has remained a popular development intervention to combat micronutrient deficiencies since the early 1990s.[4] By increasing the levels of nutrients in the crop itself, development financers, practitioners and researchers hope to improve the nutritional status of vulnerable people (Masset et al., 2011). A basic theory of change (ToC) is presented in Masset et al. (2011) (see Fig. 2). The impact logic highlights that as biofortified crops are developed to contain higher levels of micronutrients than their natural counterparts and farming households adopt these biofortified crops, consumers (including those that produce the crops) will purchase and consume biofortified foods. Assuming that the bioavailability of the biofortified crop is sufficiently high and the human body is able to absorb these micronutrients, the desired nutritional impact is generated as the nutritional status of the target population is improved.

The figure also summarizes the main results of a systematic review by Masset et al. (2011) of the impact of biofortification interventions. The authors conclude that there is currently insufficient evidence on the causal links along the ToC between biofortification interventions and their intended nutritional impact. In particular, the evidence on farming households' acceptance of biofortified crops, their impact on yields and on-farm profits, as well as the nutritional impact are deemed as 'very poor'. More recently, the 2020 review of the CGIAR's Agriculture for Nutrition and Health (A4NH) research program (CAS Secretariat (CGIAR Advisory Services Shared Secretariat), 2020) finds that even though the adoption of biofortified crops has increased, there is no evidence that they have improved dietary diversity.

2.3.2 Evidence on the impact of OFSP

Orange-fleshed sweet potato (OFSP) is a biofortified sweet potato high in beta carotene (a precursor to vitamin A), bred to combat vitamin A deficiencies and mainly promoted in Sub-Saharan Africa through the International Potato Center (CIP). It is perceived as one of the flagships of biofortification interventions (Waized et al., 2015) due to its relative success compared to other biofortified crops (Saltzman et al., 2013). The emergence of OFSP can be traced back to the early 1990s, whilst significant investments were made by donors such as BMGF, DFID/FCDO, USAID to CIP and HarvestPlus since the late 2000s/early 2010s, including activities such as breeding, pre-basic seed provision, vine multiplication, nutrition

[4] Prior to that, the dissemination of supplements (such as vitamin A supplements), conventional nutrition education, as well as food fortification were the main tools used in development interventions for nutrition (Kimura, 2013).

education, production promotion and placement, and post-harvest innovations such as processing and product development (for an overview see Low & Thiele, 2020).

To gain deeper insights into the process and potential obstacles, we examine the specific impacts of the relatively well documented case of OFSP interventions in terms of adoption, vitamin A intake, cost effectiveness and dietary diversity, and discuss their implications.[5]

Adoption Rigorous evidence with regards to the adoption of OFSP is scarce; we only found one systematic case study on the dynamics of adoption of OFSP. McNiven et al. (2016) analyze the sustainability of the OFSP intervention as evaluated by Hotz et al. (2012a), identifying critical trends of *dis*-adoption of OFSP two years after project completion. In particular, McNiven et al. (2016) find complete dis-adoption of OFSP in some districts in Uganda, whilst in one other district the adoption rate stabilized at 50%. The authors suggest that this heterogeneity in adoption questions whether impacts can be sustained over a longer period of time. Waized et al. (2015) identify critical demand-side issues contributing to the low adoption of OFSP in Tanzania, namely very low demand for OFSP products as well as fragmentation of value chains. In addition, against expectation, de Brauw et al. (2018) find that increased nutrition messages had little impact on the adoption of OFSP.

Vitamin A intake and deficiency There is some evidence that the introduction of OFSP has led to an increased intake of vitamin A, however data on its absorption in the human body is scarce. Hotz et al. (2012a) find a net positive impact on vitamin A intake in children and women resulting from OFSP consumption in Mozambique. In particular, the net increases in vitamin A intake corresponded to 55 to 118% of the age-specific estimated average requirement for vitamin A for children and women, reducing the incidence of insufficient vitamin A intake among the target groups (a reported net decrease between 32 and 55% for children and women). However, the authors did not measure the impact of OFSP consumption on vitamin A absorption and deficiency. Hence, it is not possible to draw definite conclusions regarding the change of vitamin A status of the target groups.

Similarly, Hotz et al. (2012b) find similar positive impacts of OFSP on vitamin A intake in Uganda, reporting an increase in vitamin A intake over 100% of the age-specific estimated average requirement for vitamin A. Using two different evaluation models, the study did not observe any impact of the OFSP intervention on serum retinol or the prevalence of vitamin A deficiency among women; the impact on children (3 to 5 years) was not significant for model 1, whilst a modest impact was reported for model 2. A critical factor for the lack of impact is the confounding impact of infections among the beneficiaries, which significantly reduced the authors' ability to identify variations in the concentration of serum retinol at both baseline and follow-up. Due to the seasonality of sweet potato, the authors caution that OFSP is not able to supply a consistent amount of increased vitamin A throughout the year. Additionally, the authors flag that the findings cannot be extrapolated to households that are not part of a farmer group since it is likely that individuals who are part of learning groups are more motivated and have higher capacity for on-farm production.

More recent studies do not find significant impact on adequate vitamin A intake. Jogo et al. (2019), evaluating the VISTA Mozambique project, find that, although vitamin A intake has increased among the treatment group, vitamin A deficiency strongly persists among 70% of treatment children and 73% of treatment women. De Brauw et al. (2019) evaluated the impact of an OFSP project in Mozambique three years after project completion. Even though the authors find higher vitamin A intake among children and women comparing treatment and control households, the authors find no statistical difference in the probability of *inadequate* vitamin A intake. Additionally, the authors only measure vitamin A intake using retinol activity equivalents, but do not assess changes in vitamin A status through the commonly-used indicator serum retinol concentration.

The findings demonstrate that even though vitamin A deficiency remains the main legitimation for OFSP interventions, evaluations either do not assess the impact or do not find any impact reaching vitamin A adequacy.

Dietary diversity The impact of OFSP adoption and consumption on dietary diversity is limited. Older studies found no overall impact on the dietary diversity of women (Girard et al., 2017) and children (de Brauw et al., 2015). Most recently, Girard et al. (2021) reviews the evidence of four OFSP projects with different project designs and across different implementation settings. In one project, they find only a small increase (19%) in dietary diversity of women and children in comparison to non-participants. Unfortunately, the authors do not report the size of the impact for the other three projects, but only if a significant impact was found (see Table 5 in Girard et al., 2021). We were able to find one of the four endline project reports online. Specifically, the project report for the VISTA Tanzania project finds that household dietary diversity has increased from 3.9 at baseline to 6.7 at endline (maximum 13 food groups), whereas child dietary diversity has increased from 3.9 at baseline to 4.6 at endline (maximum 9 food groups) (Grant, 2018). However, dietary diversity for both households and children have been measured in an unconventional way by adding biofortified foods as a separate food group (Grant,

[5] Note that all reported impacts in the following are statistically significant if not stated otherwise.

2018, p. 34),[6] increasing the scores for project participants by design. Additionally, the evaluation does not include a control group, resulting in the inability to disentangle the interventions' impact from external confounding factors.

In contrast, the VISTA Mozambique project evaluation (to some extent surprisingly not part of the evidence review by Girard et al. (2021)) includes a control group, and demonstrates a *reduction* in women dietary diversity among project participants (from 3.99 at baseline to 3.9 at endline), and a slight increase in child dietary diversity (from 3.28 at baseline to 3.41 at endline) (Jogo et al., 2019). However, both women and child dietary diversity at endline remain below the thresholds of five and four food groups respectively (FAO & FHI, 2016, p. 5).

Most recently, Adekambi et al. (2022) find no impact of OFSP on dietary diversity in Nigeria[7] and a positive but small impact in Ghana (i.e. an increase in 0.5 food groups). Despite the small sample size (175 and 126 adopters in Ghana and Nigeria, respectively) and the insignificant results from the Nigeria sample, the study nevertheless concludes that OFSP can be an effective tool against vitamin A deficiency.

Potential drivers of the lacking impact on dietary diversity could be related to the limited exposure to OFSP as well as the low fat/high fiber content of project participants' diets which reduce the body's bioconversion efficiency (Girard et al., 2017).

2.4 Summary of evidence

From the review above, we conclude that neither NSVCs nor biofortification/OFSP achieve their intended impacts and structurally fail to deliver significant benefits to vulnerable groups such as women and children. We demonstrate that these approaches have clear limitations in generating desired changes in improving nutrition outcomes. In the case of NSVC interventions, none of the studies identified any impact on improving nutrition outcomes, whilst in the case of OFSP interventions, only few studies determined a positive (but small) impact. It is striking that none of the OFSP studies measured the impact on the nutritional status of beneficiaries, despite it being the main impact in the ToC. OFSP studies focus mainly on outcome targets, such as adoption and vitamin A intake, falling short of measuring impact-level targets, such as vitamin A adequacy and changes in dietary diversity. However, proponents of OFSP, for example, consider it to be a cost-effective intervention, particularly in Sub-Saharan Africa (Low & Thiele, 2020). Yet, there is insufficient evidence on the cost-effectiveness, scalability, sustainability and long-term impacts on nutrition, health and income, particularly for vulnerable groups such as (female) low-income individuals and households (Ruel et al., 2018).

With respect to NSVC interventions, the review demonstrates that we know little about how the functioning of the value chain can be leveraged or improved to generate positive nutrition outcomes. For example, it remains unclear how different value chain actors and development organizations can cooperate more effectively to substantially improve nutrition security by enhancing the nutritional quality of foods, their availability, affordability and access, as well as the stability of its supply. Additionally, there is no evidence on how different types of markets, market access, and downstream market linkages can or cannot enhance nutrition outcomes. Despite the extensive evidence on the power of food companies along the value chain (see next section), we were unable to identify any studies that examined the impact of the interaction between upstream parts of the food value chain (such as producing households) and downstream parts (such as distributors and retailers) on diets and nutrition outcomes through, for instance, price mechanisms, location and product formats and designs. The influence of relative prices, changes thereof, and corresponding consumer responses remain notably understudied (Gómez & Ricketts, 2013).

With respect to OFSP interventions, the lack of impact of OFSP on dietary diversity and vitamin A absorption demonstrates the narrow view OFSP interventions have taken to address malnutrition, disregarding interactions between different food components (Girard et al., 2017), confounding impacts of infections and diseases among the target groups (Hotz et al., 2012b), as well as broader impacts along the value chain and food systems (Ruel et al., 2018).

The heterogeneity of impacts across geographic areas and socio-economic groups raises a critical question: *for whom* do NSVC and OFSP interventions generate benefits? At present, there is no evidence regarding the long-term impacts of these interventions on women in terms of their social status, health, and nutrition (see e.g. Ruel et al., 2018). Here, Rao (2020) provides an important case study, identifying the gendered impacts of OFSP in Tanzania. The author demonstrates that by reinforcing pre-existing gendered inequalities in terms of access and allocation of resources as well as the normative gendered division of labor in the production, provision and sale of food, there is only limited long-term impact of OFSP interventions in generating improved nutrition and income, rendering the benefits of the intervention temporary, ambiguous and conditional on external funding. Similarly, in the case of NSVC interventions, it remains unclear how the impact mediators (women's empowerment and nutritional awareness) influence nutrition outcomes across different socio-economic, political, environmental and cultural contexts, especially in those contexts where agriculture is contributing less and less to livelihoods (Ansari et al., 2018; Ruel et al., 2018).

[6] See FAO and FHI (2016) for details on the measurement of dietary diversity and a discussion on cutoff points.

[7] In fact, for two scores the coefficient is even negative, though insignificant (see Table 4 in Adekambi et al., 2022).

The review of the intervention types demonstrates that NSVC and biofortification/OFSP initiatives are currently not delivering on their promises of improving nutrition and income outcomes as reflected in the ToCs. In the following, we highlight the way that power and politics, which are often the root causes of poverty and malnutrition (De Schutter, 2017; Leach et al., 2020), are downplayed in corresponding ToCs of these initiatives, and how these have led to the emergence of contested narratives of the impact of NSVC and OFSP approaches.

3 Discussion: The fallacy of component solutions

The review of the intervention types reveals that both NSVC and OFSP approaches and their underlying marketization and medicalization logics do not address the root causes of malnutrition. These root causes relate to the politics of the distribution of food within and outside the household, namely the dominant role of the private sector in supplying cheap and unhealthy foods, low wages, small landholdings, limited access to productive resources, and gender inequalities (Kimura, 2013; Patel, 2012; Patel et al., 2015). Even though NSVC and OFSP interventions aim to tackle malnutrition challenges from different entry points and are presumed to follow different pathways, they both fail to consider these systemic challenges in food systems. In the following, we will draw from the literatures on food system transformation and the political economy of food to reveal the flaws in the ToCs of NSVC and OFSP interventions, as well as discuss how the politics of evidence contributes to food system lock-ins.

3.1 Flawed theories of change

Scrutinizing the ToCs of NSVC and OFSP in terms of their incorporation of food system-level dynamics and impacts, we find that the systemic nature of nutrition-related issues and patterns of incumbency, which fundamentally shape the workings and directionality of current food systems, are underestimated and often not recognized or ignored (Conti et al., 2021; De Schutter, 2017; IPES-Food, 2017; IPES-Food & ETC Group, 2021; Swinburn, 2019).

First, the lack of evidence demonstrates that the role of the private sector in contributing to public health objectives and nutrition improvements is greatly overestimated. In the case of NSVC approaches, Ansari et al. (2018) argue that current interventions insufficiently integrate the inherent incentives and objectives of the private sector in market and product expansion for profit maximization irrespective of whether unhealthy or healthy products are produced and promoted. The NSVC case study in Pakistan illustratively showcases the antagonistic relation between private sector and public sector objectives (Ansari et al., 2018). In the case of OFSP, McNiven et al. (2016) go so far as to argue that without embedding OFSP into government service provision and extension, it remains questionable to what extent OFSP adoption can be sustained. In many cases, as argued by Poole et al. (2020), the objectives of the private sector (particularly with respect to profitability) conflict with the ones of the public sector, necessitating a focal role for government interventions to ensure the availability, affordability, access and the quality of nutritious foods.

Second, the ToCs of both approaches do not address the politics of the distribution of food both within and outside the household. Within the household, Rao's (2020) study of OFSP highlights that the framing of nutrition deficiencies as a technical issue neglects the everyday realities and relations that shape the production and consumption of food and dietary diversity, particularly pre-existing gendered inequalities (e.g. regarding resource access) and the gendered division of labor within and outside of the household (Rao, 2020). Outside of the household, both approaches do not aim to understand and address how different elements of food systems, particularly private sector actors and other organizations, exercise power *over* food, which significantly contribute to the marginalization of vulnerable and less powerful citizens (Kimura, 2013; Patel, 2012). This results in the oversimplification of current nutritional challenges to production- and market-centered issues, failing to understand how seeds, crop and food production are embedded in diets and food systems.

Third, marketization and medicalization efforts suffer from what we call the *fallacy of component solutions*, which describes the fallacy that people's livelihoods can be improved by targeting discrete elements of the food system(s) without addressing it at the system level. This downplays the underlying mechanisms of how different parts of the food system are interconnected, limiting the intended impact of the interventions or potentially threatening the 'do no harm' principle (Mausch et al., 2020). Illustrative is the case study of OFSP and biofortification. OFSP interventions and medicalization efforts more generally compartmentalize the different dimensions of malnutrition and their underlying drivers, by focusing on specific nutrients (such as vitamin A in the case of OFSP), thereby reducing malnutrition to a technical issue and disregarding the broader complexities and drivers of malnutrition. By focusing on maximizing the nutritional content of an individual crop, the complexity of the malnutrition challenge is ignored. Specific micronutrient deficiencies may be part of other dietary and health considerations such as deficiencies in proteins, calories and other micronutrients as well as culture-specific dietary patterns (McDonell, 2015). Further, the embeddedness of crops and food products in the food systems and the associated political-economic and social relations are overlooked (Stone & Glover, 2017).

An illustrative example of the fallacy of component solutions is the conceptualization of malnutrition itself, which

commonly classifies malnutrition in three components, i.e. undernutrition, overnutrition and micronutrient deficiencies. Scrinis (2020, p. 2) highlights how each form of malnutrition is defined as internally homogeneous and unique, each referring to a precise and demarcated nutrition issue and solution, which leads to the decontextualization and desocialization of malnutrition uncoupled from its embeddedness into (localized) food systems.

More broadly, this demonstrates how the ToCs of NSVC and OFSP interventions are fundamentally build on the nutritionism paradigm (Scrinis, 2008), which considers food and nutrition as merely the composition of nutrients, instead of the political-economic and social-cultural environments within which food is embedded. In the two intervention types, this paradigm manifests itself in so-called single-nutrient reductionism, that is making deliberate claims of the health impact of specific nutrients, such as vitamin A in the case of OFSP, without taking into consideration overall dietary (and health) patterns, and the context and embeddedness in the wider food systems, and their impact on nutrition outcomes (Scrinis, 2013). As a result, interventions fall short of tackling broader challenges, such as the drivers of malnutrition, poverty, and the environment. Instead, they have been directed towards promoting incremental improvements on the same patterns of development that have created malnutrition and unsustainability in the first place (Conti et al., 2021).

3.2 Contested narratives and the politics of evidence

The review of the intervention types demonstrate that the current dominant regime – and its continuity—is supported by the reproduction of the narratives of success[8] by powerful system players, as both approaches tend to ignore evidence that either directly or indirectly refute some of the assumptions and claims these interventions make, such as the reproduction of (gendered) inequalities (see e.g. Rao, 2020; Schnurr et al., 2020) and power dynamics at different levels of the food systems (see e.g. Béné, 2022; Clapp & Scrinis, 2017). This raises the question of the politics of evidence: who defines which types of knowledges and materials are considered as evidence and what kind of methods are most appropriate to generate evidence (Denzin & Giardina, 2008, p. 12)? Importantly, OFSP and NSVC interventions ignore important contributions that identify and discuss the broader drivers of malnutrition, such as market structures and corporate power, poverty, low wages, small landholdings, limited access to productive and cultural resources, and gender inequalities (Harris & Nisbett, 2021; Kimura, 2013; Patel, 2012; Patel et al., 2015), intensifying food system lock-ins. The rich literature on the political economy of food highlights the disproportionate power held by corporate food system actors, such as Big Food (Clapp & Scrinis, 2017; Stuckler & Nestle, 2012), seed companies (Clapp, 2018), agricultural commodity trading companies (Clapp, 2015), processors (see e.g. Howard, 2019 for the meat industry), and retailers (Baker et al., 2020). This "ascendancy of a corporate food regime" (De Schutter, 2017, p. 9) materializes itself in terms of power *over* the conditions of production (e.g. product and quality standards), food prices, as well as marketing of products (IPES-Food, 2017). As a consequence, marketization (NSVC) and medicalization (OFSP) efforts do not challenge *what* food is produced and *how* it is distributed (Patel et al., 2015). Instead, they contribute to the reproduction of current patterns of highly concentrated agricultural and food markets, inequality, and poverty (Ramos-Mejía et al., 2018).

The neglect of opposing evidence is rooted in the 'rendering technical' practice,[9] which minimizes complex socio- and political-economic issues to discrete and distinct issues that can be solved by specific technical solutions without addressing broader political-economic relations (Li, 2007). The underlying assumption is that malnutrition in LMICs is caused by the inadequate intake of nutrients vis-à-vis scientifically-determined levels and, hence, will be solved by technical fixes (such as NSVC and OFSP) by providing the lacking nutrients through the most efficient channel of delivery, i.e. either by leveraging existing value chain structures or by biofortifying crops (see e.g. Kimura, 2013). As a result, NSVC and OFSP interventions are promoted at the expense of alternative, non-technical inquiries and approaches that focus on the political and ethical questions around food and malnutrition (Harris, 2019).

This uncovers that current, dominant approaches following the marketization and medicalization logics depoliticize societal debates and ignore the underlying causes of the deteriorating nutrition underway in most of LMICs such as subsidies and lack of taxes of unhealthy food and power and interests of food corporations (Béné, 2022). From a food systems perspective, the nutritionism paradigm and its associated interventions protect and reinforce instead of defy the current dominant regime. Hence, they reinforce food system lock-ins by favoring certain types of approaches, innovation pathways, outcomes and values, and reproducing the mechanisms that generate and intensify inequalities, exclusion, poverty and malnutrition (Conti et al., 2021; Leeuwis et al., 2021; Ramos-Mejía et al., 2018).

[8] See, for instance, IPES-Food (2016) for how 'feed the world' narratives reproduce the idea food security as predominantly to be solved by increasing the total supply of food (based on the industrial agriculture model), disregarding where and who will produce the additional food.

[9] This is what Ferguson (1994) called the anti-politics machine.

4 Where do we go from here: Dismantling the nutritionism paradigm

The review of the intervention types, their impacts (or lack thereof), and our analysis of the flaws in the ToCs of the marketization (NSVCs) and medicalization logics (OFSP/biofortification) within the nutritionism paradigm point to the deeply systemic nature of malnutrition. Currently conceived intervention logics are clearly inadequate to deal with the interconnectedness, patterns of power, politics, and path dependencies of food systems, and are hence unable to fundamentally challenge the power relations that govern food systems and their directionality. We argue that it is insufficient to 'tinker around the edges' of existing approaches, but instead a fundamental reframing of the nature of innovation and change processes is needed to address this system challenge. Undoubtedly, malnutrition is a systemic development challenge, which is deeply interconnected with questions on poverty reduction, equity, social and environmental justice, and sustainability.

Definitive solutions to address malnutrition are misleading as they tend to decontextualize and dissocialize malnutrition from its embeddedness into food systems. Instead, by drawing from the broader food system transformation discourse, we highlight key principles to guide policy and practice.

Alternative theories of change New ToCs are necessary that explicitly incorporate political economy and food system dynamics. Within the food system innovation and transformation discourses, some progress has been made regarding the development of theories of change that incorporate food system dynamics, whilst being grounded in a broad evidence base that covers diverse types of knowledges and evidence (see e.g. Dinesh et al., 2021; Douthwaite & Hoffecker, 2017; Ely & Oxley, 2014). Most notably, understanding societal change within the broader food system requires development practitioners and academics to think of impacts in terms of *contributions*, generated through complex interactions between stakeholders and implementers (Ely & Oxley, 2014; Leach et al., 2007). To ground the development and application of ToCs in the surrounding political economy, we suggest that thorough political economy analyses need to be conducted (Mcloughlin, 2014).

New evaluation frameworks and indicators The development of new evaluation frameworks and indicators can support practitioners and academics in gaining a better understanding of the complexity of malnutrition challenges. Advances in contribution analysis are valuable here as they emphasize contribution (instead of attribution) of interventions to uncover complex causal mechanisms, impact pathways, and the relative importance of various factors in generating impacts (Ton et al., 2019). Complementarily, the United Nations Development Program has proposed a portfolio-based approach to guide food system transformation and to move beyond single intervention/project evaluations (UNDP, 2022). Tracking and evaluating progress across interconnected and complementary interventions and longer time frames contribute to improved learning and inform future actions and interventions. Fanzo et al. (2021) propose a food systems framework to monitor changes, trade-offs and feedback loops within food systems. The proposed indicators, encompassing five thematic areas, can be used to assess changes in malnutrition at a system level, which provide the basis to call for changes in actions and hold decision-makers responsible. However, the authors do not discuss the importance of qualitative and mixed-methods frameworks (e.g. in-depth case studies, participatory evaluation, and realist evaluation) and indicators, which, we argue, are central to capture complex change processes, their underlying mechanisms, and the diversity of perspectives and views of different stakeholders.

Diversity of pathways and approaches Multiple and diverse development pathways, i.e. different pathways for different groups of people in different contexts, are critical to acknowledge and incorporate the diversity of the complex social, political-economic and environmental realities that fundamentally determine various issues of malnutrition (Scrinis, 2020; Stirling, 2008). This implies that there is no single pathway towards sustainable food system transformation, but rather diverse pathways which accommodate different needs and preferences and include both bottom-up and top-down approaches and cover diverse sets of actors and motives for transformation (Scoones et al., 2015). It is essential to what Stirling (2008) calls 'opening up' to wider socio-political discourses, stakeholder values and aspirations, and broaden-out choices through, for example, NGO activities and movements, in order to establish democratic practices and support a plurality of knowledges that can change the directionality of food systems (Ely et al., 2014; Nightingale et al., 2020; Smith & Stirling, 2018; Stirling, 2014).

Specifically, in addressing issues of malnutrition in both LMICs and high-income countries, multiple pathways with various directions for improvement are conceivable. Alternative approaches can increase in importance vis-à-vis conventional pathways towards healthier and more sustainable food systems by influencing laws, regulations and policies that redirect private sector incentives and behavior, increase public and private investments in healthy foods, and enable consumers to make more informed choices. However, the framing of problems and solutions is pivotal to each of the different pathways. Alternative pathways may be able to change the directionality of the current dominant regime. By accounting for this complexity and by rooting pathways in democratic principles, such as equity and social and environmental justice, they offer democratic ways to frame both problems and solutions (Anderson & Maughan, 2021; Gamache et al., 2020).

Re-politicize (mal)nutrition as a systemic and social issue It is essential to recognize malnutrition as an integrated part of wider social change processes in food systems to achieve healthy, just and inclusive societies. This requires reframing malnutrition from an issue of the lack of nutrients to a *social* problem which is influenced by a host of multiple and complex drivers (Béné et al., 2019). As a consequence, both development practitioners and academics need to engage with the contested nature of change processes in food systems and support the re-politicization of food by challenging *what* food is produced and *how* it is distributed (Patel et al., 2015). This needs to go beyond better intervention design or new technologies but bring on board political and civil society actors at multiple levels to facilitate a transformation of the system itself to better serve societal needs.

Changing the narrative To do so, a different conversation is required about the nature of malnutrition challenges and ways of addressing it. The task here is to help dismantle the nutritionism paradigm by not only accumulating relevant evidence, but more importantly engage a broad range of stakeholders and develop new coalitions to advocate for change. Specifically, transformative alliances between diverse actors supporting this transformation are critical. These alliances can serve as means of bringing together diverse actors and agendas that are interested in food system transformation as well as being prepared to undertake the necessary investments to shape laws, regulations and policies towards supporting healthier and more sustainable food systems (Schmitz, 2015). While this is a society wide project, it should also be seen as a time to recalibrate the role of public policy and the private sector. Meaningful public sector involvement and a more developmental role of the state (i.e. a state that has as its mission the sustained development of the economy, thereby actively engaging in economic planning and reversing the rolling back of the state (Mkandawire, 2001)), are necessary to influence laws and regulations, taxation, subsidies, food and input prices, as well as to undo corporate consolidation in food systems, thereby contributing to more equitable systems of food distribution, public services, and public policies (Maestre et al., 2017). Simultaneously, it is critical to manage the expectations on what the private sector is realistically able to deliver in terms of public goals of reducing malnutrition. The primary objective of the private sector remains the generation and maximization of profits even if other objectives, such as the provision of healthier foods, is added (Ansari et al., 2018; Maestre et al., 2017).

5 Concluding remarks

This paper has revisited the evidence and underlying impact logics of two highly popular nutrition intervention types. Not only is the evidence of impact scant, but, more worryingly, the reductionist tendency of key impact logics is shown to be deeply flawed. The systemic nature of malnutrition means that these challenges need to be addressed as part of wider efforts to transform the social and environmental performance of food systems. The need for resilient, just, healthy and sustainable food systems has never been more urgent. Yet, to achieve this, a fundamental rethink about the nature of nutrition challenges and the ways in which their systemic root causes can be addressed is crucial. To do so, a new research agenda is needed which addresses the complexities and political economy dimensions of malnutrition in food systems and explores how this ambitious agenda can be operationalized.

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