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Nutrition sensitive value chains: Theory, progress, and open questions☆

Summer Allen, Alan de Brauw*

International Food Policy Research Institute (IFPRI), 2033 K Street NW, Washington, D.C. 20006, United States

A B S T R A C T

The second Sustainable Development Goal (SDG) challenges the world to achieve food security and improve nutrition by 2030 but food insecurity and micronutrient deficiencies remain stubbornly high and rates of overweight and obesity are rising throughout the world. To attain SDG 2, food systems must deliver more nutritious food to populations. For food systems to do so, value chains for micronutrient-rich foods must be improved, making such foods more available and affordable to consumers. In this paper, we take a consumer focus on the value chains to consider the types of interventions that could lead to improved intakes of micronutrient-rich foods, and review the present literature on the types of value chain assessments, interventions, and initiatives that are attempting to improve nutrition as well as potential future directions.

1. Introduction

Measures of food security, in terms of both food supply and access to food, have been improving over time in developing countries. The number of people in developing countries who were undernourished decreased from 991 million people in 1990 to 780 million people in 2015 (Food and Agriculture Organization, 2015). While food systems in developing countries are getting better at providing enough food to their populations, they are not necessarily delivering the right type of food to constitute a healthy diet for a much larger share of their populations. Evidence shows that in food systems today, consumers– even those with the resources to do so– may find it challenging to obtain a nutritious diet (Alston et al., 2016). The problem of access to a nutritious diet is not isolated to developing countries. At present, the share of individuals who are overweight or obese is growing in nearly every country and multiple forms of malnutrition (stunting, wasting, micronutrient deficiencies, and overweight/obesity) are observed concurrently (International Food Policy Research Institute, 2016).

The Sustainable Development Goals (SDGs) explicitly lay out a challenge linking agriculture to nutrition, and therefore health. Specifically, the second SDG is to achieve food security and improve nutrition, while promoting sustainable agriculture. Despite economic growth and increased agricultural production in countries such as India, malnutrition rates remain high due to the complexity of the problem (Maestre et al., 2017). To attain SDG 2, then, the question is not just how to produce more calories to fully alleviate food insecurity, but how to provide a healthier basket of foods in a cost-effective and environmentally-sustainable manner. Further, in lower- and middle-income countries, food products tend to be purchased primarily through informal markets and this market structure constrains the types of interventions that can be pursued. Nonetheless, a focus solely on producers and production for household consumption has not be shown to be effective in improving nutrition.

Specifically, several reviews of agricultural interventions on nutritional outcomes have shown inconclusive results. Masset et al. (2012) review 23 agricultural interventions and find inconclusive results on nutritional outcomes, though they suggest that methodological weaknesses in the reviewed literature could contribute to the lack of evidence. In another review paper, Webb and Kennedy (2014) find a lack of evidence that agricultural interventions affect nutritional outcomes, though they stress that an "absence of evidence should not be equated with no impact." Maestre et al. (2017) similarly argue that the research thus far has not been able to demonstrate strong linkages between agriculture and nutrition and that interventions may be more effective if focused on markets and distribution as well as increasing knowledge. Perhaps in part due to this lack of evidence, Bhutta et al. (2013) do not list agricultural interventions as one of the ten most cost effective ways to reduce malnutrition among young children; they suggest complementary feeding in addition to supplementation that can either be delivered through fortifying specific foods or condiments (e.g. iodized salt) or through the health system (vitamin A capsules).

Although a few examples of successful agriculture-nutrition

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* Corresponding author.
E-mail address: a.debrauw@cgiar.org (A. de Brauw).

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interventions do exist (Hotz et al., 2012b, 2012a; Olney et al., 2015), not all interventions are necessarily cost effective or scalable. Only biofortification interventions appear to be potentially cost-effective using Disability Adjusted Life Years (DALYs) as a measure (Meenakshi et al., 2010). Homestead gardening programs, for example, are not particularly cost effective (e.g. Puett et al., 2014) and would nonetheless be difficult to scale up on a national level.[1]

Nonetheless, changing food systems at scale to lead to better nutritional outcomes requires changes in agricultural production, as the present composition of production does not provide sufficient quantities of micronutrients.[2] Interventions through agricultural value chains, can incorporate a range of value chain actors (input providers, traders, processors and consumers) critical to the provision of more nutritious food.[3] Value chain interventions differ from other interventions in that the focus is primarily on the food marketing chains and related economic benefits. Several authors have suggested that value chain interventions can potentially play an important role in promoting the consumption of more nutritious foods (Dangour et al., 2012; Hawkes and Ruel, 2012; Gelli et al., 2015). Of note, Gelli et al. (2015) set out a framework categorizing interventions by the targeted characteristics of supply and demand.

The advantage of value chain interventions is that if they are conducted in collaboration with the private sector and can be demonstrated as profitable, entrepreneurs will have an incentive to further develop them. However, to ensure that such interventions have intended effects on food systems, a change of focus is necessary; in the past, value chain interventions have focused primarily on increasing income for either farmers or other actors along the value chain, which are not sufficient for alleviating malnutrition (Downs and Fanzo, 2016). When smallholders produce for value chains related to more nutritious foods, the influences on households can be quite complex, affecting potentially household income, the local environment, and household consumption. For example, to ensure that more people have access to a nutritious diet, in many countries the production of pulses, fruits, and vegetables must increase to meet micronutrient requirements; however, this increase could imply reduced production of primary staple grains (rice, wheat, and maize). Such a shift could have a complex effect on nutrition; overall energy availability could decline, affecting poor households that disproportionately depend on staples for food needs (Bouis et al., 2011). When value chain interventions are comprehensively planned, such interventions could potentially be a cost effective way to catalyze food systems towards healthier diets. By also considering the role of women in value chains, the effects on household consumption can be enhanced (e.g. Ibnouf, 2011; Malapit et al., 2015).

Throughout this paper, we fully adopt a consumer-oriented lens (focusing on the demand for nutritious products), rather than a producer-oriented approach which focuses more on the supply of these products (e.g. Gómez and Ricketts, 2013). There is a basic disconnect between consumer demand and nutritional status and to fill that gap, we first present a very simple model of individual level consumption, showing that individuals are unlikely to demand the nutritionally optimal combination of foods. We use the model and observations from the literature to consider how the equilibrium conditions have likely been changing over time, suggesting the most promising ways that nutrition-sensitive value chain interventions can increase demand for nutritious foods. We then use this framework to classify nutrition-sensitive value chain interventions that have been developed over the past few years, and conclude by noting current gaps in the literature and potential future directions. We focus our analysis on lower- to middle- income countries, but in some cases we provide examples of interventions in high income countries where relevant.

2. Economic rationale for nutrition sensitive interventions

Nutrition is on the forefront of the present development agenda. However, the theoretical basis for nutrition-related interventions is notably absent, particularly for value chain interventions. Many value chain interventions focus solely on expanding production, rather than evaluating the consumption side of the value chain. As a result, such interventions neither help lead to a broader understanding of food systems and their relationship with nutrition, nor do they attempt to find the most effective and efficient mechanisms for influencing nutrition outcomes (Kanter et al., 2015). We start by describing a very basic example from consumer theory (e.g. Varian, 2003) as an organizing framework for thinking about the optimal nutrition in the diet. We then explore some of the challenges in optimizing the diet from a nutrition perspective, given economic conditions, and show how the model can be slightly adapted to illustrate the triple burden of malnutrition, which is the co-existence of caloric deficiency, micronutrient deficiency, and overnutrition or growing levels of overweight and obesity.

To begin, consider a consumer who has the choice between consuming two foods, denoted as c_g and c_n. We assume that c_g is energy dense, but lacks micronutrients, while c_n is less energy dense and more nutritious.[4] For example, one can think of c_g as a processed grain, such as white rice, and c_n as vegetables to eat alongside the rice. The consumer has an income m, and faces prices for the goods p_g and p_n, which implies that $p_g c_g + p_n c_n \leq m$. The budget constraint above suggests a tradeoff between consuming c_g and c_n; if one more unit of c_g is consumed, then necessarily less c_n must be consumed. We finally assume that the consumer has a utility function that describes her preferences, which is $U(c_g, c_n; \mathbf{z})$; we follow standard assumptions and assume that $U(\cdot)$ is twice differentiable and quasiconcave in its two variable arguments. The utility function allows us to define bundles of (c_g, c_n) that make the consumer equally happy, which are illustrated as indifference curves in Fig. 1.

Clearly, factors beyond prices for the two foods and the consumer's income will affect demand for the two products. Factors such as innate preferences, individual beliefs, attitudes, habits or even emotions, culture, demographic status, and information can all play important roles in shaping demand for specific foods (e.g. Ventura and Worobey, 2013). For example, a consumer may not know that c_n is healthier than c_g from the perspective of micronutrient intake, or a consumer might like the taste of c_g more than c_n. To represent these factors in the utility function, we use the vector $\mathbf{z}$. From a mathematical and graphical perspective, $\mathbf{z}$ shapes the curvature of the utility function $U(\cdot)$.

Given prices are fixed, the consumer will choose an optimal bundle (c_g^*, c_n^*) that satisfies the following two equations:

$$\frac{U_{c_g}}{U_{c_n}} = \frac{p_g}{p_n} \tag{1}$$

$$p_g c_g + p_n c_n = m \tag{2}$$

In Fig. 1, Eq. (2) is illustrated as the line representing all affordable combinations of c_g and c_n given the income m of the consumer. Based on Eqs. (1) and (2), the consumer chooses c_g^* and c_n^* at point A, where the highest possible indifference curve just touches the budget constraint. At any other bundle of goods that the consumer can afford, there is an equally preferred bundle that the consumer can also afford, and A is preferred to those bundles. However, at low income levels, indifference

[1] Moreover, they are not appropriate for many urban consumers, who presently make up more than half of the world's population, and that proportion grows every year.

[2] Note that there is a difference between having enough nutritious food available within a specific food system and each individual receiving appropriate nutrition through the food system, as the distribution is likely to be inequitable.

[3] An alternative is to biofortify energy-dense foods, as HarvestPlus has done successfully with some crops, reducing undernutrition as a consequence (Hotz et al., 2012b, 2012a). However, value chains are necessary to widely distribute biofortified crops as well.

[4] This model is similar to the one presented by Behrman and Deolalikar (1989).