TITLE

Analyzing food value chains for nutrition goals

ABSTRACT

First proposed in 2010, the use of "value chain analysis" to identify opportunities for targeted nutrition interventions in food systems is still an emerging method. This review explores and summarizes the application of value chain analysis to nutrition and from this provides five insights into how to more effectively conduct value chain analysis for nutrition: 1) use a consumer perspective to inform selection of foods and chains; 2) consider the research question, available resources, and the type of chain; 3) situate consumer research at the center of the analysis; 4) assess economic trade-offs; and 5) pay attention to governance and stakeholders' capacity for and incentives to change.

KEY WORDS

Value chain analysis; study design; food system; agriculture; nutrition

INTRODUCTION

As the source of the world's food supply, food systems have important consequences for nutrition and health. Slow progress towards reducing undernutrition and micronutrient deficiencies, together with increases in obesity and nutrition-related chronic diseases, has focused international attention on how food systems can improve access to and acceptability of healthy diets.[1] Thus there is increased interest in understanding how food systems can be levered to achieve this goal.

A food value chain is a core component of a food system and consists of all of the activities involved in bringing a particular food to consumers, including the various phases of on-farm production, processing or product transformation, delivery, and consumption or disposal as waste.[2] Central to the value chain concept is the notion that the chain operates as a system and activities are interconnected and interdependent. For the past decade, the international development community has focused on improving the competitiveness of food value chains in low- and middle-income countries as a strategy to generate growth and reduce rural poverty. These initiatives tend to focus on integrating small businesses – particularly small-scale farmers – into food value chains so that they may escape poverty through market participation.

More recently, several authors have proposed frameworks linking food systems and nutrition.[3–8] Food value chains have emerged in the context of nutrition-sensitive development as an organizing feature for addressing malnutrition in all its forms, including undernutrition, micronutrient deficiencies, overweight, obesity, and diet-related diseases.[9] Given the implications of food value chains for food availability, affordability, acceptability, and nutritional quality, the idea is that targeted intervention in chains could help tackle some of the underlying determinants of poor diets.[3,10–12]

Value chain analysis (VCA) for nutrition involves the assessment of a food value chain in order to identify opportunities to increase the supply of and demand for nutritious, healthy diets by nutritionally-

vulnerable populations, whilst also considering other development challenges.[10] Although there is obvious potential for food value chain interventions to improve nutrition, the use of VCA to identify nutrition interventions is still an emerging method.

There is much to be learned from previous research on food value chains and it is important for future nutrition-oriented studies to build on this body of evidence to maximize research investments. The objective of this paper is to identify lessons that can be used to inform the design of VCA for nutrition. It aims to enable researchers to use VCA in ways that will take full advantage of its potential contribution to sound nutrition interventions and policies. To do this, we review the origins of VCA and the emerging literature on VCA for nutrition. Using the findings, we propose and discuss five key insights to consider when designing VCA for nutrition.

OVERVIEW OF THE MAJOR TRADITIONS OF VALUE CHAIN ANALYSIS

The application of VCA to study food systems arose primarily from three broad and somewhat overlapping traditions of value chain research (Table 1): (1) *filiére* analysis; (2) VCA as a strategic management tool; and (3) VCA as a tool to study the political economy of global industrial integration. Development planners and practitioners have found elements from each useful for examining agri-food value chains and designing value chain approaches to development.

<Insert Table 1 here>

The *filiére* tradition emerged in the 1960s and 1970s as French agricultural economists sought to identify the major institutions involved in commodity chains and understand the activities and exchanges therein.[13] The approach does not have a unifying theoretical framework; rather, *filiére* analysts have used different theories and methods to explore a range of research questions about commodity chains. Much of this research has focused on how public policies and institutions affect agricultural systems and the smooth flow of food and fiber products.[13]

In the mid-1980s, Porter introduced the term 'value chain' to the management field to describe a series of value-adding activities that work together to create a product or service.[14] Value chain management developed as an approach to help businesses achieve a competitive advantage by understanding the market and creating value for consumers. It involves collaborating with trading partners to solve problems, generate ideas, and allocate resources.[15] VCA is used as a diagnostic tool to support value chain management by identifying wasteful activities, bottlenecks and other problems, and un-tapped opportunities to generate value.[16] Analyses consider three core issues across the chain: (1) the movement of materials and the contribution of each activity to value creation (material flows), (2) the generation and sharing of information (information flows), and (3) the degree of collaboration and commitment between trading partners (relationships).[16] Value chain management techniques, including VCA, are sometimes used by agri-food companies and industries.

The third tradition – known collectively as 'global chains' research – focuses on understanding the differential implications of the capitalist world economy, particularly how power is distributed and exerted.[17] Though several 'global chains' frameworks exist, the global value chain (GVC) is the most prominent and often used to answer development questions. The framework considers four dimensions of a chain: the input-output structure, geographical scope, governance structure (i.e. how the chain is controlled), and institutional context.[18] Upgrading, or the ways in which businesses, countries, or regions maintain or improve their positions in the economic system, is another key concept.[19] GVC analyses have explored different types of food value chains, including for products originating in poor countries and ending in wealthier countries.

EVIDENCE ON THE APPLICATION OF VALUE CHAIN ANALYSIS FOR NUTRITION

To review the application of VCA frameworks to nutrition, we follow the approach of Hawkes et al. and consider 'short' and 'long' food value chains separately.[20] Short chains exist where markets are served by local or regional farmers and changes to production have a direct impact on what is available for

consumption. They include chains in which consumers obtain fresh products directly from the farm or through a trader who has a proximal relationship to the farmer. Short chains may also involve other actors such as regional aggregation and small-scale processing units. Long chains are those in which farmers and consumers have a more distant connection and the design of activities to be efficient at scale increases the potential impact of upstream interventions. Although this includes any chain in which the food is traded and transformed multiple times midstream, the most obvious examples are for foods with multiple ingredients produced through large-scale manufacturing and for widely traded commodities.

Value chain research of short chains

To date, nutrition-related research on short value chains has focused mostly on traditional markets for micronutrient-rich foods in low- and middle-income countries. The main objective of this work has been to inform interventions to improve nutrition (particularly undernutrition and micronutrient malnutrition) whilst also supporting the livelihoods of chain participants.

The Global Alliance for Improved Nutrition (GAIN) and the Institute for Development Studies (IDS) have designed the "Nutritious Agriculture by Design" tool to assess how agriculture and food value chain projects can be made more nutrition-friendly.[21] The tool considers how projects promote consumption of nutrient-dense foods in producer and non-producer households. Users progress through a series of questions designed to make explicit the organization and operation of the chain and how it does or could contribute to measureable nutrition impacts. Assessments can be conducted by examining written documents, but primary data collection is recommended. IDS research teams have drawn from this tool to examine short chains for minimally-processed, nutrient-rich foods in Ghana, Nigeria, and Tanzania.[22–24] These case studies examined opportunities and challenges to mobilizing private sector involvement in addressing undernutrition and micronutrient deficiencies and involved literature reviews, expert workshops, stakeholder interviews, and site visits. In each, the findings highlighted areas for intervention, with a focus on action needed to support viable business models.[22–24]

A conceptual framework for assessing value chain interventions for nutrition was developed within the Leveraging Agriculture for Nutrition in South Asia (LANSA) program.[6] The framework outlines three key outcomes that food value chains must achieve in order to improve micronutrient intake among target populations: food must be (1) safe to eat on a sustained basis; (2) nutrient-dense at the point of consumption; and (3) consumed in adequate amounts on a sustained basis. It also specifies requirements that underpin these outcomes: participants along the chain must produce, process, and distribute the food and target households must choose to eat it. Application of the framework involves evaluation of whether, how, and why an intervention worked and a comparison of the effectiveness between the intervention and others aimed at improving nutrition. As part of LANSA, a series of case studies using this approach is being carried out across South Asia.[6]

The International Food Policy Research Institute (IFPRI) developed a complementary framework to support the identification, design, and evaluation of value chain for nutrition interventions.[3] This framework specifies three ways that value chain interventions could improve nutrition: (1) increase demand for nutritious foods; (2) enhance supply of nutritious foods by reducing costs and increasing output and economic returns along the chain; and (3) improve chain efficiency. Building on this, they outlined a five-step diagnostic approach: (1) identify the nutrition problem to be addressed; (2) analyze the macro-level food systems context; (3) characterize diets, identify constraints and relative contributions of key foods; (4) examine nutrition and food safety value addition; and (5) prioritize intervention options.[3] A wide range of potential indicators and methods are suggested.

Stand-alone studies using VCA of short chains have used other approaches. One project led by Bioversity International employed a value chain approach to the promotion of neglected and underutilized grains in the Andes.[25] Rather than a single VCA, the initiative included a range of complementary studies seeking to characterize different aspects of the value chains, including research to evaluate cultivars for the target species, identify pests and diseases affecting their production, understand obstacles to processing and use, document indigenous knowledge, characterize consumer demand and acceptance, and

assess nutritional content.[25] Masters et al. used a desk review and key informant interviews to investigate the peanut value chain in Ghana with attention to identify opportunities to strengthen the chain for improved nutrition and livelihoods.[26] Nutrition-oriented case studies in Fiji and Papua New Guinea adapted the strategic management model of VCA to identify opportunities to improve the marketing of fruits and vegetables.[27,28] Both studies incorporated research to understand what consumers value and to map and investigate the material flows, information flows, and relationships in local value chains. Recently, VCA has been used to inform food system interventions for vulnerable women and young children in Sierra Leone and Kenya. Similar to the approaches taken in the Pacific Islands, the study in Sierra Leone used consumer research, value chain mapping, and semi-structured interviews to identify entry points for nutrition in pumpkin and fish value chains.[29] In Nairobi, Kenya, a detailed quantitative assessment of nutrition and food choice in low-income households was paired with interviews, focus groups and observations along animal-source food value chains in order to assess associations between access to and use of livestock value chains and maternal and child nutrition.[30–32]

Value chain research on long chains

VCAs of long chains in the nutrition space have focused on understanding how globalization and free market forces are changing food marketing systems and thereby influencing consumption patterns primarily in high-income countries. Unlike case studies on short chains, the intention of most of these studies has not been to inform immediate nutrition action, but rather to raise awareness of the upstream forces in food systems and the downstream public health implications. To date, the emphasis of this work largely has been on overweight, obesity, and diet-related non-communicable diseases.

Gereffi and Christian made the first substantive contribution to nutrition-oriented research on long chains when they presented a GVC approach to the study of childhood obesity at the WHO Early-Stage Expert Meeting on Trade and Healthy Diets.[33] They have since applied the approach to commercial case studies.[34–36] Their findings are based on reviews of industry and government reports and analyses of

secondary data, and suggest a benefit to GVC analysis in identifying lead firms (companies with disproportionate market power in the chain), the factors that underpin the structure and function of global food industries, and leverage points for nutrition.

To analyze the Australian canned fruit industry from a nutrition perspective, Hattersley drew on insights from Neilson and Pritchard, who argue that GVC research should afford greater space to analyzing the institutional environment within which chains operate.[37,38] She interviewed key informants in the canned fruits industry and reviewed documents and reports on the sector. The study highlighted how consolidation and shifting consumer demands have led to a more consistent supply and the development of new, healthier canned fruit products, but the nutrition impacts of these changes remained unclear.

Hawkes developed a complementary framework for understanding food value chains and their implications for nutrition and diet-related disease, termed 'consumption-oriented food supply chain analysis'.[39] The approach focuses on understanding the incentives and disincentives influencing chain participants' behavior and how the incentive structure could be leveraged to better align the chain with healthy diets. The analysis draws from established approaches for examining food value chains, and involves five steps: (1) describe the stages of the food supply chain; (2) describe the organizational, financial, technological, and policy characteristics of the activities and participants at each stage and the characteristics of consumers; (3) identify the organizational, financial, technological, and policy incentives and disincentives in the chain and how they interrelate with consumer incentives; (4) analyze how the features identified in steps two and three affect the food environment; and (5) use information gathered to determine what incentives could be adjusted to improve the food environment. Hawkes applied the approach to study the supply of Coca-Cola beverages to vending machines in US schools using analysis of publically available information.[39]

Consumption-oriented food supply chain analysis also has been used to investigate the World Trade Organization's Aid for Trade initiative and the supply of oils and fats in India.[40–42] The Aid for Trade

study summarized the policy and structural barriers to fruit and vegetable production and availability in low-income countries, and highlighted opportunities for Aid for Trade to address these barriers.[40] The Indian study used document reviews and key informant interviews to map the oils supply chain and identify policy options to reduce purchases of oils and foods high in trans and saturated fat.[41,42]

INSIGHTS FOR DESIGNING VALUE CHAIN ANALYSIS FOR NUTRITION

In this section, we propose five insights for the design of VCA for nutrition. These insights are based on reviews of the primary and gray literature on food value chain research, the emerging case study evidence on nutrition-oriented value chain studies presented in Section 2, research projects in which we have been involved over the past seven years, and discussions with other researchers working in this area.[3,10,28]

Insight 1: Use a consumer perspective to guide selection of foods and chains for value chain analysis

A keystone feature of value chains for nutrition is the emphasis on consumers. The underlying premise of VCA for nutrition is that there is a discrepancy between actual and ideal dietary patterns and that systematic assessment of food value chains can uncover opportunities for targeted nutrition intervention. This is supported by basic economic modelling, which indicates that consumers are unlikely to demand a nutritionally optimal combination of foods without intervention.[12] Therefore, the starting point for analysis is understanding nutrition problems faced by target groups and what people in those groups are, or are not, eating.[3]

In many cases, this can be informed by examining existing dietary data sources, but new data collection may be required. For example, in the case study in Nairobi, the research team collected dietary, anthropometric, biochemical, expenditure, and other questionnaire data from 205 low-income households to understand intake and decisions regarding consumption of animal-source foods.[31,32] In high-income settings, evidence of actual purchasing behavior may be available, for instance through retailers' loyalty cards. Where data permit, linear modelling using tools such as Optifood can elucidate nutritional

204 constraints, estimate the deviation of existing diets from recommendations, and identify what types of
205 food could help achieve nutrient adequacy.[43]

206 VCAs traditionally examine value chains in relation to a single product or a small number of related
207 products (product family). Although this type of analysis clearly has merit, it has several conceptual and
208 methodological limitations for nutrition. First, people do not eat isolated foods produced through isolated
209 value chains.[10] Instead, they have complex diets consisting of a variety of foods and the overall quality of
210 a diet depends on the combination and quantity of different foods consumed. Second, in most settings,
211 people do not eat enough of any single product for the operation of that product's value chain to make a
212 meaningful contribution to nutrition. The effect of a single food on nutrition may be negligible, but the
213 combined effects of multiple related foods included in a dietary pattern may be large enough to be
214 detectable.[i] Third, there may be substitution and complementarity effects, such that changes to the
215 performance of one value chain may have consequences for consumption of other foods.[44] For these
216 reasons, it is imperative from a nutrition perspective to develop an understanding of the wider agri-food
217 sector, a task beyond the scope of VCA. Yet, if there is evidence that a specific food or bundle of foods
218 can solve part of an identified nutrition problem, there is a benefit to concentrating on the chains or sub-
219 sector that deliver those products.

220 One way to broaden VCA beyond individual foods is to consider product families. This can be useful
221 when the foods and beverages in a family make major contributions to nutrition for a target population.
222 The VCAs led by IDS in Ghana, Nigeria, and Tanzania provide an example of this technique.[22–24] The
223 identification of inadequate complementary feeding as a nutrition problem among the poor led the
224 researchers to analyze locally-produced complementary food mixes made of cereals and legumes. In all
225 three countries, complementary food mixes have a potentially important impact on nutrition for young
226 children and the local markets involve large numbers of small businesses and small numbers of large
227 national and multinational manufacturers. Although a variety of complementary food products are
228 available, nutrient content varies. Because no single complementary food mix and chain has a monopoly

on the sector, adopting the product family technique that looked at various chains for similar products produced by different manufacturers enabled the analysts to gain a broader view of constraints to the supply and identify options for strengthening the chains for nutrition.

The product family approach can also be applied when a single chain produces a family of similar products and the resources, activities, and relationships along the chain are common to every product in the family. Hawkes applied this technique when investigating the supply of Coca-Cola beverages to school vending machines.[39] Given the nutrition and health concerns associated with sweetened beverages and the centralized processing of Coca-Cola soft drink concentrates, her analysis focused on all Coca-Cola beverages rather than a specific product (e.g. Coca-Cola classic, Diet Coke, Fanta). Using this technique, she identified existing incentives for the sale of soft drinks in schools and opportunities for leveraging these incentives for change.

A second way to broaden VCA beyond specific foods is to consider a small number of exemplar products which collectively contribute to a nutrition problem or solution. The nutrition-oriented VCA in Fiji provides an example of this technique.[28] After identifying low fruit and vegetable consumption as the target nutrition problem, the researchers consulted with local partners to select a cluster of three locally-grown products with distinct agricultural, nutritional, and economic characteristics. They found the exemplar approach valuable because the Fijian fruit and vegetable sector is smallholder-led and most value chain participants are incorporated simultaneously in multiple chains in multiple capacities. Any effort to define roles in terms of a single chain may have precluded learning about important linkages and decisions relevant to the fruit and vegetable sector as a whole.

Insight 2: Consider the research question, available resources, and the type of value chain when making study design decisions

The second insight is that there is not one gold standard approach for VCA with nutrition objectives. Several researchers have concluded that it is very difficult to make generalizations regarding the design of

VCA for nutrition.[3,10] Value chains and nutrition challenges are context-specific, hence the most relevant concepts and methods will vary between studies.

We have identified three perspectives on or approaches to nutrition-oriented VCA that have been adapted to meet the needs of different research projects. All draw from the major traditions of VCA, examine the chain as an interlinked system, and seek to identify points in the chain that could be levered for improved nutrition. However, they differ with respect to how value chain concepts are prioritized and the degree to which the research is action-oriented. They are termed here the problem-solving approach, the GVC approach, and the consumption-oriented approach.

Problem-solving approach

The first, which we call the problem-solving approach, aligns with the strategic management tradition introduced in Section 2. It re-frames food and nutrition insecurity as entrepreneurial opportunities.[27] The business challenges are to effectively increase demand for nutrition and find profitable and sustainable ways to reach at-risk populations with nutritious, affordable, and acceptable products.

VCA from the strategic management perspective typically involves gathering detailed information on specific interlinked businesses in order to identify opportunities to reduce waste and create value. Chain participants are involved in the investigation since the success of potential interventions hinges on their readiness and ability to collaborate with each other. Market research is used to explore demand and is followed by an investigation of material flows, information flows, and relationships. Qualitative data produced from observations and interviews are reviewed and evidence is triangulated with other documents (e.g. company records and reports). Key value chain metrics, such as volume, prices, and profit margins are measured at each link in the chain. In nutrition-related studies, these can be augmented with assessments of changes in nutrition value. Finally, findings are presented to key stakeholders to draw attention to opportunities for improvement. Ideally, VCA is used to support a cycle of continuous improvement.[15,16]

This approach aligns with the tools and frameworks developed by IDS, GAIN, IFPRI, and other short chain studies in Section 3.1. Incorporation of quantitative assessments of material and information flows has been limited in nutrition-oriented studies to date, likely in part due to minimal record-keeping in emerging markets and the unpredictable nature of agricultural production and trade, indicating an area for additional methodological development. The problem-solving approach also could be applied to nutrition-related research on long value chains. Opportunities include investigating post-harvest nutrient losses, the addition of nutrient-rich ingredients, or the removal of unhealthy ingredients (e.g. salt, added sugar).

Global Value Chain approach

The second major approach is the application of the GVC framework to nutrition. The GVC perspective contrasts with the problem-solving approach's active involvement of those being studied in the research process. In GVC analyses, the researchers control the research agenda and take an outsider's view of the firms and chains under study. Information on the four key dimensions of GVC analysis is compiled mainly using publically-available reports on lead firms and the industries and markets in which they operate. Additional information may be obtained from interviews with industry stakeholders and experts. For example, Hattersley's research on the Australian canned fruit industry drew from both primary and secondary sources.[37]

As illustrated in Section 3.2, long food value chains have proven to be particularly amenable to this form of analysis because of public record-keeping. Publically held companies must prepare regular reports for shareholders and markets, and cross-border trade often is documented by governments. The GVC framework may be less well suited for short food value chains, where relationships tend to be transactional and lack explicit coordination and where public documentation is more limited.

Consumption-oriented approach

The third major approach is application of the consumption-oriented food supply chain framework. The data sources and methods used for consumption-oriented food supply chain analyses parallel those used for GVC studies. The research approach relies heavily on reviews of published reports and publically-available data, although collection of additional primary data may enrich the analysis, especially when existing evidence is limited. For instance, in examining fats supply chains in India, Downs et al. augmented document analysis with key informant interviews.[41,42] In all applications, evidence gathered is used to describe the structure and function of the chain and the incentives and disincentives at play.

To date, the few case studies that have used this approach have been of long chains. However, the framework is not specifically oriented towards a certain level of analysis and also is potentially applicable to the study of short chains. For instance, Hawkes suggests that the analysis could be used to identify opportunities to develop local fruit and vegetable chains to encourage consumption and deliver value to producers.[39] Further application of consumption-oriented food supply chain framework to different types of value chains is needed to understand its full potential.

Regardless of the approach, VCA for nutrition requires methodological flexibility. Analytical tools already exist for examining the various dimensions of food value chains and work is underway to develop metrics and methods that provide a more holistic assessment by integrating different disciplines and models.[45–47] This remains an important area for future research.

Insight 3: Situate consumer research at the center of the analysis

A market orientation – defined as the extent to which information about the market is used as the basis of decision-making – is central to the sustainability and competitiveness of value chains and the integrity of VCA.[48] In addition to shedding light on diets and consumption patterns, consumer research can provide information on how people think about nutrition, make purchasing decisions, and will perceive and react to healthier food choices. Fundamental questions relate to whether consumers perceive a gap in the diet

and their willingness to pay for foods to fill the identified gap.[3] Yet consumer research has been a marginal component of most VCAs for nutrition to date. A notable exception is the work by Dominguez-Salas et al. and Cornelsen et al. to characterize diets and drivers of animal-source food demand among low-income households in Nairobi.[31,32]

Efforts to improve VCA to include evaluation of consumer value could draw ideas from the strategic management approach which incorporates specific consumer research to understand the factors that influence consumers' food purchasing decisions and the importance of different product attributes. Within the strategic management framework, consumer research is product-specific and focused on the target consumer segments to account for the unique activities and distinct market potential of each chain.[49,50] Value chain management researchers use a combination of qualitative and quantitative research methods to achieve this.[50] In the study in Fiji, Morgan et al. used focus groups to understand general factors influencing fruit and vegetable intake among urban residents and the specific dimensions of consumer-defined value for the three exemplar products.[51] In the analysis of fish and pumpkin value chains in Sierra Leone, SPRING used barrier analysis surveys in 15 communities for a similar purpose.[29] Further insights may be generated through research involving consumer segmentation using techniques such as factor and cluster analyses. Studies of fresh vegetable value chains in Kenya and Nepal show that consumer segmentation can be useful in informing efforts to better target shoppers, even poor consumers in low- and middle-income settings.[52,53]

Insight 4: Incorporate assessment of economic trade-offs

A fourth insight is that VCA for nutrition must find opportunities to align nutrition goals for consumers with profit margins for those working along the value chain. Most food value chains are comprised of for-profit businesses that make profit-driven decisions about what they will produce and sell, and the volume and prices of those products.[6] Regardless of the analytical approach adopted, an essential question in every VCA for nutrition relates to the economic incentives for each chain participant.

Existing value chain frameworks acknowledge that an integral dimension of value in value chains is the financial benefit that accrues to participants, and that to be sustainable, participation in the chain must be profitable. However, engagement of the commercial agri-food sector in efforts to improve nutrition at larger scales has been limited and challenging, due to distrust between the private and public sectors and limited evidence on the business case for creating nutrition value.[6,54]

A weakness of existing approaches to analyzing food value chains is the lack of a functional economic model to measure the costs of current operations and the potential benefits of improvements.[16] In fact, none of the VCA case studies highlighted in Section 3 reported this type of robust economic assessment. However, tools for integrating economic considerations into food value chain research are emerging. For example, the US Department of Agriculture recently released a toolkit to guide economic assessments of planned interventions in local food systems.[55]

Understanding costs and benefits also is useful to inform decision-making and prioritize options. Research from the Pacific Islands shows that even with limited food supply data, simple macro-simulation modelling of costs and benefits of different actions is possible.[56] Assessing and explicitly discussing economic trade-offs may result in less contentious and more sustainable interventions. Further, if VCA is part of a cycle of continuous learning and development, as is advocated within value chain management, it can be used to monitor the economic impacts of interventions (and identify suitable adjustments).[3]

Insight 5: Consider governance and stakeholders' capacity for and incentives to change

The final insight is VCA should consider value chain governance and the capacity of all participants, particularly private sector participants, to adopt new business models that integrate nutrition goals.

Gereffi defined governance as "authority and power relationships that determine how financial, material, and human resources are allocated and flow within a chain".[18(p97)] In many chains, lead actors control key

resources and can exert pressure for change on trading partners with both positive and negative consequences for nutrition, whilst those with less authority may have limited scope to change processes without jeopardising their participation in the chain.[36] Further, food value chains are embedded within wider macro-level economic environments, and government policies and regulations, trade agreements, infrastructure and investment, social context, and other external forces can play a crucial role in how value chain businesses organize their operations. Analysis of governance sheds light on how a chain is coordinated, controlled, and regulated, and the relative power of different chain participants. This can provide insights into potential entry points for nutrition action.

Although the level of detail varies, most nutrition-oriented VCA case studies have considered at least one dimension of governance. Long chain studies organized around the GVC framework have sought to identify the most powerful participants, explore change over time and drivers of change, and assess implications for consumers.[33–37] For long chains that involve cross-border economic activity, other important aspects of governance are trade rules and regulations.[57] For instance, tariffs and non-tariff barriers, such as sanitary and phytosanitary measures, can have a profound influence on food value chains with implications for nutrition.58 Therefore, understanding these aspects of the business environment, in addition to the role of and incentives for lead actors, is important.

Studies of short value chains have tended to focus more on trust and commitment between trading partners and less on the distribution of power. However, even in chains not governed by formal contractual agreements, imbalances of power can impact chain participants and consumers.[59] For example, recent experimental research on maize value chains in Kenya identified a high degree of market power and strong suggestive evidence of collusion among traders with important implications for final consumer prices.[60] Understanding intra-chain dynamics in short chains and how they intersect with nutrition goals is an important area for future research, as it can suggest the types of policies and interventions that may be most effective.

A broader perspective of a value chain considers how the business environment could be improved to support value chain participants. This area has been largely overlooked in nutrition research.[54] However, it is integrated into the IFPRI, GVC, and consumption-oriented food supply chain frameworks and presents a gap that VCA for nutrition could address.

CONCLUSION

VCA is an emerging tool in nutrition intervention research and has promise to improve and promote evidence-informed nutrition action. In this paper, we reviewed the current literature to explore the different ways that VCA has been used to study food value chains, with a focus on its recent application to nutrition. Using this information, we concluded five insights for improving the design of future VCA to improve nutrition.

Understanding the basic principles of VCA, how it has been developed in different fields, and how it can be applied to nutrition-related questions is critical to maximizing its utility for nutrition policy. It is important to appreciate that VCA is flexible and can accommodate a range of nutrition questions and wide variations in data to answer them. Well-designed studies can provide a 360-degree perspective on a value chain's nutrition-related strengths and weaknesses and draw attention to potential entry points for intervention. It is equally important to understand that poorly designed VCA studies represent a lost opportunity to generate strong evidence to support decision makers aiming to make the greatest return on investment.

There is a need to adjust the traditional VCA approaches to make them work for nutrition research and policy, and finding ways to achieve this will only happen through evaluation of natural experiments of food value chains. Our review of research to date suggests a useful approach might involve a fusion of fidelity and flexibility: fidelity with the broad VCA frameworks and concepts that currently exist and flexibility to tailor the research approach to the nutrition context. Ultimately, VCA is a means to an end, so the focus should be on producing robust and useful information for nutrition interventions. More work

418 is needed to evaluate the utility of different analytical approaches and frameworks to examine different
419 types of chains, and whether VCAs for nutrition deliver on their potential to generate positive change.
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[i]Exceptions exist; where dietary diversity is limited, changes to individual value chains may lead to positive nutritional outcomes. A notable example is the introduction of biofortified β carotene-rich orange sweet potato in rural Uganda and Mozambique. Effectiveness trials showed increased vitamin A intakes among women and children in both countries and improved vitamin A status among children in Uganda.[61,62] A more recent example comes from Senegal where a value chain intervention that distributed micronutrient-fortified yogurt among pastoralists led to an increase in hemoglobin concentrations in children under five.[63]