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Value chains and nutrition: A framework to support the identification, design and evaluation of interventions.

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Executive summary

Since 2010, researchers have recognized that value chain concepts can be useful in designing strategies to achieve nutrition goals. Central to this approach is to identify opportunities where chain actors benefit from marketing agricultural products of higher nutritional value. However, value chain development focuses on efficiency and economic returns among value chain transactions, and the nutritional content of commodities is not considered. The potential for value chains to enhance nutrition through interventions is clear, but as for now there is little documented experience. Of particular relevance in terms of evidence generation is the lack of clarity in terms of the pathways linking value chains activities to nutrition. This includes understanding the requirements that need to be achieved in order for value chains to bring about increased consumption of nutritious food. In turn, there is a need to understand what constraints prevent these requirements being met and the interventions that are likely to be most effective at alleviating these constraints. These issues are all highly context specific.

This paper is aimed at developing a framework based on programme-theory concepts to support the identification, design and evaluation of value chains for nutrition interventions. We define the "value chain for nutrition approach" as the process of developing a strategy that addresses a set of nutrition problems through interventions within specific value chains. The starting point in this approach centres on diagnostics aimed at linking a set of nutrition problems of target populations to possible constraints in the supply and demand of specific foods that can then be addressed by interventions. Such a strategy includes a hierarchy of goals and objectives, where the high-level goals centre on the health and nutrition of consumers, reflecting the end result that is intended. The objectives can involve changes in agricultural production, processing, or any other related food chain activity that is relevant to the context and value chain constraints in question.

The structure of the strategy is based on the pathways through which VCN interventions can be expected to improve nutrition, including three main channels linking the demand and supply for nutritious foods:

- On the demand side, the main pathway to nutrition involves improving diets through increased consumption of nutritious foods. This may involve direct transfers to consumers (e.g. school meals) through public procurement, and/or more indirect channels including behaviour change and social marketing that influence preferences and household choices.
- On the supply side, the main pathway to nutrition is through improved economic returns, and involves the traditional value chain development framework, reducing costs, increasing output, sales and profits along the value chain, leading to improved incomes.
- A third pathway involves interventions within the value chain, which in this framework is the interface between the demand and supply pathways. Improved chain efficiency (where output is not economic, but also involves measures of nutrition and food safety) will influence the food environment, including food availability, quality and affordability that in turn can lead to improved nutrition.

These channels are interlinked, including feedback effects and important trade-offs. As a result of these dynamics, we theorise that there are three main impact domains for VCN interventions, involving 1) nutrition and health; and 2) agricultural production and 3) enterprise development for stakeholders involved in value-addition along the chain. In this framework the value chain is the set of processes that mediates these potential impacts, also highlighting that the nutrition content and food safety of a particular food can be enhanced or diminished at key points in the value chain.

We outline key steps in the strategy development process, starting with diagnostics of nutrition problems to be addressed within the broader food-system context. An analysis of diets and consumption patterns follows, identifying dietary constraints and relative contributions of specific foods to the overall diet of target populations. This understanding of current dietary patterns provides the context for subsequent food value chain analyses that can identify constraints in supply and

demand, while also examining potential entry points for interventions to enhance nutritional value. The final step in the diagnostic involves the estimation of return on investments that would support the prioritisation of interventions.

We introduce typologies for VCN interventions based on supply and demand profile of the specific value chain. Where adequate supply and demand for a specific food exists, interventions would focus on optimising the efficiency and flow of "nutrition" added-value along the chain. Where demand is constrained, interventions would work primarily to increase consumption, either directly (e.g. food transfers) or indirectly (e.g. social marketing) increasing market demand. Where supply is constrained, interventions would focus on enhancing supply-side capacity by improving production practices, organising production and post-harvest activities to increase efficiency, and facilitating the expansion of market opportunities.

We conclude by providing insights on the major research themes in this emerging multi-disciplinary field, including the following points:

- A critical issue across the potential VCN pathways are the pro-poor implications of specific interventions as well as the overall welfare impact of the approach as a whole. At a strategic level, win-win outcomes for smallholders and consumers may be possible but are not certain, and the trade-offs across the different outcomes made explicit in this paper require careful, context-specific analysis.
- Understanding consumers, intra-household dynamics and gender roles, is also not straightforward, and it will be important to understand the cost-effectiveness and feasibility of scale-up of alternative strategies to promote improved health and nutrition. The influence of value chain activities on the opportunity cost in time spent by women caring for themselves and their children, farming, or preparing food is another important area of future research.
- In terms of involving smallholder farmers in value chains, supporting diversification and increasing output of nutritious foods whilst developing reliable marketing channels for these products will be key. Questions remain on how to optimise decisions involving food production, income, and the trade-offs and risks involved in specialisation vs. diversification.
- Where supply and demand for nutritious products exist already, the focus is on interventions that enhance the nutrition added-value along the chain. As nutrition attributes are, however, mostly unobservable, quality assurance and quality signalling are critical. Although standards and common metrics can provide relevant information for stakeholders at key points in the chain and are an important starting point, the relationship between chain performance and regulatory environments is also complex, supporting the need for more evidence. Questions remain on how to provide credible and affordable means of certification and quality assurance, particularly in low-income settings. There is also a need to incorporate sustainability metrics within assessments of value chain performance.
- There is a need for standard assessment tools to better understand the context, and also for methods that integrate tools from a multi-sectoral perspective. Appropriate evaluation methods are also required to suit the breadth and complexity involved.

While there is recognized potential for VCN to provide an integrated framework with multiple impacts across agriculture, nutrition and health, there are critical evidence gaps in terms of understanding the mechanisms, costs and impacts of the interventions involved. Filling these gaps will require generating policy-relevant evidence on costs and welfare effects on producers, consumers and stakeholders involved in nutrition value-creation along the different segments of the value chain. Generating rigorous, policy-relevant evidence will require partnerships involving policy, programme and research stakeholders working across traditional disciplines. The conceptualisation of the programme impact pathways as provided in this paper, is the foundation for theory based evaluations and an important first step in the evidence generation process.

1. Introduction

The recent Lancet Series on Maternal and Child Nutrition estimated that the aggregate global burden of undernutrition caused[1] over 3 million child deaths per year and stunting prevalence in children under 5 affected at least 165 million children (Black et al., 2013). Micronutrient deficiencies including zinc and vitamin A contribute to increased child and maternal mortality, while deficiencies of iron and iodine, together with stunting, also impair the development of infants and young children. In parallel, globally, an estimated 43 million children under 5 years of age were overweight, a 54% increase from an estimate 28 million in 1990. The increasing rates of childhood overweight and obesity are likely to have important impacts on adult obesity, diabetes and other non-communicable diseases. The prevalence of overweight and obesity doubled since 1980 (from 6 to 12 percent globally), and the increase has accelerated (Stevens et al., 2012).

Cross-country evidence indicates that income growth is associated with decreasing maternal and child undernutrition (Haddad et al., 2003, Ruel & Alderman, 2013). Using cross-sectional data it has been estimated that a 10 percent increase in GDP is associated with a 6% decrease in stunting and a 4% decrease in women underweight (Figure 1). On the other hand, income growth, also has unintended negative consequences; the same data indicating that a 10% increase in GDP is associated with a 7% increase in overweight and obesity in women. The coexistence of over- and undernutrition in low- and middle-income countries has been captured in the literature as the result of the "nutrition transition", which involves rapidly changing diets (increased consumption of calories, saturated fat and sugars), coupled with reductions in physical activity and increases in sedentary lifestyle (Popkin et al., 2013). Analysis of the drivers of these trends is an active area of research. Particular attention has been drawn to the role of the changing food system and its influence on energy intake, although many other environmental and individual factors are involved (Swinburn et al, 2011). It is clear that economic growth alone cannot resolve the problem of undernutrition and that it may in fact create other problems such as overweight and obesity, and increased risks of associated chronic diseases.

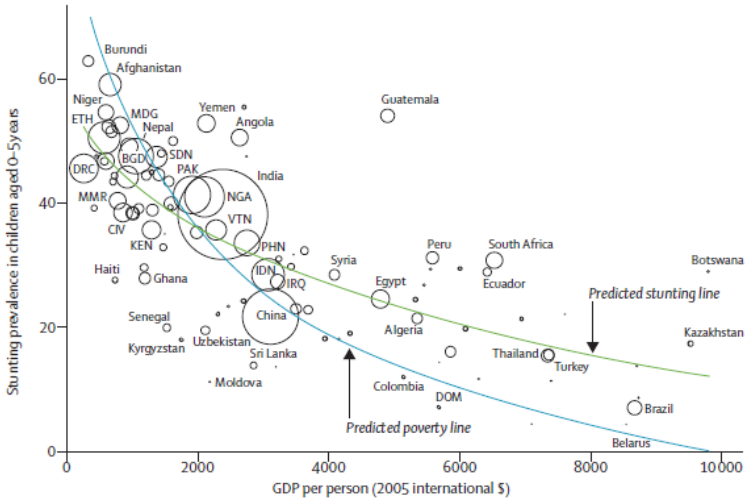

Figure 1: Prevalence of stunting in children aged 0–5 years and GDP per person. The size of the circles represents estimates of the population of stunted children aged 0-5. (Source: Ruel & Alderman, 2013).

One way of tackling these multiple challenges involves promoting food based approaches to increase access to high-quality diets (FAO, 2011). In low-income settings, households typically subsist on monotonous staple-based diets; they lack access to nutritious foods, such as fruits, vegetables, animal source foods, or wild foods of high nutrient content. Lack of diet diversity is strongly associated with inadequate intake and risks of deficiencies of essential micronutrients (Ruel 2003; Leakey 1999; Arimond et al. 2010). Economic constraints, lack of knowledge, information, and related preferences (lack of demand for nutritious foods) are critical factors that limit poor populations' consumption of

[1] It is important to note that this is a causal estimate based on comparative risk assessment methods including joint distributions of stunting, wasting, foetal growth restriction, deficiencies of vitamin a and zinc, and sub-optimum breastfeeding.

such foods. Agricultural production is just one factor in the consumption and availability of nutrients. Food is stored, distributed, processed, marketed, prepared, and consumed in a range of ways that affect the access, acceptability, and nutritional quality of foods for the consumer. Recent reviews of the contribution of agriculture in improving nutrition conclude that although agricultural programs have immense potential to improve nutrition, this potential is yet to be unleashed (Masset et al., 2011; Ruel and Alderman 2013). Current evidence suggests that limitations in the design and implementation of agriculture interventions, as well as a lack of clarity in terms of nutrition goals and interventions are partly responsible for the weak evidence base. Even more importantly, the lack of rigor in most of the existing impact evaluations prevents any clear conclusions regarding the contribution of agriculture in improving nutrition (Ruel and Alderman 2013).

Researchers and programme implementers have recently recognized that value chain concepts can be useful in designing strategies to achieve nutrition goals (Hawkes and Ruel, 2011, Ruel and Alderman, 2013). Central to this approach is to identify opportunities where chain actors benefit from the marketing of agricultural products with higher nutritional value. However, value chain development focuses on efficiency and economic returns among value chain transactions, and the nutritional content of commodities is generally not considered. The potential for value chains to enhance nutrition through interventions is clear, but as for now there is little documented experience

This paper is aimed at developing a framework based on programme-theory[2] concepts to support the identification, design and evaluation of value chains for nutrition interventions. The work draws upon existing frameworks (Henson et al., 2013, Hawkes & Ruel, 2011) and is complementary to on-going efforts on understanding impact pathways for agriculture, nutrition and health (Webb, 2013, Turner et al., 2013, Gillespie et al., 2012).

In this paper we define the "value chain for nutrition approach" as the process of developing a strategy that addresses a set of nutrition problems through interventions within specific value chains. The starting point in this approach centres on diagnostics aimed at linking a set of nutrition problems of target populations to possible constraints in the supply and demand of specific foods that can then be addressed by interventions. Such a strategy includes a hierarchy of goals and objectives, where the high-level goals centre on the health and nutrition of consumers, reflecting the end result that is intended. The objectives can involve changes in agricultural production, processing, or any other related food chain activity that is relevant to the context and value chain constraint in question. Breaking the complex scope down into different components involves a series of steps, including diagnostics of the problem, followed by the development of possible solutions (including the identification of entry points for intervention across one or more value chains), design and implementation, and evaluation and learning.

In the rest of the paper we describe some of the details that this approach entails. We begin by reviewing the emerging literature on value chains and nutrition; we then build on a synthesis of case studies on the design of value chain for nutrition interventions to capture the impact pathways linking value chains activities to potential effects on nutrition; we then propose a set of diagnostics and typologies to support the identification and design of interventions; we then draw on existing standards and references to propose a set of indicators to measure the performance of interventions. We conclude with a summary of the main research themes in this multi-disciplinary field.

[2] Following (Rossi et al., 2005), focussing on the impact theory, or causal chain linking activities to the effects they result in on target groups.

2. Value chains and nutrition

In this section we provide an overview of the main literature on value chains and nutrition. This includes a discussion of the type of research that this entails, the actors involved, as well as the potential linkages between them that could lead to improved nutrition outcomes.

2.1 What is a value chain?

A food value chain is a form of food supply chain (Figure 1)– the series of processes and actors that take a food from its production to consumption and disposal as waste (Hawkes and Ruel, 2011). In a "value" chain the emphasis is on the value (usually economic) accrued (and lost) for chain actors at different steps in the chain, and the value produced through the functioning of the whole chain as an interactive unit. A value chain is commodity specific, and as such involves only one particular food that is relevant within a diet.

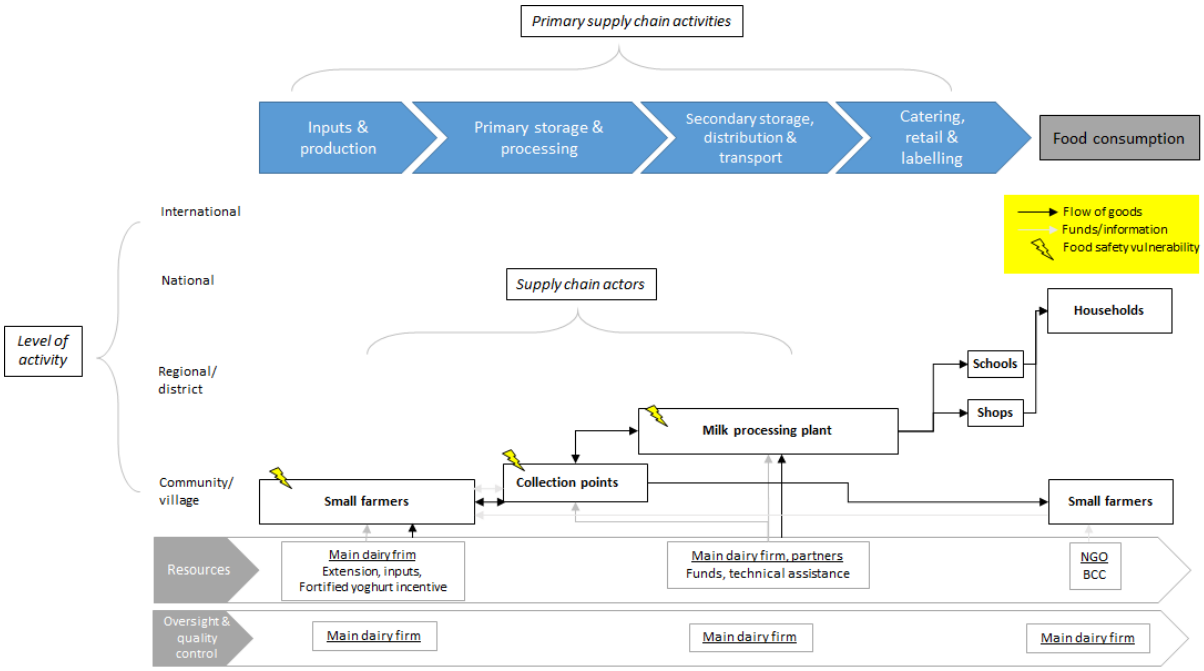

Figure 2: Stylised example of a food supply chain (Source: Adapted from Kretschmer et al, 2014).

Since the mid-1990s, value chain concepts have featured prominently in rural development discourse (Altenburg, 2007; Humphreys and Navas-Alemán, 2010; Stoian et al., 2012). As an approach to rural development, the value chain concept focuses on improving the commercial relations between two or more actors along a chain, with the expectation that such improvements yield economic benefits for those involved, including smallholders. It is also important to distinguish between value chains as a concept and value chain analysis: Value chain analysis can be thought of as a method of analysis and also a programmatic framework for the design and implementation of interventions. The value chain approach challenges governments and civil society considering how to achieve development goals to look beyond individual actors, such as smallholders or cooperatives, and look at the links between them. This enables the development of interventions to better identify common problems among actors in the chain and solutions that generate win-win outcomes and address trade-offs across these outcomes. Improved chain relations and overall chain performance could yield tangible benefits in terms of economic returns and, potentially, poverty reduction. Medium and large-scale businesses can also potentially be involved as active partners in value chain development, providing opportunities to achieve outcomes at greater scale, with potentially increased impact and sustainability.

Value chain development has become a principal element of the poverty-reduction strategies of development agencies, donors, and governments. Interest in value chain development stems largely

from an increased awareness among development organizations that success in increasingly complex agrifood markets often requires stronger collaboration among value chain actors, including producers, processors, and retailers (Hobbs, Conney and Fulton, 2000; Humphrey and Memedovic, 2006). Other important factors that have spurred interest in value chain development include growing urban demand for added-value foods in developing countries, more stringent quality and food safety standards by governments and private firms, the growth of niche markets (for example, organic and fair trade), and concern over the scarcity of agricultural raw materials. Small-scale producers have a comparative advantage in crops that require high labour inputs, such as coffee, dairy, and horticulture, and rapid growth in demand for such products has been considered an opportunity to combine economic growth and poverty-reduction goals (Bacon, 2005; Weinberger and Lumpkin, 2007). .

Value chain concepts and interventions have historically not considered nutrition, either in terms of improved nutrition of smallholder producers or of consumers in peri-urban and urban settings; rather, the focus has been mainly upon increased income for smallholders and other stakeholders along the value chain (Hawkes, 2013). As value chains play a key role in determining food availability, affordability, quality, and acceptability, they provide opportunities to promote nutrition (Hawkes and Ruel 2011). The key is to identify opportunities where value chain actors benefit from supplying the market with agricultural products of higher nutritional value. Value chain development, however, has rarely focused attention on consumers—consumers are simply considered as purchasers driving the ultimate source of demand. In this light, value chain concepts and frameworks could be enriched by a stronger consumer focus, and in particular, a focus on consumer nutrition and health.

2.2 Existing evidence linking value chains to nutrition

There is very little empirical evidence on the role of value chains in improving nutrition. The emerging literature in this field, however, advocates the opportunity for linking value chains to nutrition, and includes case studies and frameworks that begin to develop these links explicitly. Generally, the literature recognises that agricultural and food policy is more likely to positively affect nutritional outcomes when the structure and functioning of markets is taken into account. Thus, just as researchers have viewed value chains through the lens of sustainable resource management or rural poverty, they can view value chains through the lens of nutrition. Hawkes et al. (2012) draw attention to the limited reach of agricultural policy in influencing nutrition outcomes when a systems approach is not applied. They argue that the food industry can respond to changes in agricultural policy in several ways, including changes in ingredients, using different processing technologies, or supplying specific agricultural products in different forms to markets. If improved nutrition is sought through changes in agricultural policy, then an understanding of market actors and their incentives (disincentives) and capacities (limitations) to help generate healthier food products becomes important. Gereffi et al. (2009) examine the role of large, multi-national firms in determining the nutritional performance of value chains. In particular, they describe the considerable influence of certain retailers and processors on the availability, safety, quality and nutritional value of food and suggest that improved nutritional outcomes are possible by concentrating attention on the actions of these firms. Others have focused on the business environment in which food is sold. For example, Maestre et al. 2014 describe how low levels of consumer awareness, the inability for firms to signal quality to consumers, and restricted distribution outlets effectively limit the ability of the private sector to respond with nutrient dense products for mass consumption.

Recent case study evidence demonstrates how value chain concepts are being applied to understand marketing systems and their influence on nutritional outcomes. Studies in high-income countries tend to focus on diet diversity and over-nutrition. Gereffi et al. (2009) examine the value chains for chicken and tomatoes in the United States, and argue that the of powerful firms, such as supermarkets and large-scale processors, significantly shaped the availability and type of products consumed. In both cases, productivity and efficiency increased in the chain, and prices for the respective outputs of the chains dropped over time. However, gains in availability and affordability were countered with reduced variety and increased access to processed foods. Looking at the value chain for canned

peaches in Australia, Hattersley (2012) also highlighted the role of powerful firms in bringing about positive outcomes for high-end consumers through the manufacture of canned peaches with minimal processing. However, the study offered inconclusive results regarding the nutrition outcomes for consumers given the overall ambiguity involving processed fruits and diet quality.

Importantly, to date most of the debate on markets, business and value chains has focused on multinational enterprises. There is a need to question how relevant this is for the poor. Thus, the focus needs to shift to the markets in which they engage (and thus the businesses and value chains that are most relevant to the poor). In this context, it is important to recognize the ways in which food markets are transforming in developing countries. The few case studies that exist on value chains and nutrition in the context of low-income countries focus mostly on undernutrition. Maestre et al. (2014) and Robinson et al. (2014) apply a value chain perspective to understand the potential for actors along chains for ready-to-use therapeutic food (RUTF) to expand their sales in Tanzania and Nigeria, respectively. In both cases, expansion of RUTF sales was limited by weak demand, the inability to signal nutritional quality of the products to consumers, and limited access to high-quality inputs, among other factors. These cases point out the need for major changes in the business environment for the private sector to deliver greater impacts on nutrition. In this context, solutions can also involve public-private collaborations to enhance chain efficiency while providing nutritious foods to poor populations, as demonstrated by the recent work on supply chains for school meals (Gelli et al., 2013, De Carvalho et al, 2012). Padulosi et al. (2013) also apply a value chain approach to the promotion of neglected and underutilised foods in the Andes. By tackling the supply and demand constraints for these particular crops, the uptake of sustainable and improved production practices was promoted, resulting in positive nutrition and health outcomes for poor, rural populations.

A project led by the Institute of Development Studies (IDS) on Strengthening Agri-food Value Chains for Nutrition aims to identify opportunities for improving private sector involvement in food systems, and analyses strategies to overcome the barriers that prevent nutrient-rich foods reaching people suffering from undernutrition in Ghana, Nigeria and Tanzania (IDS, 2014). Anim-Somuah et al. (2013a) examine the constraints that inhibit private sector involvement in value chains of nutritious foods, including complementary foods, using multiple qualitative methods in Ghana. Drawing on the value chain analysis of groundnut and complementary foods, this study highlighted how ubiquitous aflatoxin contamination, combined with the inability to signal nutritional value and a lack of traceability of foods were important areas for policy intervention (Anim-Somuah et al. 2013b). In addition, though a range of complementary foods were available on the market that met nutrition and safety standards, they were generally not affordable to the poor, highlighting once again the potential role of the public sector to promote pro-poor outcomes. Using the same framework in Nigeria, Robinson et al. (2014) examined policy options for reducing undernutrition through market-based approaches. The study identified five major market constraints in the provision of nutrient-dense foods that were beyond the control of individual businesses, including low awareness of nutrition amongst low-income populations; low awareness is compounded with the absence of quality signalling mechanisms; poorly organised supply chains for nutrient-dense foods, resulting in higher prices and low quality; distribution networks for low-income populations are expensive; complex business environment alongside low levels of trust in institutions.

2.3 Lessons learned so far

Frameworks that incorporate value chains and nutrition are evolving and the literature identifies several important starting points (Hawkes and Ruel, 2011, Gomez and Ricketts, 2013, Henson and Humphreys, 2013, Anim-Somuah et al. 2013, Padulosi et al., 2013). Nutrition-sensitive value chains, or value chains for nutrition (VCN), can be seen as a framework to first identify and then alleviate constraints, or market failures, in terms of the supply and demand for nutritious foods. VCN involve and explicitly link activities from stakeholders at different levels across agriculture, nutrition and health sectors within an integrated system, including the following:

- As value chains include activities from food production, post-harvest through to consumers, they provide useful lenses to characterise the broader food system and identify entry points for policies and interventions to improve nutrition.
- Conceptually, economic value can be examined alongside other added-value, including nutrition but also other potential effects along the value chain, including environmental sustainability, for example.
- A broader perspective of a value chain includes the public sector, the various NGOs and private service providers that support value chain actors, providing a window to intervene in areas where markets may not yet exist or function adequately.
- VCN also provide a framework where overnutrition, undernutrition, and diets more broadly, are characteristics of stakeholders influenced both directly and indirectly by the chain activities.

However, these types of frameworks also have their challenges. The scope of VCN interventions is both extremely broad and context specific. Clearly, no one size fits all, and understanding and dealing with the breadth of scope and heterogeneity is not straightforward.. Critically, nutrition results from the quality of the overall diet, not only from the nutrient content of an individual food. In value chains the focus is generally commodity specific, rather than on how to integrate multiple chains to contribute to an enhanced quality of diet (Henson, 2013). There may be offsetting impacts such that, if one value chain works better and consumption of the associated food increases, consumption of other foods may decline. VCN interventions are therefore more likely to have success in filling gaps in the diet rather than improving overall nutritional status, though the evidence on these effects is still lacking.

The concept and issue of value chain governance is also critical and is a key tenet of the concept of value chains and of value chain analysis. It is important to understand the broader macro-level context, or enabling environment, within which food chains operate, including policy and governance; political and economic context; culture, gender and equity; climate and environment (Hawkes et al., 2012).

2.3.1 Understanding the impact pathways linking value chain activities to nutrition

In summary, though there has been considerable interest in linking value chains to nutrition, important evidence gaps limit the understanding on the feasibility of this approach. Of particular relevance in terms of evidence generation is the a lack of clarity in terms of the pathways linking value chains activities to nutrition. This includes understanding the requirements that need to be achieved in order for value chains to bring about increased consumption of nutritious food. In turn, there is a need to also understand what constraints prevent these requirements from being met and the interventions that are likely to be most effective at alleviating these constraints. These issues are all highly context specific. The conceptualisation of the programme impact pathways as presented in this paper provides the basis for theory-based evaluations[3] and is an important platform in support to the evidence generation process in this emerging, multi-disciplinary field.

[3] See Rossi et al., 2005, Habicht et al., 1999 for more details on theory-based evaluations.

3. A framework for assessing the potential impact of VCN interventions

In this section we outline some of the pathways through which VCN interventions can be expected to operate (Caldes and Ahmed, 2004, Ahmed and Sharma, 2006, Sumberg & Sabates Wheeler, 2011 and Masset and Gelli, 2013). This analysis provides the basis for the identification and design of interventions along value chains for nutritious foods. We conceptualise the impacts of value chain interventions on nutrition operating through three main channels involving the dynamics of demand and supply for nutritious foods:

- VCN interventions can increase the demand on the market by promoting consumption of nutritious foods. This can involve direct transfers to consumers (e.g. school meals) through public procurement, and/or more indirect channels including behaviour change and social marketing that influence preferences and household choices. This channel will be explored in more detail in section 3.1.
- Interventions can enhance the supply of nutritious foods by reducing costs, increasing output, and economic returns along the value chain. This more 'traditional' type of value chain channel, with a focus on nutritious foods, is described in section 3.2.
- Interventions can influence chain efficiency, affecting food availability, quality and affordability as well as other elements of the food environment that can enhance nutrition outcomes. This includes the dynamics of four value chain properties involved in "nutrition" value-addition, including nutrient density[4], food safety risk (contamination), quantity and price. These processes and characteristics will be explored in more detail in section 3.3.

These channels are interlinked and include important feedback effects and trade-offs (Figure 3). As a result of these dynamics, we theorise that there are three main impact domains for VCN interventions, involving 1) nutrition and health; and 2) agricultural production and 3) enterprise development for stakeholders involved in value-addition along the chain. In this framework the value chain is the set of processes through which the impacts in these domains is achieved, highlighting also that the nutrition content and food safety of a particular food can be enhanced or diminished at key points in the value chain.

3.1 Impact pathways through changes in food demand

Where nutrition diagnostics have identified a demand constraint (e.g. under-consumption of, or low demand for, nutritious foods), value chain interventions can be used to alleviate this constraint. Interventions that influence the demand for nutritious foods may have an impact on nutrition if they improve diets via the increased consumption of these foods. Increased consumption of nutritious foods [a] can be achieved through a combination of direct transfers (e.g. transfer of nutritious food through school meals for example, or vouchers, subsidies for consumption) and/or indirect market channels involving behaviour change campaigns or social marketing that promotes the consumption of, or willingness to pay for, the nutritious food [b]. The nutritious food may be produced by the same households consuming the food [c] or may be purchased on the market [d]. The availability (quantity available on the market), affordability (price) and quality (including nutrition content and food safety) are key issues that influence consumption at the interface between the value chain and the food environment. The intake of the nutritious food complements the consumption of other foods in the diet [e], which may be self-produced or purchased on the market. The nutritious food may be shared within the household or consumed by only a few household members. It may also substitute for other foods that would have been normally consumed or for foods with similar properties. This point highlights the need to examine changes in overall diets and not just assess consumption of one food. All these effects are mediated to some degree by women's role in the household, time allocation and decision-making [f]. Improved diets, when accompanied by adequate feeding, health and hygiene practices can then contribute to improved health and nutrition.

[4] Nutrient density lacks a formal definition but generally refers to the ratio of nutrient content to the total energy of a given food (Drewnowski, 2005).

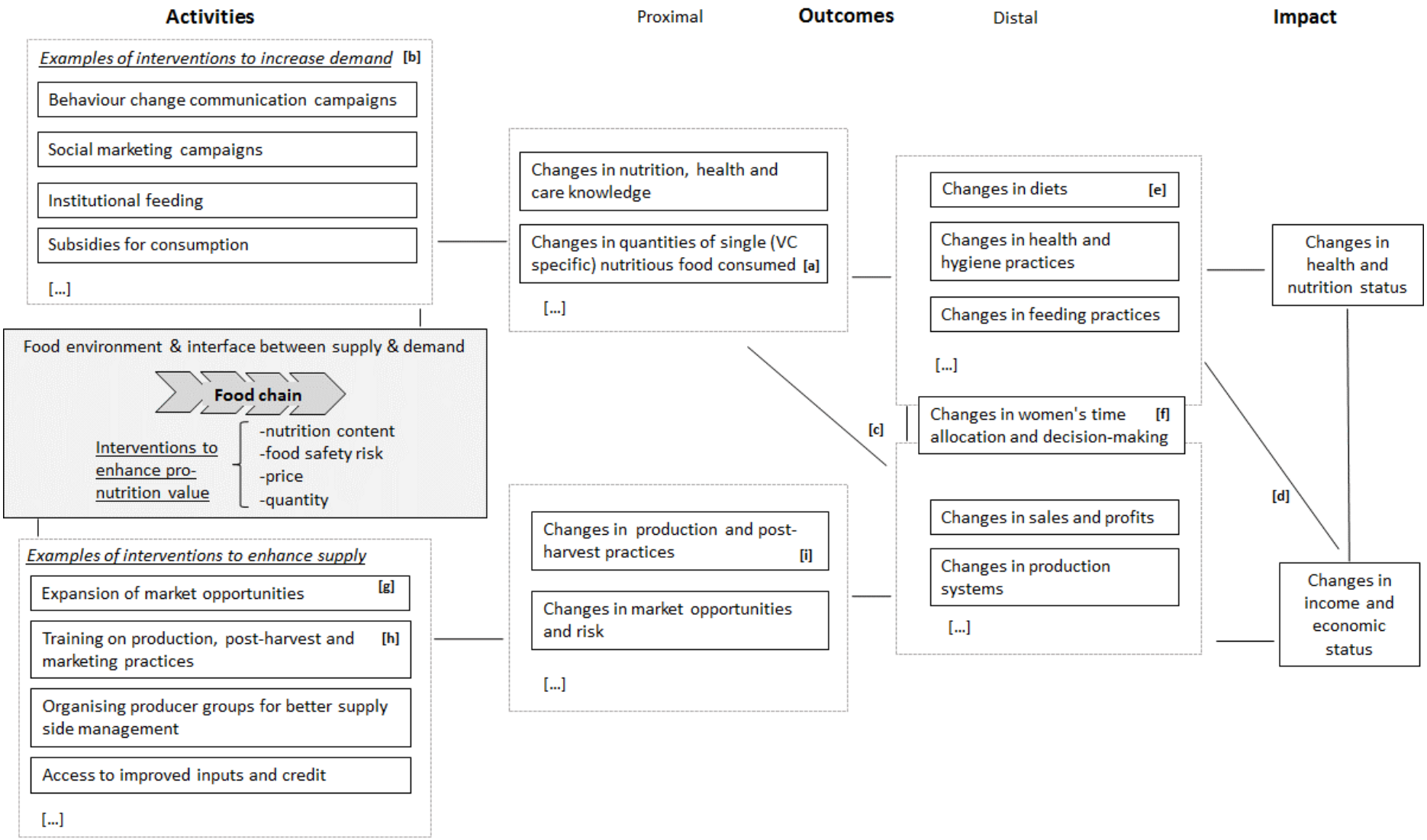

Figure 3: Simplified impact theory of supply and demand side value chain interventions (Source: Authors).

The impact of interventions on the nutrition and health status of consumers will depend on the nature of the dietary changes with the target populations. In particular, changes in individual level dietary diversity have been found to be strongly associated with micronutrient adequacy of diets for women (Arimond et al., 2010) and micronutrient density adequacy of diets in children (FANTA, 2007). Addressing micronutrient deficiencies can improve a range of health, nutrition and developmental outcomes in infants and young children, particularly if implemented alongside other demand side value chain interventions like behaviour change on health and nutrition practices (Bhutta et al., 2013).

As the emphasis of these interventions is on influencing overall dietary intake, this framework can be considered relevant to both under- and over-nutrition contexts. Where obesity is a result of the over-consumption of particular foods, the focus of demand-side value chain interventions will be to actively address this imbalance by reducing the consumption of the unhealthy foods while providing healthier alternatives. School-based behaviour change campaigns, for example, have been used to promote consumption of fruits and vegetables (Van Cauwenberghe et al., 2010), and reduce the intake of processed foods and beverages. Behaviour change campaigns can also be used to influence knowledge, attitudes and practices that are relevant to obesity, such as physical activity and the development of healthy eating habits.

Increasing the demand for nutritious foods would can also lead to expanding marketing opportunities for producers (step [g]). This increased demand can play an important role in terms of stimulating agricultural production, particularly for smallholders who face market access constraints, especially as increased demand may be regular and predictable, providing a relatively stable revenue channel and seen as a low-risk venture for producers. The extent of the effect of the increased demand on prices will depend on the level of market integration. The potential effects on producers are captured in section 3.2. Increases in demand could also be linked to the provision of information regarding nutrient quality and food safety risks of the specific food in question. These two issues will be explored in more detail in section 3.3.

3.2 Impact pathways through changes in food supply

This is the standard “value-chain” pathway: Value chain interventions can target producers and firms that often face multiple constraints in responding to the needs of actors further downstream in the chain. From a supply perspective, VCN interventions can target overall production by increasing overall yields or efficiencies through input provisions or training on improved management practices. VCN interventions can also influence the basket of products that are produced, supporting the production of higher-value crops and/or more nutritious crops through the provision of seeds, educational campaigns, or market forces. The targeting of particular crops has to be undertaken in the context of the substitution between crops for production and consumption and the long-term impacts for both incomes and nutrition at multiple scales (from the household and village-level to regional or national levels).

The impact of interventions on agricultural output and prices will depend on the supply and demand for that particular food. The change in overall demand for a nutritious food that results from increased consumption of nutritious foods will depend on the size and structure of the market as well as on substitution among the basket of goods consumed at the household level. When the supply of nutritious foods is limited, interventions can be aimed at alleviating supply constraints. This can be achieved, for example, through promotion of the adoption [h] of advanced production technologies, or mechanisms to reduce input costs so production of those crops is relatively more profitable. The supply of particular crops can also be promoted through institutional reforms. The provision of insurance, access to credit and land titling, for example, can reduce risk some for producers.

In broad terms, if supply-side constraints are not alleviated, additional demand will cause increased local prices. The extent of this effect will depend on the level of market integration. Increased prices should create additional opportunities for producers. If producers are able to increase their production of nutritious foods in response [i], the overall price effect would be dampened. However,

these relationships are complicated given that producers are often consumers as well as producers, some also being net food buyers rather than net food sellers throughout the year. The effect of price increases for particular products on smallholders who are net food buyers throughout the year is not always straightforward, and depends up on the basket of goods they produce and how easily they can transition components of their production to follow prices. In addition to the increased supply of nutritious foods, increased production and incomes for smallholders could mean that some additional income feeds back into dietary decisions, further increasing consumption and demand for nutritious foods [d].

In summary, VCN interventions can have an effect on prices and food production. They can also reduce market risk through improved links with buyers and more reliable demand. Although changes in expectations will take some time, the reduction in risk can influence a number of household coping strategies (e.g. savings and investments). Coupled with increased production and sales volumes, these changes can result in increased farm-level profits as well as more long-term decision-making and investments, and eventually increased incomes that can then lead to improved nutrition. Several of these relationships are complex and measuring intermediate results is important in order to better understand the market structure and environment, and the overall impact on both producers and consumers.

3.2.1 Enterprise development along the value chain

The previous sections outlined some of the direct and indirect effects of VCN interventions on agriculture, nutrition and health status of potential target groups. There are also a range of other potential effects on stakeholders involved in the post-harvest value chain activities. Traditionally, in value chain analysis the main emphasis has been on capturing economic returns for value chain actors. The definition of value is based on the willingness to pay for what a firm provides, and 'value' is usually measured in terms of total revenue, a function of price and quantities sold (Porter, 1985). The supply side channel summarised in section 3.2 reflects this notion of value. Moreover, the concepts presented in section 3.2 on alleviating constraints in the demand and supply of nutritious foods can be extended to activities further along the chain, where the focus shifts to stakeholders, or firms, involved in value addition. In broad terms, a similar results chain can still apply: Interventions would look to alleviate constraints in supply and demand, and strengthen market channels while increasing production volumes, reducing transaction costs and risk, leading to increased efficiency and profits, and in time leading to improved incomes.

3.3 Mediators of potential impact

The value chain activities provide the market links between the demand and supply pathways mapped in Figure 3. The performance of the market transactions along the value chain affects commercial relations and firm profits. Value chain performance also mediates the effects on nutrient intake and diets that can potentially lead to improved nutrition. Four characteristics of value chain performance are particularly relevant in determining the extent to which these effects can occur, including the quantity (or supply volumes), price, and quality (including both nutrition content and food safety) of a relevant food. These four value chain characteristics also affect major elements of the food environment, including food availability, affordability, and acceptability. In this framing, both the nutrition content and food safety of a particular food can be enhanced or diminished at key points along the value chain.

3.3.1 Improving nutrition and food safety along a value chain

Conceptually, this is equivalent to internalising these 'pro-nutrition' characteristics within an extended notion of value along the supply chain. However, for "nutrition added-value" to factor in the value chain transactions, requires reliable information on both nutrition quality/content and safety risk to be transmitted along the chain, and prices would reflect a premium for both nutrition content and food safety. In practice this is often not the case, particularly in low-income settings. As nutrition value includes properties that are akin to those of credence goods, there are no incentives to pay for quality

unless there is some form of visible, third-part activity which may be undertaken publicly (e.g. information campaigns) or privately (e.g. consumer reporting) (Minot, 2014).

Many highly nutritious foods, including meat, milk, fish, vegetables, are the riskiest in terms of food safety. Because of their perishability, these risks often grow as value chains lengthen and become more complex. For perishable, nutritious foods, informal value chains generally supply the majority of these foods, especially to poorer households, and are likely to continue to do so in the near term. Where government systems to support food safety are emerging and consumers' choices may be limited by income and information, the most important incentives to safe production – private demand and effective government regulation – are lacking.

Measurements of this pro-nutrition value, added at key points in the chain, can be used to identify bottlenecks as well as opportunities to enhance nutrition and the transmission of information. Examples of relevant interventions that enhance nutrition value include fortification, enrichment, processing multiple foods into more nutritious products, food safety and detoxification, as well as labelling and sensitisation. A number of recent activities have been undertaken to potentially enhance the flow of nutrition information along the chain that require testing, including the development of nutrient profiles for processed foods (WHO, 2013), as well as the development of metrics and benchmarks to evaluate the cost-efficiency of interventions in food supply chains (Gelli et al., 2011, Ryckembusch et al., 2012). These activities, though, also imply costs for actors along the value chain in enhancing or maintaining the nutritional value of food along the chain and communicating this in a reliable manner to consumers. How this can be achieved when the value chain also has to keep prices affordable to the poor is an important are for future research.

It is important to also examine the influence of a number of other crosscutting issues that influence the value chain pathways, including, policy, gender and coordination across sectors, amongst others. These influence of these issues on chain performance is comprehensive and as such they should be mainstreamed within this type of analysis.

3.3.2 Gender

There is growing evidence that gender discrimination is a fundamental driver of poor nutritional outcomes (Quisumbing et al., 2014). Women play important roles in production and value addition and agriculture has the potential to empower them to make better food-, health- and care-related decisions for themselves and their families. For example, it is likely that the introduction of different agricultural practices, particularly in areas where many farmers are women, will impact time allocation and labour in ways that might negatively affect child care practices. Any agricultural development that expands and formalizes markets should be careful to avoid inadvertently disempowering women by adding to their time burden and/or reducing their control over income. Understanding and monitoring these feedback effects will be important to ensure at a minimum, a "do no harm" approach to interventions.

3.3.3 Coordination

The efficiency of value chain activities is influenced by the coordination of stakeholders along the chain. In VCN, coordination involves activities and stakeholders across traditional disciplines, including agriculture and health, and often coordination between government entities and the private sector. Though there is considerable variation in the degree of intensity, most case studies in the literature (Hawkes and Ruel, 2011, Annex A) include an explicit focus on coordination activities. Understanding the need for coordination along the value chain and among agriculture and nutrition interests, and how coordination must take place in practice, are important areas for future research (Garrett and Natalicchio 2012; Harris and Drimie 2012).

4. Identifying and designing VCN interventions

In this section we draw on the analysis of the VCN impact pathways to develop the details behind the intent to systematically make value chains more relevant to nutrition. We define a "value chain for nutrition approach" as the process of developing a strategy to address nutrition problems through interventions that alleviate constraints in demand and supply in specific value chains. The high-level goals of this strategy centre on the health and nutrition of consumers, reflecting the end result that is intended. The specific objectives will relate to the main constraints that are involved (see section 4.3). The structure of the strategy is based on the pathways through which VCN interventions can be expected to improve nutrition, including three main channels linking the demand and supply for nutritious foods:

- On the demand side, the main pathway to nutrition involves improving diets through increased consumption of nutritious foods. This channel is most relevant where diagnostics have identified deficiencies in the diets of target populations.
- On the supply side, the main pathway to nutrition is through improved economic returns, and involves the traditional value chain development framework, reducing costs, increasing output, sales and profits along the value chain, leading to improved incomes.
- A third pathway involves interventions within the value chain, which in this framework is the interface between the demand and supply pathways. Improved chain efficiency (where output is not economic, but also involves measures of nutrition and food safety) will influence the food environment, including food availability, quality and affordability that in turn can lead to improved nutrition.

We develop this approach further through a series of steps that are outlined in the following sections, including diagnostics of the problem and the context, followed by the development of possible solutions (including the identification of entry points for intervention across one or more value chains), design and implementation, and evaluation and learning.

4.1 Diagnostics

The aims of the diagnostics are to link a set of nutrition problems of target populations to possible constraints in the supply and demand of specific foods that can then be addressed by interventions. In this framework, these diagnostics can be broken down into a series of five key steps, building on that described in (Timmer et al., 1983) and more recently in (WHO, 2013)[5]. It is important to note that some of the data requirements involved are complex and it is essential to be pragmatic in terms of the detail and intensity of the analysis involved. Drawing on existing data sets will be particularly relevant.

Step 1: Identifying the nutrition problem to be addressed

This step provides evidence on the factors that are contributing to nutrition problems and the extent of their contribution, some of which may be dietary while others may not. The starting point involves characterising the "nutritional problem", including nutritional status, dietary patterns and feeding practices, and other indicators related to nutritional outcomes and their determinants (UNICEF, 1990). The assessment also broadly identifies existing gendered constraints and opportunities in terms of access, intake and utilisation of nutritious foods, including nutrition knowledge, preferences, attitudes and practices. Both undernutrition and overnutrition perspectives should be covered where the nutrition transition is relevant. Potential target groups would also be identified for intervention.

Step 2: Analysis of the macro-level food systems context

This step includes both examining the macro-level context, or the "enabling environment", and characterising secular and seasonal trends in food systems. The range of dimensions involved includes policy and governance, political environment, socio-cultural norms and practices, and climatic and other environmental conditions (see FAO, 2013). This step also includes an analysis of food balance

[5]A recent example of this type of diagnostic was undertaken in Ghana (Anim-Somuah et al, 2013).

sheets, for example, in order to capture secular trends in terms of food supply. A detailed analysis of these dimensions is beyond the scope of this work and remains an important area for future research.

Step 3: Characterising diets, identifying constraints and relative contributions of key foods

This step involves examining data on diets and consumption patterns, comparing actual intake to the requirements and recommended intake for specific target groups, generally defined by age and sex. Understanding the dietary constraints in a specific location involves the development of typologies of diets, including for example, food baskets or bundles based on location-specific dietary data and dietary guidelines, that are converted to equivalent nutritional bundles using food composition tables. The different bundles can be compared to the dietary requirements for specific groups. The analysis would also need to be disaggregated by nutrient type to enable the identification of nutrition deficiencies or excesses (Ferguson et al., 2004). This type of analysis provides data on the relative contributions and prioritisation of different commodities in terms of their contribution to overall diets and nutritional intake, as well as providing an understanding of the gaps that can be filled and the recommended diets to meet these needs. Costing these diet-based food bundles using market prices provides insights on both the costs of an actual diet, and provides a basis for cost per nutrient metrics against which the cost-efficiency of interventions can later be benchmarked (Maillot et al., 2008). As collecting dietary data is resource intensive, it is important to identify existing data sources as well as gaps that would require further investments.

This step can be used to also identify foods that are 1) nutrition-poor or contaminated (through loss of nutrition value or increased food safety risks across chain); 2) under-consumed; 3) “missing” (e.g. new varieties) and 4) over-consumed (e.g. foods that are being consumed but are not healthy).

Step 4: Value chain analyses also examining nutrition and food safety value addition

This step identifies the constraints in supply and demand of nutritious foods. In addition it also identifies potential entry points for intervention along relevant chains. Characterising diets allows for the identification of opportunities for improving diet quality by enhancing the supply and demand of specific foods, including fruits and vegetables; biofortified foods; and nutritious but often traditionally, neglected and underutilized crop species (including pulses, grains and other indigenous foods).

Once commodities have been prioritised in the context of the total diet, the focus shifts to undertaking supply and value chain analyses for the target foods. In this step, the value chain analysis is broadened to include assessments of “nutrition value”, including nutrient density and food safety alongside measures of food quantity, prices and margins at key points along the chain. In this framing, both the nutrition content and food safety of a particular food can be enhanced or diminished at key points along the value chain.

This analysis involves identifying market failures and/or constraints in the supply and demand. For example, smallholder farmers may not grow optimal amounts of nutritious foods from an economic perspective because they lack access to inputs or output markets. This supply gap may also be related to the inability to insure against the risks of producing such foods or potentially because of health impacts from consuming unsafe foods due to inadequate regulations or enforcement of food safety regulations. There are a range of other factors that can impact the supply of these foods. The gender of the producer may contribute to different constraints to producing nutritious foods. For example, women producers may not be inclined to supply the market if they are not able to control the income from crop sales. Traders and processors in the informal sector may not have access to information and technology to maintain the quality and safety of perishable foods. While advances are needed in this regard, it is also is important that it is balanced since initiatives to meet food safety standards for access to export markets might lead to inappropriate regulation in domestic markets that is ineffective in terms of improving food safety and may harm the poor.

Finally, each value chain should be contextualised within the broader food system to identity constraints in terms of the “enabling environment” that may influence value chain performance.

Step 5: Prioritising intervention options

This step provides the evidence to prioritise and justify investments in specific interventions.

Once the constraints and opportunities have been identified within specific value chains, including identifying different target groups for intervention, the emphasis shifts towards guiding investment decisions, including the development of criteria to prioritise the range of interventions identified in step 4. This can include the development of business and investment case models that simulate the potential costs, effects and returns to investment for scaling-up the interventions. These models will need to consider short-term effects as well as long-term effects on these sectors and the feedback loops that exists between them (see BCG, 2009, for one such example).

4.2 Identifying and designing relevant value chain interventions

Once the diagnostics are complete and a target crop or food has been identified, the focus shifts to designing interventions aimed at alleviating the constraints in demand and supply in a specific value chain. The range of possible interventions is very broad, including research and development, direct public and/or private investment, and Government policy and regulation, amongst others. In some cases, interventions along a value chain will be relatively straightforward. This may be the case, for example, when solutions involve providing nutritional information on a given food that is already widely produced and consumed, or fortifying selected foods. In other cases, interventions along a value chain will be relatively intensive (requiring long-term investments to stimulate changes in production, processing, and marketing). The most intensive interventions will be required when major gaps or barriers exist in both the supply and demand of a specific food. This situation may emerge, for example, for a new product with considerable nutritional value as it is introduced to consumers, but adequate sources of supply have yet to evolve, as in the case of ready-to-use complementary foods. This case could also apply to specific pro-poor interventions in both supply and demand, where for example the poorest smallholders are targeted to supply foods for public distribution programmes.

The variation in intensity of investments on the supply and demand sides can be used to characterise a set of typologies for specific value chain interventions. An example is shown in 2 along with the implications for the design of value chain interventions. In this figure, the vertical axis represents the variation in existing demand (i.e. high or low demand for foods). The horizontal axis represents the differences in the production and post-harvest supply chain for these foods. Here we use the term “consistent supply” to refer to the condition where there is no major supply-side constraint.

4.2.1 Interventions to enhance pro-nutrition added value

Where demand and supply exist for a nutritious food, interventions would focus on optimising transactions in the existing chain and enhancing the ‘nutrition’ added value along the chain (quadrant A). This could be achieved by reducing the overall costs per nutrient output through, for example, fortification, by combining different foods, or by reducing contamination and food safety risks. Interventions in this quadrant can target specific points in the value chain where efficiencies can be introduced, or where nutritional/food safety leakages exist. Alternatively, interventions in this quadrant may look to provide information at key points in the chain or enhance overall flows of information along the chain. Interventions involving the provision of quality assurance and improved regulatory frameworks are also relevant in this quadrant and can lead to important gains in efficiency. This is demonstrated in the case of the school meals programme in Chile where improved tendering regulations increased transparency of financial flows and reduced transaction costs considerably (Epstein et al., 2004). The main immediate results of these types of intervention include increased efficiency (e.g. enhanced nutrient content or reduced contamination per unit price of food), or increased knowledge and willingness to pay for a nutritious and safe food. The catering/fortification HGSF implementation model (Annex 1.6), is an example of an intervention in this quadrant.

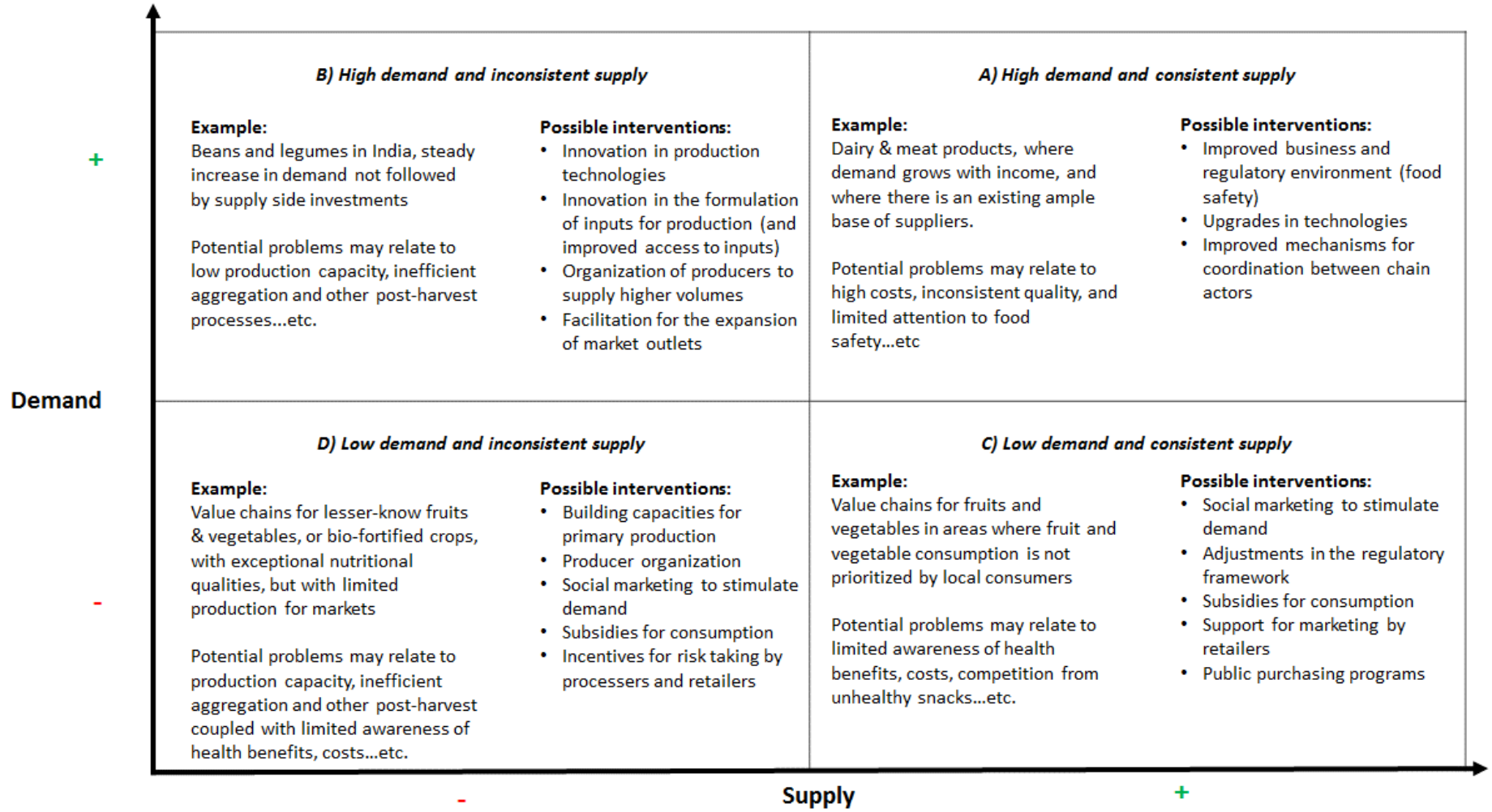

Figure 4: Typologies characterising value chain interventions based on the supply and demand of nutritious foods. (Source: Authors).

4.2.2 Interventions that enhance the supply of nutritious food

In some contexts, ample demand for a specific nutritious food from consumers may exist but the supply side is constrained (quadrant B). In this case, interventions would mainly aim to relax these constraints by, for example, by improving the organisation of production or introducing new production technologies to enhance the supply. The more immediate intended effects of interventions involve changes in production and post-harvest practices, risks from climate and markets, prices and price stability. The dairy value chain projects (Annexes 1.4 and 1.5) are examples of these types of interventions.

4.2.3 Interventions that enhance the demand for nutritious food

Where the context includes value chains for foods that are widely produced but are not consumed by the target populations (quadrant C), interventions would strive to enhance the demand for the nutritious foods, through social marketing campaigns or potentially through public procurement programmes like school meals. Behaviour change campaigns can combine the promotion of both the consumption of specific foods, and healthy behaviours and feeding practices. The immediate effects of interventions in this quadrant centre on changes in consumption, health and nutrition practices and women's time allocation and role in household decision-making. All the projects summarised in Annex, except for the EADD, included some degree of nutrition messaging aimed at increasing the demand for more nutritious foods. HGSF also provides direct food transfers to the target populations that increase the demand for that particular food on the market.

4.2.4 Introducing new types of nutritious foods

When introducing a new food within the target population, interventions would aim to develop a functioning and table source of supply while at the same time investing in demand promotion for the food (quadrant D). This quadrant captures interventions that generally require the most intensive investments on both the production and consumption sides. The introduction of biofortified crops (e.g OFSP in Annex 1.7), or new fortified products are examples of interventions in this quadrant.

4.3 Defining intervention objectives based on the context and the intended effects

The typology introduced in the preceding section leads to insights on the possible objectives for value chain interventions based on both the context and the potential sequencing of intended effects summarised in the programme theory in chapter 3. For example, where interventions look to enhance supply (quadrants B and D), by addressing agricultural production, post-harvest and marketing constraints, the resulting short-term effects would involve changes in production and post-harvest practices, as well as changes in market opportunities and risk. Where the intent behind interventions is to increase the consumption of nutritious food and the associated demand for the nutritious foods on the market (quadrants C and D), the intended short-term effects include changes in nutrition, health and care knowledge; changes in women's time allocation and decision-making roles; and increases in the quantities of the specific nutritious food consumed. Interventions across quadrants, if effective, would allow the value chain to evolve towards quadrant A, where the intent focuses on 'pro-nutrition' value addition along the chain.

This approach can be used to develop a set of context-driven objectives for interventions, including:

1) *Promoting consumption of nutritious food (quadrants C, D):* Interventions target multiple stakeholders, primarily consumers (but also producers for own consumption), and aim to improve diets by improving consumption of nutritious foods, and enhancing nutrition knowledge, attitudes and practices.
2) *Enhancing the supply of nutritious food (quadrants B, C):* Interventions mainly target producers and small- and medium-enterprises involved in the supply of nutritious foods, and aim to increase production and sales by improving agricultural practices, increasing market opportunities and reducing risk from the market (in terms of price volatility) and the environment.

3) *Increasing the nutrition added-value along the nutritious food chain (quadrant A):* Interventions would target the more aggregate value chain actors such as processors, and the regulatory environment, aiming to enhance the nutrition added-value and efficiency along the chain.

Relevant interventions can then be framed within each objective and tailored to the specific context and target groups as summarised in Table 1, building on examples presented in (FAO, 2013).

Table 1: Examples of VCN objectives and interventions within the different typologies. (Source: Authors).

Typology	Objectives	Target groups	Interventions
C,D	Promoting consumption of nutritious food	Consumers, producers	Nutrition and health messaging Product labelling Nutrition education Income transfer, food assistance
B,D	Enhancing supply of nutritious food	Producers	Training on production, post-harvest and marketing practices Access to technology, inputs and credit Organising producer groups Expansion of market outlets Nutrition and health messaging
A	Increasing pro-nutrition added-value	Processors, producers, consumers	Food safety, detoxification Fortification, reformulation, combination Reducing costs Product labelling Nutrition and health messaging

5. Indicators for evaluating value chain for nutrition interventions

This section introduces potential indicators that provide information on whether expected changes are occurring based on the impact pathways and typologies developed in the preceding sections.

5.1 Measuring changes on the demand-side pathway

Proximal outcome indicators

The most direct indicator that a VCN intervention is achieving the desired outcomes centres on changes in the quantities of nutritious food consumed. Consumption of the target food in the target population(s) should be measured using dietary recall methods (Gibson and Ferguson, 1999). If an intervention is promoting a specific nutrient (e.g. biofortified foods, or foods known to be high in a certain nutrient), it will be important to assess target nutrient consumption by using food composition tables and programs that calculate nutrient content of foods in the overall diet (Ferguson et al., 2004). Women are key determinants of nutrition during the first 1000 days, both in terms of their own nutrition and health during pregnancy, and usually in terms of child care and feeding in the first two years. Different aspects of women's empowerment are therefore crucial for nutrition, and are likely to be affected by VCN programs. In particular, women's time use (especially between agricultural activities and child care activities), maternal energy expenditure (particularly on agricultural tasks during pregnancy), and women's decision-making power (regarding the trade-offs between agricultural and child care decisions) link agriculture and nutrition. These aspects can be measured using different modules of the Women's Empowerment in Agriculture Index (WEAI, 2012). Women's knowledge, particularly around nutrition, health, and child feeding and care, can also be changed by VCN projects, and should therefore be measured. There is however no defined tool or method for this other than general survey techniques asking context-appropriate questions.

Distal outcome indicators

Infant and Young Child Feeding (IYCF) is a key issue in determining nutritional status, and has a defined set of indicators for measurement of both breastfeeding and complementary feeding (World Health Organisation 2010). Dietary diversity, a measure of nutrient adequacy in the diet and therefore of overall diet quality, is also an important distal outcome, and VCN interventions should measure it either as a key outcome, or to monitor displacement of other foods in the diet by foods promoted by the VCN intervention. There are two validated Individual Dietary Diversity Score (IDDS) measures covering the 1000 day period, one for children aged 6-23 months (World Health Organisation 2010), and one for women (FAO 2011). Dietary diversity is measured as the intake of discrete food groups over the previous 24 hours (7 food groups for children; 16 for women). Within a population group, dietary diversity is then measured as the mean number of food groups consumed, and among children the proportion achieving minimum dietary diversity (consuming 4 or more food groups the previous day). Some VCN interventions may choose to more fully evaluate effects on diets and intake, and would therefore measure nutrient adequacy in the diet directly rather than using the proxy IDDS. Measuring nutrient adequacy of the diet is generally resource intensive and requires a dietary recall to assess which foods a person has eaten; use of food composition tables or programs to calculate the nutrient composition of those foods in total; and comparison to the nutrient recommendations for the population group (age and sex) to which that person belongs (Gibson & Ferguson, 2008).

In addition to dietary diversity, meal frequency and composition are key elements of dietary adequacy for optimal IYCF. VCN interventions may impact these elements positively (though increased access to food, or knowledge of nutritious foods) or negatively (requiring more of a woman's time for agricultural production or food purchasing/preparation) on IYCF, so it is necessary to measure all the possible effects of VCN interventions on dietary adequacy. The Minimum Acceptable Diet (MAD) indicator comprises minimum dietary and minimum meal frequency for a child's age, along with appropriate milk feeds (breast

or non-breast milk) (WHO 2010), and is calculated for children aged 6 to 23 months. As VCN interventions may positively or negatively affect IYCF through increased knowledge or decreased care time as noted previously, they may also affect other health and hygiene practices through similar mechanisms. Again, there is no single defined tool or method for assessing health and hygiene practices, other than asking context-appropriate questions.

Impact indicators

Three indicators of child nutritional status are used to assess levels of undernutrition: Stunting, wasting, and underweight; each is measured in children under the age of 5 and expressed as a Z-score (the deviation from the mean of a reference population). The primary measure used in nutrition programs is stunting, based on the Height-for-Age Z-score (HAZ). An HAZ expresses a child's height for a given age, and a Z-score of less than -2 denotes stunting, or growth faltering as a result of chronic undernutrition. Stunting may be measured in a VCN intervention if the program is also addressing (or linked to other programs which address) the 'health' and 'care' determinants of undernutrition; otherwise, VCN interventions should focus on assessing dietary outcomes. Stunting is measured using standard anthropometry procedures, and population-level results for different age groups 0 to 5 years are compared to standardized reference population (WHO Multicentre Growth Reference Study Group 2006). In older children, adolescents, and adults, Body Mass Index (BMI) is used instead of Z-scores (WHO 1995); in adults, a BMI of less than 18.5 denotes underweight, and a BMI of more than 25 denotes overweight. Some VCN interventions may aim to increase levels of specific nutrients in the diet, and therefore may want to measure impact in the body. Various biomarkers for different nutrients exist, generally measured in the blood (iron and vitamin A) or urine (iodine) (Hendrick et al., 2012). Because biological processes are complex, it is generally not enough just to measure the specific biomarker, so other information must also be collected such as markers of immune function. Given the inherent complexity of measuring these impacts over time and the considerations needed to collect this type of data, those wishing to measure nutrient biomarkers in their research should work with an expert in this field.

The indicators along the food demand side pathways in Figure 3 are summarised in Table 2.

Indicators		Population group	Tools and methods	Reference
Impact				
Changes in nutrition status				
	Stunting, wasting, underweight	Children 0-59m	Anthropometry and statistical analysis	WHO Multicentre Growth Reference Study Group 2006
	BMI	>59m-adult	Anthropometry and statistical analysis	WHO 1995
	Biomarkers	All ages	Blood and urine analysis	Various
Changes in health				
	Agriculture-related disease incidence	All ages		
Distal outcomes				
Changes in consumption (diet, multiple foods)				
	Dietary diversity	Children 6-23m	Individual Dietary Diversity Score	WHO 2006
		Women	Individual Dietary Diversity Score	FAO 2011
	Nutrient adequacy	All ages	Dietary recall + food composition tables + nutrient recommendations	
Changes in feeding practices				
	Dietary adequacy	Children 6-23m	Minimum Acceptable Diet	WHO 2006
Changes in health and hygiene practices				
	Practices	Women	No defined tool or method	N/A
Proximal outcomes				
Changes in quantities of nutrious food consumed				
	Target food consumption	All ages	Dietary recall	
	Target nutrient consumption	All ages	Dietary recall + food composition tables	
Changes in nutrition, health and care knowledge				
	Knowledge	Women	No defined tool or method	N/A
Changes in women's empowerment				
	Women's time use	Women	Women's Empowerment in Agriculture Index (modules)	WEAI 2012
	Maternal energy expenditure			
	Women's decision-making power			

Table 2: Summary of indicators for the demand side pathway for VCN interventions.

5.2 Measuring changes on supply-side pathway

The indicators for the supply side pathway in Figure 3 are summarised in Table 3. The structure of these is inherently different than the nutrition-related indicators as they are often reliant upon only one or two pieces of data. How these are calculated may vary and while seemingly straightforward, some of them prove difficult to capture accurately or consistently. For example, determining the members of an agricultural household is complicated by a variety of family structures and co-living arrangements as well as migration. In each context, these dynamics should be well understood before attempting to collect this type of data. What type of data is appropriate to collect from household members is also very context-specific. Throughout these indicators, measurement error and associated data quality are important issues to consider. Farm area, used as the basis for which many inputs and outputs are analyzed, is subject to reporting bias (Carletto, et al, 2013). In addition, it is common that farmers may not have good measurements of critical components used for monitoring production including annual production (due to multiple harvests, especially for vegetables), labour (as it is often part-time), or even of the land area planted in particular crops (due to intercropping or crop rotations). This makes comparison difficult and often, additional data is needed to check for consistencies or measurement issues with these components. Examples of the difficulty in these measurements and strategies for helping to mitigate them have been documented (Diskin, 1999).

Impact		Population Group	Indicators	Reference
Changes in income/economic status				
	Household net income	all working members of household	on-farm income minus costs/rents, off-farm income (salaried or hourly), transfers/other inflows	FAO 2011
	Opportunities	household	diversity of production and off-farm opportunities; time available/use; access to improved inputs and credit	
	Risk	producer groups; local market	price volatility (input and output prices); risk-sharing through group formation; insurance/contracts	
Distal Outcomes				
Changes in sales and profits				
	Profit from all products	household	input costs and/or output prices; transaction costs; price and income stability	
	Market access	household; producer groups	new opportunties, secure marketing arrangements; volumes sold; access to high-value markets; lower transaction costs	
	Market share	household; producer groups	value-added processing (vertical integration); number of products meeting some form of standard;	EC 2009
Changes in production systems				
	Supply of nutritious foods	household; village	volumes produced; area planted; yields; share of nutritious foods and/or high-value crops produced	
	Volume, quality and post-harvest losses	household	quality produced; storage (amount, time stored, infrastructure); amount of crop lost	Diskin 1999
Proximal Outcomes				
Changes in production and post-harvest practices				
	Knowledge of improved farming practices	household; producer groups	knowledge of optimal input use etc..	
	Production practices	household; producer groups	access to inputs (e.g. credit, fertilizers, extension), number of ha with improved practices	WDI 2014; FAO 1999 (various)
	Post-harvest management	household; producer groups; village	number of storage facilities built; storage practices;	Diskin 1999
Changes in market opportunities/risk				
	Knowledge of market opportunities and prices	household; producer groups	prices (absolute and stability); contracts; available market information	EC 2009; various
	Responses to signals from market or education	household; producer groups	crop mix planted (staples versus higher-value/nutritious products)	EC 2009

Table 3: Examples of indicators for the supply side pathway for VCN interventions. [6]

Proximal outcome indicators

In the short-term, VCN interventions can enhance knowledge of improved farming practices, leading to changes in production practices that increase yields and/or efficiencies and changes in post-harvest practices such as storage. These changes can be supported by some of the interventions mentioned earlier

[6] References provided are often contextual references (of which there are many) rather than measurement references.

(e.g., educational campaigns on food safety and nutrition) as well as more direct interventions such as the promotion of increased processing. Interventions can also involve enhanced marketing channels and improve knowledge of market opportunities (prices, volumes and timing), leading to short-term production responses to these market signals (including changes in the crop-mix planted). Interventions in VCN may also lead to improved access to inputs or input-related information, shifting household-level constraints and further supporting different practices at the farm-level.

Distal outcome indicators

Changes in production practices and output could then result in increased marketed surplus, sales and profits, as well as changes in farm-level production systems and a crop-mix that favors higher-value or more nutritious crops. As a result of the changes in post-harvest practices, with time, there may be increased quality and reduced production lost. On a mid-term time horizon, changes in marketing and market information may be seen and more of the market might be captured through vertical integration. Prices may become more stable and transaction costs can decrease. Higher-value markets may be accessed and standards may be put in place to ensure quality, signal this quality to the consumers and allow producers to capture premiums. Increased agri-enterprise opportunities may result.

Impact Indicators

In the longer term, the focus is on increasing overall income through increased production and sales. As mentioned previously, VCN interventions can impact incomes and economic status, market structures, as well as create shifts in risk and opportunities. There can also be a shift in own-production of nutritious foods (increase in supply). As described in section 3.2, any increase in demand without a shift in supply could have negative effects on prices. Even with increased production of nutritious or higher quality foods, the relationship remains complex due to the fact that many rural households are net food buyers. Supply and demand interactions and corresponding effects at the household level are ultimately determined by larger market mechanisms that should be monitored when assessing potential impacts.

5.3 Indicators for measuring performance and value addition along the chain

A number of interrelated properties of value chain transactions are relevant in the context of nutrition, including the volumes or quantities of nutritious foods involved, the food quality (both in terms of nutrition content and safety) and prices. Other chain properties may also be desirable on the medium and longer term, including metrics for sustainability, for example, but these are beyond the scope of this work. A series of indicators, including nutrient profiles (WHO, 2013), can be developed based on these characteristics to benchmark and monitor performance at key points along the chain, from production to consumption (Table 4). Costs per unit nutrient output, for example, has been used to benchmark supply chains for the delivery of alternative commodity baskets and nutrition content (Ryckembusch et al., 2012, Gelli et al., 2011, Bundy et al., 2009).

Indicators	Population group	Tools and methods	Reference
Processes/flows along the chain			
Changes in nutrition added-value	Producers/processors	Laboratory analyses	
Nutrient density/profile			WHO, 2013
Contamination			
Changes in economic added-value	Producers/processors	Market analysis	
Prices			
Supply volumes			
Costs			
Margins			

Table 4: Examples of indicators for measuring nutrition value-addition along the value chain.

6. Themes for further research

The concept of VCN is innovative and therefore little evidence currently underpins activities in this area. In this paper we provided an overview of the potential direct and indirect effects of value chain activities across agriculture, nutrition and health. We proposed that the VCN approach aims to address a set of nutrition problems, with multiple objectives framed around alleviating constraints in specific value chains. We then outlined the key steps involved in developing this approach further from a multidisciplinary perspective, including considerations on diagnostics and intervention design. In this section, we conclude by building on the content generated in this paper to summarise future research themes in this emerging multi-disciplinary field.

5.1 Tools and diagnostics

The complex and context specific nature of VCN highlights the need for a set of comprehensive and flexible assessment tools to support the design and evaluation of interventions. Though a range of tools already exist for the different steps of the diagnostics proposed in this paper, ranging from macro-level, food-system trends to individual-level dietary data, future work could integrate these tools to support a multi-sectoral perspective. Additional validation and standardization of some of the different sectorial tools is also needed.

5.2 Questions on intervention design

Despite the broad pathways for potential impact, VCN interventions are very context specific. Moreover, the VCN approach may involve bundles of interventions across one or more value chains. As mentioned previously, considerable evidence gaps exist related to the implications of both single interventions and to the packaging multiple interventions. Clearly, designing, managing and evaluating this kind of approach is not straightforward. It is therefore important to be specific and carefully consider the nuances involved.

5.2.1 How to increase the demand for nutritious foods?

The emphasis on the consumers' side centers on understanding the "nutrition problem", including the available nutrition information, knowledge, attitude and practices. Diagnostics of the nutrition problem are critical to ensure that the role of value chains and the potential opportunities are captured appropriately. Understanding consumers and intra-household dynamics, including gender roles, however, is not straightforward. Data on diets, a starting point for planning and adopting a VCN approach, is expensive to collect. Furthermore, the gap of information on costs of these diets is a major barrier in terms of understanding both the economic constraints consumers face in terms of healthy diets, and also the potential market opportunities for the value chain products. Streamlining diagnostic tools is an important area of ongoing work involving partnerships between researchers and practitioners.

A better understanding is required of the potential to shape demand for safe and nutritious foods, and the cultural and market implications of changes in this demand. In contexts where interventions aim to increase the consumption of nutritious foods, important questions remain on how to reach the most vulnerable at scale, both from a short-term public-health perspective, but also in terms of long-term sustainability. The priority for nutrition interventions are children within the first 1000 day window from conception to age two as well as pregnant and lactating mothers. It will be important that the details involved in reaching these targets populations are developed explicitly as part of intervention's design and evaluation. A related area involves demand side considerations around the issue of overconsumption of processed foods, or unhealthy diets more generally, leading to overweight and obesity.

Understanding the cost-effectiveness and feasibility of scale-up of alternative strategies to promote improved health and nutrition behaviours is another important area for research.

5.2.2 How to increase the supply of nutritious foods?

From the agricultural production side, the focus is on involving smallholder farmers, supporting diversification and increasing output of nutritious foods whilst developing reliable marketing channels for these products. However there is considerable heterogeneity and multiple factors to consider; with many smallholders being net buyers throughout the year, and price effects could have a range of impacts on these producers. There also remain important questions for researchers regarding how to optimise decisions involving food production, income, and the trade-offs and risks involved in specialisation vs. diversification. It will also be critical to evaluate the most efficient methods for integrating multiple food products into the production and processing schemes of smallholder producers.

5.2.3 How to optimise the flow of nutritious foods along the chain?

Where supply and demand for nutritious products exist already, the key focus is on interventions that enhance the nutrition added value along the chain, including at a minimum, nutrition content, food safety risks, prices and quantities. Interventions in the middle of the chain (e.g., processing) are also key in terms of linking producers to consumers for a range of nutritious foods. However, the stakeholders involved are also very heterogeneous, including both the private and public sectors, and understanding the coordination along the chain also require careful assessment. In particular, as nutrition attributes are mostly unobservable, quality assurance and quality signalling are important. Although standards and common metrics, like those involved in nutrient profiling of foods, can provide some relevant information for stakeholders at key points in the chain, the relationship between chain performance and regulatory environments is also complex, supporting the need for more evidence, for example, on third-party quality assurance. Questions remain on how to provide credible and affordable means of certification, particularly in low-income settings. Similarly, assessing the challenges and opportunities for nutrition value-addition by processing foods, as in the production of nutrient-rich complementary foods for young children, alongside the pitfalls surrounding processed food more broadly is another important research area. In addition, the food production environment is changing due to pressures from climate change and population growth, highlighting the need to incorporate sustainability and resilience within the VCN framework.

5.2.4 Managing trade-offs

In VCN the heterogeneity across target groups, interventions and potential effects is very broad. The impact pathways on consumers, producers and other chain actors involve complex direct and in-direct effects. At a strategic level, win-win outcomes for smallholders and consumers may be possible but not certain, and the trade-offs across the different outcomes made explicit in this paper require careful, context-specific analysis. For example, depending on the identity of consumers, putting consumers first might not be compatible or cost-efficient, at least on the short-term, with sourcing from smallholders. However, by examining the costs and effects of interventions explicitly, it may be possible to justify any additional resources required for pro-smallholder engagement, or at least provide insights on longer-term solutions involving smallholders.

For smallholders, an important trade-off is reflected in the tension between increasing incomes and enhancing consumption of nutritious foods: the most profitable crops may be those with lower nutritional value (Henson et al., 2013). These trade-offs are complex and dynamic, and are also influenced by seasonal and secular trends. From this perspective, prioritising objectives, monitoring intended and un-intended effects, and “tweaking” intervention design in response to feedback from reliable monitoring and evaluation data will be important. Tailoring monitoring and evaluation methods to promote this flexible learning environment is also a key challenge for the research community.

Understanding the effects of seasonality across demand and supply pathways, including health, dietary and production variations will be important (Devereux et al, 2008).

It will be also important to also understand the trade-offs involving household-level decisions and gender realtions that mediate the effects on the nutrition and health, and agriculture pathways.

5.2.5 Equity and pro-poor considerations

A critical issue across the potential VCN pathways are the pro-poor implications of specific interventions as well as the overall welfare impact of the approach as a whole. On the demand side, the central issue is how to promote consumption of nutritious foods to target populations that may or may not be able to afford a healthy diet. Similarly, on the supply-side, key questions surround the feasibility of targeting the poorest small-holders and informal enterprises for intervention along the value chain, that are also more likely to involve women.

Recent experiences in Latin America, including the social development programmes of the Government of Brazil for example, involve programmes where explicit commitments were made to reach the poorest across both supply- and demand-side pathways. In this case, explicit public financial and technical commitments were made to involve the poor in the supply of nutritious foods and then channel nutritious foods back into vulnerable households through social transfer programmes (Soares et al., 2013). In Chile, public-private partnerships were developed to deliver social programmes cost-efficiently (Epstein et al., 2004). Examining the roles and interactions between public and private sector stakeholders is essential. Rigorous analyses of the more cross-country experiences of the WFP Purchase for Progress (P4P) pilot will also provide important evidence on these issues.

5.2.6 Do no harm?

The influence of value chain activities on the opportunity cost in time spent by women caring for themselves and their children, farming, or preparing food is another important area of ongoing and future research. On one hand, value chain activities involving processing may involve new products that are easier to prepare and have enhanced nutrition content. On the other hand, women's labour involvement in the value chain activities, including food production and processing, may reduce the time available for caring for younger children. Considering these gender related trade-offs will be an important priority for impact evaluations in this field.

5.3 Questions on evaluation methods

Evaluating the VCN approach and related interventions involves generating policy relevant evidence on costs and effects on producers, consumers and stakeholders involved in pro-nutrition value-creation along the value chain activities. Optimising value chain performance across the different sectors inevitably involves qualifying and quantifying trade-offs, and therefore complementing cost-effectiveness data with a better understanding of the mechanisms and impact pathways will be important. Appropriate evaluation methods are required to suit this breadth and complexity (LCIRAH/NCRSP, 2012). An analysis of the appropriate methods is beyond the scope of this paper However, the conceptualisation of the programme impact pathways, the foundation for theory-based evaluations (Rossi et al., 2005, Habicht et al., 1999), presented in Section 2.3 provides an important first step in the evidence generation process.

In terms of metrics, capturing overall performance of VCN interventions requires the collection of indicators from all the relevant stakeholders involved in the value chain activities. Developing detailed process maps that capture the activities and flows across the relevant chains can be a useful first step in identifying performance indicators (see Annex for some examples of process maps). The process maps can also be overlaid alongside the impact pathways developed in this paper to provide insights on possible effects on the different stakeholders involved. The breadth of indicators that are required to examine the whole system is clearly considerable and in practical terms this poses another challenge to evaluators. In this context, prioritising different indicators across the relevant disciplines, particularly in choosing primary evaluation outcomes is extremely useful.

Table 4: Summary of key themes for future research. (Source: Authors).

Tools and diagnostics
Require multi-level diagnostic tools (macro, meso and micro)
Methods on how to bring "sectoral" tools together form a multi-sectoral perspective
Validation and standardisation of the different sectoral tools not fully complete
Questions on intervention design
What are the mechanisms, costs and impacts of the interventions involved?
-Evidence gaps relate to both single interventions and/or to packages of multiple interventions
How to increase the demand for nutritious foods?
-What is the potential to shape demand for nutritious foods?
-What are the cultural and market implications of changes in demand?
-How to reach most vulnerable target groups at scale?
How to increase the supply of nutritious foods?
-Can smallholders diversify, increase output of nutritious foods and develop reliable marketing channels?
-How to optimise decisions involving production, income, and the trade-offs involved in diversification?
How to optimise the flow of nutritious foods along the chain?
-In what contexts are standards useful and where are they a problem?
-What is the role of third-party quality assurance and certification?
Managing trade-offs
-Are strategic win-win outcomes possible for smallholders and consumers?
-How to monitor and influence household level trade-offs that mediate potential effects on nutrition and agriculture?
Equity and pro-poor considerations
-What are the pro-poor implications of specific interventions as well as the overall welfare impact of the approach?
-How to promote consumption of nutritious foods to target populations that may or may not be able to afford a healthy diet?
-What is the feasibility of targeting the poorest small-holders for intervention?
Do no harm?
What is the influence of value chain activities on the time spent by women caring for themselves and their children, farming, or preparing food?
Questions on evaluation methods
What methods are most appropriate to evaluate VCN interventions?
-How to link data on costs and effects with better understanding on mechanisms and complex pathways?
-What is the role of simulation and scenarios in terms of understanding complex systems?
How to measure performance within sectors?
-What are the priority indicators across the sectors?
How to measure aggregate performance across multiple sectors?
-What are appropriate aggregate measures of cost-effectiveness?

5.4.1 Examining timing and sequencing of potential effects

Understanding the lags and sequencing in the potential effects along the pathways is another important element to consider explicitly in terms of intervention design and evaluation. For example, short-term studies may choose to focus on capturing changes across the processes and more proximal outcomes along the agriculture-nutrition pathways, including for example: farming practices, production, sales, women's employment and role in household decisions, nutrition knowledge and feeding practices, through to consumption and diets. More distal outcomes, including food security, income, and nutrition and health status can also be measured but would likely be the primary focus of longer-term studies where there is also an increased likelihood of potential effects. In this context, process maps like those presented in this paper (Annex 1) also provide the basis for standardised frameworks to catalogue inputs, outputs and process indicators along the chain, the starting point for meaningful comparisons of cost-effectiveness.

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