

# A conceptual framework for understanding the impacts of agriculture and food system policies on nutrition and health

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**Abstract** Agriculture and food systems are important determinants of nutrition and consequent public health. However, an understanding of the links among agriculture, food systems, nutrition, public health and the associated policy levers, is relatively under-developed. A framework conceptualizing these key relationships, relevant to a range of country contexts, would help inform policymakers as to how agriculture and food policy could improve nutrition and public health, particularly in low- and middle-income countries (LMIC). The objectives of this paper are: to present a conceptual framework, relevant to a range of country contexts and focused on the policymaker as the user, which depicts the key relationships among agriculture, the food system, nutrition and public health; and to describe how the framework can be used for understanding the impacts of agriculture and food system policies on nutrition outcomes. Existing conceptual frameworks, highlighting the relationships among agriculture, the food system, nutrition and public health ( $n=37$ ) were identified, reviewed and categorized, based on the key themes they address. Building on this analysis and synthesis a conceptual

framework was developed that assists in identifying associated policy levers and their effects on elements of the framework. The end product is a conceptual framework that presents key domains linking agriculture and food systems to nutritional outcomes and public health. The framework is relevant to a range of contexts, for example low-, middle- and high-income settings; and to policymakers wishing to examine the potential direct and indirect impacts of agriculture and food system policies.

**Keywords** Agriculture · Food systems · Nutrition · Health · Conceptual framework

## Introduction

Agriculture and food systems are important determinants of nutrition and public health, and there is an urgent need for effective multi-sectorial policymaking in this area. Statistics suggest that the dual burden of malnutrition — whether ‘undernutrition’ as characterised by indicators relating to stunting (low height for age), micronutrient deficiencies or underweight, for example, or ‘overnutrition’, often characterized by overweight and obesity — is a key public health challenge affecting countries worldwide (Black et al. 2013; Burchi et al. 2011). Many have recognized the need for agriculture and food system policy and programme interventions to address nutrition (Gillespie and Margetts 2013; James et al. 2006; Ruel and Alderman 2013; World Health Organization 2004). Existing conceptual frameworks that attempt to define these relationships only capture parts of the integrated agriculture and food system and its connection to health and nutrition (Hawkes 2006; LSHTM and UKAID a; Pinstrup-Andersen and Watson II 2011).

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Many complexities of the integrated linkages between agriculture, food systems, nutrition and health have been described previously (Carmen Casanovas et al. 2013; Haddad 2013; Hawkes 2007b; Pinstrup-Andersen 2013; Webb and Kennedy 2014). These include bidirectional linkages (Dangour et al. 2012c) and differences between high- and low-income countries (Dangour et al. 2012a; Friel et al. 2009a) as well as between urban and rural settings (Burchi et al. 2011). Such complexities render the task of demonstrating impact on nutrition outcomes along pathways from agriculture to nutrition difficult (Herforth et al. 2012). For interventions that increase both production and consumption of animal protein, for example, the evidence of subsequent nutritional benefit is limited (Berti et al. 2004; Herforth et al. 2012; Leroy and Frongillo 2007; Ruel et al. 2001). Nonetheless, if an intervention is able to influence an underlying determinant of nutrition, it is likely to have the potential to fulfil some necessary condition (although perhaps not all sufficient conditions) for improvement in nutrition (Ruel et al. 2001).

In a review of the literature, Berti et al. (2004) found that it was difficult to assess the linkages between agricultural production and nutritional outcomes due to limitations in study design as well as the many forms of capital, such as financial and human, that may be affected during agricultural production, and thereby subsequently impact nutrition. For example, agricultural interventions may lead to an increase in agricultural-based household income, or to an increase in agricultural skills that may indirectly help people to improve their agricultural-based household income, or to both (Berti et al. 2004). Another difficulty with assessing the agriculture-nutrition relationship arises from the many factors, some fairly upstream or ‘distal’, that influence nutrition.

Despite and given these complexities, there is, as proposed by Herforth and colleagues (Herforth et al. 2012), “an urgent need to strengthen the understanding of how agricultural policies, projects, and investments can be designed and implemented to achieve nutrition goals.” Thus, there is a need for improved policy interventions to address nutrition. For instance, existing reviews of food related interventions to improve nutrition in low- and middle-income countries (LMIC) (Berti et al. 2004; Carmen Casanovas et al. 2013; Girard et al. 2012; Masset et al. 2012; Ruel and Alderman 2013; Weinberger 2013) reveal a focus on farm-level interventions for producer-consumers, while evidence for the effect of policy interventions that focus on the market pathway as a means to impact nutrition is comparatively limited (Dangour et al. 2013a; Haddad 2013; Pinstrup-Andersen 2013; Turner et al. 2013; Webb and Kennedy 2014).

Yet while many frameworks have been developed for describing or understanding relationships between agriculture and nutrition, they have often been oriented towards project design and implementation, or focus on sub-sections of the food system without adequate attention to bigger-picture

linkages which are frequently needed for consideration by policymakers. To our knowledge, no framework exists that conceptualizes the key relationships among agriculture, food systems, nutrition and public health for informing policymakers concerned with improving nutrition and health, particularly in LMIC. Therefore, our primary aim was to synthesize key aspects of existing frameworks to develop such a framework — one that would help policymakers visualize the complexity of the agriculture-food system picture, including: the potential complementarities and trade-offs that may arise with the implementation of policy interventions; different country income levels; and both urban and rural settings.

## Methods

Existing literature and conceptual frameworks, illustrating aspects of the relationships among agriculture, the food system and nutritional outcomes, were identified. To focus the literature review, “nutritional outcomes” were defined as the main forms of malnutrition, including: undernutrition in terms of total energy intake, micronutrient deficiencies or low-weight- or height-for-age and; overweight and obesity. “Agricultural and food policies” were defined as: domestic and international policies; and policy-related programmes, private and public, including trade policies, with some form of agriculture or food system impact. The frameworks ( $n=37$ ) were sourced between February and March 2014, grouped according to the specific issues they portrayed or were considered distinctive and were categorized into themes (Table 1). Those frameworks that could pertain to more than one theme were placed within the thematic category that was deemed most pertinent. Frameworks were classified in the following themes: ‘UNICEF conceptual framework’ (incorporating the ‘food consumption’, ‘care’ and ‘health’ impacts on nutrition) (FAO; UNICEF 2010; USAID 2013b); ‘trade policy’ (addressing the impacts of trade and agricultural policy) (Blouin et al. 2009; Friel et al. 2013; Walls et al. 2015); ‘food chain’ (addressing the short links through which agricultural products move from production through to consumption) (Dangour et al. 2012b; Hawkes 2006, 2007a; LSHTM and UKAID a; Pinstrup-Andersen 2012); ‘food price policy’ (addressing taxation and fiscal policies) (Dangour et al. 2013b; LSHTM and UKAID b); ‘farmers’ (addressing the ‘own-production’ agricultural pathway as distinct from the ‘market’ pathway, often conceptualized in such frameworks) (Dorward 2013a, b, c; Sundberg and Birk 2014); ‘macro-level’ (the big-picture frameworks) (Friel et al. 2009b; Hawkes and Ruel 2006; Olayiwola et al. 2004; Pinstrup-Andersen and Watson II 2011); ‘synthetic’ (frameworks incorporating various key elements described above) (Ecker and Breisinger 2012; Gillespie and Kadiyala 2012; Hawkes 2010; Hawkes et al. 2012; LSHTM and UKAID c) and ‘other’ (Pinstrup-Andersen 2011a, b; Popkin 2003; USAID 2013a).

**Table 1** Selected frameworks categorized by theme

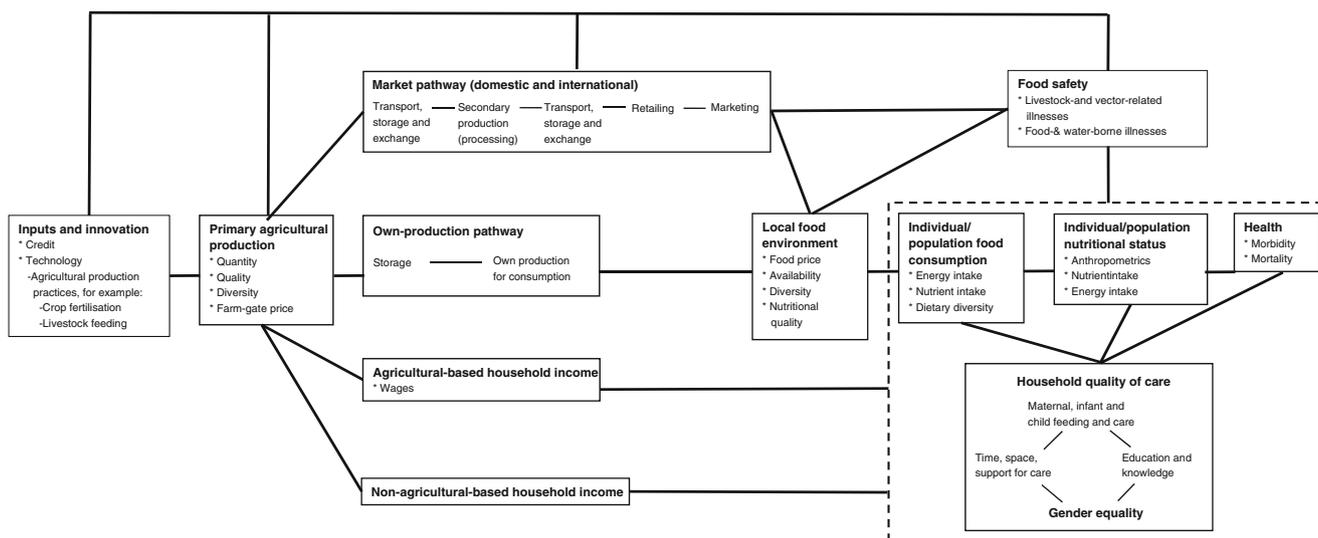
Theme	Framework (N=37)
UNICEF conceptual framework	<p><i>n</i>=3</p> <p>FAO. <i>Food insecurity and vulnerability information and mapping systems-FIVIMS framework of food security</i>. Retrieved 07/14, 2014 from <a href="http://www.fao.org/fileadmin/user_upload/fsn/docs/FIVIMS_Framework_of_Food_Security.pdf">http://www.fao.org/fileadmin/user_upload/fsn/docs/FIVIMS_Framework_of_Food_Security.pdf</a></p> <p>UNICEF. (2010). <i>UNICEF conceptual framework</i>. Retrieved 07/14, 2014 from <a href="http://www.unicef.org/nutrition/training/2.5/4.html">http://www.unicef.org/nutrition/training/2.5/4.html</a></p> <p>USAID. (2013b). <i>USAID nutrition strategy: 12/20/13 DRAFT</i>USAID.</p>
Trade policy	<p><i>n</i>=3</p> <p>Blouin, C., Chopra, M., &amp; van der Hoeven, R. (2009). Figure. Effect of trade policy on social determinants of health. From trade and social determinants of health. <i>The Lancet</i>, 373(9662), 502–507.</p> <p>Friel, S., Hattersley, L., Snowdon, W., Thow, A., Lobstein, T., Sanders, D. et al. (2013). Figure 1. Conceptual framework for the direct links between trade agreements, food environments, diets and obesity/non-communicable diseases outcomes. From Monitoring the impacts of trade agreements on food environments. <i>Obesity Reviews</i>, 14(S1), 120–134.</p> <p>Walls, H. L., Cornelsen, L., Friel, S., &amp; Smith, R. D. (2015). The impact of international food-related trade policy on nutrition and health: A systematic review. <i>Under Review</i></p>
Food chain	<p><i>n</i>=5</p> <p>Dangour, A. D., Diaz, Z., &amp; Sullivan, L. M. (2012b). Figure 1. Value chain approach to improve nutrition. From building global advocacy for nutrition: A review of the European and US landscapes. <i>Food &amp; Nutrition Bulletin</i>, 33(2), 92–98.</p> <p>Hawkes, C. (2006). Figure 2. The food supply chain: the bidirectional link between agriculture and diet-related chronic diseases. <i>Agricultural and food policy for cardiovascular health in latin america. Prevention and Control</i>, 2(3), 137–147</p> <p>Hawkes, C. (2007a). Figure 1. Conceptual framework — the relationship between agricultural policies and production practices and diet. From Promoting healthy diets and tackling obesity and diet-related chronic diseases: What are the agricultural policy levers? <i>Food &amp; Nutrition Bulletin</i>, 28(Supplement 2), 312S-322S.</p> <p>LSHTM, &amp; UKAID. (a). Figure. no title. from page 'value chains for improved nutrition.'. Retrieved 07/16, 2014 from <a href="https://ble.lshtm.ac.uk/pluginfile.php/20037/mod_resource/content/12/OER/PNO101/sessions/S1S12/PNO101_S1S12_050_020.html">https://ble.lshtm.ac.uk/pluginfile.php/20037/mod_resource/content/12/OER/PNO101/sessions/S1S12/PNO101_S1S12_050_020.html</a></p> <p>Pinstrup-Andersen, P. (2012). Figure 8. Illustrations of areas for health-sensitive policy interventions along the food value chain. From <i>food systems and human health and nutrition: An economic policy perspective with a focus on Africa</i>. Stanford University.</p>
Food price policy	<p><i>n</i>=2</p> <p>Dangour, A. D., Hawkesworth, S., Shankar, B., Watson, L., Srinivasan, C. S., Morgan, E. H. et al. (2013b). Figure 1. A conceptual framework linking food-price-related agricultural policies to food nutritional status and health. From can nutrition be promoted through agriculture-led food price policies? A systematic review. <i>BMJ Open</i>, 3(6)</p> <p>LSHTM, &amp; UKAID. (b). Figure. The complex linkages between agricultural policies, development and health. From page "drivers of the agriculture-nutrition pathways (cont)". Retrieved 07/16, 2014 from <a href="https://ble.lshtm.ac.uk/pluginfile.php/20037/mod_resource/content/12/OER/PNO101/sessions/S1S12/PNO101_S1S12_040_020.html">https://ble.lshtm.ac.uk/pluginfile.php/20037/mod_resource/content/12/OER/PNO101/sessions/S1S12/PNO101_S1S12_040_020.html</a></p>
Farmers	<p><i>n</i>=11</p> <p>Sundberg, S., &amp; Birx, L. (2014). <i>Bill and Melinda Gates Foundation learning session</i></p> <p>Dorward, A. (2013a). Figure 3. Agricultural development processes. From <i>How can agricultural interventions contribute in improving nutrition health and achieving the MDGs in least developed countries?</i> SOAS, University of London &amp; Leverhulme Centre for Integrative Research in Agriculture and Health.</p> <p>Dorward, A. (2013b). Figure 5. Market and own-production pathways for agricultural impacts on nutrition. From <i>How can agricultural interventions contribute in improving nutrition health and achieving the MDGs in least developed countries?</i>SOAS, University of London &amp; Leverhulme Centre for Integrative Research in Agriculture and Health.</p> <p>Dorward, A. (2013c). Figure 6. overlaps between development, market and own-production pathways for agricultural impacts on nutrition. From <i>How can agricultural interventions contribute in improving nutrition health and achieving the MDGs in least developed countries?</i>SOAS, University of London &amp; Leverhulme Centre for Integrative Research in Agriculture and Health.</p>
Macro-level	<p><i>n</i>=4</p> <p>Friel, S., Dangour, A. D., Garnett, T., Lock, K., Chalabi, Z., Roberts, I. et al. (2009b). Figure 2. Processes in the food and agriculture system that lead to greenhouse-gas emissions and population health outcomes. From public health benefits of strategies to reduce greenhouse-gas emissions: Food and agriculture. <i>The Lancet</i>,</p>

**Table 1** (continued)

Theme	Framework (N=37)
	374(9706), 2016–2025.
	Hawkes, C., & Ruel, M. (2006). Figure 1. Conceptual framework of the links between agriculture and health. From the links between agriculture and health: An intersectoral opportunity to improve the health and livelihoods of the poor. <i>Bulletin of the World Health Organization</i> , 84(12), 984–990.
	Olayiwola, K., Soyibo, A., & Atinmo, T. (2004). Figure 1. Linkages between globalization, food consumption, health and nutrition. From impact of globalization on food consumption, health and nutrition in Nigeria. <i>Globalization of Food Systems in Developing Countries: Impact on Food Security and Nutrition</i> , 83, 99–118.
	Pinstrup-Andersen, P., & Watson II, D. D. (2011). Figure 1.1. A conceptual framework of a food system. From <i>Food policy for developing countries: The role of government in global, national and local food systems</i> . (1st ed.) Cornell University Press.
Synthetic	n=5
	Ecker, O., & Breisinger, C. (2012). <i>Figure 2.1 overview of the FNS system</i> . From <i>The food security system A new conceptual framework</i> No. IFPRI Discussion Paper 01166)
	Gillespie, S., & Kadiyala, S. (2012). Figure 1. Mapping the agriculture–nutrition disconnect in India. From chapter 20. Exploring the Agriculture–Nutrition disconnect in India. In S. Fan, & R. Pandya-Lorch (Eds.), <i>Reshaping agriculture for nutrition and health</i> (pp. 176) International Food Policy Research Institute (IFPRI).
	Hawkes, C. (2010). Figure 3.1 A conceptual framework for the link between trade liberalisation and diet. From ‘The influence of trade liberalisation and global dietary change: the case of vegetable oils, meats and highly processed foods’. In C. Hawkes, C. Blouin, S. Henson, N. Drager & L. Dube (Eds.), <i>Trade, food, diet and health: Perspectives and policy options</i> (1 ed.) (pp. 37)Wiley-Blackwell.
	Hawkes, C., Tumer, R., & Waage, J. (2012). <i>Figure 1. the conceptual framework. from current and planned research on agriculture for improved nutrition: A mapping and a gap analysis. A report for DFID</i> .
	LSHTM, & UKAID. (c). <i>Untitled figure</i> . From page “What are the pathways linking food production to nutrition outcomes?”. Retrieved 07/16, 2014 from <a href="https://ble.lshtm.ac.uk/pluginfile.php/20037/mod_resource/content/12/OER/PNO101/sessions/S1S12/PNO101_S1S12_030_020.html">https://ble.lshtm.ac.uk/pluginfile.php/20037/mod_resource/content/12/OER/PNO101/sessions/S1S12/PNO101_S1S12_030_020.html</a>
Other	n=4
	Pinstrup-Andersen, P. (2011a). <i>Figure 4. Interactions between food systems and human health and nutrition</i> . From <i>Food systems and human health and nutrition: An economic policy perspective with a focus on Africa</i> Center on Food Security and the Environment, Stanford University.
	Pinstrup-Andersen, P. (2011b). <i>Figure 7. A simplified conceptual framework linking food availability, food security, health and nutrition</i> . From <i>Food systems and human health and nutrition: An economic policy perspective with a focus on Africa</i> . Center on Food Security and the Environment, Stanford University:
	Popkin, B. M. (2003). Figure 1. Stages of the nutrition transition. From the nutrition transition in the developing world. <i>Development Policy Review</i> , 21(5–6), 581–597.
	USAID. (2013a). <i>Framework. Draft USAID nutrition strategy results framework</i> . From <i>draft USAID NUTRITION STRATEGY: 2014-2025</i> USAID.

These classifications guided decision on all the main themes defined by boxes or domains we included in the framework, and the relationships between them. The domains included in the framework are: “Inputs and innovation;” “Primary agricultural production;” “Market pathway;” “Own-production pathway;” “Agricultural-based household income;” “Non-agricultural-based household income;” “Local food environment;” “Food safety;” “Individual/population food consumption;” “Individual/population nutritional status;” “Household quality of care;” and “Health.” Specifically, we used these existing frameworks (Table 1) to develop a more comprehensive framework (Fig. 1) with the key themes represented and linked through the domains with the clearest depiction deemed possible. In doing so, the need for

conceptualising a globally-relevant framework, which incorporates key pathways that have more direct influences on health and nutrition was recognised. Important elements of the relationships presented in the existing frameworks include: the ‘market pathway’, which includes food processing, packaging and transport, and the ‘own production’ pathway; and separate income pathways for either non-agricultural or agricultural-based income. The UNICEF conceptual framework for nutrition, which includes the contributions of food consumption, care (e.g., women’s time in the face of their role in agricultural production and innovation) and health (e.g., foodborne diseases and aflatoxins) to nutrition (UNICEF 2010), was also fundamental to informing the structure of our framework as the



**Fig. 1** Conceptual framework of the links between agriculture, the food system, nutrition and public health. Note that we have not included other important influences acting at multiple points across the framework,

including, but not limited to: culture; gender and gender inequality; weather and climate variability; political and economic circumstances

key themes of ‘gender’ and ‘household quality of care’ are strongly related to both household agricultural activities as well as dietary intake.

The framework could not include all influences on how agriculture, the food system, nutrition and public health are interconnected, some of which affect multiple points across the framework (see Fig. 1-caption). Examples of such influences include: weather and climate variability; political and economic influences, including government revenue and expenditure; and cultural influences including those shaping food preferences. Gender is another key influence across the framework. For example, women’s time, energy and decision-making power relate to both agricultural production and household income (agricultural and non-agricultural based) and thus are inextricably linked to the nutrition and health status of a household. Gender is specifically referenced in the household quality of care domain of the framework because this is a key pathway affecting nutrition, as per the UNICEF conceptual framework described earlier. The role and impact of female empowerment is deeply rooted within the household where decision-making occurs around food acquisitions, income, and dietary sources.

The development of the framework involved an iterative process of drafting and modification, including the ‘running’ of policies through the map to see if the links depicted made sense in terms of whether one could meaningfully connect a policy in one area of the framework through to nutrition and health. While nutritional considerations often differ by population sub-groups, we designed this framework to be applicable to aggregate populations, such as for people of different ages, and both sexes.

## Results

The framework developed conceptualizes the key influences of agriculture and food systems on nutrition and public health, while remaining relevant to a range of contexts (e.g., countries with different income levels and rural and urban settings). The framework is also likely to be applicable to many policies related to agriculture, food systems, nutrition or public health and addresses how agriculture and food system policies in the areas of: inputs and innovation; primary agricultural production; market pathway; own-production pathway; trade; food safety; and the local food environment, for example, may impact the relationships among agriculture, food systems, nutrition and public health (Fig. 1). Consequently, the framework includes the main aspects of how the food system is likely to link with nutrition and was designed as a guide for use by policymakers. Therefore, the framework does not include in the illustration itself the complexities of each aspect of the food system or context-specific elements. The various domains of the framework are positioned such that more distal factors affecting nutrition are on the left hand side of the framework. On the right hand side of the framework are domains and factors more proximate to the plate or mouth (e.g., “Local food environment”) and the nutrition of the particular individual or population. Also, as one moves from ‘top’ to ‘bottom’ on the framework the domains shift towards encompassing more local factors that may affect dietary intake (e.g., from ‘food safety’ to ‘household income’ or ‘household quality of care’).

The framework does not include arrows, as the influence of a policy can work in both directions along these pathways. For instance, a trade policy that increases the import of certain

foods may affect both the food environment and local agricultural production. The framework also shows that there are likely to be many factors that are influenced by any one policy. Therefore, indicators should be developed or existing indicators should be utilized for the assessment of these key factors when evaluating policy implementation. For example, government support to increase cereal production at the farm gate through agricultural research and extension investments and input subsidies will increase cereal production and income. As a result of an increase in income, farmers may be able to buy more food (and non-food products) in the market which, in the case of food, could be nutritious or not depending on the quality of what is available. At the same time, increased cereal production will likely mean that cereals will be available to the consumer at a lower price, perhaps lower than that of fruits and vegetables. Furthermore, with new agricultural policies related to cereal production that promote the prospect of higher yields and subsidies, farmers may decide to produce more cereal and possibly less vegetables and fruits, which would raise the prices of these more nutrient-rich agricultural products. Thus, whilst food would be more affordable for poor communities, the affordable foods may be biased towards cereals, and away from more nutrient-rich products, because of the relatively cheap price of cereals.

### How to use the conceptual framework for policy

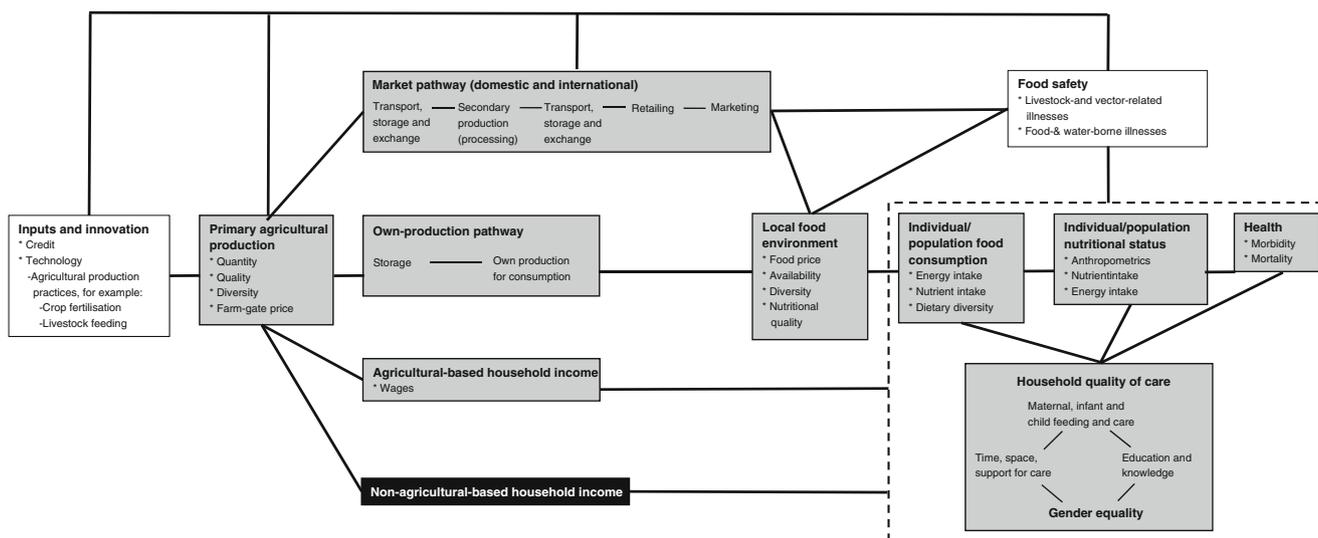
The framework is a visual tool designed to assist the understanding of how a given policy may affect agriculture, food systems, nutrition and public health. It can be used not just for tracking through a policy of interest, but also to help identify new policy areas and strategies. To use the framework we suggest the following three steps: first, identify and consider the specific policy initiative(s) of interest. Second, identify the likely entry point (i.e., starting domain) on the conceptual framework that corresponds to where the chosen policy will likely have the most immediate impact. For example, a policy that would lead to the introduction of a new crop variety would start in the “inputs and innovation” domain on the framework, while a policy to implement a conditional cash transfer program would start in the “non-agricultural-based household income” domain. Third, identify through the linked pathways within the conceptual framework how to move from the selected starting point to the outcome of interest (e.g., nutrition or health) and consider direct and indirect effects on other aspects of the system.

Figure 2 provides an example of how one might use the conceptual framework to visualize and understand the direct and indirect impacts of a policy - in this instance the effect a conditional cash transfer program may have on agriculture, food systems, nutrition and health. As such a program is a source of non-agricultural-based household income one would start from this domain on the framework to assess the

subsequent impacts of the policy. There are two main directions in which a conditional cash transfer program could have a substantial impact. In one direction, households directly involved in agriculture may use the extra income to support primary agricultural production, such as through purchasing more seed. This may lead to agricultural products that either flow into the market pathway or are used for the household’s own consumption. The impact purchases of increased seed may have on nutrition is affected by a large number of decisions on the part of the family or household making those decisions, as well as on the health, nutritional and livelihood status and stability of the household. Thus, the bidirectional linkages between the “primary agricultural production”, “agricultural-based household income,” and the “household quality of care” domains become evident because household dynamics and knowledge may affect not only how the cash transfer is utilized in terms of primary agricultural production, but also how both the agricultural-based household income as well as the agricultural products are then directly utilized by the household. Both agricultural-based household income and primary agricultural production will potentially impact dietary intake through the “local food environment” domain, either through the direct consumption of these agricultural products illustrated by the “own-production pathway” domain or through the purchase of greater amounts of foodstuffs in the “local food environment.” In the other direction, greater income as a result of a conditional cash transfer program that requires maternal and child health education, regardless of the agricultural involvement of the household, may lead to improved quality of care and diet in the household, that in turn affect nutritional status.

### Discussion

Our framework builds upon previously published frameworks to provide a globally relevant conceptualisation of the key linkages among agriculture, food systems, nutrition and health. The framework is intended as a tool for use by policymakers for the identification of agriculture and food system solutions to address issues in nutrition and public health. As a result, we have left the framework without directional arrows, so that policymakers are free to decide where, in the framework, to place their policy intervention and in what direction its effects may move within the framework. We believe such flexibility is of relevance to practice in that it allows for a better understanding of policy impacts, without assuming interest in any one direction. For example, *Bolsa Familia*, a conditional cash transfer program in Brazil, provides non-agricultural-based household income with the primary outcome of improving maternal and child health and nutrition; however, this income could also improve nutrition by various other pathways, including through the purchase of seed for agricultural production that is consumed by the targeted



**Fig. 2** Conceptual framework of the links between agriculture, the food system, nutrition and public health. An example of a public distribution system policy, a conditional cash transfer program, and the direct and indirect impacts of that policy on agriculture, the food system, nutrition and public health (*Black box with white text indicates ‘starting point’ for a conditional cash transfer policy. Grey boxes indicate where a conditional*

*cash transfer policy would likely have direct impacts, while the boxes in white are where a conditional cash transfer policy may have indirect impacts*). Note that we have not included other important influences acting at multiple points across the framework, including, but not limited to: culture; gender and gender inequality; weather and climate variability; political and economic circumstances

household (Rocha 2009). Another example is Brazil’s National School Meals Program (PNAE, its acronym in Portuguese) that also aims to improve child nutrition by requiring locally-sourced agricultural products (Rocha 2009; Sidaner et al. 2013). Thus, there is an inherent feedback loop among nutritional status and agricultural inputs and innovation that interacts through various linkages presented in our framework between these two domains. These programs highlight the multiple and sometimes bidirectional nature of effects within agriculture, food systems, nutrition and public health.

Most agriculture and food system policies would have direct as well as indirect impacts, both positive and negative, on many (if not all) other aspects of agriculture, food systems, nutrition and public health. We encourage the consideration of this bigger picture. For example, the selected policy could be taxation on unhealthy foods – a ‘fat tax’ - that starts in the ‘local food environment’ domain on the framework (with its most immediate impact on food price), but has impacts and thus outcomes on nutrition and public health and primary agricultural production. A ‘fat tax’ could also, perhaps more indirectly, affect the livestock and food processing industry.

Our framework also endeavors to distill some of the complexities regarding the pathways of production, relevant in different country and rural/urban contexts, by illustrating the two different key production pathways, the ‘market pathway’ and ‘own-production pathway,’ from which agricultural production may be consumed. Furthermore, as households are often collective units, consisting of family members of both sexes and various ages, and income in rural areas is often and

increasingly derived from a mixture of both agricultural and non-agricultural sources, we see our framework as important for better understanding how policies implemented at any level of governance may affect different types of households or people.

However, a framework designed to take into account people of all ages, sexes, and residential areas (urban and rural) may be seen as both a strength and limitation of our work. Many existing published frameworks illustrating similar relationships target sub-populations or vulnerable groups (e.g., women of reproductive age, young children, rural smallholder farmers), where it may be easier to visualize and thus understand how specific vulnerable groups may be disproportionately affected by an agricultural or food system policy. Yet, Burchi et al. (2011) aptly state that while many strategies to improve nutrition have focused on rural areas, strategies to improve nutrition in urban areas are limited, but their importance is increasing as urbanization continues with a concomitant need for urban agriculture (Burchi et al. 2011). It is important to note that as food systems are becoming increasingly globalized, the differences in these linkages between high- and low-income countries as well as urban and rural areas within a country may decrease. Furthermore, we did not exclude pathways, domains, or indicators of the domains that may be difficult to measure in practice. In LMIC especially it may be difficult to attain more than anthropomorphic measurements to assess nutritional status, for example. We are aware that, in the utilization of our conceptual framework within different countries and contexts, there will be different

challenges. Furthermore, for example, both time and gender roles – factors addressed in the framework under ‘household quality of care’ - are also influential on other aspects of the framework, yet both are also challenging to measure. Lastly, the location of the domains within the framework, in terms of their ‘distal’ or ‘proximate’ distance to nutritional outcomes, should not be interpreted as the degree of their importance as a focus for policy intervention. The distal or more structural determinants often shape the context for the more proximate domains, with the proximate influences not necessarily the most important in terms of their influence on nutrition.

The framework highlights the need to examine the quantity and quality of evidence in the published literature for the linkages depicted. Population of the framework with policy interventions appropriate to the various linkages or ‘mapping’ existing evidence and case studies across the framework would help reveal gaps in policy activity. The framework may serve as a tool for policymaking and also as a tool that provides a theoretical basis to guide multi-disciplinary research design addressing the influence of agriculture and food system policies on nutrition and public health. In starting with a policy of interest, the user may recognize that the policy under consideration is interlinked with policies that come under the purview of other ministries or sectors that should also be considered in any subsequent implementation of the original policy. Thus, the framework can be used as a tool to track a policy of interest through the various linkages suggested, and also to help identify other areas or sectors relevant to the policy and its impact on nutrition. However, whilst the framework can be used as a tool to visualize the ‘bigger picture’ and identify policy alternatives, it does not help one choose between policy alternatives or prioritize actions related to agriculture and food systems for nutrition outcomes, and thus is not suitable when deciding between alternatives for context-specific policy or programmatic action. In conclusion, we hope that the developed framework will help to shift the focus away from the problems of nutrition and health to the identification and development of effective agriculture and food system policy solutions, through helping with the conceptualization of the ‘big picture’ and highlighting both the complementarities and trade-offs in nutrition that often occur with the implementation of agriculture and food systems-related policies.

## Conclusion

There is an identified need to better understand the linkages among agriculture, food systems, nutrition and health along with the associated policy levers. To address this knowledge gap, this paper presents a conceptual framework that depicts pathways from agriculture and food systems to nutrition and health. Aimed at a wide breadth of policymakers, it is the users

who in utilizing the framework for the identification and development of agricultural and food system policies to improve nutrition will provide their own depth to the framework. Ideally, the framework will serve as a guide to help address some of the complexities in the design of agriculture and food system policies and programmatic actions to improve nutrition.

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