Ghana

POLICY ATLAS ON FOOD AND NUTRITION SECURITY

Wim Marivoet
John M. Ulimwengu
Leysa Maty Sall

VOICE FOR CHANGE PARTNERSHIP (V4CP)

The Voice for Change Partnership (V4CP) is a multisectoral programme funded by the Dutch Ministry of Foreign Affairs (DGIS), operated jointly by the Netherlands Development Organization (SNV) and the International Food Policy Research Institute (IFPRI), and implemented in six countries: Burkina Faso, Ghana, Honduras, Indonesia, Kenya and Rwanda. The V4CP supports advocacy by Civil Society Organizations (CSOs) in order to influence policies and decisions. By enhancing CSO capacities in leadership, knowledge development, advocacy skills, and organizational sustainability, CSOs are empowered to speak with a greater voice. The V4CP trains CSO members to use research evidence, data and case studies to back up their advocacy strategies. The V4CP tackles four issues—food and nutrition security, resilience, renewable energy, and water, sanitation and hygiene (WASH)—while addressing gender imbalance and climate change mitigation. By collaborating with national and international partners, different levels of government, and the private sector, CSOs contribute to improving the “enabling environment”. Strengthening the voice of CSOs in policy creation and the implementation of services ensures that the interests of communities represented by CSOs are better served.

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Chapter 1

FROM RESOURCES TO POLICYMAKING: A GEOGRAPHICALLY DISAGGREGATED JOURNEY

1.1. MAPS AS POWERFUL TOOLS FOR ADVOCACY

A popular saying states that “a picture is worth a thousand words.” Maps are pictures of our world and its conditions. They illustrate how conditions in one area relate to neighbouring areas. Maps can display political boundaries, roads, population, health status, climate conditions, natural resources, poverty, education rates, or economic activities such as crop production. They illustrate information about locations, show spatial patterns, and can be used to compare patterns between different physical characteristics or social phenomena.

Because maps help us understand the **spatial relationships** of different phenomena or conditions, they are useful for understanding where to target our attention and to set priorities accordingly. Since maps can interact with various types of data, they help us design more targeted and comprehensive programs by illustrating where needs are most severe, which bottlenecks hinder progress, and how different challenges relate geographically to one another. To inform time-constrained policymakers, maps can be powerful tools to single out a particular issue and what it takes to address it, in a concise and attractive way.

The maps in this policy atlas use data and statistics on agriculture, storage and processing infrastructure, and nutrition to consider geographically-sensitive strategies to improve **food and nutrition security (FNS)**. They offer a one-time snapshot of realities that are constantly evolving and thus subject to change when events occur or more accurate data become available. In this respect, the various waves of decentralisation in Ghana are worth mentioning. Since 1988 the country not only has increasingly devolved central administrative authority to the district level, this process also coincided with a gradual subdivision into new and smaller administrative entities for both regions and districts. Since February 2019, Ghana counts 16 regions and 216 districts. Most household survey data and statistics however are only representative for the 10 regions or 110/138/170 districts from earlier demarcations. For the latest maps, please consult the ReSAKSS eAtlas country webpage of Ghana (eatlas.resakss.org/Ghana/en), which also provides spatial data and maps beyond those covered in this report.

Box 1.1. Limitations of a spatial approach

Geographic representations can be misleading because surface areas do not necessarily equate with population numbers—especially when comparing vast yet scarcely populated areas with small densely urban settlements. Rural areas typically dominate maps, while densely-populated urban centres may appear insignificant despite their significance for large numbers of people. In a similar vein, maps often only display averages for a given administrative unit—such as a district or region—thereby ignoring dispersion or inequality within that unit. For these reasons, the spatial approach is but one of several methods to construct an appropriate level of information to inform policy decisions.

1.2. CIVIL SOCIETY ORGANISATIONS WORKING UNDER V4CP IN GHANA

The CSOs working under V4CP in Ghana represent the interests of various groups and communities such as smallholder farmers, food processors, entrepreneurs, development and environmental groups. By fostering collaboration among CSOs and relevant stakeholders, CSOs influence agenda-setting and hold the government and private sector accountable for their promises and actions. The V4CP Programme in Ghana focuses on three thematic areas: food and nutrition security, water, sanitation and hygiene, and renewable energy. This policy atlas mainly provides evidence to support the advocacy agenda of CSOs working on the first thematic area.

Under food and nutrition security, the CSOs’ main advocacy goal is to reduce the level of post-harvest losses (PHL) in the country and to improve food safety and sustainable nutrition for all. The following five CSOs operate under this thematic area: Grameen Ghana (GRAMEEN), Ghana Trade and Livelihood Coalition (GTLC), Northern Development Society (NORDESO), Peasant Farmers Association of Ghana (PFAG), and Shea Network Ghana (SNG).

Box 1.2. provides a short description of each CSO with their main geographic target zones.

Box 1.2. Description and target districts of CSOs under V4CP Programme

Grameen Ghana (GRAMEEN)

is a local non-governmental organization operating in Ghana since 2001. The organization's vision is to be a leading provider of social and economic empowerment services to poor people in Northern Ghana. The organization employs a human rights based approach to mobilize and strengthen capacities of disadvantaged groups to demand their rights in the areas of food and nutrition security, education, and water and sanitation.

Northern Development Society (NORDESO) is a local not-for-profit organization formed in 2003 with headquarters in Tamale (Ghana). Its mission is to advocate for improved food security and decent livelihoods for the vulnerable people in northern Ghana. NORDESO adopts a participatory community engagement approach to create space for dialogue and collective analysis of issues including agricultural productivity, climate change adaptation, and health education and promotion.

Shea Network Ghana (SNG) is a 200-member base organization of shea sector businesses, stakeholders and value chain actors. It seeks to advocate for sector policies, improve cooperative action among women, strengthen the value chain and create market opportunities for all actors involved, especially rural women. Particular attention is devoted to quality processing, health issues, food safety, social inclusion, and food and nutrition security. SNG partners with the V4CP programme in the East Gonja district of the Northern Region.

Ghana Trade and Livelihood Coalition (GTLC)

is a membership and advocacy organization active in all administrative regions of Ghana. It has broad experience in conducting evidence-based advocacy campaigns on national and international trade policies, national agriculture and nutrition policies as well as agriculture budget analysis. GTLC partners with the V4CP programme in the Wa West district of the Upper West Region and in Talensi district of the Upper East Region.

Peasant Farmers Association of Ghana (PFAG)

is a non-governmental organization with the mandate to advocate for pro-poor agricultural and trade policies as well as other issues affecting the livelihood of smallholder farmers. PFAG pursues its mandate by promoting a conducive environment for the growth and development of its members. This involves various activities, such as advocacy, organizational and technical capacity building, information and knowledge management, and entrepreneurship and business development.

1.3. OBJECTIVE AND OVERVIEW

This policy atlas utilises maps to investigate **how nutrition, agriculture and PHL interventions could most effectively be targeted** in Ghana. Future CSO advocacy strategies could be strengthened and enriched with spatial information that indicates *where* policy efforts would be most effective, addressing bottlenecks faced by the most deprived communities, reducing disparities, or helping zones meet their full potential.

The conceptual framework used in this policy atlas is based on the sequential pillars of food and nutrition security (FNS), typically labelled as **availability, access and utilisation**. For people to “have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 1996), the **constraints** linked to each pillar should be eliminated or adequately addressed. Figure 1.1. illustrates the sequential or hierarchical nature of these constraints, all having an impact on final nutritional outcomes. To improve nutrition, a population should first be able to produce enough food, which is contingent upon the level of agricultural potential combined with production constraints faced by farmers. Whereas biophysical constraints (such as rainfall, temperature and soil types) determine agricultural potential, *production constraints* refer to all sorts of suboptimal farming inputs and technologies (such as inferior seeds, or lack of agricultural extension). Next, households should be able to acquire diverse food items, which depends on the amount and variety of food produced along with various *access constraints*, such as low-quality transportation and storage infrastructure or economic constraints like limited purchasing power or trade restrictions. Once households acquire food, food must be properly prepared and allocated to each family member, and consumed in hygienic and healthy conditions—which are all various types of *utilisation constraints*.

Figure 1.1. Overall framework and conceptual location of each chapter

Source: Authors.

Each chapter of this policy atlas focuses on a different conceptual part within the overall framework. Chapter 2 evaluates the degree of constraints at Ghana’s district level along the full FNS pathway by comparing actual data on local agricultural potential, food production, food acquisition and nutrition status. Chapter 3 explores the regional bottlenecks faced by households in Ghana to acquire enough healthy food. By focusing on nutrients essential for human health, this chapter identifies target regions and foods for improving either agricultural production, market integration, post-harvest handling, or household food budget allocation. Chapter 4 presents an inventory of recent investments in storage and processing infrastructure in 50 districts in Northern Ghana, and links that information to statistics on local agricultural production and PHL. Chapter 5 summarises the overall findings and how they should inform policymaking in Ghana.

At the end of each chapter, we provide a short advocacy note with key messages that indicate how findings could best guide future policies. Throughout the policy atlas, explanatory boxes, key word lists and infographics contextualize each chapter.

Chapter 2

COMPREHENSIVE TYPOLOGY FOR FOOD AND NUTRITION SECURITY INTERVENTIONS

2.1. INTRODUCTION

This chapter presents a comprehensive **typology** to identify possible food and nutrition security (FNS) interventions in Ghana. We start by identifying the regions and districts of Ghana with the poorest nutritional outcomes. In the following sections, we apply the typology to explore interventions that could improve outcomes by comparing four indicators within each district: *agricultural potential*, *food production*, *food acquisition* and *nutrition outcomes*. By comparing these indicators, we identify the districts that could benefit most from efficiency improvements in *production*, *access* or *utilisation*. This chapter ends by offering policy recommendations and illuminates how geographically-specific analysis can guide the design of FNS interventions.

Figure 2.1. presents the **spatial distribution** of chronic malnutrition among children below the age of 5 years (left-hand side map) and anaemia among woman of reproductive age (right-hand side map) in Ghana in 2014.

Figure 2.1. Prevalence of stunting among children (<5 years) and anaemia among women (15-49 years) in Ghana (2014)

Source: Authors with data from DHS (2014).

With an average national stunting level below 19%, Ghana is performing relatively well compared to many other African countries (DHS 2014). However, as shown in the left-hand side map of Figure 2.1., important spatial variations exist: whereas chronic malnutrition affects more than 25% of all children in the Northern and the Volta-Savannah regions, the Eastern-Savannah region is doing markedly better with a prevalence rate below 10%. This being said, and except for increased obesity, currently, the real challenge of malnutrition in Ghana is related to micronutrient deficiencies, particularly iron deficiency. Indeed, more than 42% of women at reproductive age suffer from some form of anaemia, which results from inadequate intake of iron, malaria and intestinal worm infestation, leading to increased health

Key Words

Typology a reduction of real-world complexity to types; classification

Spatial Distribution the study of phenomena and their physical locations; the graphic display of that information

Spatial Resolution the number of pixels used to create an image (e.g. of the earth's surface). A higher number (of smaller) pixels shows more resolution and definition; fewer, larger pixels shows less

Remote Sensing scanning the earth from high altitude (i.e. satellite) to gather information

Spatial Heterogeneity the uneven distribution of a trait across regions

Conceptual Framework the way ideas are organized; a structure used to relate different concepts and show their orientation toward a shared goal

Transaction Costs costs associated with the exchange of goods/services across time, place and markets, but distinct from the actual production cost

Indicator a measurable unit that serves as a gauge or symbol to indicate the condition of something

Scatterplot a data visualization that shows the relationship between two variables. It uses dots to represent numeric values (one variable plotted along the x-axis, and the other along the y-axis)

Absolute benchmark is based on an exact target

Relative benchmarks compare entities' performance to each other

risks for mother and fetus. In addition to higher prevalence rates, anaemia among women varies considerably across districts, as shown in the right-hand side map of Figure 2.1. Scattered from north to south, the most affected districts are Gushiegu, Nkwanta, Afram Plains and Gomaa, with anaemia rates well above 65%. Somewhat less affected but still very problematic are two clusters of districts located in the Northern and Western regions, with a prevalence of anaemia between 50% and 65%. On the other hand, the districts of Sunyani and Berekum in the Brong Ahafo-forest region perform much better as less than one fifth of all women at reproductive age seems to suffer from anaemia. To address differences in nutrition status across the country, it is thus important to design policy interventions that account for **spatial heterogeneity**.

2.2. CONCEPTUAL FRAMEWORK

To guide policies and programs that address food and nutrition insecurity throughout the country, it is helpful to consider the pathway from agricultural potential to nutrition status. The **conceptual framework** laid out in Figure 2.2. shows four dimensions of FNS. The dimensions flow chronologically with each step facing constraints. For example, with respect to food production, farmers need access to land, knowledge, credit, seeds and fertilizer to be able to tap into the agricultural potential of their land. Further down the chain, even if food is sufficiently produced, families might be constrained due to all sorts of **transaction costs**, such as trade barriers or poor transportation infrastructure that results in higher local prices. Nutrition outcomes could also be affected by utilisation constraints such as lack of food safety or culinary habits, intra-household allocations, or health and sanitation conditions.

Figure 2.2. Conceptual pathway from agricultural potential to nutrition outcomes

Source: Authors adapted from Pangaribowo et al. (2013).

By assigning one **indicator** for each of the four sequential FNS dimensions (see the green boxes in Figure 2.2.), the typology helps point out where and which type of intervention would be most effective at improving the nutrition status of the Ghana population. The typology classifies each district's efficiency at transforming:

- (i) agricultural potential into food production (*production efficiency*)
- (ii) food production into food acquisition (*access efficiency*)
- (iii) food acquisition into nutrition outcomes (*utilisation efficiency*).

To estimate these three efficiency types, we create a diagram that links all the indicators. The diagram (see Figure 2.3.) displays each indicator on a different axis, thus creating a four-dimensional diagram. Starting from the axis measuring agricultural potential (top vertical axis), this diagram should be read clock-wise. The upper-right panel describes the relationship between agricultural potential and food production. In this panel, the diagonal line of average efficiency indicates the level of food production one can *expect* based on each area's agricultural potential. In a similar vein, the diagonal of *access efficiency* (lower-right panel) reflects the *expected* levels of food acquisition based on a district's level of food production. Finally, *utilisation efficiency* (lower-left panel)

represents the *expected* levels of nutrition status for every level of food acquisition. These three efficiencies compare districts in Ghana to each other, which means the *expected levels* are all based on a *relative comparison to the other districts*.

By drawing a “fork” around the lines of average efficiency, we can define three levels of efficiency: above average, below average and average. When data observations fall *within* the “fork”, efficiency is average. For example, for districts (represented by dots) that fall within the “fork” of production efficiency (upper-right panel), the level of food production is roughly what you would expect based on their agricultural potential (that is under prevailing average production constraints characterizing the country). However, when data observations fall outside this “fork” range, food production performance is either worse or better than what is (on average) observed throughout the country. In this way, we classify districts that perform better than 125% of the country average as “above average” (represented by the white space in the quadrants in Figure 2.3.). We classify districts that perform worse than 75% of the country average as “below average” (dark grey space); and “average” districts fall within the 75-125% “fork” range (light grey space). The same relative benchmarking of “above average”, “below average” and “average” applies to *access efficiency* (lower-right panel) and *utilisation efficiency* (lower-left panel).

Figure 2.3. Combined diagram of FNS dimensions

Notes: LPr, MPr, HPr respectively stand for low-, medium- and high-priority nutrition areas; Ag and nAg refer to higher (Ag) and lower (nAg) agricultural potential; HiPerf stands for high-performance areas. “Povline” refers to poverty line.

Source: Authors.

The upper-left panel in Figure 2.3. shows poverty lines for low-, medium-, and high-priority nutrition areas. In addition, the upper-left panel distinguishes between areas with higher and lower agricultural opportunities.¹ Based on these definitions, there are seven intervention types, which emerge by combining the three priority levels—High Priority area (HPr), Medium Priority area (MPr), and Low Priority area (LPr)—and two levels of agricultural potential—either higher agricultural potential (Ag) or lower potential (nAg).² Within the category of “low priority areas with higher agricultural potential (LPr-Ag),” one can further classify areas as “high-performance (HiPerf)” when their overall efficiency level is higher than 125% of the country’s average. These areas could serve as examples to others and may not be suitable for an FNS intervention since they already perform well in converting agricultural potential in nutrition outcomes.

¹ This distinction is based on the level of agricultural potential which corresponds with the intersection of the upper-bound poverty line and the line representing 125% of the average efficiency between potential and nutrition. This means that areas with an agricultural potential below this threshold will not reach a nutritional status above the upper-bound poverty line, unless they perform better than 125% of what is, on average, observed in the country.

² These types are much inspired by the work of Torero (2014).

Combining all information, the four-dimensional diagram underneath this typology depicts two sorts of benchmarking:

- 1) The upper-left panel applies an **absolute benchmark** to show the *level of nutrition-poverty urgency*. This panel also identifies whether a *focus on agricultural production* is warranted;
- 2) The other three panels apply **relative benchmarking** by comparing each district's performance with expected outcomes while roughly detailing where, along the pathway from agricultural potential to nutrition status, the biggest gains can be realised in terms of reducing production, access, or utilisation constraints.

Box 2.1. Typology examples

This box discusses the typology profile of two fictitious regions, R1 and R2, capturing data observations for various dimensions in Figure 2.3. Each region is represented by four data points, according to its values for each of the four dimensions. The precise location of data points within each of the panels thus characterises the region. The upper-left panel defines the priority level, with darker colours (green or red) indicating higher urgency, while the other panels provide insight on what type of intervention would be most effective to improve nutrition outcomes.

2.3. DATA ON FOOD AND NUTRITION SECURITY

Based on the conceptual framework above and relying on various data sources, we construct a key variable indicator for each FNS dimension.³ For quick reference, Table 2.1. summarises the indicators for each dimension and provides some descriptive statistics.

To estimate agricultural potential of each district in Ghana, we consider how many kilocalories could be produced from all available arable land, essentially translating hectares into a kilocalorie equivalent. For agricultural land estimates, we rely on two **remote sensing** satellite data sources. The first source identifies all land used for agriculture in 2015, at 30m pixel **spatial resolution** (Xiong et al., 2017). The second source (Hansen et al., 2013) indicates the amount of forest cleared between 2000 and 2015, assuming that this land was cleared for agriculture (Codjoe & Dzanku, 2009). We use these satellite data to create a map of (immediately) arable land countrywide. We assign each arable land pixel a cultivated crop (maize, rice, cassava, yam, cocoyam, plantain, soya beans and cowpeas) proportional to its share in overall national consumption. We obtained the national "food basket" data from the Ghana Socioeconomic Panel Survey conducted in 2009-2010 (ISSER/EGC, 2015). Using optimal yield data (which assumes proper fertilization, good agronomic practices and rainfed conditions) from the Ministry of Food and Agriculture (MOFA, 2016b), each assigned arable pixel of corresponding crop is then converted to estimate crop production and corresponding kilocalories.⁴ For each district, we sum up the total potential kilocalorie production of all pixels before dividing by the number of people living in that district, which then gives us the potentially-available kilocalories per person.⁵

³ We employ data indicators from different time periods, based on most recent availability; we assume that the geographical structure of older data remains constant over time.

⁴ Based on food composition data compiled by Stadlmayr et al. (2012).

⁵ To more easily observe differences across districts, we apply a 3rd-root transformation on total potential kilocalorie production. To assure consistency, this procedure is later repeated for our measure of actual kilocalorie production.

To derive an indicator for food production, we rely on district statistics of *actual* agricultural production in 2015 obtained from MOFA (2015c). We convert these 2015 production statistics for the most important cereals, tubers and pulses into kilocalories using the same food composition data as above (Stadlmayr et al., 2012). Again, for each district, we then divide the total kilocalorie production by the population of that district resulting in actual available kilocalories per person at the district level. Due to data limitations (Sumberg, Jatoe, Kleih, & Flynn, 2016), we exclude agricultural production from animal sources, such as meat, fish, milk and eggs. To represent food acquisition, we use the WFP's Food Consumption Score (FCS) from the Comprehensive Food Security and Vulnerability Analysis (CFSVA) of 2008. Based on recall data of food group consumption in the past 7 days, this composite score takes into account dietary diversity, food frequency, and relative nutritional importance of different food groups (WFP, 2008). For each district, we calculate the percentage of households with an acceptable score (i.e. above 52.5, according to World Food Programme's recommendations for Ghana). For nutrition, we rely on blood sample data from the Demographic and Health Survey (DHS) of 2014. We define our nutrition indicator as the percentage of women aged between 15 and 49 years old without anaemia (i.e. with a haemoglobin level *above* the common cut-offs set for pregnant and non pregnant women).

Table 2.1. Descriptive statistics of key FNS indicators for Ghana (2008-2015)

Indicator	Indicator components	Obs.	Mean	Min	Max
Potential	Immediately arable land (km ²)	106	478.4	2.2	3793.4
	Daily potential kilocalorie production per person	105	12304.0	3.2	126799.7
	3 rd -root transformation of daily potential kilocalorie production per person	105	19.1	1.5	50.2
Production	Daily kilocalorie production per person	105	6268.4	0.0	64241.1
	3 rd -root transformation of daily kilocalorie production per person	105	15.8	0.0	40.1
Acquisition	% of households with FCS below 52.5	80	16.2	0.0	56.7
	% of households with FCS above 52.5	80	83.8	43.3	100.0
Nutrition	% of women (15-49 years) with anaemia	73	43.3	11.7	77.3
	% of women (15-49 years) without anaemia	73	56.7	22.7	88.3

Source: Authors with data from Brown de Colstoun et al. (2017); CFSVA (2008); DHS (2014); Hansen et al. (2013); ISSER/EGC (2015); MOFA (2015c, 2016b); Pekel et al. (2016); Stadlmayr et al. (2012); UNEP-WCMC (2018); Xiong et al. (2017).

2.4. TYPOLOGY OUTCOMES

Having defined and estimated indicators for each FNS dimension for each district in Ghana, Figure 2.4. presents the four-dimensional diagram loaded with real data. This diagram consists of four **scatterplots** where each dot represents a district and its corresponding pair of values for both constituent indicators. Figure 2.5. adds the spatial dimension by presenting four country maps, each covering a quadrant from Figures 2.3. and 2.4., showing level of production, access or utilisation efficiency and one with colours representing the intervention types. For the three efficiency types (panel b, c and d), the lightest grey colour indicates districts with "better than average" efficiency while the black colour refers to districts characterised by "worse than average" efficiency. The latter districts would be potential candidates for targeted interventions to improve production, access or utilisation efficiency. Panel (a) combines nutrition priority levels of districts with relative agricultural potential of that district, displaying the seven intervention types.

We observe 22 high-priority districts, eleven with lower agricultural potential and another eleven with stronger agricultural potential. The districts with more agricultural opportunities are found in the northern part of the country, probably due to lower population densities and larger surface areas, compared to the high-priority districts in the country's south. Exceptions to this north-south divide are the southern districts of Wasa Amenfi, Afram Plains and Tongu, which display higher agricultural potential.

Although these districts all need urgent nutrition interventions (based on woman anaemia levels), the type of optimal intervention will depend upon their location. Many high-priority districts in the north suffer from a combination of production and access constraints, whereby the people of Nkwanta equally faces severe utilisation constraints while Lawra's households seem to have a slightly better access to food. In the south of the country, all high priority districts are confronted with severe utilisation constraints, a situation which is further exacerbated by high production inefficiencies in Keta, Komenda-Edina-Eguafo-Abirem, Tema, Tongu and Wasa Amenfi, and by severe access constraints for the more inland located districts of Afram Plains, Amansie, Aowin-Suaman and Asunafo. Only the coastal districts perform relatively better in terms of market access, which might be explained by the highway running from east to west near the Atlantic Ocean.

Figure 2.4. Combined scatterplot with district data, Ghana (2008-2015)

Notes: LPr, MPr, HPr respectively stand for low-, medium- and high-priority districts for nutrition; Ag and nAg refer to higher and lower agricultural potential; HiPerform stands for high-performance districts. PE, AE, UE and NE are estimated lines based on population-weighted OLS regressions with intercept through the origin, respectively having a slope of 1.101, 0.120, 1.479 and 2.810. The E75 and E125 lines are derived from the previous lines with slopes being 75% and 125% the size of the estimated slopes.

Source: Authors with data from Brown de Colstoun et al. (2017); CFSVA (2008); DHS (2014); Hansen et al. (2013); ISSER/EGC (2015); MOFA (2015c, 2016b); Pekel et al. (2016); Stadlmayr et al. (2012); UNEP-WCMC (2018); Xiong et al. (2017).

Figure 2.5. Districts by intervention type and efficiency level, Ghana (2008-2015)

Notes: LPr, MPr, HPr respectively stand for low-, medium- and high-priority districts; Ag and nAg refer to higher and lower agricultural potential.

Source: Authors with data from Brown de Colstoun et al. (2017); CFSVA (2008); DHS (2014); Hansen et al. (2013); ISSER/EGC (2015); MOFA (2015c, 2016b); Pekel et al. (2016); Stadlmayr et al. (2012); UNEP-WCMC (2018); Xiong et al. (2017).

2.5. LINKING TYPOLOGY TO POLICY

Despite its broad perspective, the typology elaborated in this chapter is useful in identifying various clusters of Ghana districts that suffer mostly from production, access and utilisation inefficiencies. Based on the above classification, any agricultural or nutrition development strategy could be improved with geographical targeting of key investments. For example, investments which aim to improve agricultural productivity should be geared towards various districts in the Northern, Upper West and Upper East regions, and to two clusters in the southwest and southeast of the country. Likewise, investment plans to overcome access constraints should also target many districts in the north of the country, combined with several districts in Eastern and Ashanti region. And finally, to address utilisation constraints, one should focus on a more scattered set of districts mainly in the south of the country. Table 2.2. presents more detail regarding the exact inefficiency profile observed for each cluster of high-priority districts in Ghana.

However, a prerequisite for an increased emphasis on the spatial dimension in the design and formulation of policy interventions is the availability of sufficiently disaggregated data. Totalling 216 districts, the country's statistical services should continue to streamline their data collection efforts in order to produce timely and reliable data representative of this local level.

Table 2.2. Efficiency profile of high-priority districts in Ghana (2008-2015)

District	Agricultural potential	Production	Efficiency Access	Utilisation
Lawra	higher	low	medium	medium
Bawku, Gonja, Gushiegu, Saboba Chereponi	higher	low	low	medium
Keta, Komenda-Edina-Eguafo-Abirem, Tema, Tongu, Wasa Amenfi	higher/lower	low	high/medium	low
Nkwanta	higher	low	low	low
Afram Plains, Amansie, Aowin-Suaman, Asunafo	higher/lower	high/medium	low	low
Agona, Gomaa, Sefwi Wiawso	lower	medium	medium	low
Yendi, Zabzugu Tatale, Bibiani Anhwiaso Bekwai, Asuogyaman	higher/lower	high/medium/low	.	.

Notes: The defining set of inefficiencies for each cluster of high-priority districts is indicated in bold.

Source: Authors with data from Brown de Colstoun et al. (2017); CFSVA (2008); DHS (2014); Hansen et al. (2013); ISSER/EGC (2015); MOFA (2015c, 2016b); Pekel et al. (2016); Stadlmayr et al. (2012); UNEP-WCMC (2018); Xiong et al. (2017).

ADVOCACY NOTE ON CHAPTER 2

The typology results of this chapter may be useful to the advocacy work of CSOs in Ghana in at least two ways. First, they facilitate advocating for more geographically-sensitive FNS policies that heed the differences across districts. Second, the results help us to question or challenge investments that fail to target the most critical bottlenecks to improving nutrition outcomes.

Two basic questions should be raised when evaluating current or future government FNS policies:

- 1) What type of bottleneck does this policy address? Is it a production, access or utilisation challenge (constraint)?
- 2) Which area, region or district of the country does this policy target?

POSSIBLE ACTIONS

- If policies lack geographic targeting, CSOs can reference Table 2.2., which lists high-priority districts and their most critical bottlenecks.
- If the policy does explicitly mention target areas, then:
 - o CSOs could ensure that priorities align with those summarised in Table 2.2.
 - o When policies target low- or medium-priority districts, CSOs could redirect attention toward high-priority areas. Alternatively, CSOs could request guarantees that investments in low-priority districts will benefit surrounding high-priority districts.
 - o When policies in high-priority districts do not prioritise the most critical bottlenecks, CSOs could request a reorientation so that interventions first address the most urgent challenges.

Chapter 3

NUTRIENT ADEQUACY MAPS FOR TARGETED POLICY INTERVENTIONS

3.1. INTRODUCTION

This chapter presents a series of **nutrient adequacy** maps to help understand, identify and locate the major challenges behind the country's insufficient or unbalanced food intake. The maps show food production and consumption data converted into corresponding calorie and nutrient amounts, comparing them with the nutrition requirements of each region's population. The adopted method roughly aligns with the food system approach currently advocated by many researchers and development partners (Ericksen, 2008; Gillespie & van den Bold, 2017; Global Panel on Agriculture and Food Systems for Nutrition, 2016; Jones & Ejeta, 2015; Pinstrup-Andersen, 2013; Stephens, Jones, & Parsons, 2018; Tendall et al., 2015). In this chapter we focus on total calories consumed (energy intake) as well as a set of **micronutrients** associated with "hidden hunger" when they are insufficiently consumed. These include calcium, iron, zinc, folate, vitamin B12 and vitamin A. Even without the obvious signs of malnutrition like stunting or "felt" hunger pangs, micronutrient deficiencies affect a person's well-being and development, and can lead to mental and cognitive impairment, poor health, low productivity, even death. By comparing nutrient consumption adequacy with the locally available food items that contain essential micronutrients, we can strategically design FNS policies.

Figure 3.1. presents the overall challenge of Ghana's undernutrition, expressed both in terms of *diet quantity* and *quality*.

Figure 3.1. Diet quantity and quality, Ghana (2016/17)

Source: Authors with data from GLSS7 (2016/17).

Whereas diet quantity refers to a sufficient intake of kilocalories, diet quality looks at intake of micronutrients. In this chapter we define nutrition adequacy at the "household level," which means that the required number of kilocalories or micronutrients for each household depends on size and demographic structure of the family. To obtain mean adequacy rates for each region, we first cap energy and nutrient household adequacies at 100% (since 100% means sufficient intake). Diet quantity is straightforward

Key Words

Nutrient adequacy sufficient intake of essential nutrients based on individual requirements for optimal health

Micronutrients essential elements required in small quantities; vitamins and minerals are two distinct sets of micronutrients

Demand constraint a limitation defined by consumers' ability to afford, or willingness to pay for a certain commodity

Adult-male equivalence a concept to standardise nutrition requirements across population groups

Sampling weights values associated with data observations that ensure that survey statistics are representative of the population

since it depends only on total kilocalories; for diet quality, we apply the same procedure for each micronutrient individually before computing the arithmetic mean at the household level, also known as the mean adequacy ratio (MAR).

The left-hand side map of Figure 3.1. shows that food energy intake is slightly better in Greater Accra and two neighbouring regions (that is Eastern and Central) with adequacy levels above 70%. In contrast, the Ashanti and Western regions as well as the northern Upper West and Upper East regions on average display calorie adequacy levels below 65% of the recommended intake. In terms of micronutrients (right-hand side map of Figure 3.1.), the spatial opposition between the South and the North is more pronounced with Upper West and Greater Accra, respectively, the most and least affected by micronutrient deficiency.

3.2. CONCEPTUAL FRAMEWORK

To generate evidence on the causes and related opportunities to address the spatial heterogeneity in food-intake deficiency, we map three distinct nutrient adequacy measures for food energy and micronutrients. The first measure, *nutrient production adequacy*, quantifies the region's agricultural production capacity to meet the minimal energy and nutrient requirements of its population. The second measure, *nutrient market adequacy*, indicates the aggregate accessibility of calories and nutrients, based on the region's population food needs. The third measure, *nutrient household adequacy*, addresses the unequal access among households within each region. By comparing the three nutrient adequacy maps and by connecting them to their corresponding food sources, we can strategically design and evaluate FNS policies.

The green colour in Figure 3.2. indicates nutrient surplus in an area, red indicates a deficit, and white indicates self-sufficiency. Panel (a) in Figure 3.2. shows three areas with insufficient nutrient production (areas B, C and D). Increasing nutrient production in these areas might be an appropriate policy strategy, but it is important to explore additional challenges and opportunities first. For example, look at area D in panels (a) and (b). Even though area D does not produce enough nutrients, its neighbouring areas E and F have production surpluses—the market in area D is *not* nutrient deficient, perhaps thanks to successful market integration with areas E and F. Given its location, area C might seek similar forms of market integration with areas E and F.

Figure 3.2. Three nutrient adequacy measures to identify and locate bottlenecks to food security

Note: White indicates self-sufficiency, green indicates surplus and red indicates deficiency.

Source: Authors.

Now look at area A in panels (a) and (b). Area A *produces* enough nutrients, but markets in area A do not sell enough to keep the local population healthy. We call this “nutrient loss.” It occurs when nutrients produced locally are traded or sold outside the area, or when post-harvest losses prevent those nutrient-rich foods from making it to local markets. Fixing the nutrient loss may require revising commercial or trade policies, improving transport infrastructure to better link markets to producers, or by investing in storage and processing capacity.

Finally, let us compare area D in panels (b) and (c). Although enough nutrients make it to the market (panel b), households still lack adequate nutritious food (panel c). Why would this be? Perhaps the nutritious food is simply unaffordable for households; or perhaps people lack nutrition knowledge and therefore ignore important nutrient-rich food. We call these obstacles **demand constraints** since they do not depend on the suppliers, but on the consumers demanding food products. Fixing these challenges might require nutrition-sensitive social protection schemes that help supplement income, or behavioural change campaigns that promote nutrient-rich foods or nutrition education.

3.3. DATA

The data used in this chapter come from various sources but each source allows us to compute estimates of nutrient adequacy for the 10 regions of Ghana. For production adequacy, we rely on the latest round of Ghana's Living Standards Survey (GLSS7) conducted in 2016/17 (GSS, 2018) combined with official statistics on agricultural production for the year 2016 (ReSAKSS, 2016). More specifically, we combine the official production statistics of 4 main cereals (maize, rice, millet and sorghum), 4 tubers (cassava, yam, cocoyam and plantain), 3 pulses (groundnuts, cowpeas and soybeans) and fish (as a combination of inland, marine and aquaculture). In addition, we obtain estimates for the remaining crops and food items using the production modules of GLSS7 (2016/17), covering not only fruit and vegetables, but also milk and eggs, and a few other items.⁶ Using food composition data compiled for West Africa (Stadlmayr et al., 2012), we convert production quantities into kilocalories and other nutrient equivalents and aggregate by region. We estimate the ratio of production adequacy by dividing the food energy and nutrient production levels by their respective required intakes according to each region's demographic makeup. We use the same approach for market adequacy, based on food consumption data obtained from GLSS7 (2016/17). This survey combines different sources of food consumption, such as purchases, home-produced or food consumed away from home. In total, more than 200 food items are covered. Quantities of food consumption are estimated by imputing regional food prices. Using the same food composition data (Stadlmayr et al., 2012), we derive aggregate nutrient consumption by region and divide it by the region's required intake levels. We derive household adequacy from the same household consumption survey, estimated at the household level by considering the family's required intake (capping all values above 100%), then averaging household ratios by region. The required intake levels for each household and region are determined using the common **adult-male equivalence** approach combined with population **sampling weights**. Each of the three measures is a ratio, where 100% reflects adequacy, and values below (above) 100% point to deficiency (surplus). The colour scheme applied throughout this chapter is pale yellow for adequacy, green for surplus and red for deficiency.

3.4. NUTRIENT ADEQUACY

Table 3.1. provides an overview of absolute gaps in nutrient production and consumption, compared to recommended intake levels as well as the three nutrient adequacy measures.

Ghana fares decently well only in protein consumption: households on average consume at least 82% of the recommended intake. In contrast, micronutrient deficiencies are alarming, especially for calcium (25%), iron (32%), vitamin B12 (42%), folate (48%) and zinc (49%). Remarkably, food energy adequacy (67%) is lower than expected—especially given the Lower-Middle Income status of the country. This rather dismal picture may be due to a combination of underreporting of food consumption by GLSS7 combined with lower physical activity levels and thus lower recommended intakes of an increasingly urbanizing society.

Apart from kilocalories, protein and folate, for which production adequacies are substantially higher than 100%, Ghana is simply not producing enough micronutrients. Indeed, production adequacies amount to only 41% for calcium, 63% for iron and 83% for zinc. In addition to insufficient national food production, the country appears to suffer from high nutrient loss, resulting either from food losses or exports: for all nutrients except vitamin A and B12, market adequacies are substantially lower than production adequacies. This observation is most pronounced for folate and iron where nutrient access is less than half of what is nationally produced. It is possible that the exceptional cases of vitamin A and vitamin B12 is due to lacking information on meat and palm oil production; therefore, should be interpreted with caution.

Market and household adequacies point to demand problems for kilocalories, protein, vitamin B12 and vitamin A. For the latter nutrient, which is typically found in fruit and vegetables, a lack of knowledge on the nutritional value of vitamin A can explain why household intake is deficient. For protein and vitamin B12, found mostly in more expensive food items such as meat and fish, unaffordability is a straightforward explanation behind their deficient intake.

⁶ Conform observations made by Sumberg et al. (2016), we were unable to obtain reliable statistics for meat production resulting in less accurate nutrient adequacy measures for protein and vitamin B12. The same is true for palm oil and its negative effect on the accuracy of vitamin A related measures.

Table 3.1. National food energy and nutrient adequacy levels based on production, consumption and recommended intake, Ghana (2016/17)

	Production	Consumption	Recommended intake	National Production Adequacy (%)	National Market Adequacy (%)	National Household Adequacy (%)
	per day, AME	per day, AME	per day, AME			
Kilocalories (kcal)	3651.9	2031.6	2750.0	132.8	73.9	66.9
Protein (g.)	(70.1)	54.7	50.0	(140.3)	109.4	82.4
Calcium (mg.)	407.4	249.8	1000.0	40.7	25.0	25.1
Iron (mg.)	17.4	8.5	27.4	63.4	30.8	31.7
Zinc (mg.)	11.6	7.0	14.0	83.1	50.0	48.9
Folate (mcg.)	538.7	207.9	400.0	134.7	52.0	48.0
Vitamin B12 (mcg.)	(0.0)	1.2	2.4	(0.9)	50.4	42.3
Vitamin A (mcg.)	(425.5)	893.1	600.0	(70.9)	148.8	57.6

Notes: Lacking reliable statistics on meat and palm oil production, the corresponding values for protein, vitamin B12 and vitamin A are put in brackets.
Source: Authors with data from GLSS7 (2016/17) and ReSAKSS (2016).

Figure 3.3. displays the same three adequacy measures for each of the six micronutrients covered in this chapter, illustrated geographically by region.

Calcium deficiency (see panel a) is the most important challenge faced by households in Ghana with those in Upper East and Upper West being hit the hardest. In the latter two regions, households reach less than 20% of their recommended intake (right-hand side map). This poor performance is due to calcium-rich food items being largely unavailable on the market (middle map). However, from a production perspective (left-hand side map), the picture is less dramatic: whereas the Central region produces roughly enough calcium for its own population, Upper West is generating a surplus. Likewise, production deficits in Northern and Volta are less pronounced compared to all other regions, such as Upper East, Brong Ahafo, Ashanti, Greater Accra, Eastern and Western where they are below 50%. Therefore, to address calcium deficiency in Ghana, the availability of calcium-rich food items should increase especially in the latter six regions while policies should focus on reducing calcium loss in the other regions. Assuming that calcium-rich food is not traded to neighbouring countries, the contrast between production and market adequacies points to important food losses, especially in Upper west, which could be reduced by investing in public and private storage and processing capacity as well as educating farmers on improved on-farm storage methods.

Given their similar spatial outlook, we discuss the various adequacy measures of *iron* (see panel b) in combination with *zinc*'s (see panel c). For both micronutrients, household adequacy is generally lower in the southern regions (except for Greater Accra), compared to those in the country's north; yet the difference between regions is less than 20% (right-hand side maps). In terms of market adequacy, roughly the same geographical differences apply, with the northern regions (and Greater Accra) having a relatively better supply of food items rich in iron and zinc (middle maps). As such, no real demand issues seem to be at play. Though, in terms of production adequacy (left-hand side maps), all regions (except Greater Accra) are performing markedly better, with the three most northern regions being self-sufficient or even generating surpluses in iron and zinc, while the regions of Volta and Eastern similarly produce enough zinc. For both micronutrients, Greater Accra, Ashanti and Western regions are the worst performers in producing iron and zinc to meet the recommended intake levels for their respective populations. Like in the case of calcium, largely the same policy recommendations can be put forward: increasing the production of food items rich in iron and zinc, especially in the more southern regions of the country while addressing the issue of food losses in the north. If increasing production is not feasible due to biophysical constraints, improved market linkages between production sites in the north and consumption centres in the south could be pursued as a valid alternative.

For *folate* (see panel d), we observe a largely similar spatial heterogeneity in nutrient production, market and household adequacy as was the case for iron and zinc. However, two major exceptions apply. First, Upper West and Upper East join the southern regions as those characterized by the lowest market and household adequacies. Second, production adequacies are on average well beyond 100%, with only two regions (Greater Accra and Ashanti) producing too little folate compared to required intake levels for their respective populations. As a result, policies to address folate deficiency should mainly focus on strengthening value chains of food items rich in folate as to reduce food losses and improve accessibility by Ghanaian households throughout the country.

For *vitamin B12* (see panel e) and *vitamin A* (see panel f), a different spatial profile emerges with household and market adequacies being higher in the most southern regions while gradually decreasing towards the country's north—with levels as low as 30% of

the recommended intake in Upper West, Upper East and Northern region. Not only do southern regions perform better, their market adequacies are also distinctively higher than the corresponding household adequacies. The difference between market and household adequacies, which is most pronounced for vitamin A, points to limited demand for food items containing these vitamins. For vitamin B12, which is solely found in more expensive animal-based food items, affordability constraints may explain the disparity. For vitamin A, which is supplied by (generally) cheaper orange and red-coloured vegetables and fruit, a lack of knowledge may explain their absence from the daily food basket. With respect to production adequacy, one should be very cautious in interpreting the corresponding maps given the methodological issues mentioned above.

Figure 3.3. Micronutrient production, market and household adequacies at regional level, Ghana (2016/17)

Panel (a): Calcium adequacy

Panel (b): Iron adequacy

Figure 3.3. Continued

Panel (c): Zinc adequacy

Panel (d): Folate adequacy

Figure 3.3. Continued

Panel (e): Vitamin B12 adequacy

Panel (f): Vitamin A adequacy

Source: Authors with data from GLSS7 (2016/17) and ReSAKSS (2016).

3.5. FROM NUTRIENT DEFICIENCIES BACK TO FOOD AND TARGETED POLICIES

In this section, we shift focus to the actual food items that supply micronutrients, considering policy recommendations that could help increase production, reduce nutrient loss and improve consumer access to healthy foods. In real life people grow and buy actual foods—not micronutrients. For each nutrient covered in this chapter, Table 3.2. presents the five most important national food items according to two criteria:

- 1) current share in overall nutrient intake (%) (left-hand side column)
- 2) cheapest prices per nutrient (expressed in *pesewas* (Gp)) (right-hand side column)

Table 3.2. also identifies the nutritional content per 100 gr edible portion of each food item (Stadlmayr et al., 2012) and its food budget share.

To address calcium deficiency in Ghana, Table 3.2. indicates that a focus on cassava and its derived products is most warranted as more than 40% of the overall nutrient intake is obtained from this tuber and because we could not find an economically better alternative.⁷ Therefore, where calcium production is most deficient and food losses are highest, policies could promote cultivation of cassava while improving the efficiency of its food value chain to generate derived products such as *Gari* and *Kokonte*.

Since the iron and zinc profiles both suffer from insufficient production combined with nutrient loss, Ghana should focus on maize, rice and cowpeas, as these are the crops that currently provide the majority of overall iron and zinc intake. However, it is worth noting that there are two economically interesting alternatives in the form of millet and sorghum, which have very low nutrient prices for iron and zinc compared to the dominant staple (rice): 1 mg of iron is almost 20 (10) times cheaper through the consumption of millet (sorghum) compared to rice, and a similar (but less pronounced) observation could be made for zinc.

To address folate deficiency, Ghana should focus less on increasing production, and more on reducing losses of food containing folate. Based on findings in Table 3.2., the government should pay attention to the food chain of cowpeas as it accounts for 16% of overall folate intake. As an alternative, households could also consider consuming more cocoyam leaves and groundnuts given their advantageous nutrient price, which is more than 6 times cheaper than rice.

Regarding the demand problems associated with vitamin A and vitamin B12, only a few economically viable alternatives exist, given that both top-5 lists contain largely the same food items. For the first nutrient, carrots are cheap vegetables rich in vitamin A. For the second, it might be advisable that households consume more canned fish products, such as mackerel and sardines, compared to smoked fish, given their very low nutrient price and despite being perhaps less tasty.

Apart from the changes in food preferences to increase the intake of micronutrients, Table 3.2. also points to another important nutrition-smart option, which is the consumption of *less* rice. Representing on average 14% of the food budget (that is local and imported varieties combined), rice is the most dominant food staple in Ghana. By default, the nutritional importance of rice in Ghanaian diets mainly stems from its high budget share rather than from its nutritional density or cheap price. In fact, for calcium, zinc and iron, we already identified cassava, millet and sorghum as more cost-efficient alternatives. In addition, compared to rice, these same alternatives have in most instances lower nutrient prices for calories, protein and folate as well.⁸ Therefore, additional studies are needed to further investigate to what extent Ghanaians might be receptive to changing their daily food basket in favour of more cassava, millet and sorghum and to reducing their overreliance on rice. In a similar vein, the country should also explore the possibility of smart diets that mix economically viable options with the main staple rice.

While working to increase agricultural production of some crops, reduce nutrient losses for others and promote more nutritious diets, social protection schemes should be considered in the short run to assure minimal intakes of essential nutrients for the most undernourished households in Ghana.

⁷ Sweet apple appears to be a cost-effective option for calcium and several other nutrients. Yet, given its low nutritional density overall, the low nutrient prices for this particular fruit item are most probably the result of an erroneously low metric food price.

⁸ The latter observations can not all be retrieved from Table 3.2. but stem from a more detailed inspection of the food budget data.

Table 3.2. Top-5 food items according to nutrient share and price, Ghana (2016/17)

	Food item	Nutrient intake share	Price per nutrient (Gp)	Nutrient content 100gr	Food budget share	Food item	Nutrient intake share	Price per nutrient (Gp)	Nutrient content 100gr	Food budget share
Calorie	Rice - Imported	14.5%	0.15	349.0	11.2%	Sweet apple	0.2%	0.01	91.0	0.0%
	Corn dough	12.3%	0.04	352.0	2.8%	Coconut (fresh)	2.0%	0.03	389.0	0.3%
	Maize (dried, white grains)	11.4%	0.04	349.0	2.2%	Maize (dried, white grains)	11.4%	0.04	349.0	2.2%
	Vegetable oil	7.4%	0.09	900.0	3.4%	Palm kernel oil	0.1%	0.04	900.0	0.0%
	Cassava (fresh)	6.4%	0.08	153.0	2.6%	Corn dough	12.3%	0.04	352.0	2.8%
Protein	Smoked fish	14.2%	5.95	38.5	10.0%	Sweet apple	0.1%	0.52	1.4	0.0%
	Corn dough	14.0%	1.66	9.5	2.8%	Maize (dried, white grains)	12.6%	1.45	9.2	2.2%
	Maize (dried, white grains)	12.6%	1.45	9.2	2.2%	Guinea corn/sorghum grains	0.7%	1.50	10.5	0.1%
	Rice - Imported	12.0%	7.87	6.9	11.2%	White beans (cowpea)	3.4%	1.55	19.2	0.6%
	Rice - Local	4.6%	5.14	6.9	2.8%	Corn dough	14.0%	1.66	9.5	2.8%
Calcium	Cassava dough	18.5%	0.12	137.5	1.6%	Sweet apple	0.4%	0.03	23.5	0.0%
	Cassava (fresh)	12.8%	0.29	42.8	2.6%	Cassava dough	18.5%	0.12	137.5	1.6%
	Cassava - Gari	6.0%	0.28	137.5	1.2%	Cassava - Kokonte	5.1%	0.20	137.5	0.7%
	Cassava - Kokonte	5.1%	0.20	137.5	0.7%	Cassava - Gari	6.0%	0.28	137.5	1.2%
	Yam - Puna	4.7%	1.50	25.8	4.9%	Cassava (fresh)	12.8%	0.29	42.8	2.6%
Iron	Corn dough	18.9%	4.68	3.4	2.8%	Sweet apple	0.2%	1.09	0.7	0.0%
	Maize (dried, white grains)	16.0%	4.33	3.1	2.2%	Millet	2.1%	2.00	9.5	0.1%
	Rice - Imported	9.3%	38.53	1.4	11.2%	White beans (cowpea)	5.8%	3.48	8.5	0.6%
	White beans (cowpea)	5.8%	3.48	8.5	0.6%	Guinea corn/sorghum grains	0.9%	4.25	3.7	0.1%
	Cassava (fresh)	4.7%	17.57	0.7	2.6%	Maize (dried, white grains)	16.0%	4.33	3.1	2.2%
Zinc	Corn dough	16.9%	9.14	1.7	2.8%	White beans (cowpea)	5.4%	6.47	4.6	0.6%
	Maize (dried, white grains)	14.1%	8.55	1.6	2.2%	Maize (dried, white grains)	14.1%	8.55	1.6	2.2%
	Rice - Imported	13.4%	46.50	1.2	11.2%	Guinea corn/sorghum grains	0.7%	8.79	1.8	0.1%
	White beans (cowpea)	5.4%	6.47	4.6	0.6%	Corn dough	16.9%	9.14	1.7	2.8%
	Rice - Local	5.1%	30.34	1.2	2.8%	Millet	0.6%	12.93	1.5	0.1%
Folate	White beans (cowpea)	16.1%	0.07	409.8	0.6%	White beans (cowpea)	16.1%	0.07	409.8	0.6%
	Cassava (fresh)	9.4%	0.51	24.0	2.6%	Cassava dough	8.2%	0.36	47.0	1.6%
	Cassava dough	8.2%	0.36	47.0	1.6%	Cocoyam leaves	3.3%	0.38	126.0	0.7%
	Maize (dried, white grains)	7.9%	0.51	26.0	2.2%	Groundnut (shelled/roasted)	1.0%	0.40	108.9	0.2%
	Rice - Imported	7.7%	2.70	20.0	11.2%	Coconut (fresh)	1.3%	0.49	27.0	0.3%
Vitamin B12	Smoked fish	31.4%	129.45	1.8	10.0%	Canned Mackerel	14.2%	22.07	6.9	0.8%
	Canned Mackerel	14.2%	22.07	6.9	0.8%	Canned sardines	6.0%	25.21	8.9	0.4%
	Kpala (Starvids) frozen	13.5%	54.13	2.4	1.8%	Bushmeat (Grasscutter)	3.5%	34.43	18.3	0.3%
	Beef with bones	9.5%	157.32	1.1	3.7%	Kpala (Starvids) frozen	13.5%	54.13	2.4	1.8%
	Canned sardines	6.0%	25.21	8.9	0.4%	Mutton mixed cut	1.2%	65.36	2.9	0.2%
Vitamin A	Palm oil (red oil)	78.1%	0.01	5720.0	1.6%	Palm kernel oil	1.5%	0.01	5720.0	0.0%
	Cocoyam leaves	3.2%	0.13	375.7	0.7%	Palm oil (red oil)	78.1%	0.01	5720.0	1.6%
	Tomatoes (fresh)	3.0%	1.12	52.0	5.6%	Carrot	1.3%	0.11	713.3	0.3%
	Plantain (green)	2.0%	1.03	43.0	3.5%	Cocoyam leaves	3.2%	0.13	375.7	0.7%
	Palm kernel oil	1.5%	0.01	5720.0	0.0%	Margarine	0.2%	0.14	819.0	0.0%

Note: The grey-shaded columns represent the two ranking variables used to derive top-5 lists of food items for each nutrient.

Source: Authors with data from GLSS7 (2016/17).

ADVOCACY NOTE ON CHAPTER 3

Let us consider some key advocacy messages from this analysis:

1. Ghana's population suffers from micronutrient deficiency, also known as "hidden hunger," which can cause severe cognitive and physical health, and human development problems.
2. The causes behind Ghana's hidden hunger depend both on geographic location, the type of micronutrient, and corresponding food sources that supply that micronutrient.
3. To address hidden hunger, policy interventions should be geographically-sensitive and tailored to specific foods.
4. The table below summarises the main findings per micronutrient, starting with calcium which has the lowest national nutrient adequacy. Proposed priority actions are **in bold** and underlined text roughly indicates priority locations.

Nutrient	National Household Adequacy	Targeted policy interventions
Calcium	25.1%	<ul style="list-style-type: none"> - Increase availability of cassava in the regions of <u>Upper East, Brong Ahafo, Ashanti, Greater Accra, Eastern and Western</u> - Reduce food losses and strengthen value chains of cassava and derived products in the regions of <u>Upper West, Central, Northern and Volta</u>
Iron, Zinc	31.7-48.9%	<ul style="list-style-type: none"> - Increase availability of maize and rice in the <u>southern regions, especially in Greater Accra, Ashanti and Western</u> - Reduce food losses and strengthen value chains of maize and rice across <u>all regions and especially in Upper West, Upper East and Northern</u> - Increase nutrition awareness of cost-effective food items rich in iron and zinc, such as millet and sorghum
Vitamin B12	42.3%	<ul style="list-style-type: none"> - Increase nutrition awareness of cost-effective food items rich in vitamin B12, such as canned fish products
Folate	48.0%	<ul style="list-style-type: none"> - Reduce food losses and strengthen value chains of cowpeas across <u>all regions (except for Greater Accra)</u> - Increase nutrition awareness of cost-effective food items rich in folate, such as coco-yam leaves and groundnuts
Vitamin A	57.6%	<ul style="list-style-type: none"> - Increase nutrition awareness of cost-effective food items rich in vitamin A, such as carrots
All nutrients	---	<ul style="list-style-type: none"> - Implement social protection programs in the short run to guarantee a minimal intake of key nutrients to the most undernourished households, a large share of which live in the regions of <u>Upper West, Upper East and Northern</u> - Increase nutrition awareness of the limitations of a diet dominated by rice, a staple which is overall less nutritious and less cost-effective compared to other main staples such as cassava, millet and sorghum

Chapter 4

POLICIES AND INITIATIVES ON STORAGE AND PROCESSING INFRASTRUCTURE TO ADDRESS POST-HARVEST LOSSES IN NORTHERN GHANA

4.1. INTRODUCTION

[...] Mr. Speaker, the "One-District-One-Factory" policy has taken off, and 79 factories under the scheme are at various stages of operation or construction. Another 35 are going through credit appraisal. All told, there is a lot of activity going on under the scheme, and it has awoken the interest of young people to go into manufacturing business. Under the Rural Enterprises Programme, funded by the African Development Bank and the International Fund for Agricultural Development, 50 small-scale processing factories will be established by the end of the year in 50 districts across the country, particularly in areas where there is evidence of significant post-harvest losses. These will be owned and managed by organized youth groups, with technical support from the Ministry of Trade and Industry. [...] (<https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Full-Text-President-Akufo-Addo-s-SONA-2019-725124#>)

Key Words

Post-harvest losses unintentional food losses which occur after harvest and before consumption

Relative Adequacy Index an index used to compare the adequacy of one thing (such as storage infrastructure) with another related thing (such as PHL or agricultural production)

In his 2019 State of the Nation Address, the President of Ghana pointed to a vibrant and promising set of ongoing and future economic and infrastructural activities, aiming (among other things) at reducing the level of **post-harvest losses** (PHL) in the country. At international level too, there is growing awareness and interest to deal with this issue, as reflected in various Sustainable Development Goals (SDG), and most specifically in SDG 12.3 on "halving by 2030 of per capita global food waste at the retail and consumer levels and the reduction of food losses along production and supply chains, including post-harvest losses". In addition, the latest report on the State of Food and Agriculture by FAO is entirely dedicated to this topic (FAO, 2019).

PHL are a particular subset of unintentional food losses which occur after harvest and before consumption. Losses observed during agricultural production (that is at harvesting) should be excluded from PHL, although this is not always the case (Delgado, Schuster, & Torero, 2017). Losses observed at consumption stage are often more deliberate and therefore labelled as "food waste" (FAO, 2014). Another food loss type is pre-harvest losses. They occur as a result of pest, disease, lack of rainfall or agricultural inputs, but tend to be ignored in most food loss estimations, despite their importance in determining the loss magnitude in later stages (Delgado et al., 2017). To stress the importance of the waste part, all food losses combined (except pre-harvest losses) are commonly designated as "food loss and waste (FLW)" (FAO, 2014). Within the particular category of PHL one can further identify the following stages: post-harvest handling (such as drying, threshing, shelling, winnowing, stacking, loading), storage (on- and off-farm), processing and distribution.

Depending on location, crop (or food group), range of the value chain considered and precise methodology adopted, many different FLW estimates exist.⁹ Globally, total FLW is estimated at 32% of total production (Gustavsson, Cederberg, Sonesson, van Otterdijk, & Meybeck, 2011) and 24% of total calories produced (Kummu et al., 2012; Lipinski et al., 2013). In absolute terms, these estimates correspond to an average of 280-300 kg/year of food for human consumption that is lost or wasted per person in Europe, North America and Oceania compared to 120-170 kg/year for an average person in Sub-Sahara Africa and South and Southeast Asia. In the former regions, around one third of all FLW occurs at retail and consumption stage, whereas this percentage is below 10% in the latter regions. Across commodity groups, the highest FLW estimates are found among roots and tubers (30-60%) and fruit and vegetables (35-55%), followed by fish and seafood (30-50%) (Gustavsson et al., 2011).

Figure 4.1. presents some key estimates of crop losses observed in Ghana along various stages of the food value chain.

⁹ For example, Delgado et al. (2017) compile an overview of FLW estimates from recent studies by methodological approach and length of the food value chain considered. Another example concerns the Global Initiative on Food Loss and Waste Reduction (called "Save Food"), led by FAO, which presents estimates on FLW by food group and geographical zone for each of the major stages of the food value chain (see www.fao.org/save-food).

Figure 4.1. Food loss and waste: terminology and estimates, Ghana

Notes: The estimates retained for FAO (2011) each time concern the highest value of both available seasons. The methodology to derive PHL estimates from GLSS7 (2016/2017) is briefly explained in text below.

Source: Authors based on Delgado et al. (2017); FAO (2011, 2014); MOFA (2010); Mutungi and Affognon (2013); APHLIS (www.aphlis.net) database (2011); and GLSS7 (2016/17).

Unsurprisingly, due to variations in methodology, scope of the value chain considered and years of interest, FLW estimates vary considerably. For example, for maize, rice, sorghum and millet, estimates range from 14.0% to 35.1%, from 6.9% to 30.7%, from 7.5% to 26.3%, from 7.0% to 25.9%, respectively. For the other crops, the difference across estimations is less pronounced. Yet remarkably, official estimates provided by MOFA (2010) and those published by FAO (2011) do not match, especially for maize, despite being all based on the same post-harvest study commissioned by the Policy Planning, Monitoring and Evaluation

Directorate (PPMED) of MOFA. Similar to the global estimates, roots and tubers, horticultural crops and fish are the most vulnerable food groups in Ghana. Mango especially stands out with an estimated FLW of more than 60%.

Irrespective of measurement issues, PHL are clearly a major challenge in Ghana, not only in terms of wasting productive resources and unnecessarily contributing to green-house gas emissions; they also threaten the country's food and nutrition security. Reflected in the introductory quote above, the government of Ghana has therefore embarked on a number of ambitious policies in order to reduce PHL. Although each food loss stage requires a particular set of policy actions and technologies (such as extension services to improve harvesting practices or the introduction of hermetic bags or plastics drums to improve on-farm storage (Sugri, 2016)), much policy attention is currently devoted to extending and improving off-farm storage and processing capacity.

This focus on market storage is warranted based on a systematic review conducted by Vowotor et al. (2013), which applied a two-tier screening approach on all relevant literature on PHL measurement in Ghana occurring between 1980 and 2012. This extensive review of 115 articles mainly covers laboratory experiments to measure weight loss at storage under varying conditions (related to crop varieties, moisture levels, storing equipment, time intervals, etc.). Following this review, reported loss estimates range from 8% to 54% for maize, 6% to 19% for rice, 10% to 27% for cassava, 24% to 97% for yam, 11% to 70% for fish, 20% to 50% for tomatoes and 36% to 61% for mango (Vowotor et al., 2013).

The objective of this chapter is to screen and map the major policies on current and planned activities regarding storage and processing infrastructure in the northern part of Ghana, before linking this information with data on agricultural production and PHL. Whereas the first brings together infrastructural data across various policies and initiatives, the latter allows for an identification of districts which are currently undersupplied and therefore should receive priority attention. The six major policy initiatives discussed in this chapter are: (i) Ghana Commercial Agriculture Project (GCAP), (ii) Northern Rural Growth Programme (NRGP), (iii) Ghana Grains Council (GGC), (iv) Ghana Commodity Exchange (GCX), (v) One-District-One-Factory (1D1F) and (vi) Infrastructure for Poverty Eradication Programme (IPEP).

4.2. POLICIES AND INITIATIVES ON STORAGE & PROCESSING INFRASTRUCTURE

The Ghanaian political landscape is currently characterised by many different policies and initiatives to extend storage and processing capacity throughout the country. In this section, we list the various initiatives by distinguishing those which directly or mostly fall under the supervision of MOFA and those outside its immediate responsibility. For each policy, we will tabulate and map all recently added infrastructure within the former administrative regions of Upper East, Upper West and Northern, while including additional information on crops, facilities and capacities. At the end of this section, all information will be combined in two comprehensive maps.

MOFA-led initiatives

Key policies of MOFA are largely outlined in three documents, each with a different time horizon. The first entails the long-term vision of MOFA captured by the second Food and Agriculture Sector Development Policy (FASDEP II) (MOFA, 2007). This sectoral policy, which is in line with the country's Growth and Poverty Reduction Strategy (GPRS II) and with the Comprehensive Africa Agriculture Development Programme (CAADP), is the overall framework for the implementation of strategies to modernise the agriculture sector in Ghana. Resulting from a consultative process with key stakeholders, this policy emphasises the sustainable utilisation of resources and the role of market and private actors in the development process. Given its more generic perspective, FASDEP II provides little information on current or planned storage and processing infrastructure. The same is true for the flagship policy Planting for Food and Jobs (PFJ), which is a more short-term policy with an annual setting of agricultural production and employment targets, an identification of targeted crops and a fixing of subsidised prices for seed and fertilizer (Tanko, 2019). Covering 2017-2020, the strategic plan behind the implementation of PFJ defines the following five pillars to structure major interventions of PFJ: (i) seed, (ii) fertilizer, (iii) extension services, (iv) marketing, and (v) e-agriculture. Mainly under the marketing pillar, some key information is provided on storage and processing infrastructure. One key activity is to make an inventory of existing warehouses and their functional status, in order to identify those that should be rehabilitated, where to build new medium-sized warehouses, and what additional facilities should be added in terms of sorting, grading, processing and packaging (MOFA, 2017). An investment budget of nearly 3 million GH¢ for rehabilitating 130 existing warehouses and 4 million GH¢ for creating 86 new warehouses has been earmarked in 2018 (MOFA 2017:68). To date, it is unknown whether the inventory has been completed and/or whether locations for rehabilitation and construction have been identified.

Unsurprisingly, most concrete information on storage and processing infrastructure can be found in MOFA's third key policy document comprising the country's Medium-Term Agriculture Sector Investment Plan (METASIP-II) (MOFA, 2015b). This document, together with a recently elaborated Agriculture Investment Guide (AIG) (MOFA, 2018), deals with various activities to improve the country's infrastructure in better linking farmers to markets while creating added value along the food chain. For example, under the second programme area on Food and Nutrition Security and Emergency Preparedness, it is stated that "Post-harvest losses are still high as a result of poor storage facilities for all types of agricultural produce" (MOFA 2015:35). Similarly, the fourth

programme area on Marketing of Agricultural Products aims to increase market integration through improvements in post-production management, development of an effective domestic market and expansion of agricultural exports (MOFA, 2015b). The following four key initiatives stand out.

Ghana Commercial Agriculture Project (GCAP)

The Ghana Commercial Agriculture Project (GCAP), established in 2012, aims to improve agricultural productivity and production of both smallholder and nucleus farms in Accra Plains and the SADA Zone.¹⁰ The latter zone covers the three former administrative regions of Upper East, Upper West and Northern, combined with bordering districts in former Volta region and Brong Ahafo. In addition to improving irrigation infrastructure (mainly in Accra Plains), GCAP has added 15,790 MT storage capacity spread over 18 warehouses, 16 of which are located in the Northern SADA zone. Table 4.1. and its corresponding map present the spatial distribution of additional warehouses under GCAP in Northern Ghana. Most warehouse capacity has been added in Tamale Metropolitan district, thanks to the construction of a 5000-MT grain unit in this regional economic hub. Bordering Burkina Faso in the North, warehouse capacity also substantially increased in Sissala East, where the largest warehouse in Tanina (2,000 MT) can store legumes next to grains. Three districts of Northern Ghana have seen their grain storage capacity increase by around 1,000 MT with the construction of one bigger warehouse (800 MT) in Kumbungu and a combination of smaller storage units in Bolgatanga and Bawku West. In the remaining six districts, GCAP sponsored one additional storage facility of maximum 500 MT. Remarkably, all additional capacity sponsored by GCAP benefited the northeastern part of Northern Ghana. In addition, of the seven districts where V4CP-CSOs are active and focus on food and nutrition security (FNS), only Mion benefited from additional GCAP storage capacity.

Table 4.1. GCAP sponsored warehouses by district, Northern Ghana

District	Location	Crops	Capacity (MT)
Chereponi	Chereponi	Grains	500
Bolgatanga Municipal	- Bolgatanga	Grains	500
	- Bolgatanga	Grains	500
Sissala East	- Tumu	Grains	500
	- Tanina	Grains & Legumes	2,000
Kassena Nankana East	Navrongo	Grains	120
Bawku West	- Zangoyire	Grains	500
	- Zebila	Grains	500
	- Binaba	Grains	200
Builsa North	Sandema Builsa	Grains	200
Binduri	Bazua	Grains	400
Mion	Mion	Grains & Legumes	500
Kumbungu	Kumbungu	Grains	800
Tamale Metropolitan	- Tamale Central	Grains	120
	- Tamale Metro	Grains	5,000
Karaga	Karaga	Grains & Legumes	200

Source: Authors based on MOFA (2018:68).

Northern Rural Growth Programme (NRGP)

The Northern Rural Growth Programme (NRGP) ran from 2007 to 2016 in 32 districts in Northern Ghana. Based on three initial components, namely (i) commodity chain development, (ii) rural infrastructure, and (iii) access to financial services, the objective of NRGP is to sustainably strengthen rural livelihoods to fight poverty and improve food security. Under the second component, the program has built ten 1,000-MT warehouses and four packhouses, for packing fruits and vegetables. Table 4.2. and its corresponding map display the spatial distribution of ware- and packhouses under NRGP in Northern Ghana. Compared to the previous initiative, infrastructural investments under NRGP are more equally spread across the region, with none of the districts receiving more than one additional infrastructure. In intervention zones of V4CP-CSOs focusing on FNS, a warehouse and packhouse have been built respectively in Nanumba North and Talensi.

Table 4.2. NRGF sponsored infrastructure by district, Northern Ghana

District	Infrastructure type	Capacity (MT)
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¹⁰ See official website of Ghana Commercial Agriculture Project (<https://gcap.org.gh>).

Chereponi	Warehouse	1,000
Nanumba North	Warehouse	1,000
Gushiegu	Warehouse	1,000
Sawla-Tuna-Kalba	Warehouse	1,000
Savelugu-Nanton	Packhouse (fruit & vegetables)	na
Sissala West	Warehouse	1,000
Lawra	Warehouse	1,000
Nadowli	Warehouse	1,000
Jirapa	Packhouse (fruit & vegetables)	na
Bulisa South	Warehouse	1,000
Garu-Tempene	Warehouse	1,000
Kassena-Nankana East	Packhouse (fruit & vegetables)	na
Talensi	Packhouse (fruit & vegetables)	na

Source: Authors based on MOFA (2015b:49, 2016:40).

Ghana Grains Council (GGC)

Through the provision of capacity building and marketing services, the Ghana Grains Council (GGC) aims “to become the leading industry association supporting the competitiveness of West African grains Industry”.¹¹ A key service of GGC is its warehouse receipts system, which allows farmers to store excess production while using the receipt as loan collateral to obtain credit from financial institutions. As such, this initiative addresses the lack of storage facilities, improves farmer’s access to credit and facilitates market exchange through aggregation and quality control. Currently, GGC has 12 large certified and 22 approved community warehouses to store grains and legumes, with the community warehouses operating under a manual warehouse receipt pilot program. Table 4.3. and its corresponding map show the spatial distribution of additional storage facilities under GGC in Northern Ghana. Compared to the previous initiatives, GGC operates both at a higher and lower capacity level. The certified warehouses have the highest capacity, ranging from 1,000 MT in Savelugu-Nanton, Tolon and West Mamprusi to 6,000 MT in Sissala East and even 18,000 MT in Tamale Metropolitan. Regarding CSO-FNS operating with funding of the V4CP programme, none of the GGC certified warehouses were built in their focal districts. In contrast, the numerous but smaller community warehouses (either 80 or 200 MT) are more equally distributed across Northern Ghana. In some districts, multiple community warehouses have been built, like in Gushegu and Sissala East, resulting in a slightly higher combined storage capacity compared to other districts. In terms of CSO-FNS coverage, three out of seven districts received additional infrastructure: one 80-MT community warehouse in Talensi and one 200-MT community warehouse each in East Gonja and Nanumba North.

¹¹ See official website of Ghana Grains Council (www.ghanagrainscouncil.org/en/about-us/vision-mission).

Table 4.3. GGC certified and approved community warehouses by district, Northern Ghana

District	Location	Warehouse type	Capacity (MT)
Bawku West	Binaba	Community	200
Binduri	Bazua	Community	80
Bulsa North	Sandema	Community	200
East Gonja	Salaga	Community	200
Garu-Tempene	Garu	Community	80
Gushiegu	- Kapatinga - Kpugi - Shelilanyili	Community Community Community	80 80 200
Jirapa	Hain	Community	80
Karaga	Gaa	Community	80
Kpandai	Kpandai	Community	200
Nanumba North	Chamba	Community	200
Savelugu-Nanton	- Savelugu - Diare - Tamalgu	Certified Community Community	1,000 80 80
Sawla-Tuna-Kalba	Gindabuo	Community	80
Sissala East	- Tumu - Tumu - Bugubelle - Kruboi	Certified Community Community Community	6,000 80 80 80
Sissala West	Jawia	Community	80
Talensi	Pwalugu	Community	80
Tamale Metropolitan	- Lamashegu-Tamale - Datoyili-Ta-male - Chanzini-Ta-male	Certified Certified Certified	18,000 500 1,000
Tolon	Nyankpla	Certified	1,000
Wa East	- Bulenge - Loggu	Community Community	80 80
West Mamprusi	Walewale	Certified	1,000

Source: Authors based on data downloaded from www.ghanagrainscouncil.org (16 July 2019).

Ghana Commodity Exchange (GCX)

The Ghana Commodity Exchange (GCX) is an initiative similar to GGC, which functions as a trading platform linking buyers and sellers of commodities (currently only maize, soybean and sorghum) while providing services in terms warehousing and quality control.¹² Table 4.4. and its corresponding map provide an overview of current GCX warehouses, their location and characteristics in Northern Ghana. Similar to the previous initiatives, Tamale Metropolitan district has been well served with another 500-MT warehouse where all three crops can be stored, and which has a trading office attached. In Wa Municipal and Bulsa North, GCX warehouses are smaller and have fewer facilities, either in terms of crops or the presence of a trading office. In the intervention zones of CSO-FNS under the V4CP programme, again none of the corresponding districts has received additional infrastructure from GCX. In addition, farmers are required to store at least 1 MT of crops to access GCX facilities, which makes this initiative less adapted to smallholder farmers.

¹² See official website of Ghana Commodity Exchange (<https://gcx.com.gh>).

Table 4.4. GCX warehouses by district, Northern Ghana

District	Location	Crops and other characteristics	Capacity (MT)
Tamale Metropolitan	Tamale	- maize, soybean, sorghum - has trading office	500
Wa Municipal	Wa	- maize, soybean, sorghum	400
Bulsa North	Sandema	- maize - has trading office	250

Notes: GCX also has a satellite trading office in Tumu (Sissala East) yet without storage infrastructure.
Source: Authors based on data received from GCX.

Other policy initiatives

One-District-One-Factory (1D1F)

Set up under the direct supervision of the president of Ghana in 2017, the One-District-One-Factory (1D1F) initiative aims to stimulate economic growth at district level through industrialisation.¹³ Much of this initiative relies on the private sector, whereby the role of the government is limited to facilitating investment in basic infrastructure (power and feeder roads) and providing credit in the form of equity and long- and short-term trade/asset financing. Four financing brackets are defined, ranging from less than 50,000 USD (micro-scale) to more than 5,000,000 USD (large-scale). Although not confined to the agriculture sector, this industrialisation aims to reduce food imports and increase food availability.

The 1D1F-initiative has 151 running projects, most of which concern new factories, with a total of 69 factories currently in operation. More than two thirds of all ongoing projects focus on agriculture or a directly related industry (such as agro-processing, food and beverage processing). Table 4.5. and the corresponding map provide an overview of the eight factories scheduled under this initiative in Northern Ghana. Except for one (motor) bike assembler in Tamale Metropolitan, all factories involve agro and food processing. Three of them are located in Tamale Metropolitan, while the remaining four are scattered across the region, in Kumbungu, Garu-Tempane, Bolgatanga and Wa Municipal. To date, no factory is scheduled in the intervention zones of CSO-FNS operating under the V4CP programme.

While the reduction of PHL is not the ultimate objective of the 1D1F-initiative, the processing of food into derived products will extend shelf life of agricultural produce. Unfortunately, we were not able to access more detailed information on the status of operations, the precise nature of activities, nor related storage and processing capacity.

¹³ See official websites of One-District-One-Factory (<http://1d1f.gov.gh>).

Table 4.5. One-District-One-Factory by district, Northern Ghana

District	Industry	Factory activities
Tamale Metropolitan	Agro Processing	1. Manufacturing of cotton yarns 2. Rearing and processing of guinea fowl 3. Processing of sheanuts and soybean
Tamale Metropolitan	Manufacturing	Assembling and distribution of (motor) bikes
Kumbungu	Food Processing	Processing of cassava into industrial starch
Garu-Tempene	Agro Processing	Production of beverages
Bolgatanga	Agro Processing	Manufacturing of garment
Wa Municipal	Agro Processing	Processing of soybeans into cake and refined oil

Source: Authors based on data downloaded from www.1district1factory.gov.gh/about (12 December 2019).

Infrastructure for Poverty Eradication Programme (IPEP)

Another flagship programme initiated by the Government of Ghana and supervised by the Ministry of Special Development Initiatives (MSDI) is the Infrastructure for Poverty Eradication Programme (IPEP). This programme aims to reduce poverty and inequalities, especially in rural communities, through the provision of basic infrastructure.¹⁴ For each of the country's constituencies, the Cedi equivalent of 1 million USD is earmarked to construct improved toilet facilities, solar-powered water systems, small dams or prefabricated grains warehouses. Depending on the chosen infrastructure, this programme has received various labels, such as one-village-one-dam, one-district-one-warehouse or simply one-million-one-constituency. Table 4.6. and its corresponding map display the geographical distribution of IPEP grains warehouses in Northern Ghana, which all have a similar capacity of 1,000 MT. Again, Tamale Metropolitan district is best served as it received two warehouses, thus increasing its storage capacity with 2,000 MT. All other warehouses were constructed in different districts scattered across the region, but none (except one, Yendi) were located in the focal districts of CSO-FNS operating under the V4CP programme.

¹⁴ See official website of MSDI (www.msdi.gov.gh/ipep.html).

Table 4.6. IPEP warehouses by district, Northern Ghana

District	Location	Warehouse type and crops	Capacity (MT)
Bunkpurugu	Bunkpurugu	prefabricated grains warehouses	1,000
Central Gonja	Buipe	prefabricated grains warehouses	1,000
Tamale Metropolitan	- Tamale - Tamale	- prefabricated grains warehouses - prefabricated grains warehouses	1,000 1,000
Yendi	Yendi	prefabricated grains warehouses	1,000
Bawku Municipal	Bawku	prefabricated grains warehouses	1,000
Builsa North	Sandema	prefabricated grains warehouses	1,000
Garu-Tempene	Tempani	prefabricated grains warehouses	1,000
Kassena Nankana East	Navrongo	prefabricated grains warehouses	1,000
Kassena Nankana West	Paga	prefabricated grains warehouses	1,000
Pusiga	Pusiga	prefabricated grains warehouses	1,000
Lambussie Karni	Lambussie	prefabricated grains warehouses	1,000
Sissala East	Tumu	prefabricated grains warehouses	1,000
Wa East	Funsi	prefabricated grains warehouses	1,000

Source: Authors based on data downloaded from www.msdi.gov.gh/ipep.html (9 July 2019).

Combined storage capacity across districts in Northern Ghana

This section takes stock of the storage infrastructure in Northern Ghana across the six policies and initiatives discussed above, that is GCAP, NRGF, GGC, GCX, 1D1F and IPEP. Due to lacking information on processing, we only consider storage capacity. Furthermore, this overview is certainly not exhaustive. For example, the Rural Enterprises Programme (REP), headed by the Ministry of Trade and Industry, which aims at increasing the number of enterprises in all rural districts, is not considered in this chapter due to a lack of data. The same goes for Millennium Development Authority (MIDA) and Masara N'Arziki Farmers Cooperative (MAFA), which both implemented projects involving the increase in storage capacity throughout the country. In addition, by focusing on the most recent initiatives, we ignore any existing warehouse infrastructure.

Figure 4.2. presents two maps. The left-hand side map displays the number of different storage policy initiatives that have benefitted the districts in Northern Ghana. Receiving investments from five different initiatives (that is all except NRGF), Tamale Metropolitan is clearly best served, followed by Builsa North and Garu-Tempene, which each received additional storage infrastructure from four different programs. Sissala East and Kassena Nankana East were targeted by three different initiatives, while all remaining districts (45) were at best served by two programs. Regarding the intervention zones of CSO-FNS working under V4CP programme, Talensi and Nanumba North were assisted by two programs, and Yendi, Mion and East Gonja received one additional storage infrastructure. Wa West and Nanumba South so far have been ignored by the six policy initiatives discussed.

The right-hand side map of Figure 4.2. presents the combined additional storage capacity, expressed in metric tons (MT), resulting from investments under each of the six policy initiatives. Not surprisingly, the spatial distribution of additional storage capacity largely follows the same pattern as the number of implemented programs (cf. left-hand side map). With close to 30,000 MT of additional storage capacity, Tamale Metropolitan clearly stands out. As could be observed in previous sections, this outcome is mainly due to substantial investments under GGC (around 18,000 MT) and GCAP (around 5,000 MT). The same observation applies to Sissala East, whose accumulated warehouse capacity increased by almost 10,000 MT, mainly stemming again from GGC (around 6,000 MT) and GCAP (2,500 MT). Despite being served by at least three programs, Builsa North, Garu-Tempene and Kassena Nankana East saw their storage capacity increase by 1500-2100 MT for the first two districts and by 1000-1500 MT for the latter. Among districts targeted by CSO-FNS under V4CP programme, Nanumba North was best served with additional storage capacity amounting to slightly more than 1000 MT, which results from the construction of NRGF and GGC warehouses. Yendi also received a 1000-MT warehouse with IPEP funding, while increased storage capacity in the other CSO-FNS districts was lower than 1000 MT.

Figure 4.2. Combined additional storage capacity, Northern Ghana

Note: The six policy initiatives involve Ghana Commercial Agriculture Project (GCAP), Northern Rural Growth Programme (NRGP), Ghana Grains Council (GGC), Ghana Commodity Exchange (GCX), One-District-One-Factory (1D1F) and Infrastructure for Poverty Eradication Programme (IPEP).

Source: Authors based on MOFA (2018:68; 2016:40; 2015b:49), data received from GCX and data downloaded from www.ghanagrainscouncil.org (16 July 2019); www.1district1factory.gov.gh/about (12 December 2019); www.msdi.gov.gh/ipep.html (9 July 2019).

4.3. LINKING STORAGE INFRASTRUCTURE AND AGRICULTURAL NEEDS

Having sketched a broad overview of recent investments in storage infrastructure in Northern Ghana, this section brings in spatial data on agricultural production and PHL in order to see how these investments match up with current agricultural needs, as well as to guide future investments. To do so, we develop a **relative adequacy index** (RAI) which assumes that the level of storage capacity should broadly align with the level of agricultural production (or PHL). If this index is close to 100%, it means that the ratio of storage capacity over agricultural production (or PHL) is similar to the average ratio observed across the region; if the index is below 100%, then a district is relatively undersupplied with storage facilities. That is, other districts, relative to what they produce (or what gets lost), received more storage capacity, and vice versa for indices above 100%.

Relying on this RAI measure, Figure 4.3. displays combined additional storage capacity relative to overall production of dry crops, such as cereals and beans.¹⁵ Due to the substantial investments described above, Tamale metropolitan and Sissala East are relatively oversupplied with additional storage facilities. Kassena Nankana East and West, Bunkpurugu and Chereponi have also received more additional capacity compared to other districts with similar levels of agriculture production, yielding a RAI above 170%. On the other end of the spectrum, there are 19 districts which, compared to their agricultural output, were insufficiently served by the recent storage programs, recording RAI of below 30%. These districts are located in scattered fashion across northern Ghana, with some concentration around Tamale metropolitan, which might serve as a regional storage hub for its surrounding districts. Only one CSO-FNS intervention zone, Nanumba North, received additional storage facilities according to its level of agricultural production, yielding a RAI between 90% and 110%. In contrast, the other intervention zones of CSO-FNS operating under the V4CP programme, are all relatively undersupplied, with a RAI below 30%. Unless these undersupplied districts are served by initiatives outside those discussed in this chapter, future investments to increase storage capacity should be targeted to districts with the lowest RAI.

¹⁵ Here we assume that all warehouses discussed in this chapter are able to store dry crops, such as maize, millet, rice, sorghum, soybean and cowpea.

Figure 4.3. Combined additional storage capacity versus agricultural production, Northern Ghana

Source: Authors based on MOFA (2018:68; 2016:40; 2015b:49), data received from GCX and data downloaded from www.ghanagrainscouncil.org (16 July 2019); www.1district1factory.gov.gh/about (12 December 2019); www.msdi.gov.gh/ipep.html (9 July 2019); <https://eatlas.resakss.org/Ghana/en> (16 July 2019).

The above analysis broadly indicates where storage facilities might be most desirable in terms of agricultural output, yet the government of Ghana's primary aim was reducing PHL. In this sense, storage infrastructure should be prioritized in areas suffering most from PHL. Using household data from the latest Ghana Living Standard Survey (GLSS7) conducted in 2016/2017, we estimate crop losses along the household value chain. More specifically, we define PHL as the difference between the total quantity harvested over the past year (augmented with the amount of stock from the previous period) and the sum of its various uses, such as food used for payment in kind to landlord and day labourers, food stored for future seeding, food processed or consumed by the household and food used to increase current stocks. Undeniably, this household survey has not been conceived to produce accurate PHL estimates at district level, which requires other and more tailored surveys. Indeed, various issues complicate a straightforward estimation of PHL at household level: (i) use of different measurement units across various food uses, (ii) restriction of stock information to the major crops only with long recall periods, (iii) potential overlap between consumption from one's own production and processed food, (iv) lack of information on food losses during processing and (v) non-representative sample at district level. Despite these limitations, the PHL estimates derived from GLSS7 broadly align with those observed in a recent study in Sawla-Tuna-Kalba and Kintampo North districts, which examined PHL using farmers' declarations and objective measurement (GSARS, 2017).

Table 4.7. presents PHL estimates of key food staples in seven selected districts in Northern Ghana, all expressed as the total amount of food lost along the household value chain divided by the total amount of food harvested (including food stocks at the beginning of the agricultural year). For the four main cereals produced in Northern Ghana, PHL range from 4.6% for maize to 20.3% for sorghum, both estimates from Nanumba North. In Talensi, maize losses were similar (5.4%), sorghum losses were smaller (5.5%), and millet PHL amounted to 18.8%. The remaining districts' PHL estimates for cereals in Table 4.7. all fall within a 11-13% interval. With an estimate of 18.9% for yam, Nanumba North appears to suffer substantially more from PHL in root and tubers compared to East Gonja, whose estimates are almost twice as low. For pulses, the level of PHL is generally higher, ranging between 12.7% for beans in Talensi and 31.1% for groundnuts in Wa West. The remaining groundnut producing districts in Table 4.7.—Nanumba North and West, and East Gonja—all suffer from PHL close to 20%.

Table 4.7. Household-level PHL estimates (%) by selected district, Northern Ghana

District	maize	rice	sorghum	millet	cassava	yam	beans	ground-nut
Wa West	11.6	na	na	12.8	na	na	23.2	31.1
Talensi	5.4	na	5.5	18.8	na	na	12.7	14.4
Mion	na	na	na	na	na	na	na	na
Yendi	na	na	na	na	na	na	na	na
Nanumba N.	4.6	na	20.3	na	na	18.9	14.0	20.1
Nanumba S.	12.4	na	na	na	na	na	na	18.8
East Gonja	11.1	na	na	na	9.2	11.1	na	21.5

Notes: Given the severity of methodological issues, these PHL estimates only provide a rough indication of food losses at district level.

Source: Authors based on GLSS7 (2016/2017).

By multiplying district-level PHL for dry crops with corresponding estimates on actual production, we obtain another indication of where storage capacity would be most useful. Relying on the RAI measure, Figure 4.4. displays combined additional storage capacity relative to estimated amounts of PHL for dry crops. Despite wide variation in PHL as discussed above, the overall picture remains broadly the same. Again, Sissala East, Kassena Nankana East and West, and Bunkpurugu figure among districts relatively oversupplied with additional storage infrastructure. According to this metric, Sissala West and Nanumba North appear to be relatively oversupplied as well, each having a RAI above 140%. This observation reflects the relatively lower PHL in those districts, especially for dry crops, which represent a higher share in overall production. In the other intervention zones of CSO-FNS working under the V4CP programme, the same insufficient RAIs prevail. Having been insufficiently served by the crop storage programs discussed in this chapter, future investments to increase storage infrastructure should be directed to Wa West, Talensi, East Gonja and Nanumba South, as well as to other districts with RAIs below 30%.

Figure 4.4. Combined additional storage capacity versus PHL estimates, Northern Ghana

Source: Authors based on MOFA (2018:68; 2016:40; 2015b:49), GLSS7 (2016/2017), data received from GCX and data downloaded from www.ghanagrainscouncil.org (16 July 2019); www.1district1factory.gov.gh/about (12 December 2019); www.msdi.gov.gh/ipep.html (9 July 2019); <https://eat-las.resakss.org/Ghana/en> (16 July 2019).

4.4. CONCLUDING REMARKS

In SDG 12.3, as well as throughout the latest flagship report by FAO (2019), the issue of PHL is gaining traction among policy-makers and development partners. Apart from international attention, Ghana is implementing policies and undertaking various initiatives to reduce PHL, which remain a major obstacle to the country's food security. PHL constitute a waste of resources, imply reduced incomes to farmers and result in less food being supplied to the market. The importance of dealing with PHL is further confirmed by data from GLSS7 (2016/2017), which allowed to calculate district-level PHL estimates for the country's main crops.

In this chapter, we discussed six recent major policy initiatives, each of which involved the construction of off-farm storage capacity and/or processing capacity, including: (i) GCAP, (ii) NRGP, (iii) GGC, (iv) GCX, (v) 1D1F and (vi) IPEP. For each policy or initiative, we described its main objective, tabulated the various infrastructures and related characteristics, and mapped the locations. This stocktaking exercise was limited to 50 districts in Northern Ghana, covering the former administrative regions of Upper East, Upper West and Northern. We devoted special attention to seven districts that are the main intervention zones of various CSOs focusing on FNS under the Voice for Change Partnership (V4CP) program.

Several districts in Northern Ghana were notably underserved by the six policies discussed in this chapter. These districts either did not receive additional storage infrastructure, or their storage capacity is far below the level of dry crop production or corresponding PHL, relative to other districts in Northern Ghana. Apart from Nanumba North, districts targeted by CSOs under the V4CP programme, suffer from severe undersupply of additional storage capacity, and should therefore receive attention in the future. Most additional infrastructure has been concentrated in Tamale Metropolitan and, to a lesser extent, in Sissala East. This concentration would make sense if farmers located far from these hubs can easily access the regional infrastructure. In this respect, it is worth mentioning that some initiatives may be less adapted to smallholders, such as GCX, which requires a minimum storage of 1MT to utilise the facility. It is unclear whether similar requirements apply for the various other initiatives.

Of course, the overview produced in this chapter is not exhaustive; it is largely driven by available information. It also does not account for existing infrastructure. There is a clear bias toward storage capacity as opposed to processing capacity, which is more important to address PHL of roots and tubers. As it is largely confined to storage, this chapter may contribute to ongoing efforts to compile an inventory of all available warehouses and their functionality across the country, one of the major activities under the PFJ policy (MOFA 2017).

ADVOCACY NOTE ON CHAPTER 4

Key messages from this chapter:

1. Post-harvest losses (PHL) are a major problem in Ghana. PHL inefficiently use productive resources and unnecessarily contribute to greenhouse gas emissions; they also threaten the country's food and nutrition security.
2. The government of Ghana has implemented or facilitated various policies and initiatives to reduce PHL through the provision of additional off-farm storage and processing capacity. These include: (i) Ghana Commercial Agriculture Project (GCAP), (ii) Northern Rural Growth Programme (NRGP), (iii) Ghana Grains Council (GGC), (iv) Ghana Commodity Exchange (GCX), (v) One-District-One-Factory (1D1F) and (vi) Infrastructure for Poverty Eradication Programme (IPEP).
3. Paying attention to the spatial dimension (the geographic distribution of storage and processing infrastructure) will improve targeting of future investments and increase the efficiency of the country's food system.
4. Using a relative adequacy index (RAI) based on (i) additional storage capacity from six major policies, and (ii) estimates of agricultural production and PHL, we observe a marked geographic disparity across districts in Northern Ghana. Whereas Tamale metropolitan and Sissala East are clearly best served, many districts were insufficiently served or did not benefit at all by any of the recent storage programs or initiatives.
5. The most deficient districts in terms of additional storage capacity relative to dry crop production and PHL are summarised in the table below.

Relative to:	Most undersupplied districts in Northern Ghana
Dry crop production	Wa Municipal, Jirapa, Bongo, Wa West, Mamprusi East., Bole, Saboba, Daffiama, Nandom, Talensi, West Gonja, Yendi, Tolon, Zabzugu, Nanumba South, Savelugu, Karaga, Kpandai, East Gonja
Dry crop PHL	Wa Municipal, Jirapa, Bongo, Wa West, Sawla-Tuna-Kalba, Mamprusi East, Daffiama, Nandom, Talensi, Mamprusi West, Nanumba South, Karaga, East Gonja

Chapter 5

BOTTLENECKS AND LOCATION-SPECIFIC ADVOCACY SOLUTIONS

The basic premise of this policy atlas is that **agricultural transformation takes place in a heterogeneous context**. By being geographically sensitive and taking account of biophysical, economic and social variations across the country, policy design and implementation could be more effective. While this viewpoint became part of mainstream development discourse several decades ago, tools that can handle heterogeneity have remained rare. In this policy atlas, we rely on maps to highlight and describe heterogeneity, identify bottlenecks and to suggest location-specific advocacy solutions.

Maps are powerful tools to capture heterogeneity, prioritise and develop an advocacy strategy. By disaggregating data by a country's administration units (i.e. regions, districts), different data, such as food production, consumption or climate data, can be combined in the same analysis—even though they may be measured in very different ways. Maps allow data and findings to be summarised in a concise visual picture, in contrast to a table that would require many rows (one for each region or district) and be unattractive and unable to display spatial relationships. Finally, maps can tell a convincing story instantly, which is an important feature when dealing with time-constrained policy makers.

Now, what is the story told by this policy atlas?

Hidden hunger is a serious challenge in most regions of the country. Even though households (on average) meet 82% of their recommended protein intake, micronutrient adequacies are substantially lower. Calcium, iron and vitamin B12 are most problematic, with national adequacy rates ranging from 25.1% to 42.3%. Intakes of folate, zinc, and vitamin A are slightly higher, ranging between 48.0% and 57.6%. Because adequately consuming micronutrients leads to better nutrition outcomes, addressing hidden hunger could be an important advocacy topic for CSOs. Since many donors and development agencies nowadays require interventions to be “nutrition-sensitive,” CSOs could help harmonise government efforts along the full food system, from production to final consumption.

As mentioned in the introduction, the CSOs working on FNS under the V4CP programme mostly focus on removing **access constraints** and particularly on reducing PHL. Although access inefficiencies are ubiquitous across the country, **Bawku, Gonja, Gushiegu, Saboba Chereponi, Nkwanta, Afram Plains, Amansie, Aowin-Suaman and Asunafo** suffer from both lower-than-average access efficiencies and the highest anaemia rates among women of reproductive age, making them high-priority areas. While other districts may suffer equally from low access efficiency (as is the case for many districts in Northern Ghana), the effect on final nutrition outcomes is smaller. In a similar vein, there may be other high-priority districts that could also benefit from increasing access efficiency, but other bottlenecks appear more critical.

According to the nutrient adequacy analysis in Chapter 3, the distribution of cassava, maize, rice and cowpeas—currently the most important sources of calcium, iron, zinc and folate—suffers from “nutrient loss”, which in turn leads to micronutrient deficiencies among the local population. Assuming limited cross-border trade, this observation points to PHL that are most pronounced in Upper West, Central, Northern and Volta regions for cassava, and involve roughly all regions of the country for maize, rice and cowpeas. Given that Upper West, Upper East and Northern are currently producing surplus amounts of iron, zinc and folate, policies might further tap into the agroecological potential of this part of the country, while building appropriate transport, storage and processing infrastructure to link northern production sites to southern consumption centres.

The inventory and spatial analysis of Chapter 4 revealed an uneven endowment in off-farm storage (and processing) infrastructure in Northern Ghana related to six recent major policy implementations. Unless they are covered by other infrastructure programs, several districts in Northern Ghana have not received their proportional share of additional storage capacity relative to the level of dry crops they produce or their corresponding PHL. In fact, most additional infrastructure has been concentrated in Tamale Metropolitan and, to a lesser extent, in Sissala East. This concentration would only make sense if farmers located further from these hubs could reach and access the new infrastructure.

In addition to access inefficiencies impeding FNS, various areas of the country face **production constraints**. These constraints appear most critical in the high-priority districts of **Bawku, Gonja, Gushiegu, Keta, Komenda-Edina-Eguafo-Abirem, Lawra, Nkwanta, Saboba Chereponi, Tema, Tongu and Wasa Amenfi**. Since most of these districts also have higher agricultural potential, removing production constraints might have a multiplier effect on the reduction of national production shortages in calcium, iron and zinc. Moreover, given that the same districts are mostly located in the country's north, increasing production efficiencies might naturally lead to the development of breadbaskets of cassava, maize and rice, unless other regions are equally

suitable for the cultivation of these crops. In any case, to increase people's intake of calcium, markets in Brong Ahafo, Ashanti, Greater Accra, Eastern and Western should be better supplied, either with locally-produced cassava or with cassava grown in the northern part of Ghana. Similarly, markets in the most southern regions, especially in Greater Accra, Ashanti and Western, need greater supplies of maize and rice in order to increase local intake of iron and zinc. If a strategy of concentrated production hubs is preferred, accompanying measures of market integration should be considered.

Utilisation constraints appear critical to most of the districts suffering from high anaemia rates among women, particularly in **Keta, Komenda-Edina-Eguafo-Abirem, Tema, Tongu, Wasa Amenfi, Nkwanta, Afram Plains, Amansie, Aowin-Suaman, Asunafo, Agona, Gomoa and Sefwi Wiawso**. In these districts, access to a diverse range of food items is less important than how the foods are utilised at the household level to generate nutrition outcomes. Apart from culinary practices and intra-household allocation, nutritional health outcomes also depend on healthcare, water and sanitation infrastructure and practices.

Not all targeting should be driven by geographic location. Large numbers of deprived and malnourished people may live in administrative areas with average performances that appear less critical due to pronounced internal inequality within those areas. Addressing FNS bottlenecks may take time. In the short run **social protection programs** could guarantee minimal intake of key nutrients for the most undernourished households. These programs could take the form of food or cash transfers, food fortification, nutrient supplementation or **nutrition awareness campaigns** aimed at redirecting people's food preferences towards more nutritious and balanced diets. Largely consisting of empty calories, Ghana's overreliance on rice could be replaced by more nutrient-dense, cost-effective alternatives: cassava to increase intake of calcium; millet and sorghum to increase intake of iron and zinc; canned fish products to increase intake of vitamin B12; cocoyam leaves and groundnuts to increase intake of folate; and carrots to increase intake of vitamin A.

Various key **policies and programs on agriculture, nutrition and PHL could be enriched with more spatial detail**. The maps in this policy atlas could thus help CSOs prioritise selection of advocacy topics and corresponding strategies to inform policies on how to best address location-specific bottlenecks across the country.

REFERENCES

- Codjoe, S. N. A., & Dzanku, F. M. (2009). Long-term determinants of deforestation in Ghana: The role of structural adjustment policies. *African Development Review*, 21(3), 558–588. <https://doi.org/10.1111/j.1467-8268.2009.00223.x>
- Delgado, L., Schuster, M., & Torero, M. (2017). *The Reality of Food Losses; A New Measurement Methodology* (IFPRI Discussion Paper No. 01686). Washington, DC.
- Ericksen, P. J. (2008). Conceptualizing food systems for global environmental change research. *Global Environmental Change*, 18, 234–245. <https://doi.org/10.1016/j.gloenvcha.2007.09.002>
- FAO. (2011). *Continental Programme on Post-Harvest Losses (PHL) Reduction; Rapid Country Needs Assessment*. Rome: Food and Agricultural Organization of the United Nations.
- FAO. (2014). *Definitional Framework of Food Loss*. Rome: Food and Agricultural Organization of the United Nations.
- FAO. (2019). *The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction*. Rome: Food and Agriculture Organization of the United Nations. <https://doi.org/10.4324/9781315764788>
- Gillespie, S., & van den Bold, M. (2017). Agriculture, Food Systems, and Nutrition: Meeting the Challenge. *Global Challenges*, 1(3), 1–12. <https://doi.org/10.1002/gch2.201600002>
- Global Panel on Agriculture and Food Systems for Nutrition. (2016). *Food systems and diets: Facing the challenges of the 21st century*. London. <https://doi.org/http://glopan.org/sites/default/files/ForesightReport.pdf>
- GSARS. (2017). *Field Test Report on the Estimation of Crop Yields and Post-Harvest Losses in Ghana*. Rome: Global Strategy to improve Agricultural and Rural Statistics.
- GSS. (2018). *Ghana - Ghana Living Standard Survey (GLSS 7) 2017*. Accra: Ghana Statistical Service. Retrieved from <http://www.statsghana.gov.gh/nada/index.php/catalog/97>
- Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., & Meybeck, A. (2011). *Global food losses and food waste*. Rome: Food and Agricultural Organization of the United Nations.
- Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., ... Townshend, J. R. G. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, 342(November), 850–853. <https://doi.org/10.1126/science.1244693>
- ISSER/EGC. (2015). *Ghana Socioeconomic Panel Survey: 2009 -2010*. Accra: Institute of Statistical, Social and Economic Research (ISSER), University of Ghana and Economic Growth Center (EGC), Yale University.
- Jones, A. D., & Ejeta, G. (2015). A new global agenda for nutrition and health: the importance of agriculture and food systems. *Bulletin World Health Organization*, 94(December), 228–229. <https://doi.org/10.2471/BLT.15.164509>
- Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O., & Ward, P. J. (2012). Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. *Science of the Total Environment*, 438, 477–489. <https://doi.org/10.1016/j.scitotenv.2012.08.092>
- Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R., & Searchinger, T. (2013). *Reducing Food Loss and Waste*. World Resource Institute. Washington, DC: World Resource Institute. Retrieved from <http://unep.org/wed/docs/WRI-UNEP-Reducing-Food-Loss-and-Waste.pdf>
- MOFA. (2007). *Food and Agriculture Sector Development Policy (FASDEP II)*. Accra: Ministry of Food and Agriculture.
- MOFA. (2010). *Medium Term Agriculture Sector Investment Plan (METASIP), 2011-2015*. Accra: Ministry of Food and Agriculture.
- MOFA. (2015a). *2014 Agric Sector Annual Progress Report*. Accra: Ministry of Food and Agriculture.
- MOFA. (2015b). *Medium Term Agricultural Sector Investment Plan (METASIP) II, 2014–2017*. Accra: Ministry of Food and Agriculture.
- MOFA. (2015c). *Multi-Round Annual Crop and Livestock Survey (2015)*. Accra: Ministry of Food and Agriculture.
- MOFA. (2016a). *Agricultural Sector Progress Report 2015*. Accra: Ministry of Food and Agriculture.
- MOFA. (2016b). *Agriculture in Ghana: Facts and Figures (2015)*. Accra: Ministry of Food and Agriculture.
- MOFA. (2017). *Planting for Food and Jobs; Strategic Plan for Implementation (2017-2020)*. Accra: Ministry of Food and Agriculture.
- MOFA. (2018). *Investment Guide for the Agriculture Sector in Ghana*. Accra: Ministry of Food and Agriculture. Retrieved from <http://mofa.gov.gh/site/wp-content/uploads/2018/11/Final Draft Agric Investment Guide 2018-10-19.pdf>
- Mutungi, C., & Affognon, H. (2013). *Gaps and Outlook for Postharvest Research and Innovation in Ghana*. ICIPE Policy Brief no 4/13. Nairobi: International Centre of Insect Physiology and Ecology. Retrieved from <https://idl-bnc-idrc.dspacedirect.org/handle/10625/52221>
- Pangaribowo, E. H., Gerber, N., & Torero, M. (2013). *Food and nutrition security indicators: A review* (ZEF Working Paper No. 108). Bonn. <https://doi.org/ISSN 1864-6638>
- Pinstrup-Andersen, P. (2013). Nutrition-sensitive food systems: From rhetoric to action. *The Lancet*, 382, 375–376. [https://doi.org/10.1016/S0140-6736\(13\)61053-3](https://doi.org/10.1016/S0140-6736(13)61053-3)
- ReSAKSS. (2016). Ghana eAtlas. Retrieved November 15, 2018, from <http://eatlas.resakss.org>
- Stadlmayr, B., Charrondiere, R. U., Enujiugha, V. N., Bayili, R. G., Fagbohoun, E. G., Samb, B., ... Burlingame, B. (2012). *West African Food Composition Table*. Rome: Food and Agricultural Organization of the United Nations. Retrieved from <http://www.fao.org/docrep/015/i2698b/i2698b00.pdf>
- Stephens, E. C., Jones, A. D., & Parsons, D. (2018). Agricultural systems research and global food security in the 21st century: An overview and roadmap for future opportunities. *Agricultural Systems*, 163, 1–6. <https://doi.org/10.1016/j.agsy.2017.01.011>
- Sugri, I. (2016). *Reducing the high cyclical losses after harvest in northern Ghana*. The Africa Research In Sustainable Intensification for the Next Generation.
- Sumberg, J., Jatoo, J., Kleih, U., & Flynn, J. (2016). Ghana's evolving protein economy. *Food Security*, 8(5), 909–920. <https://doi.org/10.1007/s12571-016-0606-6>
- Tanko, B. (2019). Planting for Food and Jobs (PFJ) Campaign for 2019 Launched. Retrieved July 9, 2019, from <http://mofa.gov.gh>
- Tendall, D. M., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q. B., ... Six, J. (2015). Food system resilience: Defining the concept. *Global Food Security*, 6(October), 17–23. <https://doi.org/10.1016/j.gfs.2015.08.001>
- Torero, M. (2014). Targeting investments to link farmers to markets: a framework for capturing the heterogeneity of smallholder farmers. In P. B. R. Hazell & A. Rahman (Eds.), *New Directions for Smallholder Agriculture*. Oxford: Oxford University Press.

<https://doi.org/10.1093/acprof>

- Vowotor, K. A., Mensah-Bonsu, A., Mutungi, C., & Affognon, H. (2013). *Postharvest losses in Africa – Analytical review and synthesis: the case of Ghana*. Nairobi: International Centre for Insect Physiology and Ecology.
- WFP. (2008). *Food Consumption Analysis, Calculation and use of the food consumption score in food security analysis*. Rome: World Food Programme, Vulnerability Analysis and Mapping Branch (ODAV).
- Xiong, J., Thenkabail, P. S., Tilton, J. C., Gumma, M. K., Teluguntla, P., Oliphant, A., ... Gorelick, N. (2017). Nominal 30-m cropland extent map of continental Africa by integrating pixel-based and object-based algorithms using Sentinel-2 and Landsat-8 data on Google Earth Engine. *Remote Sensing*, 9(10), 1–27. <https://doi.org/10.3390/rs9101065>

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About the Authors

Wim Marivoet is Research Fellow, **John M. Ulimwengu** is Senior Research Fellow, and **Leysa Maty Sall** is research analyst in the West and Central Africa Office of the International Food Policy Research Institute (IFPRI). This policy atlas has been prepared in close collaboration with the ReSAKSS eAtlas technical team led by Mohamed Abd Salam El Vilaly and Racine Ly, and with Manson Nwafor (ReSAKSS-WA). The authors wish to acknowledge the input of many participants who contributed to the discussion at various in-country workshops (2018-2020). They are also grateful to Fernando Sedano and Samuel Benin for their assistance with data analysis and commenting on individual chapters, and to Julie Kurtz and Fleur Wouterse for copy-editing and final revision.

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West and Central Africa Office | Lot #2 Titre 3396 - BP 24063, Dakar-Almadies, Senegal

Tel: +221 33 869 98 00 | Fax: +221 33 869 98 41

Email: ifpri-dakar@cgiar.org | wca.ifpri.info

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