VOICE FOR CHANGE PARTNERSHIP (V4CP)

Ghana

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

Wim MARIVOET and Leysa Maty SALL

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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#)

In his 2019 State of the Nation Address, the President of Ghana points 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).

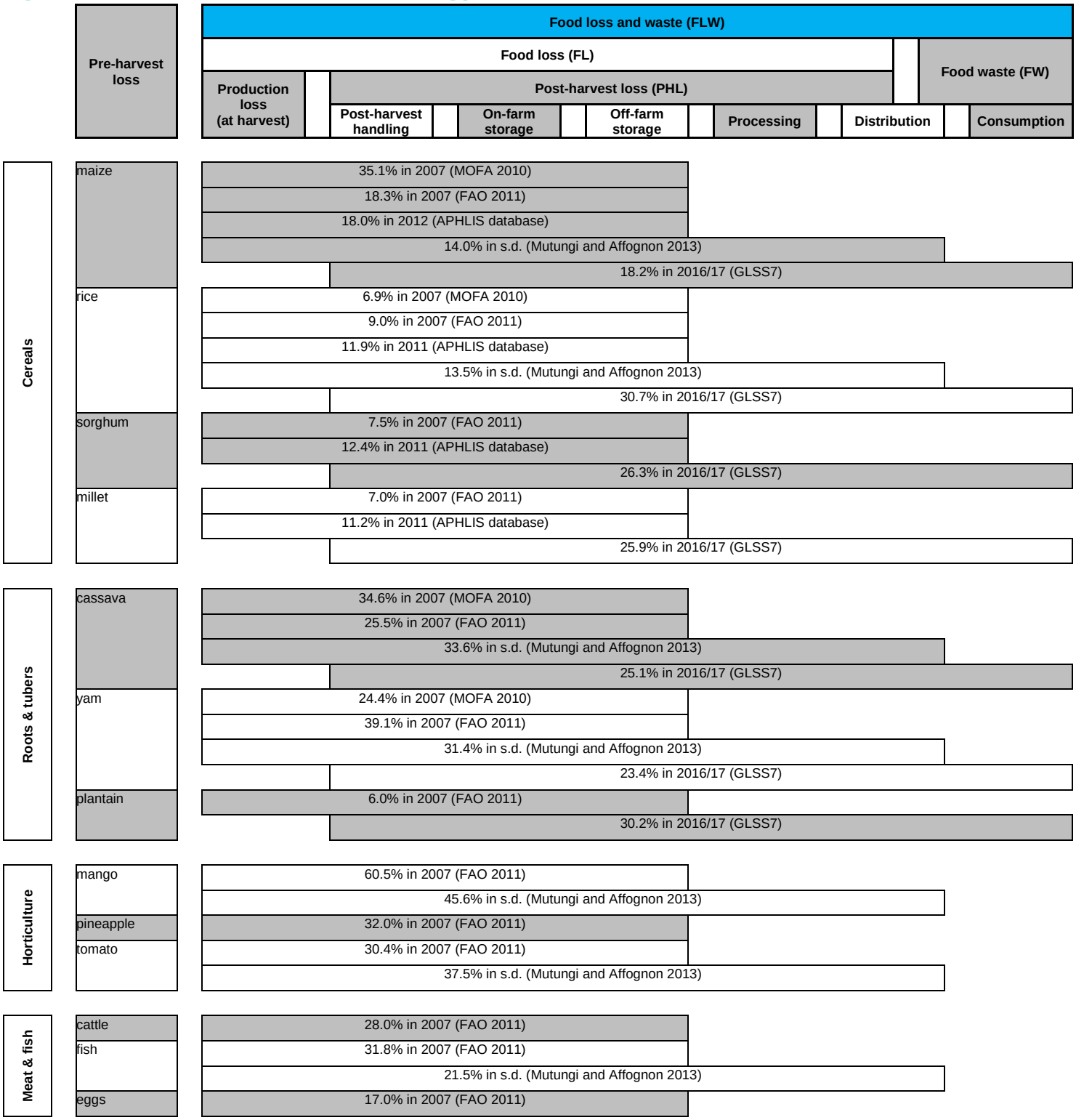
PHL are a particular subset of unintentional food losses which occur after harvest and before consumption. Losses observed during agricultural production (that is at harvesting) should be excluded from PHL, although this is not always the case (Delgado et al. 2017). Losses observed at consumption stage 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.[1] Globally, total FLW is estimated at 32% of total production (Gustavsson et al. 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 1 presents some key estimates of crop losses observed in Ghana along various stages of the food value chain.

[1] 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 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. Remarkably however is that the 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. Especially mango, with an estimated FLW of more than 60%, stands out.

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 policy case 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 brief 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).

POLICIES AND INITIATIVES ON STORAGE AND 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 or initiative, but restricted to the three former most northern administrative regions (that is Upper East, Upper West and Northern region), we will tabulate and map all recently added infrastructure by district (50), including additional information on crops, facilities and capacities. At the end of this section, all information will be combined in two more 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 puts emphasis on the sustainable utilisation of resources and on 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 2015a). 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 2015a). The following four key initiatives stand out.

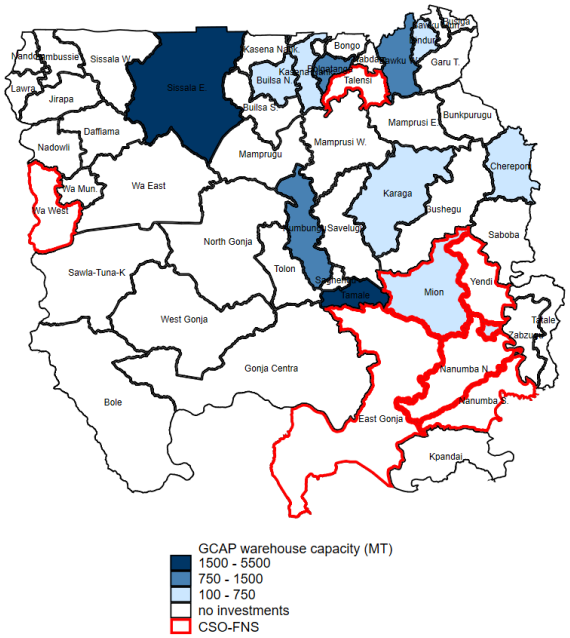
Ghana Commercial Agriculture Project (GCAP)

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.[2] The latter zone covers the three (previous) administrative regions of the Upper East, Upper West and Northern region, combined with bordering districts in (previous) 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 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, which follows mainly from 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 with around 1,000 MT: whereas in Kumbungu this relates to the construction of one bigger warehouse (800 MT), the capacity increase in the other two districts is characterised by various smaller units (two additional storage units in Bolgatanga and three in Bawku West). In the remaining six districts, GCAP sponsored each time one additional storage facility of maximum 500 MT. Remarkably, when drawing a northwest-to-southeast diagonal through Northern Ghana, one can observe that all additional capacity under GCAP was realised the northeastern part of this region. In addition, of the seven districts where V4CP-CSOs are active and focus on food and nutrition security (FNS), only Mion could profit from additional GCAP storage capacity.

Table 1. GCAP sponsored warehouses by district, Northern Ghana

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

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



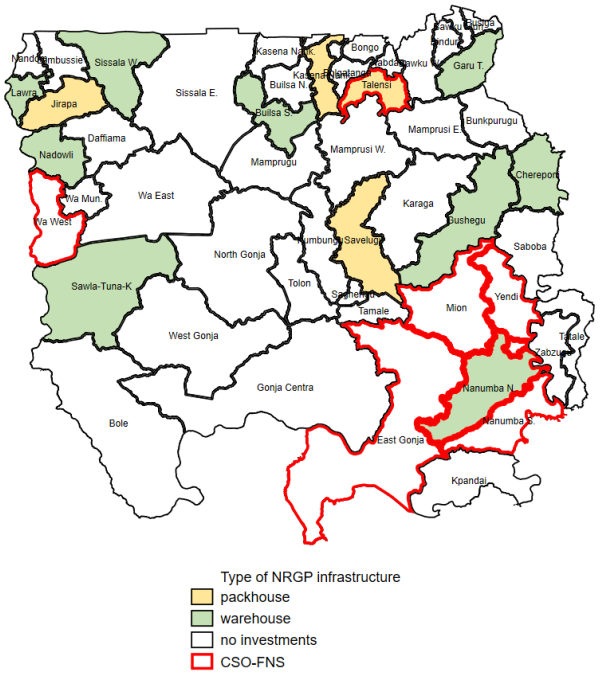
[2] See official website of Ghana Commercial Agriculture Project (https://gcap.org.gh).

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, which are (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, this program has built ten 1,000-MT warehouses and four packhouses, for packing of fruit and vegetables. Table 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 while none of the districts receive more than one additional infrastructure. Regarding the intervention zones of V4CP-CSOs focusing on FNS, a warehouse and packhouse have been built respectively in Nanumba North and Talensi.

Table 2. NRGP sponsored infrastructure by district, Northern Ghana

District	Infrastructure type	Capacity (MT)
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
Builsa South	Warehouse	1,000
Garu-Tempane	Warehouse	1,000
Kassena-Nankana East	Packhouse (fruit & vegetables)	na
Talensi	Packhouse (fruit & vegetables)	na



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

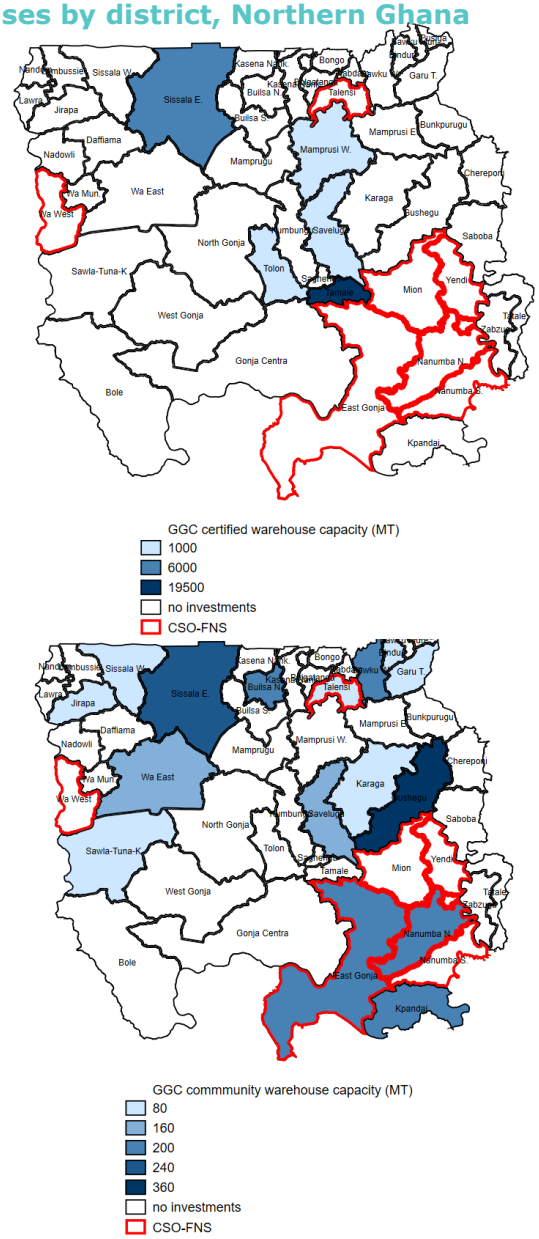
Ghana Grains Council (GGC)

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".[3] 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; whereby the latter type operates under a manual warehouse receipt pilot program. Table 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 program, none of the GGC certified warehouses were built in their focal districts. In contrast, the numerous community warehouses are much smaller (either 80 or 200 MT), but 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.

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

Table 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
Builsa North	Sandema	Community	200
East Gonja	Salaga	Community	200
Garu-Tempane	Garu	Community	80
Gushegu	- 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).

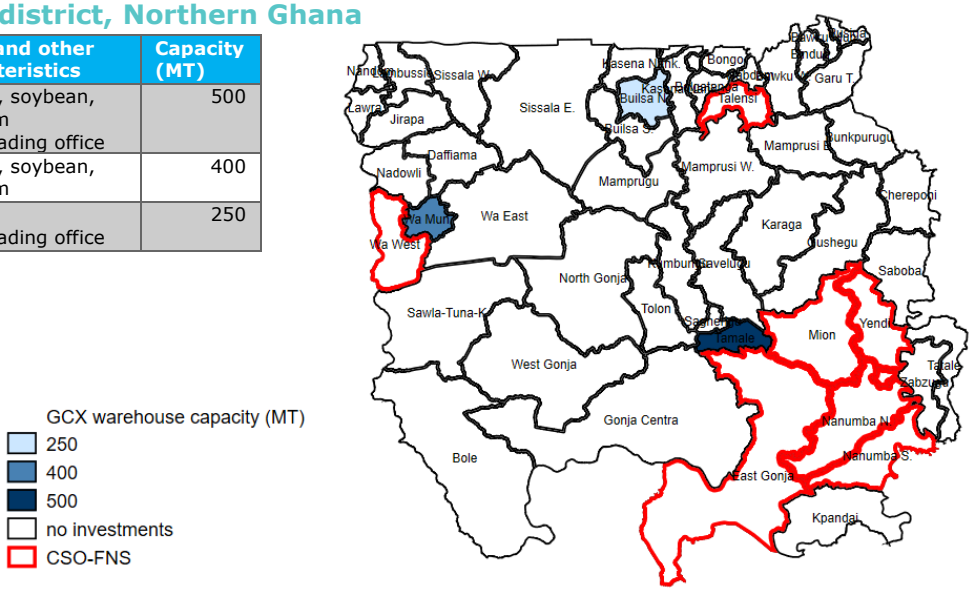
Ghana Commodity Exchange (GCX)

A similar initiative as GGC is Ghana Commodity Exchange (GCX), which functions as trading platform linking buyers and sellers of commodities (currently only maize, soybean and sorghum) while providing services in terms warehousing and quality control.[4] Table 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 Builsa North, GCX warehouses are smaller and have less facilities, either in terms of crops or the presence of a trading office. Regarding the intervention zones of CSO-FNS under the V4CP program, again none of the corresponding districts has received additional infrastructure from GCX. In addition, to access GCX facilities, farmers are required to store at least 1 MT of crops, which makes this initiative less adapted to smallholder farmers.

[4] See official website of Ghana Commodity Exchange (https://gcx.com.gh).

Table 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
Builsa 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.[5] Much of this initiative relies on the private sector, whereby the role of the government is limited to facilitation in terms of investing 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 drive aims at reducing food imports and increase food availability.

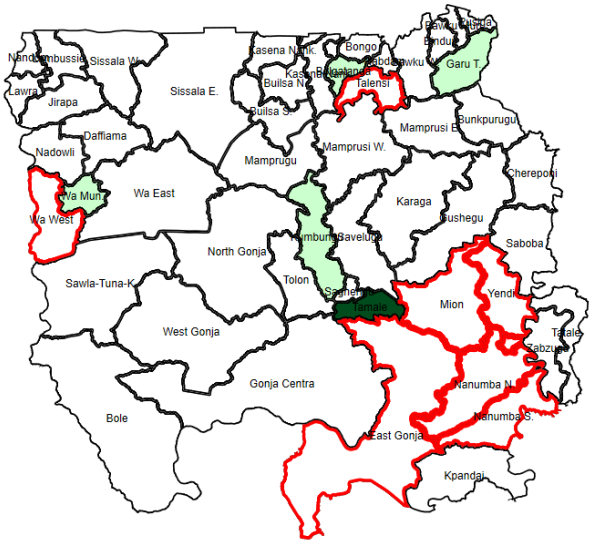
The 1D1F-initiative has 151 running projects, most of which concern new factories while a total of 69 factories are currently in operation. More than two thirds of all ongoing projects focus on agriculture or a directly related industry (such as agro-processing, food and beverage processing). Table 5 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, that is 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 program.

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

[5] See official websites of One-District-One-Factory (http://1d1f.gov.gh).

Table 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-Tempane	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).

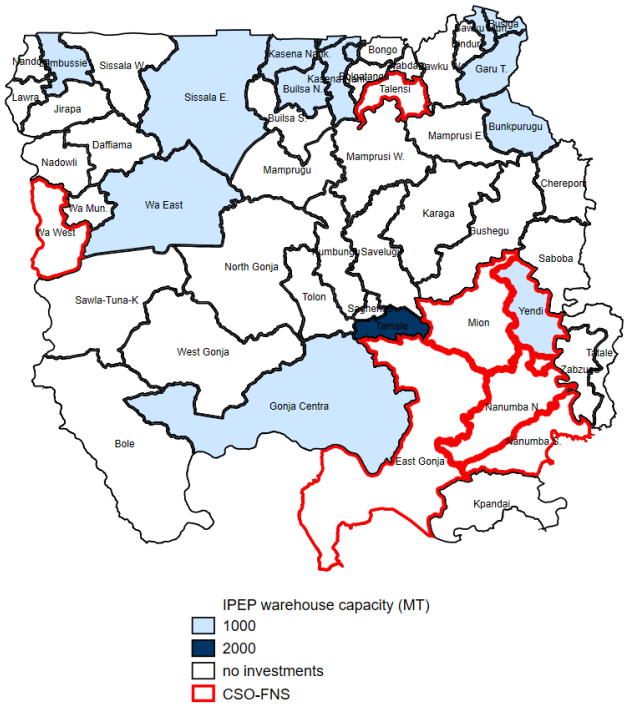
Infrastructure for Poverty Eradication Programme (IPEP)

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 at reducing poverty and inequalities, especially in rural communities, through the provision of basic infrastructure.[6] 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 infrastructure type of interest, this programme receives various other denominations, such as one-village-one-dam, one-district-one-warehouse or simply one-million-one-constituency. Table 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) was located in the focal districts of CSO-FNS which operate under the V4CP program.

[6] See official website of MSDI (www.msdi.gov.gh/ipep.html).

Table 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-Tempane	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).

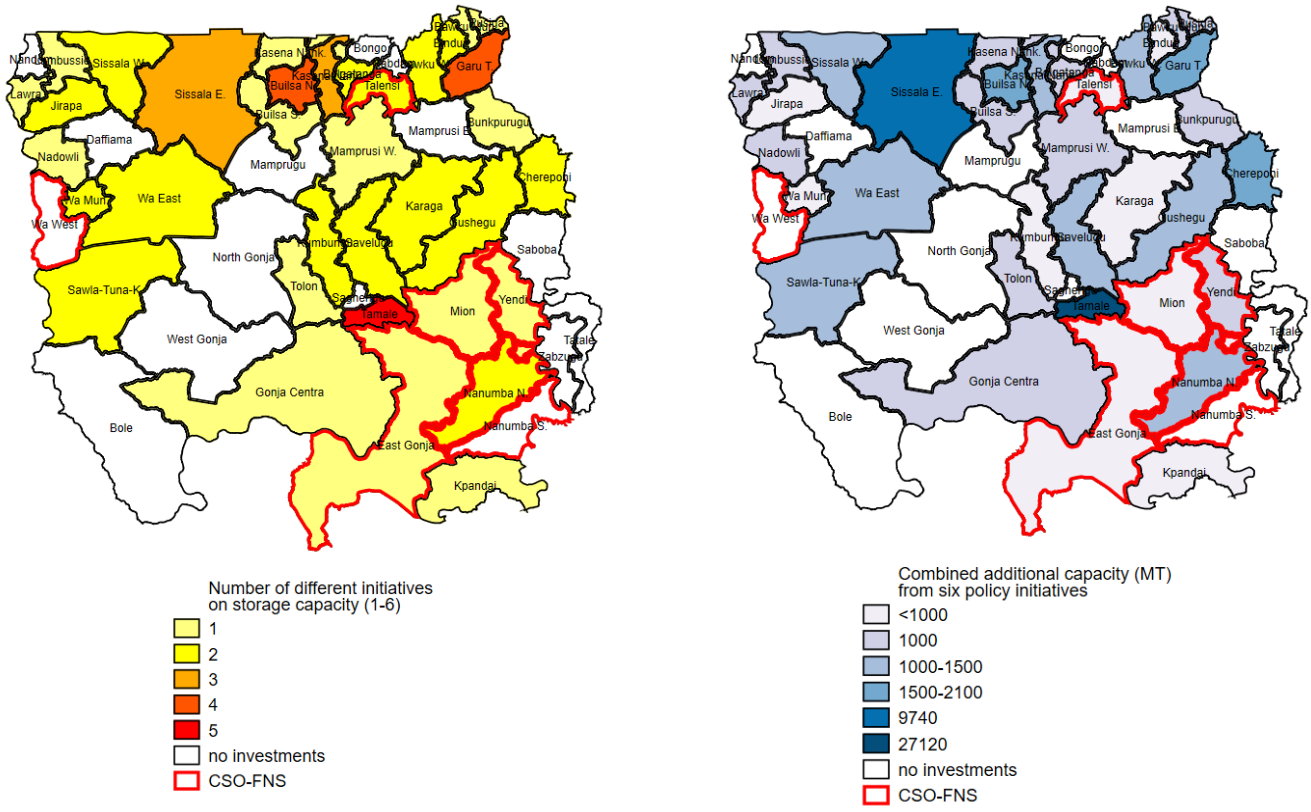
Combined storage capacity across districts in Northern Ghana

This section takes stock of the storage infrastructure in Northern Ghana across the six policies and initiatives discussed above, that is GCAP, NRGP, 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 brief 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 2 presents two maps. The left-hand map displays the number of different policy initiatives on storage that districts in Northern Ghana have benefitted from. Receiving investments from five different initiatives (that is all except NRGP), Tamale Metropolitan is clearly best served, followed by Builsa North and Garu-Tempane, 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 considered by two programs. Regarding the intervention zones of CSO-FNS working under V4CP program, Talensi and Nanumba North were considered by two programs, and Yendi, Mion and East Gonja still received one additional storage infrastructure. Wa West and Nanumba South so far have been ignored by the six policy initiatives discussed.

The right-hand map of Figure 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 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-Tempane 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 program, Nanumba North was best served with additional storage capacity amounting to slightly more than 1000 MT, which results from the construction of NRGP 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 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.ghanagrain-scouncil.org (16 July 2019); www.1district1factory.gov.gh/about (12 December 2019); www.msdi.gov.gh/ipep.html (9 July 2019).

LINKING STORAGE INFRASTRUCTURE AND AGRICULTURAL NEEDS

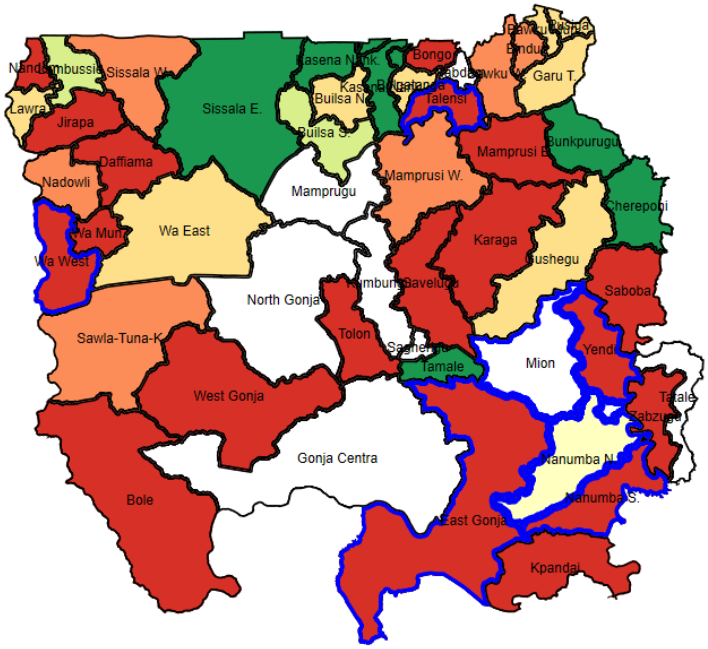
Having sketched a broad overview of recent investments in storage infrastructure in Northern Ghana, this section brings in spatial data on agricultural production and PHL in order to see how these investments match up with current agricultural needs as well as to guide future investments. To do so, we develop an index of relative adequacy (IRA) 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 when other districts relative to what they produce (or what gets lost), received more storage capacity; and vice versa for when the index is above 100%.

Relying on this IRA measure, Figure 3 displays combined additional storage capacity relative to overall production of dry crops, such as cereals and beans.[7] Following substantial investments as described above, Tamale metropolitan and Sissala East are relatively oversupplied with additional storage facilities. In addition, Kassena Nankana East and West, Bunkpurugu and Chereponi have also received much more additional capacity compared to other districts with similar levels of agriculture production, thus yielding an IRA above 170%. On the other end of the scale, there are 19 districts which, compared to their agricultural output, were either not or too little considered by any of the recent storage programs or initiatives, thus recording an IRA below 30%. These districts are located in scattered fashion across northern Ghana, with perhaps some concentration around Tamale metropolitan, which might serve as a regional storage hub for its surrounding districts. Only one district, that is Nanumba North, received additional storage facilities according to its level of agricultural production, that is yielding an IRA between 90% and 110%. In contrast, the other intervention zones of CSO-FNS, which operate under V4CP program, are all relatively undersupplied,

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

indicated by an IRA below 30%. As far as these districts are not considered by other initiatives outside those discussed in this brief, future investments to increase storage capacity should be targeted to districts with the lowest IRA.

Figure 3. Combined additional storage capacity versus agricultural production, Northern Ghana



IRA	Interpretation
<100%	Relatively **under**supplied with storage capacity
≈100%	Storage capacity relatively **aligned** with production
>100%	Relatively **over**supplied with storage capacity

Index of Relative Adequacy (%)
(combined storage capacity relative to production of dry crops)
170 - 700
140 - 170
110 - 140
90 - 110
60 - 90
30 - 60
0 - 30
No data
CSO-FNS

Source: Authors based on MOFA (2018:68; 2016:40; 2015b:49), data received from GCX and data downloaded from www.ghanagrain-scouncil.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).

Although the previous analysis allows for a broad indication of where storage facilities might be most desirable, the real issue that the government of Ghana aims to address however concerns PHL. In this sense, storage infrastructure should best be located in areas suffering most from this particular problem. 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 own production and food processed, (iv) lack of information on food losses during processing and (v) non-representative sample at district level. PHL estimates derived broadly fall within the ranges observed by a recent study in Sawla-Tuna-Kalba and Kintampo North district, which examined PHL through farmers' declarations and objective measurement (GSARS 2017). Despite the latter observation, the estimates presented in this section should be considered with caution.

Table 7 presents PHL estimates for seven selected districts and main food staples consumed 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). Regarding the four main cereals produced in Northern Ghana, PHL range from 4.6% for maize to 20.3% for sorghum, both in Nanumba North. Despite a similar performance for maize (5.4%) and much smaller losses for sorghum (5.5%), Talensi's PHL of millet amount to 18.8%. The remaining districts' PHL estimates for cereals in Table 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. Regarding pulses, the level of PHL is generally higher and ranges between 12.7% for beans in Talensi and 31.1% for groundnuts in Wa West. The remaining groundnut producing districts in Table 7, that is Nanumba North and West, and East Gonja, all suffer from PHL close to 20%.

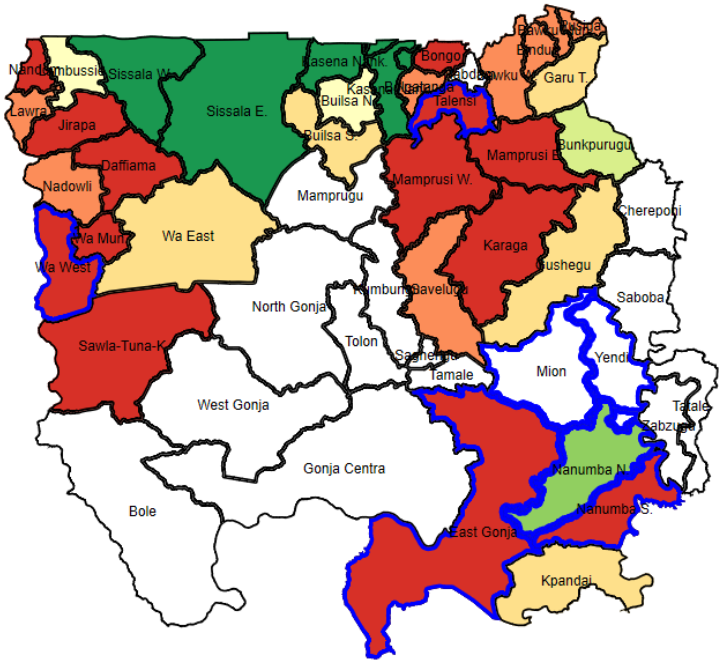
Table 7. Household-level PHL estimates (%) by selected district, Northern Ghana

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 IRA measure, Figure 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 those districts being relatively oversupplied with additional storage infrastructure. In addition, when using this specification, Sissala West and Nanumba North appear to be relatively oversupplied as well, each having an IRA above 140%. This observation relates to PHL being relatively lower in those districts, especially for dry crops which take a higher share in overall production. Regarding the other intervention zones of CSO-FNS working under the V4CP program, the same classification and conclusions prevail: given that they were insufficiently considered by programs and initiatives discussed in this brief, future investments to increase storage infrastructure should be geared to Wa West, Talensi, East Gonja and Nanumba South as well as to other districts with IRA below 30%.

Figure 4. Combined additional storage capacity versus PHL estimates, Northern Ghana



IRA	Interpretation
<100%	Relatively **under**supplied with storage capacity
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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://eatlas.resakss.org/Ghana/en (16 July 2019).

CONCLUDING REMARKS

Manifest in SDG 12.3 as well as throughout the latest flagship report by FAO (2019), the issue of PHL is currently gaining traction among policymakers 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. This is further confirmed by data from GLSS7 (2016/2017), which allowed deriving a proper set of district-level PHL estimates for the country's main crops.

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

Unless considered by other ongoing or future programs and initiatives, several districts in Northern Ghana have not received due attention in the six policies discussed in this brief. This observation is reflected in inexistent additional storage infrastructure or by extra capacity below the level of dry crop production or corresponding PHL, as relatively observed in other districts in Northern Ghana. Apart from Nanumba North, districts targeted by CSOs under the V4CP program, 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, further located from these hubs, could reach and access the infrastructure thus created. In this respect, it is worth mentioning that some initiatives may be less adapted to smallholders, such as GCX, where a minimum storage of 1MT is required to benefit from this facility. For various other initiatives it is unclear whether similar requirements apply.

Of course, the overview produced in this brief is not exhaustive, and largely driven by available information, either received or accessed online. It also does not take into account existing infrastructure. There is also 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 brief may contribute to ongoing efforts to compile an inventory of all available warehouses and their functionality across the country, as mentioned as one of the major activities under the PFJ policy (MOFA 2017).

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About the Authors

Wim Marivoet is Research Fellow and **Leysa Maty Sall** is Research Analyst in the West and Central Africa Office of the International Food Policy Research Institute (IFPRI). The brief has been prepared in close collaboration with the ReSAKSS eAtlas technical team led by Racine Ly and with Manson Nwafor (ReSAKSS-WA). The authors wish to thank Fleur Wouterse for her comments and suggestions on earlier versions.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
A member of the CGIAR Consortium | A world free of hunger and malnutrition
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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