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Bridging Production Gaps with Regenerative Agriculture: A Strategic Framework for School Meals Programmes

The path to transformation

Briefing Paper 2 of 2

Summary

Our first policy brief, Utilising Geospatial Data Analysis to Enhance School Meals and Regenerative Agriculture Interventions mapped the socio-ecological "hotspots" where key socio-ecological variables converge in Ghana, Nigeria, Kenya, and Rwanda. The analysis allowed us to identify the regions where these intersecting challenges are most severe.

Building on the results, this second briefing paper explores the potential agricultural challenges driving the nutritional crises within those hotspots, and the role that school meals programmes (SMPs) may play in alleviating such challenges.

Key Results

- This theoretical exercise revealed a consistent surplus of starchy staples—such as roots and tubers— alongside a critical deficit in essential fruits, vegetables, and pulses in malnutrition hotspot regions.
- The findings align with global evidence and reinforce the importance of redesigning agricultural systems for resilience, sustainability and healthy diets.
- To do this, interventions must be evidence-based and tailored to the diverse contexts and unique production landscapes of each country.
- Redesigning agricultural systems so they are locally led and prioritise regenerative practices enables existing knowledge and crop diversity to be utilised.
- New agricultural systems can be supported and fostered by SMPs to ensure children the rights to health and a healthy environment.

Introduction

Despite agriculture's important role in the economies of Ghana, Nigeria, Kenya, and Rwanda, all four countries face a persistent and critical lack of sufficient and nutritious food. This challenge is not uniform; it is concentrated in specific “hotspots” of vulnerability across each country. In our first briefing paper, we define these hotspots of vulnerability as regions where critical conditions of key socio-ecological variables (including population density, biodiversity threats, agro-ecological zones, farm size, water risk, land degradation, poverty levels, and school attendance) overlap. These hotspots therefore represent regions where interventions are most needed to improve regenerative agricultural production, nutritional status and their interlinkages contributing to the overall socio-ecological resilience.

In this next phase of geospatial analysis, we leverage the environmental baselines established in our first brief, specifically regarding water risk, biodiversity threats, and land degradation, to assess the productive capacity of these regions. We move from mapping vulnerability to quantifying the 'theoretical production gap,' determining not just where interventions are needed, but exactly which food groups the local landscape is currently capable of providing to close the nutritional divide for landscape inhabitants.

This second briefing paper moves from geospatially mapping hotspots of vulnerability to exploring potential solutions. We examine the intersection of agricultural production and nutritional status to calculate the "theoretical production gap". This metric reveals the disconnect between current agricultural production yields and the population's nutritional requirements. By quantifying this gap, we can identify the types of nutrient-dense foods that are in deficit in hotspots of vulnerability. This evidence-based approach may enable policymakers to integrate regenerative agriculture (RA) practices that can enable nutrient-dense food production that can further contribute to improving the design and functioning of School Meals Programmes (SMPs), key to addressing nutritional gaps.

Approach

We utilised methods documented in our first brief to map the regions where overlapping malnutrition variables (e.g. stunting, wasting, and underweight in children; anemia in women of reproductive age) are most prevalent in Ghana, Nigeria, Kenya, and Rwanda. These represent “malnutrition hotspots”. We then calculated and analysed the theoretical production gap in each region to identify food group deficits and surpluses. Finally, we considered the existing agricultural and SMP landscapes in each region to recommend agricultural interventions that have potential to close the theoretical production gap.

How we estimated the theoretical production gap

To understand the theoretical gap between the amount of food produced in these ‘hotspot’ regions relevant to the national nutritional requirements, we calculated a theoretical Self-Sufficiency Ratio (SSR) for seven key food groups at the subnational level. The theoretical SSR is a standard metric used to compare a region's own production of a commodity, such as food, against its own consumption requirements. It is typically used to assess food security status and reliance on trade. In this brief, it allows us to quantify the theoretical production gap by revealing which food groups are in deficit or surplus relative to the population's nutritional requirements. The theoretical SSR calculation:

- SSR = ((Total Production / Total Requirement) - 1) x 100
  Negative values show a deficit, positive values show a surplus.

We estimated the nutritional requirements in the four countries using a blended approach informed by national Food-Based Dietary Guidelines (FBDGs) for daily energy needs (kcal/day) and the EAT-Lancet reference diet (Willet et al., 2019). This allowed us to determine the proportional balance of food groups required to meet nutritional energy targets.

We used the Spatial Production Allocation Model (SPAM, 2020) dataset to estimate the total production tonnage for seven plant-based food groups: cereals, roots/tubers, pulses, nuts/seeds, vegetables, fruits, and oils.

It is critical to note that this analysis is an evidence-based estimation. Therefore, two key assumptions should be taken into account:

- Limited scope: We only analysed the specific plant-based crops available in the SPAM dataset. This analysis does not include animal-source foods, wild-harvested foods, or other cultivated crops outside the dataset.

- No trade: We are comparing the reality of what is grown in a region with the region's nutrition requirements. This analysis intentionally adopts a 'local-first' lens. By simulating a scenario without trade, we expose the current capacity of local food systems to support their own school communities. This highlights what local supply chains can be strengthened to contribute towards planet friendly SMP.

Results

The cumulative assessment of malnutrition such as stunting, wasting, underweight, and anemia, revealed malnutrition hotspots. Those hotspot, flag regions where vulnerable populations (i.e. children and pregnant women) significantly experience more than one type of malnutrition. All four countries, notably Ghana, Nigeria and Kenya report extensive areas with severe malnutrition hotspots flagging three and four overlapping forms of malnutrition (Dark purple regions) (Figure 1). Malnutrition hotspots, although less severe in Rwanda, also show regional divides (One form of malnutrition in the North West region and two in the South East region).

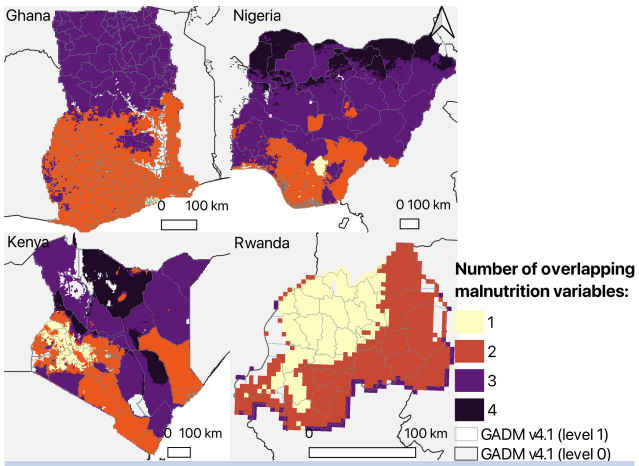

Figure 1. Overlapping malnutrition variables: stunting wasting and underweight in children; anemia in women of reproductive age. Source: Institute for Health Metrics and Evaluation (IHME), 2021, 2020; Local Burden of Disease Child Growth Failure Collaborators, 2020.

The food availability per food group assessments reveal a widespread surplus of calorie-dense starchy staple foods (roots and tubers) coexisting with severe deficits in micronutrient-rich foods (vegetables, fruits, and oils). This confirms the dominance of specialised production systems ensuring (calories), rather than healthy diets through more diversified production systems. More specifically, we foresee opportunities to develop value chains and markets for family farmers growing nutrient-rich crops. School meals are especially relevant as an outlet for perishable, fresh, and diverse foods produced sustainably that benefit from shorter value chains. Each region can prioritise a diverse range of locally adapted cultivated species that can contribute to closing nutritional gaps and to the resilience of production systems and the well-being of rural communities by building a holistic approach around these species—including technical support, recipes, storage and transport solutions, and farmer organisations.

The calculations of the theoretical SSR also reflect contrasting differences among regions and countries (Figure 2). For instance, food production patterns reveal strong spatial imbalances across food groups, with regions simultaneously experiencing surpluses in some commodities and deficits in others. Vegetables and oils frequently emerge as structurally deficient, while cereals, tubers, and pulses often show surplus potential. Other regions, such as Northern East Kenya show a persistent deficit of food crops, in a pastoral dominant region. These mismatches highlight the importance of spatially targeted production, trade, and planning strategies to address nutritional gaps and improve food system resilience.

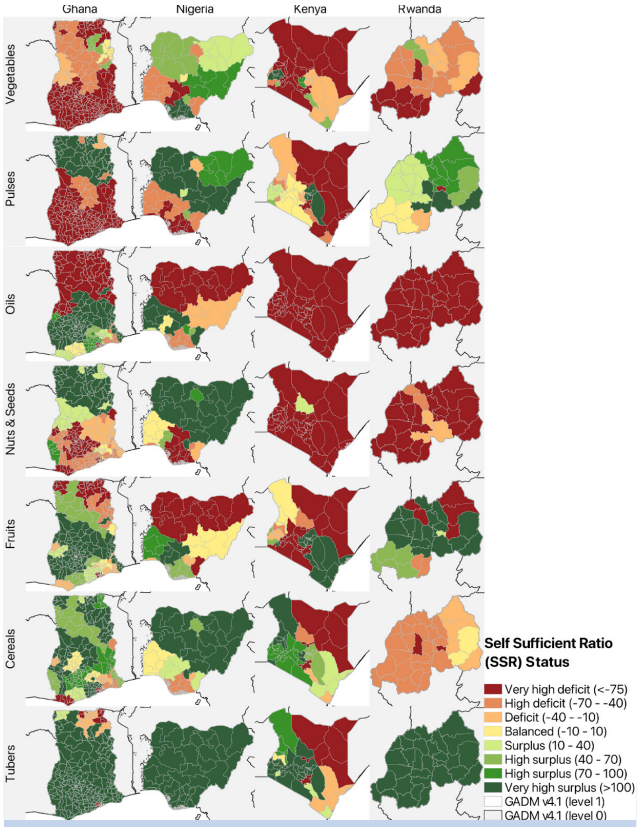

Figure 2. Self-Sufficiency Ratio percentage (SSR) in across countries and seven food groups (sorted from the most deficit (veg) to the least). See supplementary materials for data source.

The theoretical SSR can also help identify regions vulnerable not only for specific food groups, but for achieving overall healthy diets (Figure 3). Across the studied countries, most regions experience deficits in three or more food groups, highlighting the risks of one-crop or single–food group specialisation, which can exacerbate and reinforce nutritional gaps. Promoting diversification and multifunctional landscapes, particularly in regions with high deficits and malnutrition, therefore emerges as a critical strategy to improve dietary adequacy, resilience, and food system sustainability.

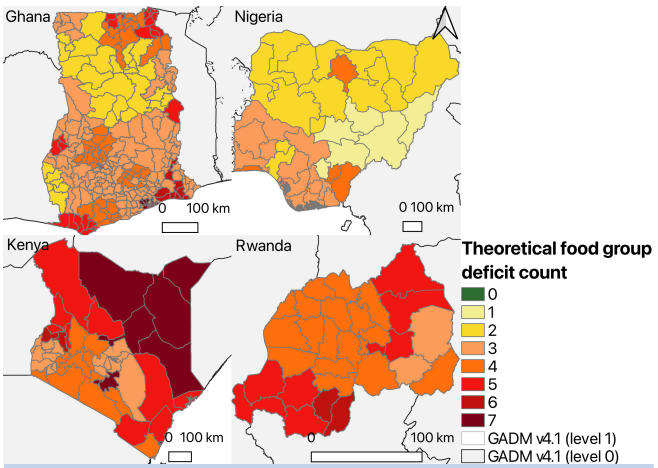

Figure 3. Number of food groups theoretical deficient from local production if were allocated to ensure local communities healthy diets (following national dietary guidelines)

Discussion

This geospatial analysis allowed us to locate regions of Ghana, Nigeria, Kenya, and Rwanda impacted by critical gaps in theoretical food group production diversity and multiple forms of malnutrition. These regions may benefit from diversification strategies that mobilise regenerative agricultural (RA) practices designed and selected specifically to alleviate malnutrition, improve production systems and farmers livelihoods. Meldrum et al. point to a vast range of possibilities for re-designing multifunctional production systems. Africa is home to over 1,000 traditional edible leafy greens, fruits, and vegetables that remain invisible and under utilised in current agriculture development efforts (Meldrum et al. 2018). The utilisation of local cultivated diversity (i.e. plants, insects, livestock, fish, mushrooms, algae) in space and time at the farm and landscape level and through a wide range of RA practices can lead to farms and landscapes with restored land, clean and sufficient water, enabling biodiversity to thrive and producing sufficient and nutritious foods (Meldrum et al. 2018, Ulian et al. 2020, Muhanji et al. 2011).

Redesigning production system will require strong, knowledgeable and well equipped extension services that can advise on the use of this diversity and practices. For instance, by promoting intercropping for dark leafy vegetables—which are rich in vital micronutrients—alongside diverse local staple crops with varying vulnerability to droughts. This intercropping allows for more productive use of arable lands and can result in increased yields and improved soil health, ultimately producing more nutritious food from the same plot of land. Similarly, integrating diverse fruit and nut trees into agroforestry systems, farmers can boost food production and enhance the availability of nutrient-dense foods.

By cross-referencing these findings with findings from our first policy brief, we can confirm that the malnutrition hotspots identified in this brief largely overlap with remote, agrarian regions dominated by smallholder farming. These areas are uniquely impacted by interconnected socio-ecological stressors. Therefore, the nutritional crisis is not the result of any single issue, rather, multiple converging issues.

Recommended strategies

While Ghana, Nigeria, Kenya, and Rwanda seem to face similar nutrition and socio-ecological challenges and stressors, they present unique combinations of barriers and opportunities that require a customised approach to interventions. Based on our previous analysis of key socio-ecological variables—including population density, biodiversity threats, agro-ecological zones, farm size, water risk, land degradation, poverty levels, and school attendance—and the results of this analysis of malnutrition hotspots and theoretical production gaps, we present country-specific recommendations for integrating RA and SMP interventions.

Ghana: balancing agriculture with environmental protection

Ghana's key agricultural zones, particularly in the south, present a complex challenge. These regions are critical for the nation's biodiversity, but they are also the regions that suffer most from severe crop species threats and land degradation. Many of the farmlands in this region have less than the minimum semi-natural habitat required to support crucial ecosystem services, such as pollination and pest control. Thus, the primary challenge for agriculture interventions is to meet the country's need for agricultural production while

simultaneously addressing the urgent task of restoring ecological function.

School meals programmes (SMPs) may offer a strategic solution by creating a stable market for farmers that incentivises them to adopt biodiversity-friendly RA practices, especially in these high-priority areas for biodiversity. By linking food procurement, notably for schools, directly to sustainable farming methods, Ghana can advance commitments towards multiple sustainable development goals, climate adaptation, biodiversity and land degradation neutrality commitments.

Nigeria: a country with two different realities

Nigeria's food system is characterised by two distinct regional profiles. The North is contending with an array of interconnected crises. Geospatial data reveals a convergence of severe water risk and concentrated malnutrition hotspots overlaid with significant water-related conflict. As detailed in our first brief, these northern zones have experienced notable fatalities linked to resource disputes. Consequently, closing the production gap here is not merely an agricultural challenge but a peacebuilding one. For instance interventions could prioritise supporting drought resistant or tolerant crops, along with practices that retain and improve the use of water in scarce contexts. The South faces a severe threat to biodiversity due to human activity—a pattern clearly visible along the coast and inland.

These divergent realities call for tailoring and co-developing in each region context dependent strategies. Interventions that contribute to building community resilience and peacebuilding seem more relevant in the North, whereas the South seems to require careful attention to interventions that contribute and restore biodiversity.

Kenya: the challenge of the drylands

Kenya's food system is largely defined by its vast arid and semi-arid lands, which are dominated by scattered cropland and grazing production systems. This region faces extreme water stress, high rates of malnutrition, and frequent, often deadly, water-related conflicts, as shown in the maps. The primary challenge is to implement agricultural programmes in the context of extreme water scarcity.

There is an opportunity to implement regenerative practices appropriate for dryland and pastoral systems, such as sustainable water management and improving rangeland health. School meals programmes procurement specifications in these regions could explicitly favor drought-tolerant indigenous animal and crop species(e.g., sorghum, millet, specific legumes). This is a critical adaptation strategy given the climate projections identified in our first brief, which forecast increased temperature and precipitation volatility for these specific dryland zones. While the north is dominated by these arid conditions, the south of Kenya features more diverse agricultural systems that also face significant land degradation but offer different opportunities for crop diversification.

Rwanda: big challenges on small farms

Farmers in this country face the compounding pressures of limited arable land and severe soil erosion. While smallholder farming is common across all four countries, Rwanda faces a unique constraint due to the prevalence of micro-holdings (often <1 ha) situated on steep, erosion-prone slopes. This geography poses particular challenges and notably require RA practices that retain, and stabilise the precious soils. Interventions, can support farmers re-design farms to maximise the economic return per hectare for micro-holders in vulnerable lands while addressing the national vegetable deficit. Furthermore, shifting to perennial high-value horticulture (such as fruit trees and agroforestry) could contribute to addressing the severe soil erosion and terrain limitations identified in Brief 1, stabilising slopes that are currently degrading under annual staple crop pressure.

In Rwanda, SMPs can create a reliable market and stable income for smallholders while providing the financial security needed to invest in soil-restoring regenerative practices. In this way, public procurement could directly support the restoration of land health at a national scale.

Key takeaways

Different forms of malnutrition overlap across regions and countries. Similarly, the theoretical SSR identifies areas where multiple food groups are likely insufficient to meet population needs. Where SSR deficits coincide with malnutrition, this signals that markets are failing to fill nutritional gaps and that highly specialised agricultural systems are not contributing to resilient agricultural landscapes.

Redesigning production systems to build on existing crop diversity, alongside a wide range of regenerative agriculture (RA) practices adapted to local conditions, is therefore essential. Such approaches represent a central strategy for advancing planet-friendly meals while strengthening agricultural resilience. If well planned, these efforts can also support progress toward global goals on land degradation, climate change, biodiversity, water, and sustainable development.

The maps and analyses presented here, rather than an exact diagnostic, aim to stimulate discussion, reflection, and collaboration, fostering the multisectoral and multistakeholder engagement required to design and implement strategies that deliver planet-friendly SMPS.

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About this policy brief

This project brief is part of a series aiming to convey the results and progress of the Food Systems Transformation Through School Feeding Project, funded by the International Development Research Centre (IDRC) and the Rockefeller Foundation under the Catalyzing Change for Healthy and Sustainable Food Systems (CCHeFS) initiative. The full series can be found at www.regenerativefoodsystemsalliance.org/policy-briefs/.

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