Rwanda

NUTRIENT ADEQUACY MAPS FOR TARGETED POLICY INTERVENTIONS

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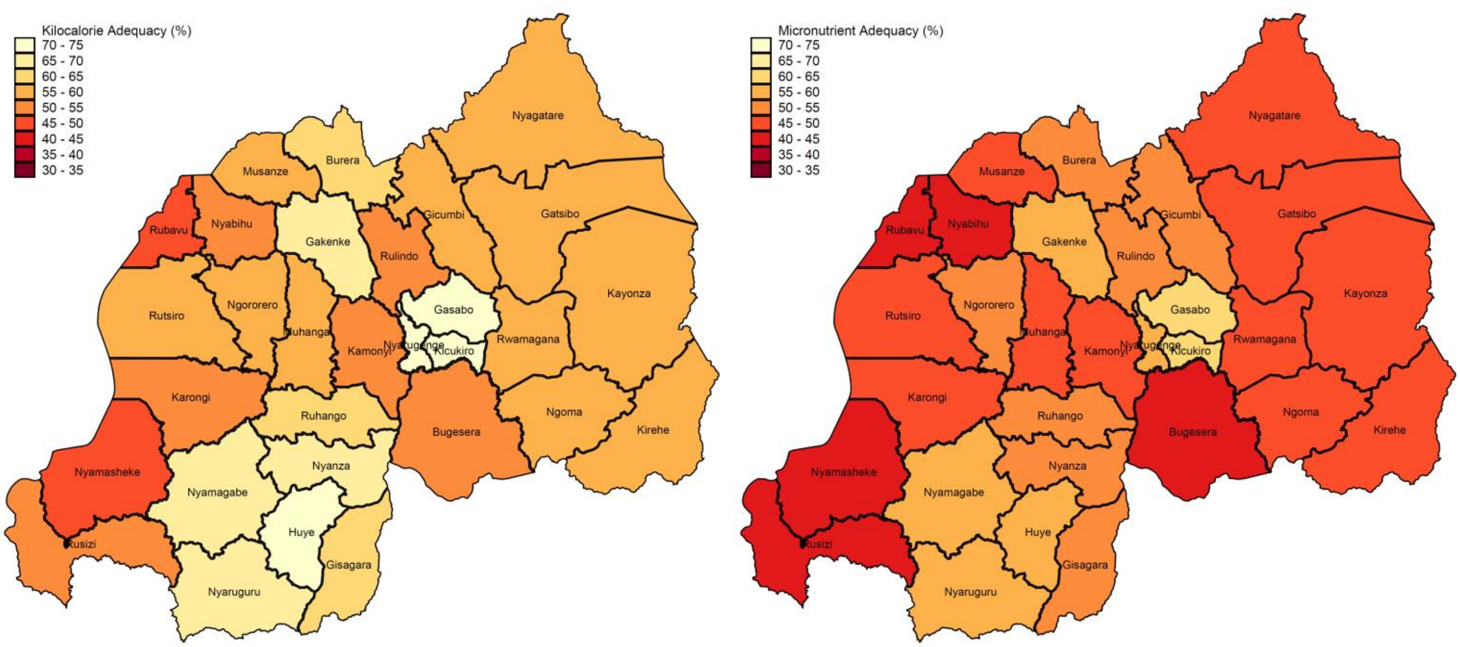
INTRODUCTION

This brief presents a series of nutrient adequacy maps to help understand, identify and locate the major challenges behind Rwanda's insufficient and unbalanced food intake. The maps are obtained by converting food data into corresponding levels of calorie and key nutrients for both production and consumption, while comparing them with the nutritional requirements of each district's population. As such, our approach combines the comprehensive and sequential logic critical to system approaches recommended by researchers and development partners to fight malnutrition (Ericksen 2008; Gillespie and van den Bold 2017; Global Panel on Agriculture and Food Systems for Nutrition 2016; Jones and Ejeta 2015; Pinstrup-Andersen 2013; Stephens et al. 2018; Tendall et al. 2015).

In this brief, in addition to energy intake, we focus on a set of micronutrients including calcium, iron, zinc, folate, vitamin B12 and vitamin A; often used to describe "hidden hunger" in case of insufficient intake. Figure 1 presents the overall challenge of Rwanda's undernutrition, expressed both in terms of diet quantity and quality. Whereas diet quantity refers to a sufficient intake of kilocalories, diet quality looks at intake of micronutrients. More precisely, we define kilocalorie adequacy at the household level as the number of actual kilocalories consumed divided by the recommended intake based on size and demographical structure of the family. Before averaging these ratios at district level, we first truncate all values at 100%, indicating sufficient intake. For micronutrient adequacy, we apply the same procedure for each of six nutrients individually. Subsequently, we take the arithmetic mean of all micronutrient adequacy rates at the household level, also known as the mean adequacy ratio (MAR), before estimating its district average.

Figure 1. Diet quantity and quality (Rwanda 2013/14)



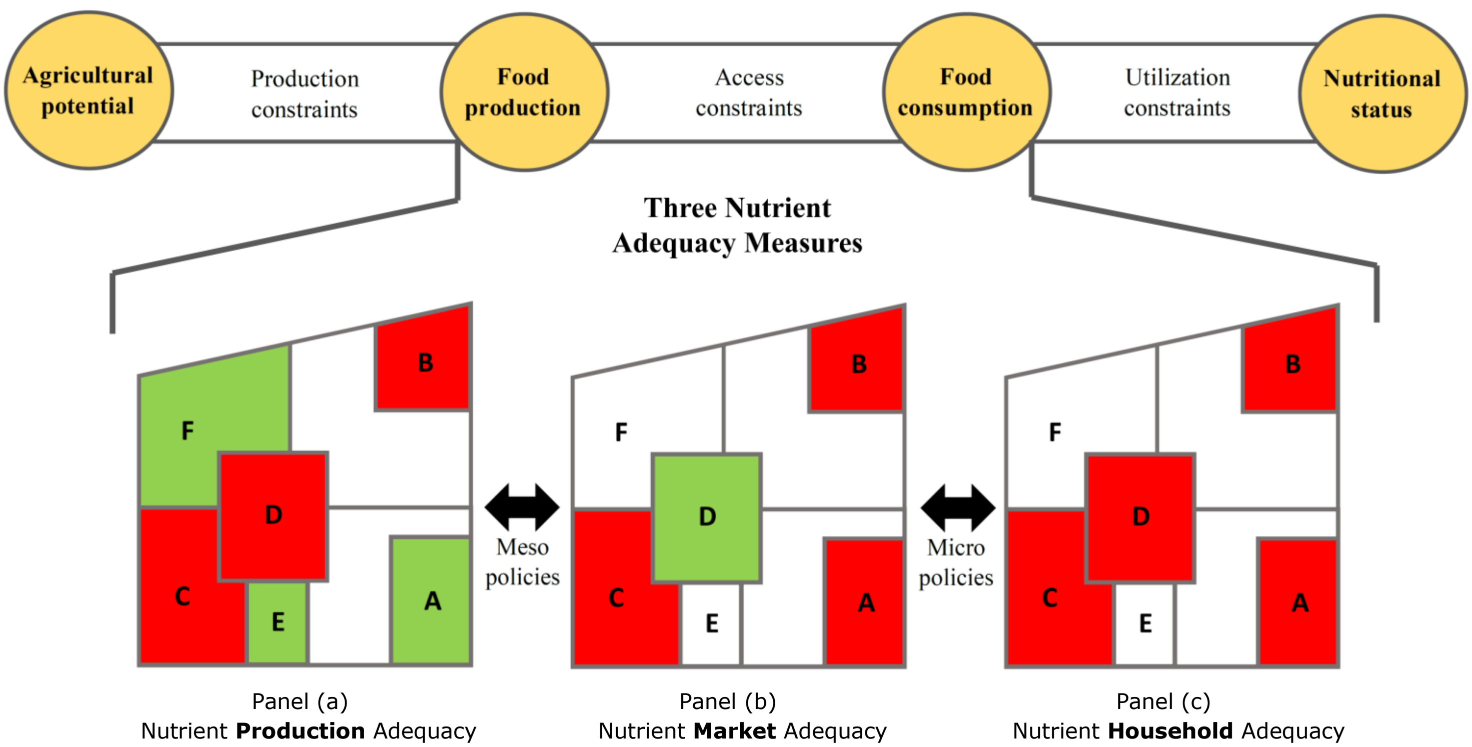
Source: Authors with data from EICV4 (2013/14).

The left-hand map of Figure 1 shows that food energy intake is relatively better in the three districts composing Kigali city as well as in Huye with adequacy levels above 70%. On the contrary, households living in Nyamasheke and Rubavu in the country's West are doing much worse and reach at best 50% of their recommended intake. In terms of micronutrients (right-hand map of Figure 1), the situation is more precarious with generally lower adequacy levels but with largely the same spatial distribution: diets in Kigali are more diversified while those in various districts in the West as well as in Bugesera are characterized by a lack of essential micronutrients.

CONCEPTUAL FRAMEWORK AND DATA

To generate in-depth 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 each key nutrient (for details, see Marivoet and Ulimwengu 2018). The first measure, nutrient production adequacy, quantifies the district'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 the district's population to adequate amounts of calories and nutrients, while the third measure, nutrient household adequacy, also highlights the unequal access among households within each district. By spatially opposing these sets of adequacy maps and by relating nutrient deficiency levels back to actual food items, different food and nutrition security policies could be defined. This is illustrated by the maps in Figure 2, where the green colour points to surplus, red to deficit and white to self-sufficiency. At the meso level, based on production and market adequacy, areas can be classified either as suffering from insufficient food production (such as area B and C) and post-harvest losses (area A), or with potential for increased market integration with neighbouring areas (area C). At the micro level, when comparing the maps of market and household adequacy, areas suffering from an insufficient demand of food (such as area D) can be easily detected. The demand constraint could be related either to low real incomes, a condition which makes nutritious food simply unaffordable to households, or to a lack of knowledge on the nutritional value of certain food items. Whereas the former requires nutrition-sensitive social protection schemes, the latter might be addressed by behavioural change campaigns.

Figure 2. Three nutrient adequacy measures to identify and locate bottlenecks to food security



Source: Authors.

The data used in this brief come from two main sources, each of them allowing for district level estimates (30). More specifically, for production adequacy, we rely on the official production statistics of the agricultural year 2016-2017 (season A and B combined) provided by the National Institute of Statistics of Rwanda (NISR 2017). These comprise data on 4 main cereals (maize, sorghum, rice and wheat), 5 tubers (cassava, Irish potato, sweet potato, yam/taro and plantain), 4 pulses (beans, peas, groundnuts and soybeans) combined with sweet and beer bananas and complemented with aggregate production estimates on other fruit and vegetables[1]. Using a food composition table (FCT) compiled for West Africa (Stadlmayr et al. 2012), these production quantities are then converted into kilocalories and other nutritional equivalents, and aggregated by district. The ratio of production adequacy is then obtained by dividing these food energy and nutrient production levels by their respective required intakes as defined by each district's demographical structure. The same generic approach is followed for market adequacy, based on food *consumption* data obtained from the Integrated Household Living Conditions Survey (EICV4) conducted in 2013/14 (NISR 2016). This survey combines two different sources of food consumption; food purchases and consumption from own produce. In total, more than 120 food items are covered for which quantities are obtained through the imputation of regional food prices. Using the same FCT, we derive aggregate nutrient consumption by district, which is then divided by the district's required intake levels. Household adequacy is derived from the same household consumption survey; estimated at household level by considering the family's required intake and truncating all values above 100%, before averaging household ratios by district. The truncation function assures that households with a surplus intake for a particular nutrient can not compensate for deficient intakes observed in other households within the same district. As a result of this function, household adequacy by construction can not exceed 100%. The required intake levels for each household and district are determined using the common approach of adult male equivalence scales 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 generic colour scheme applied throughout this brief is pale yellow for adequacy, green for surplus and red for deficiency.

NUTRIENT ADEQUACY

Table 1 provides an overview of absolute gaps in nutrient production and consumption as compared to recommended intake levels as well as the three nutrient adequacy measures. Apart from folate and proteins where households reach at least four fifths of the recommended levels, the average Rwandan diet looks very dismal. Indeed, vitamin B12 adequacy is extremely low (10%) while for most other micronutrients, households barely reach half of their recommended intake levels: 48% for calcium and iron, 50% for zinc and 57% for vitamin A. With an average kilocalorie adequacy level below 60%, hunger, in addition to micronutrient deficiency, remains critical for many Rwandese families. Insufficient production of food items containing those lacking nutrients is certainly one key explanation for the low intake levels observed. This is certainly true for iron and zinc with production adequacies of barely 50%, and to a lesser extent for kilocalories (around 76%). Same holds for calcium and vitamin B12 despite limited production statistics (see above). Given these data limitations, it is difficult to assess the precise magnitude of nutrient leakages between production areas and markets. However, with respect to food energy, there are significant leakages with market adequacies being substantially lower than production adequacies (62% versus 76%). Interestingly, the Rwanda market appears to be supplied by imported food items rich in folate given that market adequacies significantly exceed production adequacies.

Table 1. National food energy and nutrient adequacy levels based on production, consumption and recommended intake, Rwanda (2013-2017)

	Production per day, AME	Consumption per day, AME	Recommended intake per day, AME	National Production Adequacy (%)	National Market Adequacy (%)	National Household Adequacy (%)
Kilocalories (kcal)	2077.6	1696.0	2750.0	75.5	61.7	59.5
Proteins (g.)	(47.6)	50.5	50.0	(95.2)	101.0	79.3
Calcium (mg.)	(370.0)	484.3	1000.0	(37.0)	48.4	47.6
Iron (mg.)	12.8	13.0	27.4	46.8	47.4	47.7
Zinc (mg.)	7.2	7.2	14.0	51.2	51.5	50.4
Folate (mcg.)	490.7	706.2	400.0	122.7	176.6	92.3
Vitamin B12 (mcg.)	(0.0)	0.3	2.4	(0.0)	11.4	9.9
Vitamin A (mcg.)	(342.7)	376.9	600.0	(57.1)	62.8	56.8

Notes: In absence of reliable statistics on meat, fish, dairy and palm oil production, the corresponding values for protein, calcium, vitamin B12 and vitamin A are put in brackets.
Source: Authors with data from EICV4 (2013/14) and NISR (2017).

[1] We were unable to obtain reliable statistics on meat, fish and dairy production, which will render the nutrient measures of protein, calcium and vitamin B12 much less accurate. And the same is true for palm oil with respect to vitamin A related measures.

By comparing market and household adequacies, we could highlight demand problems for proteins, folate and to a lesser extent 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 proteins and folate, found mostly in more expensive food items such as meat, fish and pulses, unaffordability may be a straightforward explanation behind their deficient intake.

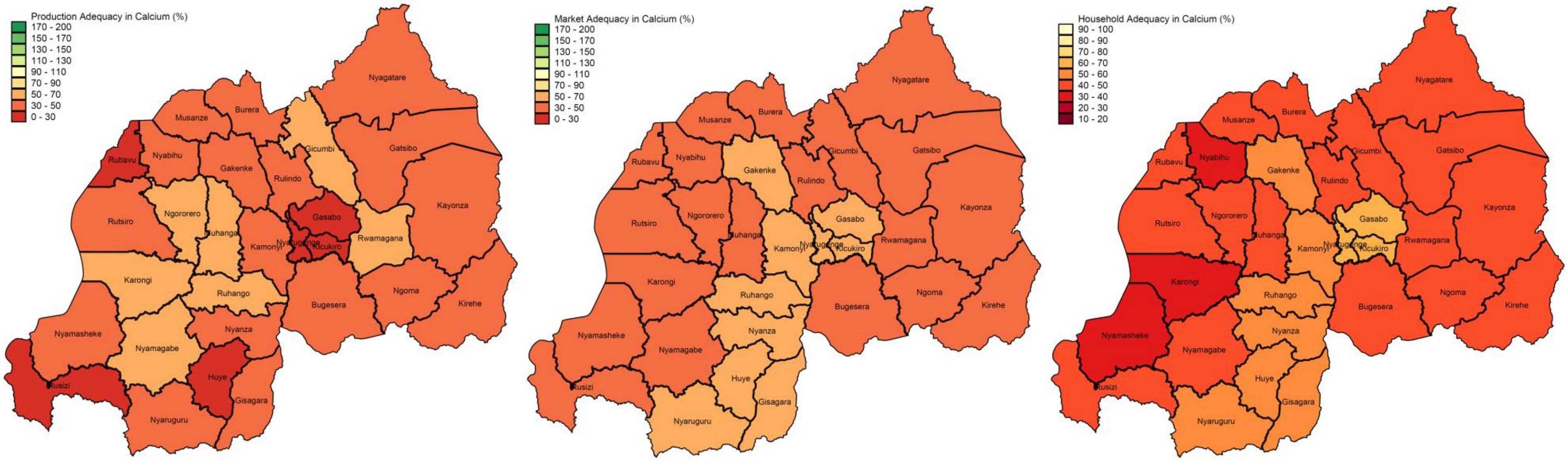
Figure 3 displays the same three adequacy measures for each of the 6 micronutrients covered in this brief. For the most alarming nutrient deficiencies, vitamin B12 (see panel (e)), the same spatial outlook applies to the majority of districts: low production of food items containing vitamin B12 (left-hand map), resulting in deficient market supply for the same nutrient (middle map) and low corresponding adequacies observed at household level (right-hand map). Kigali is a minor exception with slightly better access and household adequacy levels for its three composing districts.

Other important FNS challenges faced by Rwanda households are calcium (see panel (a)), iron (see panel (b)) and zinc (see panel (c)) deficiencies. For all three micronutrients, the adequacy measures depict a highly similar nutrient landscape. Indeed, each time, the more densely populated districts of Kigali have lower production adequacies. Similar pattern is observed in Rusizi for all three nutrients, in Huye for calcium and iron, and in Rubavu for only calcium. However, slightly higher production performances are recorded in various districts scattered throughout the country with Nyagatare and a couple of other districts in the North doing noticeably better in terms of producing iron and zinc. These spatially unequal production adequacies are a bit levelled out in terms of market access, which points to some degree of market integration between production sites and consumption centers. There is still significant geographical diversity when analyzing nutrient household adequacies, with Kigali generally performing better while Nyamasheke and Rusizi are doing worse for at least two out of three nutrients. Demand constraints, either in terms of unaffordability or lack of knowledge on nutrition, may be the underlying causes behind these lower intakes.

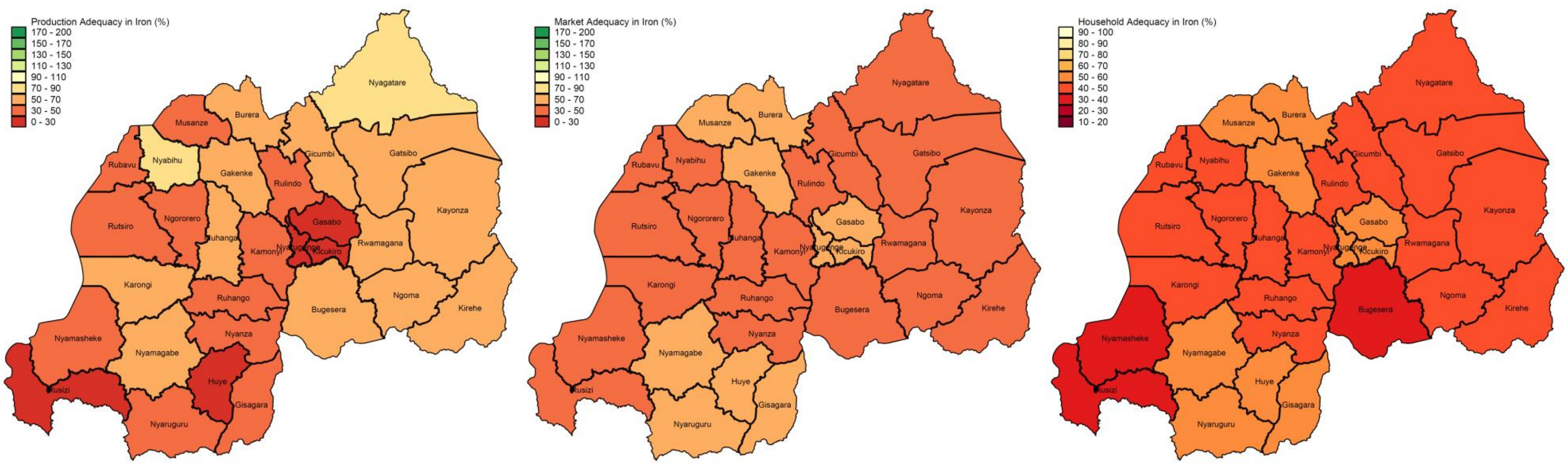
Regarding vitamin A deficiency (see panel (f)), we observe a slightly different spatial combination of nutrient adequacies. Again, the urbanized districts of Kigali combined with Rusizi and Huye are far from producing enough vitamin A to feed their respective populations. In this case however, various districts, mainly in the country's South, are roughly self-sufficient, which may relate to the more favourable biophysical conditions in those areas for growing crops rich in vitamin A (such as sweet potatoes). In terms of market adequacies we also observe lower market integration compared to calcium, iron and zinc, with Bugusera and three districts in the North being the most undersupplied. In the next section, we will link this difference in performance to higher levels of perishability of food items containing vitamin A. Therefore, for this nutrient to reach the more distant markets in the country's North, policies should focus on improving road infrastructure, food storage, conservation and processing capacity of food items rich in vitamin A, which in turn may increase its uptake.

Compared to all other micronutrients, folate deficiency (see panel (d)) is certainly not a priority. On average, Rwanda is producing enough folate to properly feed its population, while those districts without sufficient local production (again Kigali, Rusizi, Huye and Rubavu) seem to be well connected to their hinterland or to markets abroad. Given these favourable market conditions, nutrient household adequacies are for most districts well above 90%, and only a limited number of districts perform slightly worse.

Figure 3. Micronutrient production, market and household adequacies at district level, Rwanda (2013-2017)

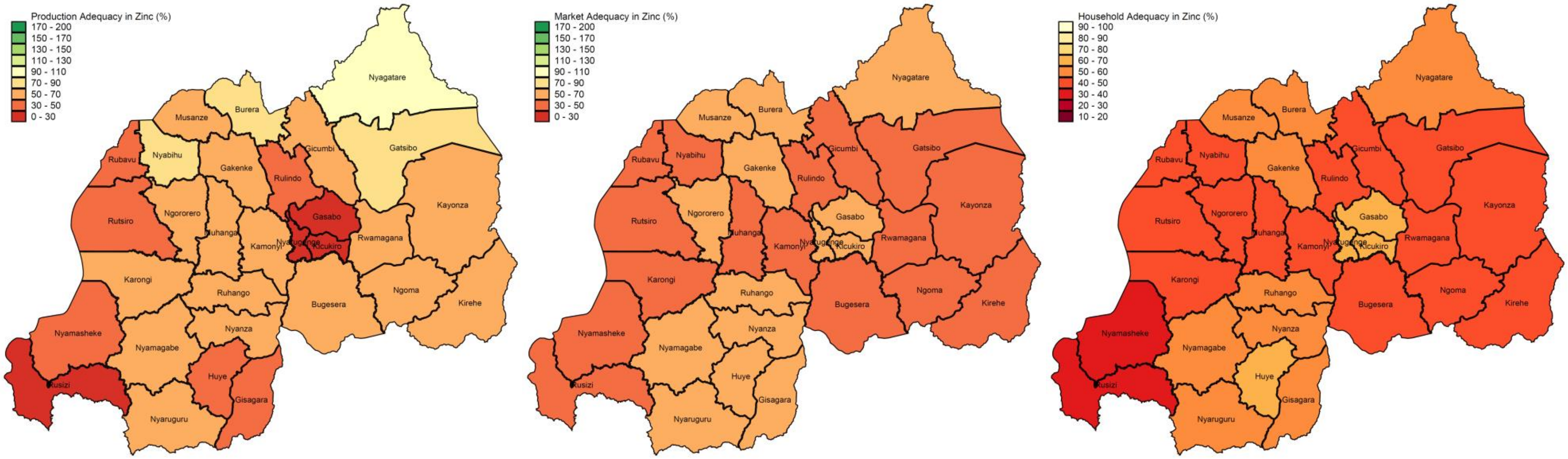


Panel (a): Calcium adequacy

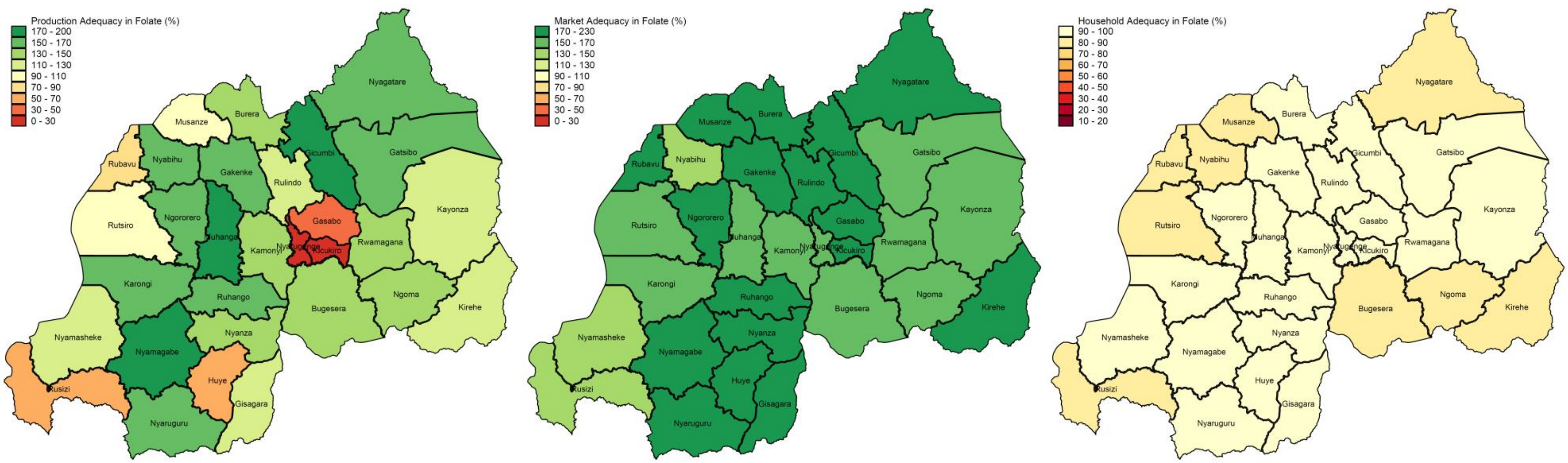


Panel (b): Iron adequacy

Figure 3. Continued

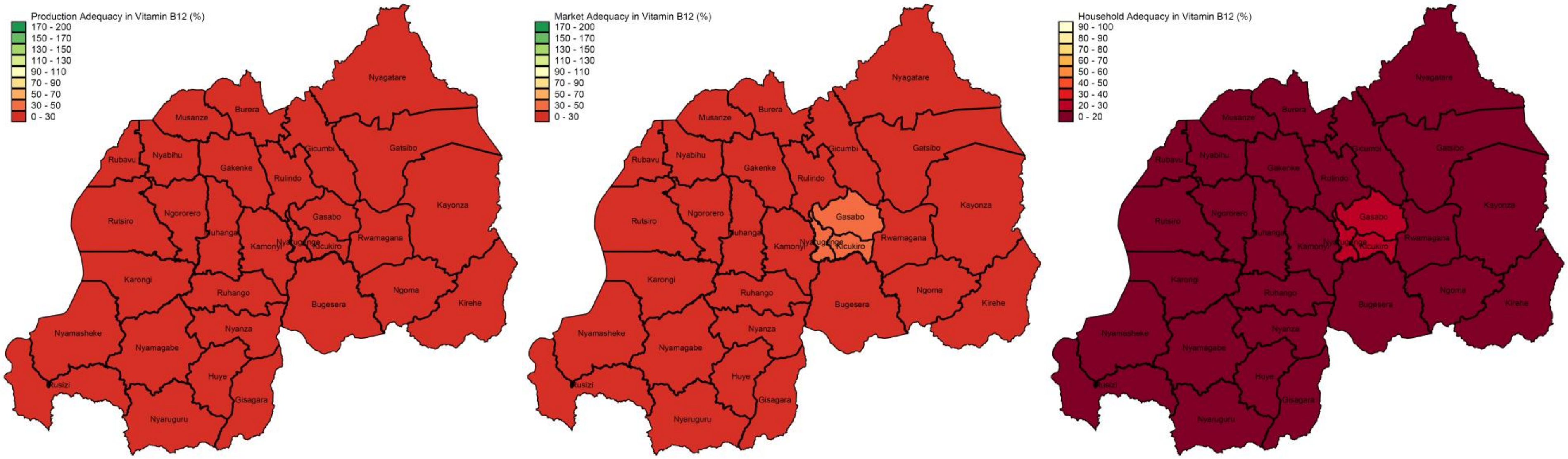


Panel (c): Zinc adequacy

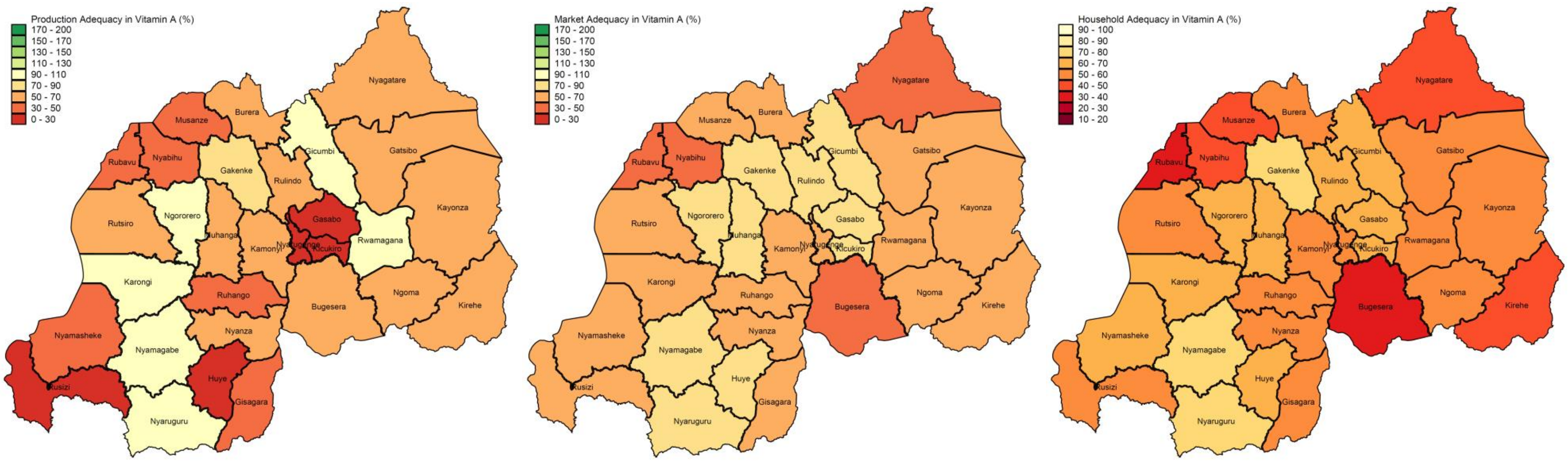


Panel (d): Folate adequacy

Figure 3. Continued



Panel (e): Vitamin B12 adequacy



Panel (f): Vitamin A adequacy

Source: Authors with data from EICV4 (2013/14) and NISR (2017).

FROM NUTRIENT DEFICIENCIES BACK TO FOOD AND TARGETED POLICIES

For policy recommendations, we convert the above findings back to the food dimension to guide the selection of food items to be targeted for increased production, trade or consumption, and their specific locations. Indeed, policies can not be designed and implemented based on nutrient deficiency information alone, given their elusive nature as compared to actual food items. Indeed, no one grows or goes to the market to buy micronutrients. For each nutrient covered in this brief, Table 2 presents the five most important national food items following two distinct criteria. The first criterion ranks food items according to their actual share in overall nutrient intake; and the second lists the five cheapest food items based on their prices per nutrient (expressed in Rwanda Franc (RWF)). In addition to the two ranking variables, Table 2 also provides for each food item the nutritional content per 100 gr edible portion (Stadlmayr et al. 2012) and its food budget share.

To address vitamin B12 deficiency, the country should dramatically produce more animal products, so they become much more available and affordable on the market, which in turn will increase the uptake of this particular micronutrient. Currently, more than 95% of overall vitamin B12 intake is obtained through the consumption of dairy products (i.e. fresh and curdled milk), for which no cost-effective alternatives exist as largely the same food items rank best in both top-5 lists of Table 2. In absence of such alternatives and given current sub-optimal production, policies should consider the development and implementation of nutrition-sensitive social protection schemes to assure at least a minimum uptake of vitamin B12 throughout the country.

The similar significant spatial heterogeneity for calcium, iron and zinc as observed in the previous section stems from the fact that roughly the same food items are responsible for intakes of all three nutrients (see left-hand side of Table 2). Indeed, dry beans account for the highest share in nutrient intake, followed by sweet potato, amaranth, Irish potato and cassava flour. The dry condition of beans and cassava flour, which facilitates transportation and trade, might explain the higher levels of market integration previously observed for each of the three nutrients. As a result, the location for increased production of food crops rich in calcium, iron and zinc or the selection of cross-border entry points seems less important. When increased production is not feasible in the short run (perhaps due to biophysical constraints), it is worth considering small modifications to the daily food bowl. The right-hand side of Table 2 provides an insight into the most cost-effective alternatives. In this respect, soybean (dry and flour) appears to be a good option given its low nutrient price and high nutritional density per 100 gr edible portion. Indeed, for all three nutrients soybeans provide more intake per RWF franc spent compared to most of the food items in the current food basket. In addition, cassava leaves have low nutrient prices for both calcium and iron too, while the consumption of curdled and fresh milk could further increase the uptake of calcium in a cost-effective way. As observed above, the latter dairy products are equally important for vitamin B12. As such, slight changes in food budget allocations might increase the uptake of calcium, iron and zinc considerably. Further, policies in Rwanda should not only examine to what extent people would be receptive to changing their food preferences, but also subsequently promote, depending on biophysical properties, the production of these alternative food crops.

The issue of perishability as highlighted above is confirmed in Table 2; indeed, both top-5 lists of vitamin A cover food items which are highly perishable by nature, like dark-green leafy vegetables, tubers and fruits. Therefore, investing in transport infrastructure to reduce travel time between harvest and consumption, or the development of processing capacities to improve storage and conservation are policies worth considering to increase market access to vitamin A, especially in the more northern districts. Moreover, the demand problems associated with vitamin A should be tackled by informing the population about the nutritional value of vitamin A rich food items, while highlighting the existence of some economically viable alternatives, like spinach, mangos and carrots. Indeed, the three food items all have nutrient prices (substantially) below that of sweet potato, which is currently the most important source of vitamin A. Therefore, a higher budget share devoted to spinach, mangos and carrots might considerably increase nutrient adequacy levels. To promote any of these changes in food preferences, behavioural change campaigns should account for the comprehensive effect on all nutrient intakes.

Table 2. Most important food items by nutrient according to nutrient share and price, Rwanda (2013/14)

	Food item	Nutrient intake share	Price per nutrient (RWF)	Nutrient content 100gr	Food budget share	Food item	Nutrient intake share	Price per nutrient (RWF)	Nutrient content 100gr	Food budget share
Calorie	Dry beans	19.7%	0.12	337.7	14.1%	Dry maize (grain)	2.2%	0.06	351.0	0.8%
	Sweet potato	18.6%	0.11	115.5	12.9%	Sorghum	0.6%	0.09	344.0	0.3%
	Cassava (flour)	10.5%	0.09	335.0	5.7%	Cassava (flour)	10.5%	0.09	335.0	5.7%
	Irish Potato	8.6%	0.23	80.0	12.1%	Sorghum (flour)	1.6%	0.10	347.0	1.0%
	Banana - cooking	8.5%	0.17	140.0	8.7%	Avocado	1.4%	0.10	154.0	0.9%
Protein	Dry beans	44.6%	1.72	22.7	14.1%	Soya Flour	2.4%	1.49	34.5	0.6%
	Sweet potato	8.1%	8.71	1.5	12.9%	Soya (dry)	0.2%	1.51	32.0	0.0%
	Irish Potato	6.8%	9.76	1.9	12.1%	Dry beans	44.6%	1.72	22.7	14.1%
	Fresh beans	5.5%	3.34	7.8	3.4%	Dry maize (grain)	2.0%	2.20	9.1	0.8%
	Corn (flour)	5.3%	4.10	9.5	4.0%	Sorghum	0.6%	2.84	10.5	0.3%
Calcium	Dry beans	22.4%	0.28	142.2	14.1%	Amaranth	16.7%	0.05	380.0	1.8%
	Amaranth	16.7%	0.05	380.0	1.8%	Cassava leaves	5.3%	0.10	276.1	1.2%
	Sweet potato	13.7%	0.41	31.5	12.9%	Curdled Milk	2.9%	0.18	121.0	1.2%
	Cassava (flour)	11.7%	0.21	137.5	5.7%	Fresh milk	7.3%	0.19	120.0	3.2%
	Fresh milk	7.3%	0.19	120.0	3.2%	Soya (dry)	0.1%	0.21	231.6	0.0%
Iron	Dry beans	34.2%	5.46	7.2	14.1%	Amaranth	8.3%	2.89	6.2	1.8%
	Sweet potato	14.5%	11.80	1.1	12.9%	Cassava leaves	3.2%	4.98	5.5	1.2%
	Amaranth	8.3%	2.89	6.2	1.8%	Dry beans	34.2%	5.46	7.2	14.1%
	Irish Potato	7.6%	21.10	0.9	12.1%	Dry maize (grain)	1.7%	6.08	3.3	0.8%
	Fresh beans	4.6%	9.67	2.7	3.4%	Soya (dry)	0.1%	6.21	7.8	0.0%
Zinc	Dry beans	35.4%	13.50	2.9	14.1%	Soya (dry)	0.1%	10.20	4.7	0.0%
	Sweet potato	13.1%	33.27	0.4	12.9%	Dry maize (grain)	2.2%	12.39	1.6	0.8%
	Irish Potato	7.8%	52.44	0.4	12.1%	Soya Flour	1.7%	13.14	3.9	0.6%
	Corn (flour)	6.0%	22.50	1.7	4.0%	Dry beans	35.4%	13.50	2.9	14.1%
	Cassava (flour)	4.9%	39.64	0.7	5.7%	Sorghum (flour)	2.0%	16.44	2.1	1.0%
Folate	Dry beans	52.6%	0.09	433.7	14.1%	Dry beans	52.6%	0.09	433.7	14.1%
	Sweet potato	17.4%	0.25	52.0	12.9%	Soya (dry)	0.1%	0.13	375.0	0.0%
	Fresh beans	3.9%	0.29	89.7	3.4%	Green pea (dry)	0.3%	0.13	510.0	0.1%
	Irish Potato	3.9%	1.05	17.5	12.1%	Soya Flour	1.5%	0.15	345.0	0.6%
	Cassava (flour)	3.1%	0.62	47.0	5.7%	Spinach	0.1%	0.19	176.0	0.1%
Vitamin B12	Fresh milk	76.7%	38.22	0.6	3.2%	Fresh milk	76.7%	38.22	0.6	3.2%
	Curdled Milk	18.7%	57.35	0.4	1.2%	Curdled Milk	18.7%	57.35	0.4	1.2%
	Eggs	1.9%	195.42	0.9	0.4%	Sheep/mutton/lamb meat	0.1%	164.08	2.9	0.0%
	Goat meat	0.7%	245.66	1.1	0.2%	Eggs	1.9%	195.42	0.9	0.4%
	Fish (fresh/frozen)	0.7%	609.16	0.6	0.5%	Goat meat	0.7%	245.66	1.1	0.2%
Vitamin A	Sweet potato	45.7%	0.19	69.2	12.9%	Amaranth	16.1%	0.07	240.7	1.8%
	Amaranth	16.1%	0.07	240.7	1.8%	Spinach	0.4%	0.08	409.0	0.1%
	Banana - cooking	10.7%	0.54	43.0	8.7%	Cassava leaves	8.3%	0.10	285.6	1.2%
	Cassava leaves	8.3%	0.10	285.6	1.2%	Mangos	2.0%	0.11	206.7	0.3%
	Tomatoes	3.1%	0.51	52.0	2.3%	Carrots	2.1%	0.15	713.3	0.5%

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 EICV4 (2013/14).

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