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DIETARY PATTERNS IN MALI: IMPLICATIONS FOR NUTRITION POLICY

by

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ABSTRACT

As other West African countries, Mali's population is experiencing changes in lifestyle and diets that are driven in part by urbanization and income growth. We bring new empirical evidence regarding whether Malian are shifting toward highly processed foods, meals purchased away from home, sugary and/or potentially obesogenic foods. At a macro-scale, we examine the distribution of consumption across food groups and processing content, comparing urban and rural areas. At a micro-scale, we investigate whether women's diets meet minimum adequate standards, contain key sources of micronutrients, and include elements such as fats and sugars. We utilize two recently collected, large-scale datasets. We find that on-farm production represents only 25% of the food consumed by rural households during the hungry season and 36% after harvest. Processed food shares are greater in urban (60%) than rural areas (48%), and considerably higher overall than those reported for Eastern and Southern Africa, but with a lower portion of highly processed foods and negligible shares of meals consumed outside the home. Average dietary diversity scores are higher in urban than in rural households. Both women's and household diet diversity are subject to seasonality in both locations. About half of farm women interviewed did not meet minimum adequate dietary diversity during the lean season. Women consumed few sugars. Achieving food and nutrition security in Mali will require supporting national policies and investments in agro-processing and food markets to ensure the provision of affordable, diversified, and healthy foods year-round in both urban and rural areas. Smallholder self-sufficiency appears an elusive goal.

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I. Introduction

Malnutrition represents the number one risk factor in the global burden of disease, affecting over one in three persons (GLOPAN 2016). Diets lacking in nutrients and digestive conditions that impair absorption of nutrients are the main causes of malnutrition. Paradoxically, undernutrition persists in Sub-Saharan Africa alongside new trends in overnutrition, which result in obesity—a situation that has often been referred to as the "double burden of malnutrition." A third burden is micronutrient deficiency (Gómez et al. 2013).

Low-income countries of Sub-Saharan Africa are severely hit by malnutrition. For instance, one-quarter and half of households are moderately to severely food insecure in Mali (WFP 2017). At the same time, these countries have among the fastest growing obesity rates. From 1980 to 2015, obesity rates went up from less than 2% to over 13% in Mali (The GBD 2015 Obesity Collaborator 2017). Yet, these obesity rates remain lower than in Southern Africa, where the rate of adult obesity (31%) is now equal to the rate of child stunting (Haggblade et al. 2016). A global review by (Imamura et al. 2015) shows that while consumption of healthy foods rose and that of unhealthy foods declined in higher income countries between 1990 and 2010, the opposite appears to have been the case in some lower income countries of Africa and Asia and thus, worldwide.

Income and urbanization are driving factors of transformation in national diets. As incomes increase and population urbanize, demand for more diversified and convenient foods (i.e., easy-to-prepare and ready-to-eat) is on the rise. In Eastern and Southern Africa, the share of processed food represents 70-80 percent of food expenditures of the middle class and shares are similar between urban and rural areas (Tschirley et al. 2015). In Tanzania, the diets of rural migrants have shifted away from traditional food, such as cassava, towards greater consumption of sweets, animal products, and food eaten away from home once they arrived in urban areas (Cockx and Weerdt 2016).

The most rapidly urbanizing region in Sub-Saharan Africa, West Africa is experiencing changes in its lifestyle and diets. Nearly half of the region's population dwells in cities, and as a middle class gradually emerges, research indicates growing proportions of convenience and processed foods, animal products and perishables in the diets of both rural and urban consumers (Taoundyande and Yade 2012; Me-Nsope and Staatz 2013; Me-Nsope 2014; Hollinger and Staatz 2015). These patterns are not entirely negative—since, for example, the perishable category includes fresh vegetables and fruits. Since diet transformation has more recently begun in West Africa (Zhou and Staatz 2016; and Theriault et al. 2018), and rates of adult obesity are lower compared to other regions of Sub-Saharan Africa, policymakers in this region may have the opportunity to "bend the curve" in the direction of healthier diets (Agyemang et al. 2015; Haggblade et al. 2016).

In this paper, we contribute to the diet literature by examining the dietary compositions by food groups at the macro and micro scales and discussing their implications for nutrition in Mali. We bring new empirical evidence on whether diets in Mali are shifting toward more highly processed foods, with greater shares of food purchased away from home, more sugars and/or potentially obesogenic foods. At a macro-scale, we will examine the distribution of consumption across food groups and processing content and analyze whether the distribution varies by urban and rural residence. This macro-scale analysis is useful for understanding how consumer demand for food groups changes as populations urbanize.

At a micro-scale, we investigate the extent to which women's diets, in particular, meet minimum adequate standards, contain key sources of micronutrients, and include elements such as fats, sugars, and food purchased away from home. We purposively focus on women's diets, since these are strong indicators of the diets of their children and other members of the household. In addition to being responsible for meal provision, Malian women who manage plots, conferred to them for their use by the household head, are expected to supplement the overall household with food supply when necessary. The micro-scale analysis provides detailed insights on aspects of the nutrition situation within farm households. Taken together, findings from the macro and micro-scale analysis inform on the types of policies that is needed to enhanced diets in order to "bend the curve" toward better nutrition in Mali.

We begin by reviewing basic concepts related to diet and nutrition. We then present the methodological approaches used to address our research questions in section III. We describe the data sources in section IV. We present and discuss the findings from the macro and micro scale analyses in section V. Concluding remarks are provided in section VI .

II. Conceptual Background

Malnutrition refers to "deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients" (WHO 2018). It encompasses three conditions: undernutrition, overnutrition, and micronutrient-related malnutrition. Wasting (low weight-for-height), stunting (low height-for-age), and underweight represent different forms of undernutrition. Children are the most at risk for undernutrition. In Mali, 13% of children under the age of 5 years old are wasted and 38% are stunted (UNICEF 2013). Undernutrition can have long-term adverse consequences, such as growth failure and can lead to greater mortality (Victora et al. 2008).

Overnutrition, which leads to overweight and obesity (high weight-for-height), has been on the rise since the 1980s. In fact, the prevalence of obesity has doubled in more than 70 countries worldwide, including in Mali (The GBD 2015 Obesity Collaborator 2017). There has been a sharp increase in disease burdens related to high body mass index, such as cardiovascular disease (The GBD 2015 Obesity Collaborator 2017). Accelerated infant weight gain during the first 1000 days has been associated with increased risk of obesity (Woo Baidak et al. 2016).

The third condition is micronutrient deficiencies, which refers to the inadequate intakes of vitamins and minerals, such as iodine, iron, vitamin A, and calcium. Micronutrients are not made by our body but rather come from our diet. As the other two malnutrition conditions, micronutrient deficiencies can have adverse effects on growth and development. For instance, iodine deficiency, and iron deficiency anemia can hamper with the intellectual development of children under five years of age (Walker et al 2007).

The UNICEF's (2015) conceptual framework depicts the multifaceted causes, consequences, and impact of child undernutrition (see Figure A1 in appendix). Note that this framework can be adapted to include adults and the other two malnutrition conditions (i.e., overnutrition and micronutrient deficiencies). It shows the existence of a feedback loop between malnutrition causes and consequences. The socio-cultural, economic, and political context can lead to malnutrition with its short-term and long-term consequences on human growth, development, and lifespan, while malnutrition and its consequences can lead to poverty.

In addition, food choices made by households and household members can affect crop production choices, food imports, food stocks, and the farming environment, which in turn can influence agricultural and food policies. Within a household, female members play a catalytic role in household nutritional outcomes. In fact, previous research shows that interventions targeting women through empowerment activities, such as the promotion of increased control over income from product sales, lead to positive nutritional outcomes, especially for children (Ruel and al. 2013).

III. Methodology

a. Demand for food groups across income levels and area of residency

First, at a macro-scale, we follow a similar approach as in Tschirley et al. (2015) to analyze food group intake patterns across areas of residency. We first distribute aggregated, household food consumption by commodity group and food expenditure category. For example, commodity groups include those frequently reported in similar studies (cereals; pulses; roots and tubers; fats and oils; vegetables; fruit; poultry and eggs; dairy; other meat; fish). Food expenditure categories are defined by source (own production as compared to purchased goods). Own production is divided between perishable and non-perishable items. The purchased category is then differentiated by degree of processing (none, low, high) and perishability. Food away from home is considered separately among purchased items (or as highly processed, non-perishable). To gain additional policy insights, specific commodities of national policy importance can be analyzed separately from aggregated groups (e.g., sorghum and millet as compared to rice and maize).

Household expenditures are then computed for each food item in each expenditure category and converted into expenditures per commodity group within that category. Total market expenditures at the consumer level are calculated by summing across all households (h) for each commodity group i within each food expenditure category *f*:

$$W_{iiii} = \sum_h W_{iiii}^h \qquad (1)$$

Procedures for mapping multiple ingredient items in each food category have been developed by Tschirley et al. (2015), with our adaptations to Malian data. Purchased foods are defined as unprocessed if they undergo no transformation from their original state beyond removal from the plant and (for non-perishables) drying. Processed foods are assigned to the high-value added category if they satisfy at least two of the following three conditions: multiple ingredients; physical change induced by heating, freezing, extrusion, or chemical processes (i.e. more than simple physical transformation); and packaging more complex than simple paper or plastic. Foods satisfying one of those criteria are classified as low-value-added, processed.

Data can then be summarized as food expenditure aggregates from household data. We can compare average diets between rural and urban households to reveal diet changes induced by urbanization. With increased urbanization, we may expect increase in demand for convenience and processed foods.

b. Household and Individual Diet Diversity

Second, at a micro-scale, we apply indicators based on measurement of household and individual diet diversity. Dietary diversity refers to the number of different food items or food groups that a household or an individual has consumed over a specified period (i.e., over the preceding 24 hours or week). Nutritionists have documented a positive correlation between anthropometric measures in adults and children and the diversity of energy, macro and micronutrient intakes, and more favorable anthropometric measures in adults and children (Arimond et al., 2010; Steyn et al., 2006). By contrast, diets composed of a narrow range of food items, such as starchy staples, often lack macro and micronutrient adequacy even though they meet caloric requirements.

The household diet diversity score (HDDS) measures food access of a household to a number of different food groups (Vellema, Desiere, and D'Haese 2015). A major limitation of the HDDS is that it does not differentiate among household members. It does not provide inform on whether the dietary diversity is shared equally across all household members (IDDEP 2019). In contrast, individual dietary diversity indicators, such as the women's dietary diversity score (WDDS) and minimum dietary diversity for women (MDD-W), provide information on individual household members. These indicators provide some indirect but valuable insight on nutrient adequacy for women and their children (FAO and FHI 360 2016; Martin-Prével et al. 2015).

Here, we utilize information collected from the household head, about the household consumption in a specific recall period, to compute the HDDS. The HDDS consists of food groups whose number and composition are adapted to the country and analytical context. Originally, the HDDS was based on 12 food groups proposed by FANTA and elicited in 16 categories (Swindale and Bilinsky 2006). Currently, there is no general consensus on which food groups to include and research continues to propose new guidelines (Kennedy, Ballard and Diop 2013). Across research contexts, the HDDS count covers various food groups and the foods included in the groups reflect modifications that result from pre-testing of the instrument.

Information collected from female individual household members is utilized to compute both individual dietary diversity indicators. The MDD-W is a binary variable (0-1) measuring whether or not the respondent's consumption exceeded 5 out of 10 food groups over a specific recall period. In contrast, to the HDDS, only nine food groups are employed to compute the WDDS (Table 1). In particular, fats and oils are not included because previous research suggested that this group did not contribute to micronutrient density in the diet (Kennedy, Ballard and Diop 2013). Similarly, the sugars group and the group consisting of spices and condiments are not considered to be important for this indicator.

In addition, we derive indices for micronutrient adequacy, including vitamin A and iron, from the same survey instrument using the approach suggested by Kennedy, Ballard and Diop (2013). These indices are constructed as counts only over the food sources that are rich in either source of nutrients.

IV. Data

We utilize the nationally representative 2014/15 LSMS-ISA data for Mali to analyze the demand for food groups across areas of residency (macro-analysis). With probability of selection proportional to size of population as of the 2009 Census, the statistical sample is nationally representative of both rural and urban areas excluding the region of Kidal. The total sample size was limited by inability to collect data in some regions because of political insecurity, with the largest sample losses in the regions of Mopti, Tombouctou and Gao. The final sample includes about 3,804 households as compared to the planned sample of 4,218. The number of standard enumeration areas was 1070, with 80% in rural areas, including 2-3 households per standard enumeration area.

To examine the dietary diversity (micro-scale analysis), we utilize the 2014/15 LSMS/ISA dataset and 2018/19 PREPOSAM dataset. The LSMS-ISA dataset includes a household dietary diversity module, whereas the 2018/19 PREPOSAM dataset includes an individual dietary diversity module. Table 1 provides information regarding each dietary diversity score/indicators; HDDS, MDD-W and WDDS.

Ten food groups were utilized by the LSMS-ISA team in Mali, with the composition as shown in Table 1. As implemented in Mali, the HDDS refers to the frequency of consumption during the week preceding the survey. In addition to the HDDS, the Mali questionnaire included questions concerning the provision of meals to persons who were not household members, distributed by age category of the recipient. Data on food consumption was collected twice- during the period of July to August (lean season) and during the period of October to December (harvest season). We include a summary of one of these variables. We analyze data weighted by the probability of selection.

The PREPOSAM dataset was collected by the Institut d'Economie Rurale and Michigan State University in repeated visits from October of 2017 through February of 2019. Diet information was collected twice—in July of 2018 and February of 2019. The sample was stratified by agroecological zone, including the zones of the Delta du Niger (heavily based on irrigated rice production in, with surrounding areas of dryland farming based on millet production) and the Plateau de Koutiala (based on sorghum and a cotton-maize rotation in a rainfed system). A sample of 60 standard enumeration areas was selected in each of the zones, with 20 farm households per standard enumeration area. Here again, we analyze data weighted by the probability of selection.

In July of 2018, all women of aged 15-60 were interviewed within households surveyed, totaling 5930 women. In February of 2019, to ascertain whether patterns in the data were attributable to season, the team returned to a subset of 1026 women interviewed in the first visit. The sample included all previous respondents in a random selection of villages from the original 60, retaining the original stratification but excluding those villages where enumerators had experienced security concerns. Seasonal comparisons are based on the subsample of 1026 women interviewed in both July of 2018 and February of 2019. Mean values were not significantly different between the larger and smaller sample in the same season (July 2018). Women were asked about their food consumption over a 24-hour recall period.

V. Results

a. Commodity composition of diets in rural and urban areas

The structure of food budgets in rural and urban Mali as of 2014/15 is indicated in Tables 2-5, according to commodity group, and differentiated by degree of processing and perishability. Food consumption data were collected twice during the LSMS-ISA in Mali. The first visit commenced in July, and corresponds to the "hungry season." The second was undertaken in December and January, during harvest.

As seen in Tables 2 and 4, purchased foods represented 96% of the average food budget of urban households, with tiny percentages of own production (backyard and peri-urban areas), food purchased as a snack or meal outside the home and tobacco. Highly processed food composed 15% of the urban diet—in the form of refined wheat products, liquid and dried milk, and oils. Meats other than poultry occupy 16-17% of the average budget, followed by rice (13-14%) and vegetables (13-14%). Oils (7-8%) and fish (8-9%) come next in order of size and with root crops, fruits, wheat products, sorghum or millet at 5% or less. Products with sugar (sugary foods, soft drinks, sugar for tea or coffee) are 4-6% of the average budget. Maize is less important than we expected, at 2% only in urban areas during both periods. In the average urban household, no foods were received as gifts.

As indicated in Tables 3 and 5, in rural areas, purchased food represented 72% of budgets during the hungry season and 60% in the harvest season. Gifts were more common, but food purchased away from home was negligible in the overall composition of food consumed. The order of importance in the food budget by commodity differed slightly from that of urban areas in that season: rice (16%), millet or sorghum (11%), meats other than poultry (10%), vegetables (9%), oils or fish (5%), sugar (5%), fruit, pulses, maize, or salt (4%). Highly processed foods represented less than half the share indicated in urban areas (7%, as compared to 15%). Nonetheless, foods with any type of processing were 60% of the average budget in urban areas and 48% in rural areas. The difference between urban and rural areas in Mali is noteworthy given the findings of Tschirley et al. (2015) that shares are similar between urban and rural areas in Eastern and Southern Africa.

Comparing diet structures in the two periods, we found almost no change on average in urban areas. We expect this to be the case except for peri-urban areas where some home production for consumption occurs. In the second visit in rural areas, a larger share of total consumption was derived from on-farm production (36% compared to 25% in the first visit), and a smaller percentage of this was perishable—reflecting the harvest of rice. Rural households allocated about 1/5 of their food budget to rice during harvest season. The share of the budget allocated to millet and sorghum remained relatively stable across both periods. Shares by extent of processing remained about 50/50 unprocessed and low extent of processing. Highly processed, purchased foods represented 7% of the rural budget in either season.

b. Household diet diversity scores: access to food

The distribution of household diets by food groups and frequency of consumption in number of days consumed per week is shown in Table 6. Cereals are among the most frequently consumed category (at least 6 out of 7 days) in either season, regardless of urban or rural residence. However, fish and meat, sugars, and fats and oils are consumed 6 out of 7 days per week by households in urban areas, in both seasons. By contrast, consumption of fish and meat rises from under 4 to slightly over 4 days per week in rural areas after harvest in February. Between seasons, household consumption of oils and fats rises from about 3 to nearly 5 days per week and sugars increase from only 2 days per week to 6 in rural areas. Vegetables are frequently consumed on average by urban households (5 days per week in either season), but less often by the typical rural household. Fruits appear to be consumed far less often, with an average of 2-3 times per week by urban households, and only 1-2 days per week by rural households. The food groups of legumes and seeds (including cowpeas and groundnuts, among other foods) and dairy and eggs are also consumed more in urban than in rural areas, but similarly across seasons.

Statistical tests comparing mean values confirm that differences between urban and rural areas in the frequency of consumption (days per week) are highly significant for all food groups measured in the LSMS-ISA except for legumes and seeds in the post-harvest period, which is weakly significant at under 10%. Surprisingly, seasonal differences are highly significant in urban as well as rural households for all food groups except legumes and seeds and dairy and eggs. This finding underscores the profoundly rural nature of food consumption in Mali—that is, constrained food choices of urban households appear still to reflect production patterns in rural areas, which shape rural consumption more directly.

Average HDDS scores out of 10 food groups are shown in Table 7, by season and residence. Means differ statistically at a significance level of well under 1% between seasons in both urban and rural areas, and also between urban and rural areas, in each season. Nationally, they averaged 7.5 groups out of 10 in September of 2014 and 8.0 in February of 2015. Plotting of histograms show that the frequency distributions are actually skewed to the left rather than normally distributed—implying that most households have access to more rather than fewer groups. However, this finding actually conveys little nutritional information since groups include spices and condiments, fats and oils—which are included in the sauces consumed daily in Mali—and sugar—which is consumed in tea or coffee at a minimum. Further, fish and meat have been combined, as well as dairy and eggs.

Malian households customarily share food with individuals outside their household, including but not limited to extended family. Table 8 shows that the average number of meals shared was greatest with adults from 16 to 65 years of age, in either season (over 2). The next most frequent category was children between 5 and 15 years of age (slight over 1 in either season). Children under 5 followed, with just under 1 occasion in either September or February. Adults over 65 were rarer, although this group is also less common in the age distribution.

c. Women's diet diversity and adequacy scores: diet quality

In Table 9, we see the detail included in the women's indicators of diet quality (WDDS and MDD-W) compared with the Household Dietary Diversity Score. Table 9 includes categories that separate the nutrient content, such as fruits and vegetables that are known to be relatively rich sources of vitamin A, and organ meat, which is a source of iron. However, since we requested for each subcategory, these could not be aggregated across the broader categories of the HDDS. Between the two seasons (pre- and post-harvest), we see dramatic changes in rural women's consumption of starchy staples, including cereals and white roots and tubers. In our survey zones, the order of frequency of consumption among cereals was similar in July for maize, rice and millet (each about 3 days per week, with sorghum only once), but millet led after harvest (4 days per week), followed by rice, maize and sorghum. Groundnut, a consistent ingredient for the stews and sauces that accompany the starchy staple, was consumed 3-4 days per week on average. Green leafy vegetables are consumed 4-5 days per week in either season, and other vegetables 5 days a week post-harvest. In either season, fish was more frequently consumed on average (2 days for fresh and 4 days for dried) than meat. Eggs are rarely consumed but each type of milk or milk product is consumed 1-2 times per week in both July and February. Although women consume fats and oils 6-7 days per week on average, the amounts are likely to be small—equivalent to that added to sauces and stews. Among foods with higher sugar content, only sweetened tea or coffee was consumed most of the week (5 out of 7 days). Wild plants or fruits were consumed 3.5 days per week at the mean during July, but only 2.2 days per week after the harvest in February. This corresponds to food availability on farms, and underscores the continued importance of natural areas surrounding communities.

Average dietary diversity scores of women in the Delta du Niger and Plateau de Koutiala are shown in Table 10. Scores are weighted by the probability of selection, which varied by enumeration area, in order to represent averages for the study population under study. Over half (53%) of 5,930 women between the ages of 15 and 60 consumed less than 5 of the 10 food groups included in the MDD-W during the 24-hour period preceding the interview. The likelihood that a woman fell below minimum adequacy was much greater among households on the Plateau than in the Delta (65% vs. 42%). According to FAO and FHI 360 (2016), the MDD-W is a proxy for the probability of micronutrient adequacy. Micronutrient adequacy is a "critical dimension of diet quality" (ibid.).

A comparison of the average WDDS between the Delta and the Plateau shows a difference of meaningful magnitude (4.6 vs. 3.9 respectively, or slightly more than half a food group). Since these averages are weighted by the probability of selection to obtain population estimates, we cannot test the difference for statistical significance. T-tests with the unweighted sample suggest significant differences in means at 1% whether or not we assume equal variances. We also find that differences between the two zones in the underlying distributions of the score (which ranges from 0 to 9) are significant at 1% with a Kruskal-Wallis test and chi-squared statistic. Regional differences in women's dietary diversity can be explained in part by massive public investments in irrigation schemes in the Delta, which allow farmers to grow nutritious foods, such as vegetables, during the dry season. Overall, however, the distribution appears normal in shape (Figure 1).

In July of 2018, women were interviewed during the "hungry season," when farm families are also working in their fields. Especially considering the low scores observed in this season, the team thought it was important to return following the harvest and test for seasonal differences. Comparisons between July 2018 and February 2019 are shown in Table 11. The MDD-W rises to 80% after harvest, suggesting that four out of five women consume at least 5 of the 10 groups included in this score. Similarly, the WDDS rises from a mean of 4.3 to 5.6—implying an increase of more than one food group on average.

Other indicators are also of interest, and each of these differs significantly by season. Women spent 59 FCFA on average after harvest compared to 35 FCFA on meals or snacks purchased outside the home. Clearly, they had more cash to spend from sales of production on their plots or receipts shared with other family members. The frequency of consumption of all special categories increased, including soda or juice, sugars, fats and oils, but also foods rich in iron and vitamin A.

Concurrently, the likelihood that a respondent consumed a wild plant in the 24 hours preceding the survey declined from 60% to 40%. These are often considered to be "famine foods," although baobab leaves and other foods gathered in common areas around the farm also play a role in the usual diet of many rural households in Mali. Evidently, wild plants are still a key component of the rural diet in Mali—in either season.

In terms of relative importance in the diet, and concerns about the rise in consumption of obesogenic foods in Sub-Saharan Africa, we do not observe high consumption of sugary foods by farm women in Mali. Even after harvest, the chances are only 1 in 10 that a farm woman in Mali consumed a soda or juice in the day before the survey. Chances are 4 out of 5 that she consumed some type of sugar, but sugar added to tea or coffee accounts for most of this consumption. Fats and oils were consumed by almost all farm women in either season, and these were most probably in limited amounts used daily for preparation of sauces to accompany the starchy staple.

Over half of them reported consuming wild fruits or plants during the preceding 24 hours, and 40 % had consumed these seven days during the previous week. To test for seasonal differences, the team intends to conduct the interviews with a subset of the overall sample in early 2019. Expectations are that seasonal differences will be significant, although this does not diminish the gravity of the findings with respect to July 2018. Four out of five women reported having consumed at least some cooking oil daily over the previous week, though amounts may be small. Slightly over a third (35%) had consumed foods rich in iron during the 24 hours before the survey, but only 16% had consumed foods rich in vitamin A.

VI. Discussion

In this paper, we analyzed the dietary patterns and their implications for nutrition in Mali. First, we reviewed the key concepts related to nutrition. Next, we described the methodological approaches used to examine the dietary compositions by food groups at the macro and micro scales. Then, we presented matrices developed with the LSMS-ISA 2014-15 data (nationally representative sample of 3,804 households) to depict the current "macro" structure of food consumption in rural and urban Mali. We then consulted primary data we collected in multiple visits between October 2017 and July 2018 among roughly 2400 households, including nearly 9200 plot managers and almost 6000 women between the ages of 15 and 60. We used these "micro" data to explore the diet quality of farm women in the agroecological zones of the Delta du Niger and the Koutiala Plateau. We then compared diet quality between seasons for a subsample of about 1000 women.

Estimates derived from the LSMS-ISA showed that in 2017/18 in Mali, on-farm production provided on average of only 25% of the food consumed by rural households during the hungry season, rising to 36% in the harvest season. In their analysis of LSMS data (circa 2010) from Ethiopia, Uganda, Tanzania, Malawi and Zambia, Tschirley et al. (2015) found that own production accounted for 43% of food consumed (annually). Differences between regions might be explained by higher productivity in Eastern and Southern Africa, or by the time difference between the surveys, but the estimates for Mali are disturbing given the reliance of the population on income from farm production. These data suggest that a goal of achieving family farm self-sufficiency is unrealistic in rural Mali. Food is still received as gifts in rural areas, but we found gifts to be of negligible importance in urban areas.

In Mali, consumption of food with any type of processing was considerably lower in rural than in urban areas (48% as compared to 60%). However, both of these estimates are higher than the 39%

estimate reported by Tschirley et al. (2015) for Eastern and Southern Africa. We estimated the share of highly processed foods to be 15% in urban areas and 7% in rural areas. Tschirley et al. (2015) report 20% for both rural and urban areas combined all five countries. Thus, highly processed foods still represent a relatively smaller share of processed foods consumed by urban and especially rural residents in Mali.

Food purchased outside the home remains a feature of urban as compared to rural households in Mali—but still occupies a negligible percentage of the average budget (2%). By contrast, food purchased outside the home represented 12% of food expenditures in rural areas and 33% in urban areas of Tanzania in 2010 (Tschirley et al. 2017). Haggblade et al. (2016) report survey data indicating that in Johannesburg, 28% of adults aged 19 to 30 years consume fast foods 2 to 3 times weekly; among 17-year-olds from Soweto, 50% of males and 38% of females consume 8 or more street food and fast-food meals weekly.

Together, these findings indicate that while both rural and urban diets in Mali have shifted heavily toward purchased foods and processed foods, the shares of highly processed foods and meals purchased outside the home (street, or fast foods) are still low relative to some other countries of Sub-Saharan Africa. Of course, processing is not always bad; for example, drying for preservation and removal of toxicity has positive effects on nutrition and health (Cliffer et al. 2019). Rising consumption of meals away from home, packaged and ultraprocessed foods cause greater concern than does consumption of processed foods in general (ibid.). Given these cross-regional comparisons, we conclude that in Mali, it may still be possible to “bend the curve” toward healthier diets and avoid the overnutrition now faced by many other nations.

As might be expected, we found that meat consumption occupied a higher share of the food budget in urban areas—which is undoubtedly related to higher incomes. Average budget shares allocated to sorghum and millet are considerably higher in rural areas, reflecting the limited level of processing and trading of these cereals. The share of maize in the budget was lower than other cereals in either rural or urban areas (2-4%). This has relevance for the extent to which this crop is favored over sorghum and millet by the fertilizer subsidy and other farm policies—in large part because of its relation to cotton. Among cereals, the share of rice in the budget is the greatest in both rural and urban areas, but slightly more so in rural as compared to urban areas. This is not surprising given the importance that the Malian government gives to rice in its strategy to achieve food and nutrition security (e.g., input subsidies and investment in irrigation schemes). Nor is the finding unique to Mali; rice has been favored by farm policy in most countries of West Africa for decades.

Urban households have a higher dietary diversity score than rural households. In Tanzania, Cockx and Weerdt (2016: 3) found little evidence of differences in dietary diversity “between individuals who relocated from rural to urban areas and their initial household members who stayed behind.” We might hypothesize that the difference between Mali and Tanzania could reflect greater differences in access to a broader range of foods between urban and rural markets in Mali, combined with income differentials. Another obvious difference is that Cockx and Weerdt (2016) controlled for household, measuring changes among migrant family members—thus controlling for multiple intervening factors. In their Bamako study undertaken a decade ago, Kennedy et al. (2009) found that women’s diets were dominated by the starchy staples (refined white rice, refined wheat flour and millet) that provided half of the energy, with edible vegetable oil (included in the sauces that accompany the staples) also providing a substantial portion of energy. They found considerable diversity across major food groups, although it was limited to certain types of food items within those groups. In particular, snacks and foods such as fruits, peanuts, and doughnuts made of cowpea flour enhanced diversity scores for rural women. Similarly, in neighboring Ouagadougou, Burkina Faso, Becquey et al. (2010) concluded that urban diet diversity was rather low (though higher than in rural areas), but variability was introduced through "snacking"—which was not associated with higher risk of being overweight.

We also found that the dietary diversity scores of both urban and rural households are lower during the lean season than during the harvest season. Seasonal differences observed in household access to food in both urban and rural areas are also observed in the micronutrient adequacy of rural women, which is a component of diet quality. Compared to the post-harvest season, Malian farm women consume one less food group during the lean season and the percentage of them consuming at least 5 out of 10 food groups dropped by 34% (from 79.5% to 45.1%). Over a decade ago, research by Savy et al. (2006) highlighted the importance of seasonal variations in dietary diversity in rural areas of Burkina Faso, also demonstrating that whether changes are positive or negative depends on the availability of food sources other than the cereals, including wild plants and fruits, and income—since this enables women in better-off households to purchase livestock products and oil. Differences in food consumption patterns also exist between agro-ecological zones. Farm women residing in the Plateau de Koutiala have lower diet quality scores than women located in the Delta du Niger. The Delta du Niger has benefited from massive public investments in irrigation schemes, contributing to more diverse crop choices. While this is also the case for the cotton-growing areas of Sikasso, including Koutiala, the "paradox of Sikasso" is that despite these long-term public investments through the cotton industry, poverty, inequality and malnutrition (Mesple-Somps et al. 2008; Smale et al. 2011).

Overall, the likelihood that a woman between the ages of 15 and 60 meets minimum adequate dietary diversity rose from 45% to 80% between July and February. While this is encouraging, it does not diminish the gravity of the nutritional stress experienced by women and their families during the 'hungry' season in Mali. Women's consumption of starchy staples, fruits and vegetables is season-dependent in our study zones, but less so their consumption of fish, groundnuts, milk products and oil—which they appear to rely on more than meat or eggs. Sugary foods are rarely consumed in our study zones by women of reproductive age, except in the form of sweetened tea or coffee.

In their study of over 5000 women of reproductive age in the region of Kayes, Mali, Adubra et al. (2019) found that an even lower percentage of women (27%) reached the MDD-W; those who did consumed animal source foods and/or vitamin A-rich foods more frequently. The authors also tested the relationship between the MDD-W for individual women and the food security of their households, confirming a significant association with both the Household Hunger Score and the Household Food Insecurity Access scale, as well as a farm production diversity score. This attests to the utility of this rapid assessment indicator as both a predictor of diet quality for women and of overall food security for their households.

Several policy implications emerge from our study on dietary patterns. Private and public investments to minimize the rural bias and seasonality effects on the dietary diversity of Malians households and individuals are needed. At the farm level, small-scale irrigation schemes, as pursued by the Malian government and donors, can contribute to balanced nutrition by increasing crop diversity and productivity. Yet, given the heavy dependence of the population on purchased food, more off-farm investments are needed to achieve food and nutrition security. This requires developing food markets and the agro-processing sector to enable the provision of affordable, diversified, and nutritious food year-round in both rural and urban areas.

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Table 1. Definitions of dietary diversity scores and indicators

	Variable construction	Food groups included	Group content in Mali
HDDS	1 to 10 food groups*	cereals	millet, sorghum, fonio, rice, maize and products
		tubers, plantains	potato, sweet potato, plantain, manioc, taro
		legumes, seeds	cowpea, beans, groundnut, sesame
		vegetables	lettuce, tomato, eggplant, okra, sweet pepper, green bean, cucumber, peas
		fish and meat	fresh and smoked fish, beef, mutton, chicken
		fruits	mango, orange, other citrus, melon, pineapple
		dairy, eggs	fresh and powdered milk, yoghurt, cheese, eggs
		oil, fats	butter, palm oil, groundnut oil
		sugar	sugar in powder or piece, honey, bonbons
		spices, condiments	salt, pepper, maggi cubes, garlic, ginger, tamarind
WDDS	1 to 9 food groups	starchy staples	cereals, white tubers and plantains (as above)
		dark green leafy vegetables	amaranthus (*pron boulou*), kale, spinach, leaves of cassava, sweet potato, bean, sorrel, *zofon boulou*
		vitamin A-rich fruits and vegetables	pumpkin, carrot, squash, orange sweet potato, red sweet pepper, mango, papaya, red palm
		other fruits and vegetables	tomato, onion, eggplant, okra, sweet peppers, green bean, cucumber, lemon, melon, orange
		organ meat	liver, kidney, heart or other organ meat
		fish and meat	flesh meats and fish (as above)
		eggs	eggs
		legumes, nuts and seeds	beans, peas, cowpea, groundnuts
		dairy	as above
MDD-W	at least 5 out of 10 food group=1, 0 else	grains, white roots a nd tubers, and plantains	cereals, tubers and plantains (as above)
		pulses (beans, peas and lentils)	cowpeas, beans

		nuts and seeds	groundnuts, sesame
		dairy	as above
		meat, poultry and fish	as above
		eggs	
		dark green leafy vegetables	as above
		vitamin A-rich fruits and vegetables	as above
		other vegetables	as above
		other fruits	as above
Other indicators	consumed=1, 0 else		
fats/oils			vegetable oil, butter, margarine, karite
iron			flesh or organ meats
vitamin A			vegetables or fruits rich in vitamin A (as above)
sugars			jam, candy, soda or juice, or sugar in tea or coffee
soda/juice			soda or juice
wild plants			fruit of the baobab, *nere*, *tamarin*
outside costs			FCFA spent on snacks or meals purchased outside the home in the preceding 24 hours

* As defined in Mali, but reduced from the 12 groups of Kennedy, Ballard and Diop (2013), which are developed from 16 categories in the questionnaire.

Source: LSMS-ISA Mali 2014-15 and IER/MSU survey data 2018-19

Table 2. Share (%) of food budget by commodity group, processing and perishability, urban enumeration areas, first visit (July- August)

Commodity group	Purchased						All Purchased	All Own Production	All Gifts	Food Purchased outside the Home	Tobacco	Total
	Unprocessed, Non-perishable	Unprocessed, Perishable	Low-processed, Non-perishable	Low-processed, Perishable	High-processed, Non-perishable	High-processed, Perishable						
rice	0.00	0.00	0.13	0.00	0.00	0.00	0.13	0.00	0.00	N/A	N/A	0.14
maize	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	N/A	N/A	0.02
millet_sorghum	0.05	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	N/A	N/A	0.05
wheat	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.00	0.00	N/A	N/A	0.05
other_grains	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.00
pulses	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.01
roots	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	N/A	N/A	0.05
oils	0.00	0.00	0.02	0.00	0.05	0.00	0.08	0.00	0.00	N/A	N/A	0.08
fruit	0.00	0.06	0.00	0.00	0.00	0.00	0.06	0.00	0.00	N/A	N/A	0.06
vegetables	0.01	0.12	0.00	0.00	0.00	0.00	0.13	0.00	0.00	N/A	N/A	0.13
poultry	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	N/A	N/A	0.02
other_meats	0.00	0.00	0.00	0.17	0.00	0.00	0.17	0.00	0.00	N/A	N/A	0.17
liquid_milk	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	N/A	N/A	0.01
dried_milk	0.00	0.00	0.00	0.00	0.04	0.00	0.04	0.00	0.00	N/A	N/A	0.04
other_dairy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.01
fish	0.00	0.04	0.00	0.04	0.00	0.00	0.08	0.00	0.00	N/A	N/A	0.08
salt	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.01
sugars	0.00	0.00	0.03	0.00	0.00	0.00	0.04	0.00	0.00	N/A	N/A	0.04
other_nuts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.00
Total	0.09	0.27	0.21	0.24	0.10	0.05	0.96	0.01	0.00	0.02	0.01	1.00

Source: Authors, constructed from LSMS-ISA 2014 in Mali.

Table 3. Share (%) of food budget by commodity group, processing and perishability, rural enumeration areas, first visit (July- August)

Commodity group	Purchased: Unprocessed, Non-perishable	Unprocessed, Perishable	Low-processed, Non-perishable	Low-processed, Perishable	High-processed, Non-perishable	High-processed, Perishable	All Purchased	All Own Production	All Gifts	Food Purchased outside the Home	Tobacco	Total
rice	0.00	0.00	0.12	0.00	0.00	0.00	0.12	0.04	0.00	N/A	N/A	0.16
maize	0.02	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00	N/A	N/A	0.04
millet_sorghum	0.07	0.00	0.01	0.00	0.00	0.00	0.08	0.03	0.00	N/A	N/A	0.11
wheat	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	N/A	N/A	0.02
other_grains	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.01
pulses	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.02	0.00	N/A	N/A	0.04
roots	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.02
oils	0.00	0.00	0.02	0.00	0.03	0.00	0.05	0.02	0.00	N/A	N/A	0.07
fruit	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.01	0.00	N/A	N/A	0.04
vegetables	0.02	0.05	0.00	0.00	0.00	0.00	0.06	0.02	0.00	N/A	N/A	0.09
poultry	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.02
other_meats	0.00	0.00	0.00	0.09	0.00	0.00	0.09	0.01	0.01	N/A	N/A	0.10
liquid_milk	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	N/A	N/A	0.02
dried_milk	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	N/A	N/A	0.01
other_dairy	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	N/A	N/A	0.03
fish	0.00	0.02	0.00	0.04	0.00	0.00	0.06	0.01	0.00	N/A	N/A	0.07
salt	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.00	0.00	N/A	N/A	0.04
sugars	0.00	0.00	0.05	0.00	0.00	0.00	0.05	0.00	0.00	N/A	N/A	0.05
other_nuts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	N/A	N/A	0.03
Total	0.13	0.11	0.25	0.16	0.04	0.03	0.72	0.25	0.03	0.00	0.01	0.99

Source: Authors, constructed from LSMS-ISA 2014 in Mali.

Table 4. Share (%) of food budget by commodity group, processing and perishability, urban enumeration areas, second visit (October-December)

	Purchased									Food Purchased outside the Home	Tobacco	
Commodity group	Unprocessed, Non-perishable	Unprocessed, Perishable	Low-processed, Non-perishable	Low-processed, Perishable	High-processed, Non-perishable	High-processed, Perishable	All purchased	All Own Production	All gifts			Total
rice	0%	0%	12%	0%	0%	0%	12%	0%	0%	N/A	N/A	13%
maize	2%	0%	0%	0%	0%	0%	2%	0%	0%	N/A	N/A	2%
millet_sorghum	3%	0%	0%	0%	0%	0%	4%	0%	0%	N/A	N/A	4%
wheat	0%	0%	0%	0%	0%	3%	3%	0%	0%	N/A	N/A	3%
other_grains	0%	0%	0%	0%	0%	0%	0%	0%	0%	N/A	N/A	0%
pulses	1%	0%	0%	0%	0%	0%	2%	0%	0%	N/A	N/A	2%
roots	0%	5%	0%	0%	0%	0%	5%	0%	0%	N/A	N/A	5%
oils	0%	0%	2%	0%	5%	0%	7%	0%	0%	N/A	N/A	7%
fruit	0%	5%	0%	0%	0%	0%	5%	0%	0%	N/A	N/A	6%
vegetables	1%	12%	0%	0%	0%	0%	14%	0%	0%	N/A	N/A	14%
poultry	0%	0%	0%	4%	0%	1%	5%	0%	0%	N/A	N/A	5%
other_meats	0%	0%	0%	15%	0%	0%	15%	0%	0%	N/A	N/A	16%
liquid_milk	0%	0%	0%	1%	0%	1%	1%	0%	0%	N/A	N/A	1%
dried_milk	0%	0%	0%	0%	5%	0%	5%	0%	0%	N/A	N/A	5%
other_dairy	0%	0%	0%	0%	0%	0%	0%	0%	0%	N/A	N/A	0%
fish	0%	4%	0%	4%	0%	0%	9%	0%	0%	N/A	N/A	9%
salt	0%	0%	2%	0%	0%	0%	2%	0%	0%	N/A	N/A	2%
sugars	0%	0%	6%	0%	0%	0%	6%	0%	0%	N/A	N/A	6%
other_nuts	0%	0%	0%	0%	0%	0%	0%	0%	0%	N/A	N/A	0%
Total	8%	27%	22%	24%	10%	5%	96%	1%	0%	2%	1%	100%

Source: Authors, constructed from LSMS-ISA 2014 in Mali.

Table 5. Share (%) of food budget by commodity group, processing and perishability, rural enumeration areas, second visit (October to December)

	Purchased									Food Away-from-Home	Tobacco	
Commodity group	Unprocessed, Non-perishable	Unprocessed, Perishable	Low-processed, Non-perishable	Low-processed, Perishable	High-processed, Non-perishable	High-processed, Perishable	All purchased	All Own Production	All gifts			Total
rice	0%	0%	11%	0%	0%	0%	11%	9%	0%	N/A	N/A	21%
maize	1%	0%	0%	0%	0%	0%	1%	4%	0%	N/A	N/A	5%
millet_sorghum	3%	0%	0%	0%	0%	0%	3%	8%	0%	N/A	N/A	12%
wheat	0%	0%	0%	0%	0%	2%	2%	0%	0%	N/A	N/A	3%
other_grains	0%	0%	0%	0%	0%	0%	0%	1%	0%	N/A	N/A	1%
pulses	1%	0%	0%	0%	0%	0%	2%	3%	0%	N/A	N/A	5%
roots	0%	2%	0%	0%	0%	0%	2%	0%	0%	N/A	N/A	3%
oils	0%	0%	2%	0%	3%	0%	5%	2%	0%	N/A	N/A	7%
fruit	0%	2%	0%	0%	0%	0%	2%	0%	0%	N/A	N/A	2%
vegetables	1%	4%	0%	0%	0%	0%	6%	2%	0%	N/A	N/A	8%
poultry	0%	0%	0%	1%	0%	0%	1%	1%	0%	N/A	N/A	3%
other_meats	0%	0%	0%	9%	0%	0%	9%	1%	1%	N/A	N/A	11%
liquid_milk	0%	0%	0%	1%	0%	1%	1%	1%	0%	N/A	N/A	2%
dried_milk	0%	0%	0%	0%	1%	0%	1%	0%	0%	N/A	N/A	1%
other_dairy	0%	0%	0%	0%	0%	0%	1%	0%	0%	N/A	N/A	1%
fish	0%	2%	0%	4%	0%	0%	7%	1%	0%	N/A	N/A	8%
salt	0%	0%	2%	0%	0%	0%	2%	0%	0%	N/A	N/A	2%
sugars	0%	0%	4%	0%	0%	0%	4%	0%	0%	N/A	N/A	4%
other_nuts	0%	0%	0%	0%	0%	0%	0%	0%	0%	N/A	N/A	0%
Total	7%	11%	20%	15%	4%	3%	60%	36%	4%	1%	1%	100%

Source: Authors, constructed from LSMS-ISA 2014 in Mali.

Table 6. Frequency of food group consumption by households in Mali, by residence and season (2014-15)

Food group	Days consumed per week					Days consumed per week					Difference of means (pvalue) Seasonal		Residential
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Urban	Rural	September
September			Urban					Rural					
cereals	1405	6.57	1.41	0	7	2399	6.25	1.85	0	7	0.0000	0.0000	0.0000
tubers, plantains	1405	1.71	1.84	0	7	2399	0.60	1.33	0	7	0.0000	0.0000	0.0000
legumes, seeds	1405	2.95	2.21	0	7	2399	2.50	2.47	0	7	0.4252	0.0000	0.0000
vegetables	1405	5.09	2.55	0	7	2399	2.87	2.90	0	7	0.0001	0.0000	0.0000
fish and meat	1405	6.23	1.85	0	7	2399	3.87	2.72	0	7	0.0040	0.0000	0.0000
fruits	1405	2.30	2.49	0	7	2399	0.97	1.95	0	7	0.0000	0.0056	0.0000
dairy, eggs	1405	3.85	2.88	0	7	2399	2.66	2.76	0	7	0.0536	0.7446	0.0000
oil, fats	1405	6.13	1.90	0	7	2399	4.26	2.91	0	7	0.0005	0.0000	0.0000
sugar	1405	6.61	1.47	0	7	2399	5.57	2.43	0	7	0.0002	0.0000	0.0000
spices, condiments	1405	6.56	1.58	0	7	2399	5.98	2.27	0	7	0.0053	0.0000	0.0000
February			Urban					Rural					February
cereals	1405	6.75	1.11	0	7	2399	6.60	1.34	0	7			0.0005
tubers, plantains	1405	2.19	1.88	0	7	2399	0.81	1.41	0	7			0.0000
legumes, seeds	1405	2.90	2.03	0	7	2399	3.04	2.53	0	7			0.0834
vegetables	1405	5.35	2.34	0	7	2399	3.58	2.90	0	7			0.0000
fish and meat	1405	6.38	1.56	0	7	2399	4.30	2.59	0	7			0.0000
fruits	1405	2.68	2.46	0	7	2399	1.10	1.96	0	7			0.0000
dairy, eggs	1405	4.00	2.82	0	7	2399	2.68	2.73	0	7			0.0000
oil, fats	1405	6.32	1.66	0	7	2399	4.93	2.64	0	7			0.0000
sugar	1405	6.77	1.10	0	7	2399	6.02	2.02	0	7			0.0000
spices, condiments	1405	6.68	1.34	0	7	2399	6.42	1.74	0	7			0.0000

Source: Authors, based on LSMS-ISA Mali 2014-15.

Table 7. Household dietary diversity scores, by season and residence (2014-2015)

	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
		Urban			Rural	
HDDS (September)	1405	8.62	1.88	2399	6.84	2.32
HDDS (February)	1405	9.01	1.55	2399	7.45	1.98

Source: Authors, based on LSMS-ISA Mali 2014-15.
Differences between seasons and residence, by season are statistically significant at <1%

Table 8. Number of days in week preceding the survey that a household in Mali shared a meal with someone who is not a household member

	September 2014					February 2015				
Age group	n	mean	min	max	sd	n	mean	min	max	sd
Adults 16-65 years	1173	2.20	0	7	2.07	1092	2.11	0	7	2.01
Adults over 65 years	1014	0.34	0	7	1.12	1006	0.45	0	7	1.38
Children 5 years or less	1046	0.97	0	7	1.89	1031	0.75	0	7	1.61
Children 5-15 years	1077	1.23	0	7	1.81	1050	1.37	0	7	1.87
Total	4310	1.22	0	7	1.90	4179	1.19	0	7	1.86

Source: Authors, based on LSMS-ISA Mali 2014-15.

Table 9. Days per week of food group consumption by women of reproductive age in rural Mali, by season (2017-18)

Food group	July 2017				February 2018			
	Days consumed per week				Days consumed per week			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Cereals								
sorghum	0.78	2.06	0	7	1.83	2.86	0	7
millet	3.12	3.19	0	7	4.02	3.02	0	7
maize	3.11	3.37	0	7	2.30	3.01	0	7
rice	3.29	2.76	0	7	3.48	2.62	0	7
fonio	0.04	0.33	0	7	0.11	0.51	0	7
cereal products	1.65	2.00	0	7	2.38	2.25	0	7
Tubers and plantains								
roots and tubers (white)	0.38	1.00	0	7	1.41	1.80	0	7
roots and tubers (orange)	0.10	0.57	0	7	0.31	1.04	0	7
Legumes, seeds								
legumes (not groundnut)	0.97	1.82	0	7	1.51	2.16	0	7
groundnut	3.28	2.58	0	7	3.89	2.67	0	7
sesame	0.03	0.37	0	7	0.11	0.56	0	7
Vegetables and fruits								
green leafy vegetables	5.11	2.60	0	7	4.08	3.07	0	7
vitamin A-rich vegetables	0.80	2.04	0	7	1.27	2.31	0	7
other vegetables	2.61	2.90	0	7	5.26	2.42	0	7
vitamin A-rich fruits	0.18	0.76	0	7	0.59	1.21	0	7
other fruits	0.39	1.17	0	7	0.79	1.47	0	7
Fish and meat								
beef	0.98	1.47	0	7	0.70	1.25	0	7
lamb, goat meat	0.73	1.24	0	7	0.98	1.33	0	7
poultry	0.28	0.68	0	7	0.44	0.84	0	7
organ meat	0.22	0.81	0	7	0.21	0.72	0	7
insects, rodents	0.04	0.33	0	7	0.19	0.76	0	7
other meats	0.02	0.21	0	7	0.03	0.32	0	7
fish (fresh)	1.50	2.40	0	7	2.13	2.45	0	7
fish (dried)	4.09	2.81	0	7	4.89	2.60	0	7
Dairy, eggs								
eggs	0.43	1.13	0	7	0.38	0.93	0	7
milk (fresh)	0.86	1.86	0	7	1.25	2.10	0	7
milk products (yoghurt, curd)	1.16	2.15	0	7	1.67	2.43	0	7

milk (powdered)	1.28	2.25	0	7	1.79	2.48	0	7
Oils, fats								
palm oil or fruit	0.10	0.62	0	7	0.38	1.21	0	7
other oil	6.38	1.49	0	7	6.41	1.50	0	7
Spices, condiments	6.90	0.55	0	7	6.95	0.43	0	7
Sugar								
honey, jam	0.81	1.57	0	7	1.62	2.11	0	7
sodas, bottled juices	0.42	1.18	0	7	0.46	1.00	0	7
sweetened tea or coffee	5.12	2.71	0	7	5.37	2.61	0	7
Wild plants or fruits	3.49	3.12	0	7	2.24	2.68	0	7

Note: compared for same women (n=1087). Source: Authors, based on data collected by IER/MSU in 2017-18.

Table 10. Women's diet quality scores in Mali, by agroecology, July 2018

Agro-ecological zone	n	MDD-W 0	MDD-W 1	All women	WDDS
		(%)			(mean)
Delta du Niger	2486	42	58	100	4.55
Plateau de Koutiala	3444	65	35	100	3.97
All zones	5930	53	47	100	4.28

Statistical tests not feasible with weighted data.
With sample proportions, Pearson chi2(1) = 751.7102 Pr = 0.000
With sample means, statistical significance with less than 1% with either equal or unequal variances. Kruskal-Wallis chi-squared test shows statistically different underlying distributions.
Source: Authors, based on IER/MSU data.

Table 11. Women's diet quality scores and other indicators in Mali, by season

Variable	Obs	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Difference of means (pvalue)
	July 2018					February 2018				
MDD_W	1,087	0.451	0.498	0	1	0.795	0.404	0	1	0.0000
WDDS	1,087	4.32	1.51	0	9	5.61	1.44	1	9	0.0000
outside costs	1,087	35.4	166	0	3000	58.9	198	0	3900	0.0024
soda or juice	1,087	0.065	0.247	0	1	0.107	0.309	0	1	0.0004
sugars	1,087	0.802	0.399	0	1	0.845	0.362	0	1	0.0037
fats or oils	1,087	0.946	0.227	0	1	0.966	0.181	0	1	0.0247
iron-rich	1,087	0.363	0.481	0	1	0.419	0.494	0	1	0.0047
vitamin A-rich	1,087	0.140	0.347	0	1	0.737	0.441	0	1	0.0000
wild plants	1,087	0.585	0.493	0	1	0.393	0.489	0	1	0.0000

Source: Authors, based on IER/MSU data.

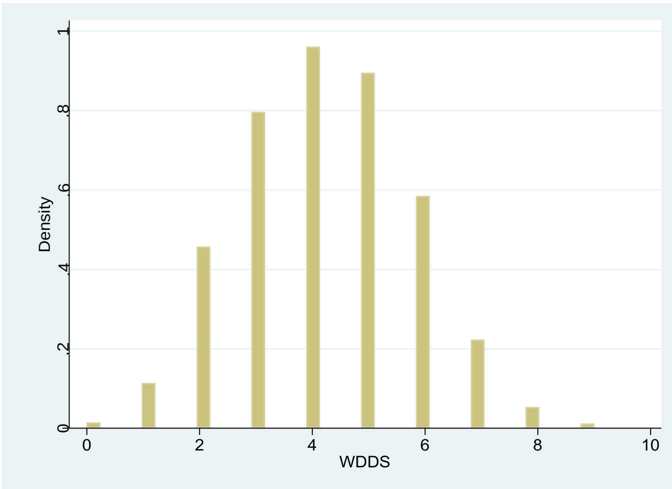
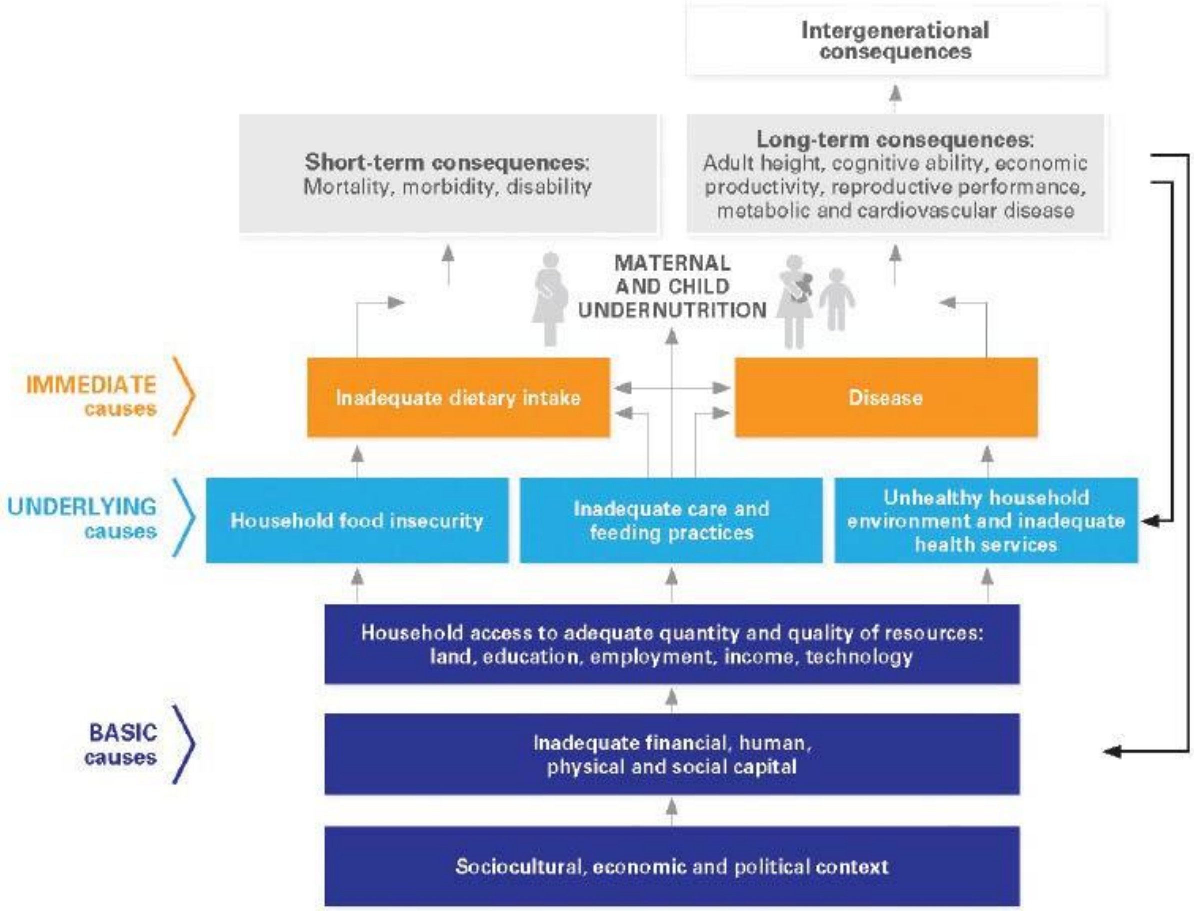


Figure 1. Distribution of Women's Dietary Diversity Score (values range from 0-9, n=5930930)
Source: Authors, from data collected by IER/MSU in 2017-18.

Appendix- Figure A1: UNICEF's Conceptual Framework of Undernutrition



Source: UNICEF 2015:9

Figure A2. Comparison of commonly used indicators (FAO and FHI 2016)

Table 1. Simple food group diversity indicators currently in use or advocated for use at population level

	HDDS[a]	IYCF MDD[b]	WDDS[c]	MDD-W[d]
Population sampled/unit of analysis	Households	Infants and young children aged 6–23 months	Women aged 15–49 years	Women aged 15–49 years
Validated against	Kilocalorie availability as assessed in household-level consumption surveys	Micronutrient density compared with desirable density for complementary foods, assessed by 24-hour recall or weighed food records	Micronutrient adequacy assessed by multiple 24-hour recalls	Micronutrient adequacy assessed by multiple 24-hour recalls
Meaning	Proxy for household-level access to kilocalories (dietary energy), which is one dimension of household food security Reflects economic access to a diet with higher kilocalories per capita	Proxy for the adequacy of the micronutrient density of infant and young child diets Reflects one of several favourable infant and young child feeding practices	Proxy for the probability of micronutrient adequacy of women's diets Reflects micronutrient adequacy, which is one critical dimension of diet quality	Proxy for the probability of micronutrient adequacy of women's diets Reflects micronutrient adequacy, which is one critical dimension of diet quality
Number of food groups	12	7	9	10[e]
Threshold for dichotomous indicator	No dichotomous indicator	4 or more of the 7 food groups	No dichotomous indicator	5 or more of the 10 food groups
Indicator tabulation includes fats/ oils, sweets, and all beverages, including alcohol	Yes	No	No	No
Foods consumed outside the home	Not included	Included	Included	Included

[a] HDDS = Household Dietary Diversity Score; see http://www.fantaproject.org/monitoring-and-evaluation/household-dietary-diversity-score and Food and Agriculture Organization of the United Nations (FAO) (2011).

[b] IYCF MDD = Minimum Dietary Diversity indicator, as an indicator of infant and young child feeding practices; see http://www.who.int/maternal_child_adolescent/documents/9789241596664/en/.

[c] WDDS = Women's Dietary Diversity Score; see FAO (2011).

[d] MDD-W = Minimum Dietary Diversity for Women of Reproductive Age

[e] During analytic work comparing candidate indicators to micronutrient adequacy for women, the 7-group IYCF MDD and dichotomous indicators based on the 9 groups in the WDDS were explored but did not perform as well as the 10-group MDD-W (Martin-Prével et al., 2015).