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Changes in food diets in West Africa and their implications for domestic producers

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ABSTRACT

Food consumption patterns in West Africa have changed over the past few decades, with a higher proportion in the food basket of animal products, fats, sugars and certain cereals such as rice and wheat. These trends, their causes and implications for food security and households have been widely studied but their meaning for agricultural production and farmers remain a more open field of investigation. Have farmers changed their production patterns in reaction to changing diets of increasingly urbanized consumers? Has agricultural production in West Africa diversified or has it concentrated on a smaller number of highly demanded commodities? What are the implications on the value of the farmers' production and their exposure to risks? The aim of this article is to provide statistical evidence on the economic implications for West African farmers of structural changes in the agricultural sector, such as the impact of the shift towards more diverse, calorie-intensive and often more expensive diets. After a presentation of the data and analytical framework, this article compares long-term food consumption and production trends of West African countries. Then, by combining two international datasets on food balance sheets and agricultural producer prices, the implications of these structural changes on the value of agricultural production and the uncertainties associated with the farmers' activities are assessed.

Keywords: Food balance sheets, structural changes, food trends

PAPER

1. Introduction

The comparison of today's food diets with what they were in the 1960s shows that food consumption patterns in West Africa have changed significantly, with a higher proportion in the food basket of animal products, fats, sugars and certain cereals such as rice and wheat (Vincent C., 2015). A number of megatrends are usually invoked as explanatory factors: rapid increase in urbanization rates, from 7.5% in 1950 to 31% in 2000 (OECD, 2011), a rate that has continued to increase since then; a deepening of globalization, facilitating the import of commodities which, until recently, were not considered as staple food items in West Africa such as rice, wheat or sugar; more recently, rising per capita incomes have also contributed to the evolution in diets, both in terms of calorific intake and composition.

The implications of these trends on food security have been widely studied[2] but their meaning for agricultural production and farmers remain a more open field of investigation. This imbalance in the analysis is first explained by the fact that the change in diets directly affects households and consumers and only indirectly farmers and agricultural production. It can also be explained to some extent by the existence of household surveys or population censuses that allow for a detailed analysis of consumption patterns. Many efforts at national and international level have been and are being made to improve household data, with initiatives such as the LSMS (Living Standards Measurement Study).

The stress that has been put on household statistics is due in part to its importance as a major data source for economic and social statistics: data on household expenses is needed to measure poverty and to construct many of the Millennium Development Goal (MDG, now SDG) indicators, in addition to being the main data source for the weights of the Consumer Price Indices (CPI); household survey data is widely used by national accounting departments to measure and calibrate household consumption, a major component of the supply and use equation in national accounts.

1 At the time this article was written and submitted.
2 Recent references include Vicent (2015), Bricas (2015a and 2015b) and Worku (2015).

Comparatively, fewer resources have been directed towards the measurement of agricultural production and farm-specific data: agricultural censuses and farm structural surveys are infrequent in West Africa, leading to data that lack in timeliness, quality, and level of detail and to the absence of proper sampling frames.

The poor measurement of agricultural production at farm level also has to do with the fact that agricultural statistical services are usually separated from national statistical institutes. Farm-level studies made by non-governmental organizations or the private sector often rely on their own data sources and data collection vehicles instead of using national surveys, which are often lacking or considered of insufficient quality. As a result, many of the analysis of the agricultural sector that can be found in the literature generally lack statistical representativity and is restricted in terms of geographical or commodity coverage. In addition, given the cost of carrying-out statistically representative surveys, these are often one-time exercises, impeding the construction and analysis of time-series. Notwithstanding the limitations attached to data on West African agriculture, international datasets compiling nation-wide data on agriculture do exist, allowing the analysis and comparison of macro-level trends on agricultural production and supply. The Food Balance Sheets (FBS), disseminated and updated on a regular basis by the FAOSTAT platform, is in this respect a unique data source which remains under-exploited.

The purpose of this study is to provide statistical evidence on the long-term trends (1960 - present) affecting the supply and demand of agricultural commodities in West African countries[3], based on aggregated sources of information such as the FBS. Through the construction and analysis of appropriate statistical indicators, this study seeks to identify the major trends of the farming sector in West Africa, in a context of changing food diets, and respond to questions such as: have farmers changed their production patterns in reaction to changing diets of increasingly urbanized consumers? Has agricultural production in West Africa diversified or has it concentrated on a smaller number of highly demanded commodities? What are the implications on the value of the farmers' production and their exposure to risks?

After a presentation of the data and analytical framework, this article compares food demand and production trends in West African countries since the beginning of the 1960s. Then, the implications of these structural changes on the value of agricultural production and the uncertainties associated with the farmers' activities are assessed. These analyses are based on two international datasets on food balance sheets and agricultural producer prices. The last Section concludes and identifies further lines of research.

2. Data and analytical framework

The statistical indicators constructed in this article are mainly based on the Food Balance Sheets (FBS) and agricultural producer prices compiled by FAO's Statistics Division and disseminated through its on-line data dissemination platform, FAOSTAT[4]. The data, its underlying compilation framework, and the main statistical indicators used in this study are presented in the remaining of this section.

2.1 Supply and use equation: the framework for Food Balance Sheets

The supply and use equation states that at any point in time there has to be a balance between the supply of an agricultural commodity and its different uses, for a country or any other geographical grouping, as illustrated by equation (1) (FAOSTAT, 2015):

$$\underbrace{Q_i + M_i}_{\text{Supply}} = \underbrace{C_i + NC_i + F_i + Sd_i + X_i + L_i + \Delta S_i}_{\text{Use}}$$

Where:

Q_i : Quantity produced of commodity i

M_i : Quantity imported

C_i : Quantity available for human consumption

NC_i : Quantity available for industrial or other non-food uses

F_i : Quantity used as feed for livestock

Sd_i : Quantity used as seed

X_i : Quantity exported

L_i : Quantity lost during transportation and storage at farm and wholesale levels

ΔS_i : Change in stocks between two periods

This analytical framework, generally referred to as Food (or Commodity) Balance Sheets (FBS), is analogous to the concept of supply and use equilibrium in national economic accounts.

[3] According to the United Nations classification, West Africa is composed of the following countries: Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo.

[4] http://faostat3.fao.org

It is useful in that it provides a complete picture of the sources of supply and use for a given commodity and a quantification of the associated flows. The common unit used is the raw commodity equivalent, such as kg of wheat, paddy rice, etc., which allows a standardization of the flows associated with different degrees of processing of the commodity. For example, humans or animals generally consume products that are based on some degree of processing of one or more commodities (wheat flour, pasta, bread, feed meals, etc.), whereas exports or imports may include both the commodity in its raw or processed form (cocoa beans and chocolate, for example).

To allow a proper aggregation of flows, processed products are therefore converted back to their raw commodity equivalents using appropriate technical conversion factors (also referred to as extraction factors)[5].

2.2 Statistical indicators

For the purposes of this study, several statistical indicators have been constructed using data from FAOSTAT (FBS, agricultural producer prices) and World Bank's World Development Indicators (agricultural GDP). The indicators are defined below.

2.2.1 Food production and consumption

Production (Q) is one of the variables of the supply-use equation of the FBS. It measures the total amount of the commodity produced for a given time period and country (or any other geographical grouping). C, the amount of the commodity available for human consumption, is given in the FBS framework by the difference between total supply and all the uses other than C. It does not mean that C is the amount actually consumed: losses occur in the transportation, storage and distribution process at the retail level; and a share of food is wasted by households after the actual purchase or production. Nevertheless, this indicator provides a measure of the domestic demand for the commodity in question and can therefore be considered as a proxy for potential consumption[6].

From equation (1), we consider the ratio $r = Q / C$ as the measure of the capacity of domestic production to satisfy domestic food demand. In this article, r is used as an indicator of the extent to which farmers in West Africa have adapted their production mix to the changes in domestic food demand.

2.2.2 Diversity of food production and consumption

Empirical evidence tends to suggest that there is a positive correlation between income per capita and diversity in diets. Doan D. (2014) has estimated that in the case of China income effect on food diversity is significant and positive, but diminishes along the income distribution and overtime. It is interesting to test if these results also hold for a region such as West Africa, which has seen income per capita rise in most of its countries, even if this rise has been relatively recent. In line with the objective of this study, it is also relevant to understand if agricultural production has diversified or not, in other terms if farmers have responded to changing diets by broadening their product mix or by specializing on a smaller number of commodities. To respond to these questions, a measure of diversity is constructed: is the Herfindahl-Hirschman index for C and n the number of commodities. To respond to these questions, a measure of diversity is constructed:

$$div = 1 - \left({[HHI - 1/n]} \Big/ {1 - \frac{1}{n}} \right)$$

Where:

$$HHI = \sum_{i=1}^{n} \left(C_i \Big/ \sum_{i=1}^{n} C_i \right)^2$$

div is the complement of the normalized Herfindahl-Hirschman index: as the latter measures market concentration, the complement (one minus the normalized *HHI*) measures diversity. The diversity index for food production is computed exactly in the same way, replacing C by Q. As *HHI* varies between $1 / n$ and 1, div varies between 0 (minimum diversity) and 1 (maximum diversity).

2.2.3 Agricultural value of production

Changes in the production mix of farmers impacts the average value of their production. The amount produced valued at farm-gate prices gives the value of production: v = Q.P, where Q is the production of the commodity and P its farm-gate price. A decomposition of changes in can help determine if farmers have benefited from the changing structure of their production, by isolating the share of the change in

[5] For example, it is estimated that 100g of raw wheat are needed to produce 80g of wheat flour. To convert wheat flour to its raw wheat equivalent, wheat flour quantities are multiplied by 1/80%, the reciprocal of the extraction factor (80%).
[6] In this study, we will refer to indiscriminately as consumption, demand or potential consumption.

v that is due to a structural effect such as, for example, a change in the production mix towards higher-priced commodities. This is done by decomposing the growth rate of the average value of production in a price, quantity and structural (or weighting) effect, as described in Annex 1.

2.2.4 Agricultural prices and margins

The deflator of agricultural production measures changes in the average prices in the agricultural sector: defl = V/Q. It is generally presented in the form of an index: indeed, as it aggregates all kinds of products, its direct interpretation in value per quantity unit has little meaning.

Comparing defl to indicators such as the deflator of the Gross Domestic Product (GDP), an economy-wide measure of inflation, provides a gross indication on the evolution of producer margins. Comparing defl to the food Consumer Price Index (food CPI) provides an indication of the evolution of producer margins with respect to those of other actors of the food chain, such as wholesalers, retailers, transporters or importers. For example, a persistently higher inflation in food consumer prices respective to agricultural producer prices is an indication that average margins of farmers are decreasing relative to wholesalers and retailers margins.

2.2.5 Risks

Farmers operate in an uncertain environment and are exposed to a wide array of risks. The impacts of some of these risks, such as natural catastrophes, are to a large extent independent from the nature of the activities of the farm. Similarly, as farmers are generally price-takers, they face an uncertainty in the prices that they will receive for their product. Farmers can to some extent insure themselves against the impact of some of these risks, through the purchase of hedging instruments such as weather derivatives or futures contracts. However, most of these tools are still out of the reach of farmers in developing countries. Instead, farming practices and commodity specialization can and are used by some as a risk management tool. Indeed, the revenue of a farm in monoculture is more exposed to production risks (a pest, for example) and to price risks (if the price of this commodity plunges, so does the farm revenues) than for a multi-output farm which can spread these risks across different commodities. Therefore, the question of the extent to which structural changes in the production mix affect the exposure of farmers to uncertainties and risks on their revenues is a relevant one. The benefits for farmers of a change in production structure towards higher-priced products may be mitigated by a higher exposure to price and/or production-related risks. This means that, when taking into account the probability distribution of yields and farm-gate prices, the expectancy of earnings may in reality be lower than for a production structure composed of lowerpriced but less risky commodities.

Risk is often approximated through a measure of historical variability. In this study, the coefficient of variation[7] will be used to measure variability in quantities (production risk) and average prices (price risks). We will also provide a measure of the exposure to price risks, based on a decomposition of the variance in average prices. Refer to Annex 2 for details on this decomposition.

The data sources on which these indicators are based and the different operations that had to be done to standardize and fill data gaps are presented in the remainder of this section.

2.2 Food Balance Sheets

A Food Balance Sheet (FBS) presents a comprehensive picture of a country's food supply and utilization during a specified reference period, a calendar year in the case of FAO's FBS data. The FBS shows for each food item (each primary commodity) the availability for human consumption that corresponds to the sources of supply and its utilization (FAOSTAT, 2015). FBS bring together the larger part of the food and agricultural data in each country, as it compiles country information on production, trade and utilization produced at national level. It is therefore a derived statistics and its statistical reliability depends on the accuracy and quality of the underlying data produced by the countries, which is known to be highly variable. In fact, the food available for human consumption (C) is often not measured in the FBS but calculated as a residual. Knowing that there are many gaps particularly in the statistics of utilization for non-food purposes, such as feed, seed and manufacture, as well as in those of farm, commercial and even government stocks, C has to be used with caution. In spite of all these imperfections, FAO's FBS are one of the few database (if not the only one) that compiles annual data for such a large set of countries with more than 50 years of history. Moreover, these imperfections can be partly mitigated by considering the trends and not the absolute values, as done in this study. This is possible thanks to the availability of long time-series (the FBS data in FAOSTAT starts in 1961) and the full coverage of West African countries. Furthermore, this study focuses on the analysis of regional trends, limiting country comparisons that may be hampered by differences in the way the data is compiled.

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[7] The coefficient of variation is defined as the standard deviation divided by the mean of the distribution.

2.3 Agricultural producer prices

FAO's agricultural producer price data set is the other source of information used in this study. It provides data on farm-gate prices for more than 130 countries and 200 commodities. Its level of commodity detail, country coverage and data history[8] makes it a unique source of information for the investigation of long-term trends in producer prices. Information on prices is collected annually from the countries, compiled, harmonized and disseminated in July-August of each year. The quality of FAO's producer prices data set depends largely on the quality of the underlying country data.

While a country will generally adequately report data for its major commodities, data availability and quality is lower for minor commodities, or for highly volatile and seasonal items such as fruits and vegetables. Adding noise to the data is the uneven adherence of the reported prices to the farm-gate concept: while some countries report the price of the commodities when they leave the farm, others provide the price at the first point of sale, at wholesale markets or even at retail stores or markets. African countries in particular tend to report wholesale or retail prices, especially for fruits and vegetables.

Focusing on the trends instead of the absolute values cancels out some of these biases, to the extent that these do not vary in time and that the series are exempt from breaks.

2.4 Matching categories of the food balance sheets and agricultural producer price datasets

To compute the value of production, producer prices have to be available for each of the items produced. The commodity classifications used for the FBS and the producer prices differ slightly: the former is a hybrid classification that incorporates most of the raw commodities (for example, wheat and wheat products) but also some processed items (butter, sweeteners, olive oil, etc.). The producer price dataset uses a classification solely based on raw commodities (milk, sugar cane, olives etc.). A procedure to associate the appropriate price to the corresponding item of the FBS data set has therefore been implemented:

- If an item is common to the two datasets, the price of the item is taken and attributed to the corresponding item of the FBS classification without any further modification (except unit transformations);
- If an item of the FBS classification is more highly aggregated than in the price classification, the prices of the corresponding items of the latter are averaged and applied to the FBS item. For example, the price of the item sesame seed and sesame seed oil of the FBS classification is equal to the unweighted average of the price of sesame seed and sesame seed oil, which constitute two different items in the price classification;
- In the opposite case where the item of the price classification corresponds to more than one item of the FBS classification, the price of the former is applied to all the items of the latter. For example, the price of the single item oranges and mandarins from the price list is applied individually to oranges and mandarins, that form two distinct commodities in the FBS list;
- The price of processed products such as butter or vegetable oils is computed based on the price of the raw commodity from which they originate[9], by multiplying the price of the processed item by the reciprocal of the extraction rate. For example, if the price of one litre of cow milk in Mauritania is 0.392 USD (FAOSTAT, 2015) and if the extraction rate of butter to cow milk is 4.2% (4.2g of butter can be produced from 100g of cow milk), the price of one kg of butter will be equal to 0.392*(1/(4.2%))=9.3 USD. This procedure assumes that the price of a processed product is only a function of the price of the raw commodity from which it is produced and implicitly considers that transformation margins are equal to zero. This necessary assumption undermines the plausibility of the absolute prices constructed in this way. However, given the relative stability of transformation margins over time, the analysis of trends may adequately reflect changes in producer prices. This matching procedure and transformation in prices can be summarized in correspondence matrices, an example of which is given in Annex 3.

2.5 Estimation of missing data

The data reported on producer prices is generally incomplete, especially for minor or highly seasonal or volatile items. To ensure that the value of production is computed for all countries over the same set of commodities, missing item prices are estimated. The method is straightforward:

- The missing price for an item is estimated by the average price of the item group to which it belongs. For example, if the price of maize is missing, it is estimated by the average price of cereals;
- If the data is too scarce to compute item group averages, the missing price is imputed by the average regional price for the same item. For example, the missing price for maize is estimated using the average maize price in the West Africa region.

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[8] The data goes back to 1961, although due to a temporary halt in the FAO's data collection activities the data series before and after 1991 have been split into two not necessarily compatible datasets. This article uses only the most recent dataset, from 1991 onwards.

[9] In this classification a processed product originates from only one raw commodity, which simplifies the computations. The computation procedure as described in Annex 3 can in theory accommodate products based on several raw commodities.

This Section has presented the information sources, the main transformations operated to the raw data and defined the different indicators used in this study. We will now analyze and compare the trends in food diets and production in West Africa.

3. Have West African farmers adjusted their production to changing diets?

3.1. Food diets are getting richer

Statistical evidence suggests that West African diets tend to converge towards "western" standards, characterized by a larger share of animal products, fats and sugars in food consumption. Urbanization and economic growth, which contribute to the emergence of a new middle class, are among the main drivers of this structural change (Vincent C., 2015).

The data compiled here for West Africa shows that the share of items such as sugars and vegetable fats in the per capita kilocalories available has risen from an average of 3.7% in 1961-1979 to 5.0% in 2000-2011 for sugars and from 12.8% to 14.6% for vegetable fats and oil crops. In contrast, the share of traditional food staples has declined: for roots and tubers, for example, it has fallen from 17.1% to 14.3%. For other food categories, the changes are less significant: cereals still represent more than half of the calories available, with little change compared to the 1961-1979 average. The weight of meat and animal products has also remained stable over the period of analysis, just under 8.0%. The data also confirms that overall food supply per capita (excluding alcoholic beverages) has increased at a steady pace, from an average of 1957 in 1961-1979 calories per day to 2434 for the period 2000-2011. Changes in food consumption habits become more apparent when looking within the aggregated categories. For instance, the share of wheat and rice relative to traditional cereal crops such as sorghum and millet has increased significantly (Figure 2). The rise in the share of rice is a common and defining characteristic of the evolution in West African food diets. Several studies, such as Me-Nsope and Staatz (2013), have indicated that there is a positive correlation between on the one hand income per capita and urbanization rates, and on the other hand the share of rice in food diets. For meat and animal products, the share of poultry meat has increased markedly (from 2% in 1961-1979 to 6% in 2000-2011). It has also been the case, but to a lesser extent, of eggs, pork meat and pelagic fish. In contrast, bovine and mutton meat have lost ground (from 14% to 10% for beef and from 7% to 6% for mutton). Milk (excluding butter) remains by far the largest item consumed within this category, with a stable share in diets oscillating around 35%. Among the excitants, cocoa has gained significant ground to the expense of coffee and, to a lower extent, tea: its share in the consumption of excitants averaged 68% over the period 2000-2011, against 40% in 1961-1979.

One of the characteristics of the change in food diets is their greater calorific content: the average number of kilocalories by kilogram of food available for consumption has increased from just above 1860 kcal/kg in 1961 to around 2000 kcal/kg in the recent years, after reaching a peak during the mid-80s at 2050 kcal/kg (Figure 3). This is the result of a greater reliance on commodities with a higher calorific content, a change that occurred both within item categories (wheat and rice, for example, have a higher calorific content than millet and sorghum) and between them (higher proportion of fats and sugars in food diets compared to other items, for example). Cereals and oils and oil crops have seen their energetic content rise at a steady and sustained pace: rice and wheat drove the increase for cereals; for oil crops, the rise is due to the higher availability of calorie-rich soybeans and derived products such as soybean oil. Conversely, the average calorie content for meat and animal products has slightly decreased, reflecting the increase in share of less calorie-rich poultry meat and products.

This article will now investigate if the changing composition of food consumption evidenced above has been accompanied by an increase in the diversity of food diets and agricultural production, or if new products have simply replaced old ones.

3.2. More diverse food diets

Recent analysis of consumption behaviors of households or individuals in West Africa have concluded that food diets are becoming more diverse, with significant intra-category substitutions, in a broad context of rising demand for items with higher calorific, fat and sugar content. It has become apparent that lifestyle changes that accompany increases in income are correlated with diversification in food types and with the consumption of products with high added value, animal products and fruits (Bricas et al., 2015). However, most of these studies have concentrated on urban and peri-urban dwellings, leaving out rural households, which, in spite of their declining weight, still represent around three quarters of the population in West Africa[10]. Can the results for urban or peri-urban households be extrapolated to the population as a whole? The analysis of FBS data, which includes by construction all food items produced domestically or imported in the country, can help answer this question.

[10] Source: Africapolis, dynamiques de l'urbanisation 1950 – 2020 : approche geo-statistique, Afrique de l'ouest

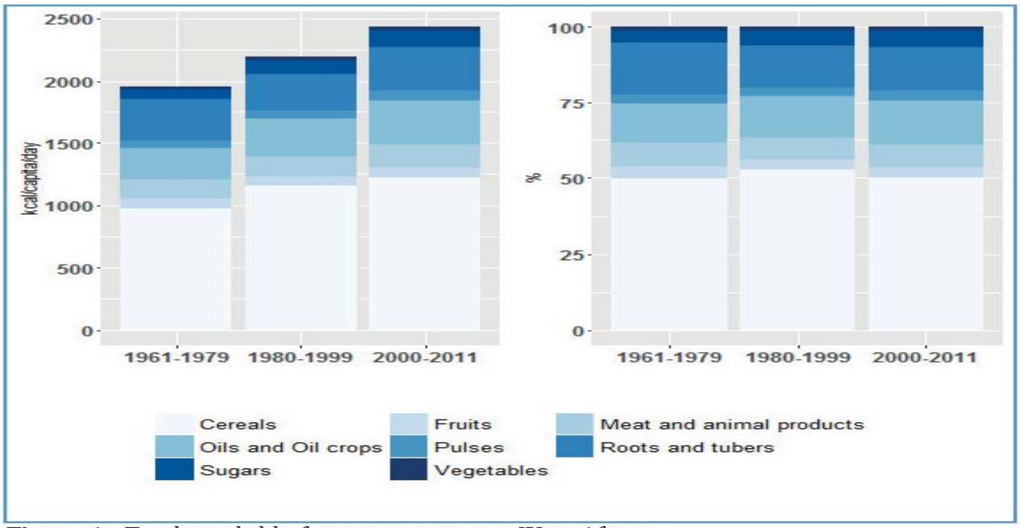

Figure 1: *Food available for consumption in West Africa*
Source: FAOSTAT 2015, author's calculations.
Note: Spices, Excitants and Other are excluded from the legend because of their negligible contributions.

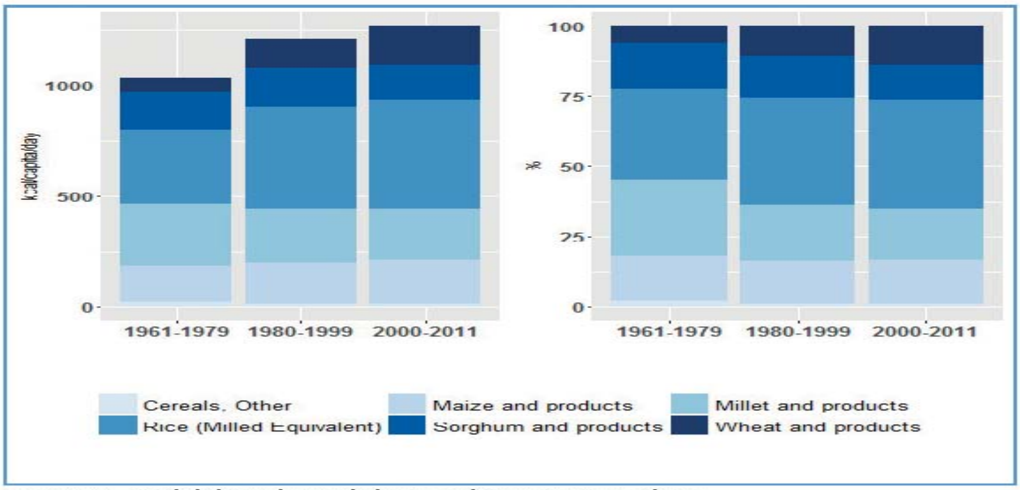

Figure 2: *Availability of cereals by cereal type in West Africa*
Source: FAOSTAT 2015, author's calculations.
Note: Oats, Barley and Rye are excluded from the legend because of their negligible contributions.

Figure 3: *Calorific content of food available for consumption in West Africa*
Source: FAOSTAT 2015, author's calculations.

The measure of diversity used in this study is the complement of the normalized Herfindahl-Hirschman index, the latter being widely used to measure market concentration (refer to the second section of this article for details). According to this indicator, the diversity in the food available for consumption has increased over the last 50 years for a large majority of Western African countries (Figure 4). This measure also shows that the dispersion among these countries with respect to food diversity has decreased. This indicates the existence of a common trend underpinning the change in food diets in the region, characterized by a re-balancing of the consumption in cereals (with wheat and rice increasing in share) and meat (white meat in complement to red meat). Interestingly, the group of countries that was significantly behind in terms of food diversity (Niger, Liberia, Sierra Leone and Benin) has progressively caught-up with the rest of the countries. This is a sign of improving production conditions and/or an increased capacity of these countries to satisfy food demand through imports.

Contrary to food diets, the diversity of agricultural production has not increased (Figure 4). The diversity indicator also shows that the dispersion among Western African countries with respect to production diversity has widened. This may reflect different food and agricultural strategies, with some countries preferring to widen their production scope while others tend to specialize on a reduced number of crops. The dispersion among countries also highlights their different endowments and capacity to import. The fall in the production diversity of countries such as Nigeria and Sierra Leone, for example, reflects the tendency of commodity-rich countries to neglect domestic agricultural production, a phenomenon that has been exacerbated by the commodity super-cycle of the 2000s[11]. Additionally, the increased demand for cocoa has clearly been one of the drivers of the concentration of agricultural production in the two main cocoa-producing countries of the region, Ivory Coast and Ghana. These findings suggest that farmers in West African countries have responded in different ways to changing and more diversified diets.

To understand if domestic production is now better able to satisfy food demand or, on the contrary, if it has lost ground with respect to foreign providers, food demand has to be compared with production. This is done below.

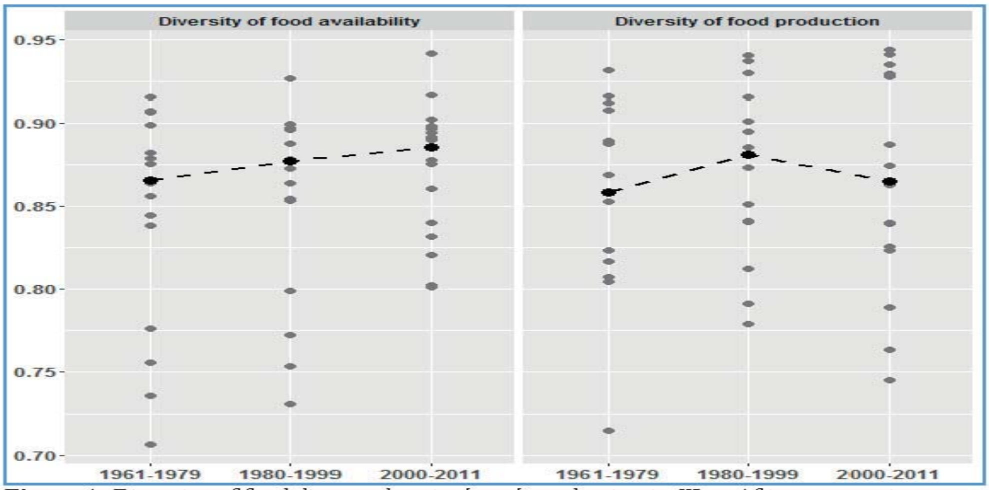

Figure 4: *Diversity of food diets and agricultural production in West African countries*
Source: FAOSTAT 2015, author's calculations.
Note: the dots correspond to individual country data. The median is represented by the connected dots in black.

3.3. Food demand versus. food production

Overall, production-to-demand ratios have not improved nor deteriorated significantly (Figure 5). In a context of increasing food demand and changing food diets, this suggests that producers have scaled-up their production for emerging commodities and/or generated additional surpluses for their major commodities. A stable ratio may be the reflection of an increase in the production of commodities that are largely exported and not meant to be sold on the domestic market (such as cocoa) and not necessarily an indicator of self-sufficiency. A commodity-level analysis is better adapted to draw conclusions that are more meaningful on the capacity of domestic producers to satisfy internal demand. For cereals, the ratio of production to demand has remained stable slightly above one, meaning that West Africa produces enough of the commodity to satisfy internal demand.

Looking at this ratio for the different cereal crops reveals that output of both traditional and emerging crops has increased in volume, but the demand for the latter has outpaced its output. For example, the production of rice has doubled since the beginning of the 1960s to reach 20kg or above per capita in the region but is still insufficient to cover the demand, which has tripled to reach more than 30 kg per capita in 2013. Regarding wheat, because agro-climatic conditions in West Africa are not favorable to the production of this cereal, the increase in demand has directly translated into a higher import dependency. On the contrary, surpluses of maize, a traditional crop, have significantly increased, generating additional export capacity.The statistical evidence provided in this section confirms a structural change in food demand: it has increased in quantity, is more energy-intensive and diverse. In response to these changing preferences, the agricultural sector has partially adjusted its production, by scaling-up its output for emerging food staples such as rice but also by increasing its output for certain traditional commodities, some of them with a good export potential (cacao, maize, sorghum, for example). This has generated revenues that can in turn be used by countries to import the commodities for which they are in greater deficit, such as wheat and, to a lesser extent, rice and certain processed products such as sugar. The next section will delve more deeply into the economic implications for the agricultural sector of the change in the composition of its production mix: has it translated into a higher average remuneration for its products? Is the agricultural sector more exposed now to production and price shocks?

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[11] The 2000s commodities boom or the commodities super cycle was the rise in many physical commodity prices (such as those of food stuffs, oil, metals, chemicals, fuels and the like) which occurred during the decade of the 2000s (2000–2009), following the Great Commodities Depression of the 1980s and 1990s. The boom was largely due to the rising demand from emerging markets such as the BRICS countries, as well as the result of concerns over long-term supply availability.

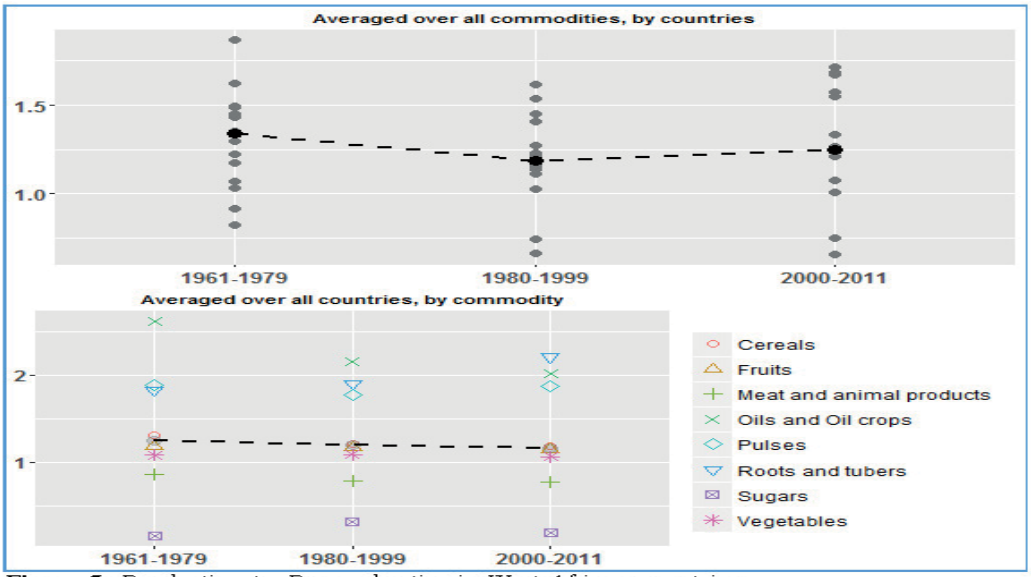

Figure 5: *Production-to-Demand ratios in West African countries*
Source: FAOSTAT 2015, author's calculations.
Note: The median is represented by the greys dots connected with the black line.

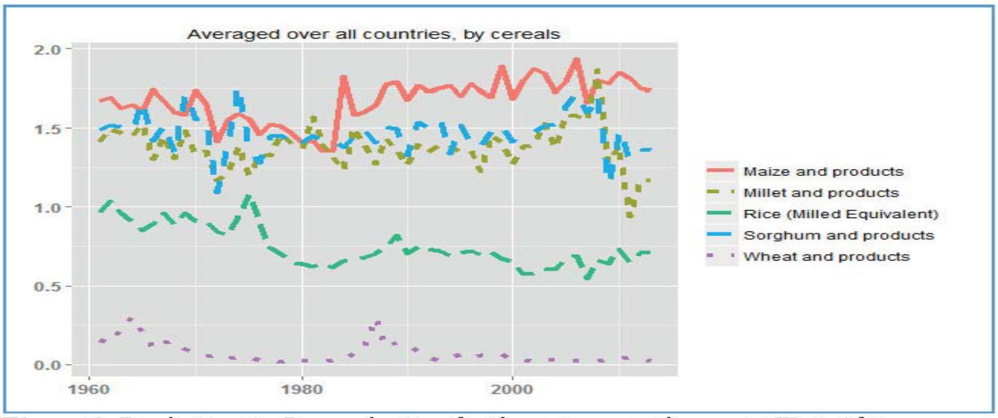

Figure 6: *Production-to-Demand ratios for the major cereal crops in West Africa*
Source: FAOSTAT 2015, author's calculations.

4. Changing food diets and production patterns: economic implications for farmers

4.1. Agricultural value of production: a price-driven increase

The value of agricultural production has risen relatively steadily in West Africa since the beginning of the 1990s, at an average annual rate of 8.5% (Figure 7). This increase has been determined largely by fluctuations in prices (for details on the decomposition procedure, see Annex 1). Fluctuations in quantities have had a smaller influence on value of production, although it has become more significant during the past 10 years. The effect of structural changes (structural or weighting effect due to a change in the production mix) appears minor compared to price and quantity effects. Weighting effects reflect longer-term changes in the specialization of production which, when looked at on an annual basis, are necessarily lower than those resulting from more volatile components such as price and quantities. That said, the average structural effect over the period of analysis, at +0.04%, is negligible compared to the average price and quantity effects (respectively +5.1% and +3.4%). This suggests that the product-specialization of the agricultural sector in West Africa has not been made towards products with a structurally higher remuneration potential. While this is true on average for West Africa, it is not necessarily the case for all individual countries within this region. Indeed, section 3 has revealed different specialization patterns in West Africa, with some countries that diversified their production to satisfy changing consumer preferences while some others tended to specialize into a smaller number of commodities with a higher revenue potential (cacao, etc.).

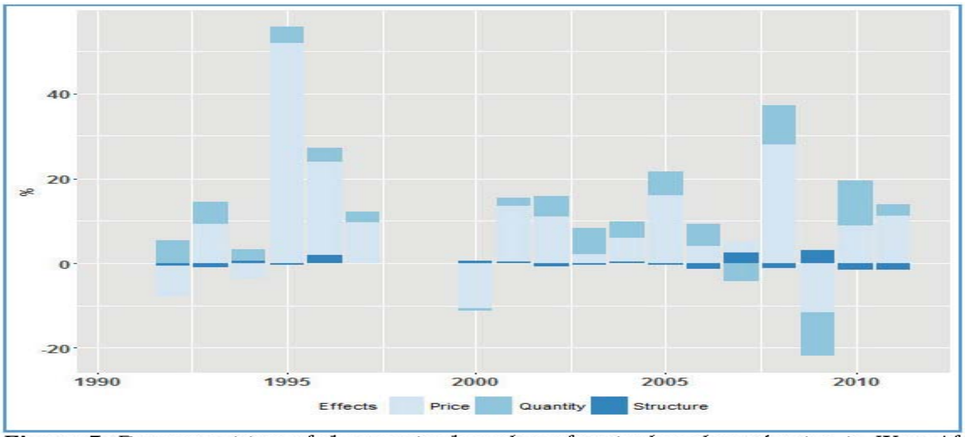

Figure 7: *Decomposition of changes in the value of agricultural production in West Africa.*
Source: FAOSTAT 2015, author's calculations.
Note: 1998 and 1999 have been omitted because of the distortion created by the devaluation of the Naira in 1998.

4.2. Agricultural prices and margins in West Africa have not evolved to the benefit of farmers

Put aside the correction in prices after the end of the 2007-2008 food price crises[12], average agricultural prices in West Africa rose at a steady and sustained pace: the deflator of agricultural production has been multiplied by 2.4 from 2000 to 2012. This does not necessarily mean that producer margins have risen, because the price of agricultural inputs has probably risen in parallel. In fact, taking the GDP deflator as a proxy for the price of inputs, no clear-cut conclusion can be made on the evolution in agricultural margins: the two deflators have evolved at similar rates from 2000 to 2009 (Figure 8). Since then, the GDP deflator has been increasing faster, pointing to deterioration in producer margins. More data points are needed to conclude if this trend is persistent, transitory or if it is due to a statistical artefact. The fact that food consumer prices have increased at a higher pace than agricultural producer prices indicates that farmers have probably seen their margins reduced to the expense of intermediaries (wholesalers and retailers). The widening gap between consumer and producer prices may also reflect structural changes in West African food markets, echoing changes in food diets: food chains are becoming wider and more sophisticated with the emergence of new actors in the agro-industrial complex, lessening the link and widening the gap between prices at both ends of the chain.

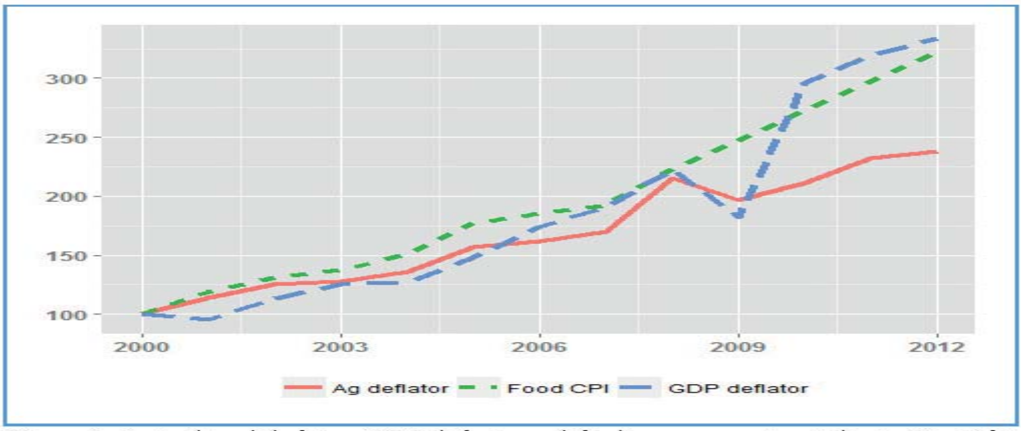

Figure 8: *Agricultural deflator, GDP deflator and food consumer price index in West Afric (100=2000)*
Source: FAOSTAT 2015, World Development Indicators (The World Bank), author's calculations.

The level of uncertainty in the price paid to farmers and, by consequence, in their revenues is a key determinant of production decisions as well as, to some extent, private investment in agriculture. We will know delve into the analysis of the risks to which West African agriculture is exposed, especially price-related risks.

4.3. Decreasing price variability but higher exposure to price-risks

Risks of different nature are faced by farmers: uncertainties affecting yields are mainly exogenous, as most of them are climate-related. Yet, as crops and agricultural activities are diversely exposed to climate-related risks, the composition of the farmer's agricultural production and, by extension, the production specialization of an entire country or region has an impact on the overall exposure to production risks.

[12] World food prices increased dramatically in 2007 and the 1st and 2nd quarter of 2008 creating a global crisis and causing political and economical instability and social unrest in both poor and developed nations. This series of events is usually referred to as the 2007-2008 food price crises.

Farming practices also have a role: for a given crop, specific varieties may be more tolerant or resistant to droughts; cultural practices such as crop rotations may improve water use efficiency[13]; an appropriate use of inputs may also mitigate the impact on yields of adverse climate-related events. An agricultural sector highly specialized in the production of a small number of commodities, with a low level of infrastructure and input use will be highly dependent on weather conditions and therefore over-exposed to adverse climate-related events: yields, production and revenues will, as result, be more volatile and uncertain.

Another class of risks is that affecting the farmer's selling prices. When considering individual crops or agricultural activities, these risks can be considered as largely independent from the farmer's practices: except in exceptional cases, farmers are price-takers and the price received reflects local, national or international market conditions. The price trends, seasonality and volatility are highly dependent on the nature of agricultural products: perishable and non-storable commodities tend to be more volatile than non-perishable and storable ones. The price of some commodities such as rice, wheat or maize is mainly determined on international markets while for others prices mainly reflect local market conditions: the price variability (or uncertainty) of different groups of agricultural commodities tends to some degree to be independent from one another. As a result, the overall price risk faced by a farmer is to some extent dependant on the set of commodities that are produced. His exposure to price risks can be mitigated by choosing commodities with less correlated prices, much similarly to a financial investor who would construct a portfolio of stocks from companies with different activities in order to diversify its risks. By extension, the overall exposure to price risks of a country or region's agricultural sector is dependent on its commodity specialization. The contribution of the product specialization to price risks, defined mathematically in Annex 2, measures the exposure of farmers to these risks.

The results, illustrated by Figure 9, indicate that the variability in price has been declining since the beginning of the 90s: the coefficient of variation has declined from close to 120% at the beginning of the period to just under 80% in 2012. The 2007-2008 food price crises, which was characterized by surging and volatile prices on international agricultural markets, have little impacted agricultural prices in West Africa: the price variability did increase during this period, but by a limited amount (the coefficient of variation rose to 93%, slightly above the pre-crisis levels).

This may be explained by the composition of food production in West Africa: the commodities that saw their price increase the most, wheat and soybeans, are not the region's main crops. Furthermore, as most of the agricultural output in West Africa is either consumed by the farmers themselves or destined to local markets, prices of agricultural commodities respond rather to local market fundamentals than to international market shocks, at least on the short to medium-term. If the impact of the 2007-2008 food crises on agricultural producer price variability has been mild in West Africa, the same is not necessarily true for consumers: their diets, especially of those living in urban centers, relies more heavily on imported commodities and therefore make them more vulnerable to international price shocks. That said, recent econometric evidence suggest that the overall impact on food consumer prices in the region was limited: for example, Cachia (2014) estimates that only 10% of the initial shock in international commodity prices is transmitted to food prices after 4 months, 20% after 8 months.

Figure 9 also indicates that the decrease in variability of average agricultural prices has not been accompanied by a reduction in the exposure to price risks, quite the contrary. The contribution of the commodity production structure to the average price variability, what we named exposure to price risks, has in fact been increasing since the beginning of the 90s (Figure 9, right-hand side graph).

This means that a shock in commodity prices would probably have a higher impact on average prices now compared to the beginning of the 90s: farmers are more exposed to price shocks, either positive or negative. As the final formula of Annex 2 clearly shows, a greater exposure to price shocks can be the result of two effects, which can potentially be combined:

- A structural increase in the correlation between commodity prices. Theoretical and empirical evidence suggests that the integration of commodity markets and the harmonization of farming practices have contributed to increase the correlation between commodity markets. For example, it has been demonstrated that the emergence of bio-fuels has not only increased the integration between energy and agricultural markets but also among crops that are used to produce bio-diesel (soy, oilseeds, etc.) and ethanol (wheat, corn, sugar crops, etc.). This effect may be significant in parts of Europe, Latin and North America, but less in West Africa where the quantities destined to the biofuel market are marginal;
- The second potential effect is an increased specialization in the production of crops with a higher price correlation. In West Africa, the higher share in production of cereals such as rice, maize and wheat and crops such as soybeans has probably contributed to increase the overall exposure to price risks: these commodities are more integrated to international and regional markets than traditional cereals and their prices are known to be highly correlated. For detailed empirical evidence on the co-movements between major agricultural commodities, see for example de Nicola F. et al. (2014).

[13] Crop rotations improve the soil's physical characteristics and structure, reducing or eliminating the necessity to till or plough. The hydrologic supply and the exploration capacity of the plants are therefore improved.

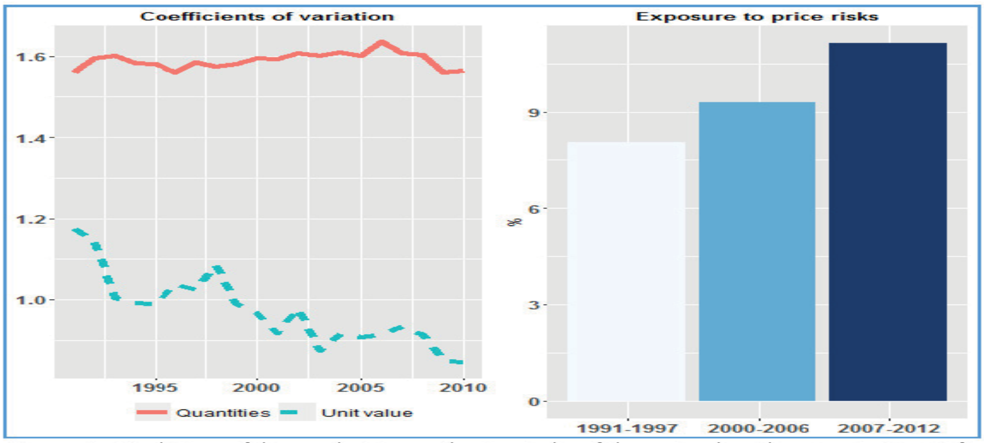

Figure 9: *Evolution of the production and price risks of the agricultural sector in West Africa.*
Source: FAOSTAT 2015, author's calculations.
Note: on the right-hand side figure, data for 1998 and 1999 has been omitted because of the distortion created by the strong devaluation of the Naira, the Nigerian currency, in 1998.

5. Conclusion

This article tried to brush a global picture of the trends in food demand and agricultural production in West Africa. It has first been shown that food diets are getting richer and more diverse, in line with structural socio-economic drivers such as urbanization and increasing income per capita.

At the same time, agricultural production has also evolved: it has responded to changing preferences of West African consumers by scaling-up its output of commodities such as rice, maize and certain animal products such as poultry. This increase in production has failed to match the corresponding rise in demand because yields in West Africa have only started to improve substantially in the past few years. For example, yields for rice (paddy) have been stable around 1.5 tons per hectare during the 1990s and the beginning of the 2000s. They have just recently started to improve to reach levels slightly above of 2.0 tons. In a context of a surging population, a rapid and significant improvement in cereal yields is a pre-requisite to the improvement of food security and a reduction in poverty rates in the region.

Agricultural production has also specialized in commodities that are in greater demand both domestically and abroad, such as cocoa, soybeans or maize. These new specialization patterns have economic repercussions for farmers: they received on average higher prices for their products but prices in the economy rose as well, sometimes faster, such as food prices paid by consumers. This suggests that margins in the agricultural sector have lost ground with respect to other actors of the chain, a structural trend given the higher sophistication and widening of the food chains. New production patterns and higher integration of agricultural commodity markets have also contributed to increase the exposition of West African agriculture to price shocks, a factor that has not yet been a source of concern given the decreasing trend in price variability in West Africa, only mildly affected by events such as the 2007-2008 food crises.

More work and statistics are needed to understand if the specialization of West African farmers has resulted in higher net returns for farmers. High-value or cash crops are also generally grown in input-intensive systems, with high costs. There is a statistical gap that needs to be filled to understand better production costs and returns of agricultural production, especially in West Africa where nation-wide statistically representative data is scarce. Further investigation is also needed to better identify production changes and substitutions within commodity groups, extending the analysis to the agro-food industry in order to see if food production in West Africa is getting higher up in the value chain. Finally, a more formal and comprehensive analysis of the commodity linkages is necessary to better understand the risks to which farmers are exposed, a phenomenon that is often overlooked but which has great implications on the vulnerability of farmers and their households.

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ANNEXES

1. Decomposition of the growth rate of agricultural value of production

The change in the aggregate value of production can be decomposed intro three components: a price effect, a quantity effect and a structural (or weighting) effect. The latter measures the extent to which changes in values are the result of a modification in the commodity mix. This annex describes one possible method to perform this decomposition.

The value of production for a given commodity is equal to its farm-gate price times the quantities produced: $v_{i,t} = p_{i,t}q_{i,t}$, where i denotes the commodity and t the time period. The value of production for a bundle of commodities is therefore: $v_t = \sum_{i=1}^{n} p_{i,t}q_{i,t}$, where n is the fixed number of commodities produced[14].

We start by defining two variables:

- The average farm-gate unit value of the basket of commodities produced : $\bar{p}_t = \frac{\sum p_{i,t}q_{i,t}}{\sum q_{i,t}}$; and
- The average quantities produced: $\bar{q}_t = \frac{1}{n}\sum q_{i,t}$

v_t is therefore also equal to: $v_t = \bar{p}_t n \bar{q}_t$

As v_t is a strictly positive variable, we can take its natural logarithm:

$\ln(v_t) = \ln(\bar{p}_t) + \ln(n) + \ln(\bar{q}_t)$

$\Delta\ln(v_t) = \Delta\ln(\bar{p}_t) + \Delta\ln(\bar{q}_t)$, where $\Delta x_t = x_t - x_{t-1}$ is the first-difference operator.

For "small" enough changes in $\bar{p}_t$ and $\bar{q}_t$: $\dot{v}_t \cong \vec{p}_t + \vec{q}_t$, where the dotted variables indicate simple growth rates. We will now determine $\vec{p}_t$ and $\vec{q}_t$, starting with the former:

$$\bar{p}_t = \frac{\sum p_{i,t}q_{i,t}}{\sum q_{i,t}} = \sum \frac{q_{i,t}}{\sum q_{i,t}} p_{i,t} = \sum \theta_{i,t}p_{i,t}$$

$$\Delta\bar{p}_t = \sum (\theta_{i,t}p_{i,t} - \theta_{i,t-1}p_{i,t-1})$$

$$\Delta\bar{p}_t = \sum \Delta\theta_{i,t}p_{i,t} + \sum \theta_{i,t-1}p_{i,t} - \sum \theta_{i,t-1}p_{i,t-1}$$

$$\Delta\bar{p}_t = \sum \Delta\theta_{i,t}p_{i,t} + \sum \theta_{i,t-1}(p_{i,t} - p_{i,t-1})$$

$$\vec{p}_t = \frac{\Delta\bar{p}_t}{\bar{p}_{t-1}} = \underbrace{\sum \Delta\theta_{i,t}\frac{p_{i,t}}{\bar{p}_{t-1}}}_{ES} + \underbrace{\sum \theta_{i,t-1}\left(\frac{\Delta p_{i,t}}{\bar{p}_{t-1}}\right)}_{EP}$$

$\vec{p}_t$ is composed of two effects:

- ES, which measures the effect on the change in average prices of changes in the commodity shares ($\Delta\theta_{i,t}$). For example, a rise in the production share ($\Delta\theta_{i,t} > 0$) of commodities with higher than average prices ($p_{i,t} > \bar{p}_{t-1}$) will contribute to increase the growth rate in average prices beyond the simple share increase ($\Delta\theta_{i,t}\frac{p_{i,t}}{\bar{p}_{t-1}} > 1$). ES is therefore said to measure a structural or weighting effect; and
- EP, which captures the effect on the change in average prices of commodity-specific price variations (price effect).

Turning to $\vec{q}_t$:

$$\bar{q}_t = \frac{1}{n}\sum q_{i,t}$$

$$\vec{q}_t = \frac{\frac{1}{n}\sum(q_{i,t} - q_{i,t-1})}{\frac{1}{n}\sum q_{i,t-1}}$$

[14] A fixed n is assumed here for simplicity, but this decomposition method can also be applied to a situation in which the number of commodities $n(t)$ varies in time.

$$\vec{q}_t = \frac{\sum \Delta q_{i,t}}{\sum q_{i,t-1}}$$

$$\vec{q}_t = \sum \frac{q_{i,t-1}}{\sum q_{i,t-1}} \frac{\Delta q_{i,t}}{q_{i,t-1}}$$

$$\vec{q}_t = \sum \theta_{i,t-1} \dot{q}_{i,t}$$

$\vec{q}_t$ is equal to the sum of the commodity-specific quantity changes weighted by their respective quantity shares (quantity effect).

It follows from the above that the growth rate in the value of produced for the set of commodity produced is equal to the sum of a price effect (EP), a quantity effect (EQ) and a weighting or structural effect (ES):

$$\dot{v}_t \cong \underbrace{\sum \Delta\theta_{i,t} \frac{p_{i,t}}{\bar{p}_{t-1}}}_{ES} + \underbrace{\sum \theta_{i,t-1} \left(\frac{\Delta p_{i,t}}{\bar{p}_{t-1}}\right)}_{EP} + \underbrace{\sum \theta_{i,t-1} \dot{q}_{i,t}}_{EQ}$$

2. Decomposition of the variance of average agricultural prices

The variance of $(\bar{p}_t)_{t=1,\dots,T}$, $V(\bar{p}_t)$[15], measures the variability in time of average agricultural prices and can be considered as a proxy for the apparent price risk faced by the agricultural sector.

Using the notations of Annex 1, we can write: $V(\bar{p}_t) = V(\sum \theta_{i,t} p_{i,t})$, where $\theta_{i,t}$ is the share of commodity i in the total quantity produced at period t. By decomposition of the variance: $V(\bar{p}_t) = \sum_i V(\theta_{i,t} p_{i,t}) + \sum_{\substack{i,j \\ i \neq j}} COV(\theta_{i,t} p_{i,t}, \theta_{j,t} p_{j,t})$, where COV is the covariance operator[16].

We now decide to compute the variance over several time intervals $T_1, \dots, T_h, \dots T_H$, such that $\bigcup_{h=1}^{H} T_h = [1, \dots, T]$ and, more importantly, $\theta_{i,t} \cong \theta_{i,T_h}$ $\forall h = 1, \dots, H$. This assumption states that quantity shares are stable within the different time intervals T_h (their variance is 0) and that they can therefore be considered as exogenous and not as random variables.

It follows from this assumption and from the linearity of the variance and covariance that:

$$V_{T_h}(\bar{p}_t) = \underbrace{\sum_i \theta_{i,T_h}^2 V_{T_h}(p_{i,t})}_{EP} + \underbrace{\sum_{\substack{i,j \\ i \neq j}} \theta_{i,T_h} \theta_{j,T_h} COV_{T_h}(p_{i,t}, p_{j,t})}_{ES}$$

ES measures the effect of the composition of agricultural production on the apparent average price risk faced by farmers. In other words, it measures the exposure of the agricultural sector to price risks. *EP* measures the effect of the price variability of individual commodities on the variability in average prices of the bundle of commodities produced by the agricultural sector.

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[15] The variance of a random variable is a statistical measure of its dispersion from the mean. The unbiased estimator $V(\bar{p}_t)$ is given by $v(\bar{p}_t) = \frac{1}{T-1} \sum_{t=1}^{T} (\bar{p}_t - \bar{\bar{p}})^2$, where $\bar{\bar{p}} = \frac{1}{T} \sum_{t=1}^{T} \bar{p}_t$.

[16] The covariance between two random variables $(X_t)_{t=1,\dots,T}$ and $(Y_t)_{t=1,\dots,T}$ is a statistical measure of the link between these two variables. The unbiased estimator of the covariance is given by: $cov(x_t, y_t) = \frac{1}{T-1} \sum_{t=1}^{T} (x_t - \bar{x}_t)(y_t - \bar{y}_t)$, where $\bar{x}_t$ and $\bar{y}_t$ are the means of the distributions.

3. Correspondence matrices: the example of Cap-Verde

Below is provided an extract of the correspondence matrix of Cap-Verde used to match the products of the producer price classification to the FBS classification and estimate the price of all the items of the latter. It has to be read in the following way:

- Regarding wheat, there is a one-to-one correspondence between the items of the price list ("Wheat") and the item of the FBS list ("Wheat and wheat products"): the price of both items will therefore be equal ;
- Fonio, absent of the FBS list, is added to the item "Cereals, Other": the price of this item will therefore include the price of fonio, as well as other cereals not present in the FBS list;
- Rice is expressed in two different units: in its raw form in the price list ("Rice, paddy") and in milled equivalent in the FBS classification. The coefficient in the corresponding cell is the technical conversion factor: 1.5kg of paddy rice is needed to produce 1Kg of rice in milled equivalent. For a given quantity, the price of the rice in milled equivalent will therefore be equal to the price of the paddy rice times 1.5.
- ... And so on.

As technical conversion factors vary from country to country, the correspondence matrices are country specific.

Table 1 - Correspondence matrix between the Food Balance Sheets classification (FBS) and the producer price classification (PP)

PP \ FBS	Wheat and products	Cereals, Other	Sugar cane	Sugar non-centr.	Sugar (raw)	Groundnuts (shelled)	Butter, ghee	Rice (milled)
Wheat	1	0	0	0	0	0	0	0
Rice, paddy	0	0	0	0	0	0	0	1,5
Fonio	0	1	0	0	0	0	0	0
Sugar cane	0	0	1	12,5	0	0	0	0
Sugar, cane, raw, centrifugal	0	0	0	0	1	0	0	0
Groundnuts, with shell	0	0	0	0	0	1,4	0	0
Milk, whole fresh cow	0	0	0	0	0	0	21,1	0

4. Main data tables

Table 2a - Food available for consumption in West Africa by commodity group

kcal / capita / day (% points)	1961-1979	1980-1999	2000-2011
Cereals	975 (49,8)	1156 (52,7)	1220 (50,1)
Excitants	1 (0)	1 (0,1)	3 (0,1)
Fruits	77 (3,9)	69 (3,2)	76 (3,1)
Meat and animal products	153 (7,8)	164 (7,5)	188 (7,7)
Oils and Oil crops	251 (12,8)	302 (13,8)	354 (14,6)
Other	1 (0)	2 (0,1)	3 (0,1)
Pulses	62 (3,2)	63 (2,9)	79 (3,2)
Roots and tubers	334 (17,1)	297 (13,5)	348 (14,3)
Spices	6 (0,3)	7 (0,3)	8 (0,3)
Sugars	72 (3,7)	101 (4,6)	121 (5)
Vegetables	27 (1,4)	30 (1,4)	34 (1,4)
Total	**1957** (100)	**2193** (100)	**2434** (100)

Table 2b - Food available for consumption in West Africa by cereal type

kcal / capita / day (% points)	1961-1979	1980-1999	2000-2011
Barley and products	0 (0)	1 (0)	1 (0)
Cereals, Other	24 (2,3)	12 (1)	10 (0,8)
Maize and products	161 (15,6)	186 (15,4)	201 (15,9)
Millet and products	281 (27,2)	243 (20,1)	227 (17,9)
Oats	0 (0)	0 (0)	0 (0)
Rice (Milled Equivalent)	331 (32,1)	460 (38)	492 (38,8)
Rye and products	0 (0)	0 (0)	0 (0)
Sorghum and products	172 (16,6)	175 (14,5)	160 (12,6)
Wheat and products	62 (6)	132 (10,9)	177 (14)
Total	**1031** (100)	**1209** (100)	**1269** (100)

Table 3 - Diversity of food availability and production in West Africa, by country

Diversity index	1961-1979		1980-1999		2000-2011	
	Availability	Production	Availability	Production	Availability	Production
Benin	0,88	0,82	0,89	0,81	0,89	0,76
Burkina Faso	0,84	0,86	0,86	0,88	0,88	0,89
Cabo Verde	0,78	0,91	0,88	0,94	0,92	0,94
Côte d'Ivoire	0,90	0,87	0,90	0,89	0,89	0,87
Gambia	0,84	0,81	0,85	0,87	0,90	0,87
Ghana	0,92	0,89	0,90	0,84	0,90	0,79
Guinea	0,91	0,91	0,85	0,93	0,84	0,94
Guinea-Bissau	0,86	0,93	0,80	0,94	0,83	0,94
Liberia	0,74	0,82	0,77	0,85	0,82	0,83
Mali	0,87	0,92	0,87	0,92	0,90	0,93
Mauritania	0,88	0,71	0,88	0,78	0,86	0,82
Niger	0,71	0,80	0,73	0,79	0,80	0,84
Nigeria	0,91	0,89	0,93	0,87	0,94	0,86
Senegal	0,88	0,86	0,88	0,90	0,88	0,93
Sierra Leone	0,76	0,85	0,75	0,90	0,80	0,74
Togo	0,86	0,80	0,90	0,84	0,89	0,84
Median	**0,87**	**0,86**	**0,88**	**0,88**	**0,89**	**0,87**

Note: the diversity index varies between 0 (minimum diversity) and 1 (maximum diversity)

Table 4a - Production-to-Demand ratios in West Africa, by country

	1961-1979	1980-1999	2000-2011
Benin	1,49	1,45	1,71
Burkina Faso	1,35	1,27	1,26
Cabo Verde	0,82	0,67	0,66
Côte d'Ivoire	1,49	1,61	1,55
Gambia	1,87	1,15	1,07
Ghana	1,34	1,41	1,57
Guinea	1,18	1,14	1,27
Guinea-Bissau	1,34	1,23	1,33
Liberia	1,03	1,14	1,08
Mali	1,22	1,15	1,21
Mauritania	0,92	0,74	0,75
Niger	1,43	1,22	1,24
Nigeria	1,62	1,54	1,67
Senegal	1,45	1,11	1,01
Sierra Leone	1,07	1,03	1,69
Togo	1,30	1,23	1,23
Median	**1,34**	**1,19**	**1,25**

Table 4b - Production-to-Demand ratios in West Africa, by commodity group

	1961-1979	1980-1999	2000-2011
Cereals	1,31	1,21	1,18
Fruits	1,18	1,17	1,15
Meat and animal products	0,86	0,79	0,77
Oils and Oil crops	2,61	2,15	2,02
Pulses	1,88	1,77	1,87
Roots and tubers	1,83	1,91	2,21
Sugars	0,15	0,32	0,19
Vegetables	1,08	1,09	1,06
Median	**1,24**	**1,19**	**1,16**