

## Geospatial Disease of Cereals and Prevalence of Malnutrition in Cote d'Ivoire

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### Abstract

The aim of this work is to make an inventory of the cereals available in areas of prevalence of malnutrition in Côte d'Ivoire.

To this end, a descriptive and documentary study was carried out in Côte d'Ivoire From February to November 2017. Cereal production areas have been identified by combining malnutrition prevalence data. The analysis showed that the northern and northeastern areas of Côte d'Ivoire are considered critical with malnutrition proportions in the past 40%. Those in Central, West and Northwest Côte d'Ivoire, with malnutrition in excess of 30%, are considered serious. As for cereal production, it is effective on all the extent of the Ivorian territory. However, the quantities and types of cereals differ from one area to another.

Additional studies on other foods would be needed to assess the design of balanced formulas for complementary children's flours and to better define the scope of actions to combat effectively against malnutrition in Côte d'Ivoire.

**Keywords:** Cereals; Malnutrition; Côte d'Ivoire

### Introduction

Malnutrition is a public health problem in developing countries, despite the diversity of agricultural products [1-3]. Malnutrition results in deteriorating health and high mortality among mothers and their children [4,5].

In Côte d'Ivoire, malnutrition by deficiency is still considered a concern despite a relative decline in the prevalence rate from 29.8% to 21.6% [6,7]. In addition, nearly 1/3 of children under five (5) years of age does not have optimal growth, 1/5 child is born with low weight, 4/5 children are anaemic and 3/5 children are at risk of hypovitaminosis A [7]. In addition, the majority of foods used to start weaning are cereals.

Cereals, on the other hand, appear as essentially energy foods (330 - 385 kcal/100g) [8]. The fiber level is variable. Protein content ranges from 6% to 10% in extreme cases, but is most often between 8% and 11%.

In Côte d'Ivoire, few studies have highlighted cereal production and the prevalence of malnutrition. Thus, this study aims to make an inventory of cereals in areas of prevalence of malnutrition in Côte d'Ivoire.

### Methodology

A descriptive and analytical study was carried out on the prevalence of malnutrition according to cereal production areas in Côte d'Ivoire.

At first glance, the information shown on the map below was re-selected according to the regional division of the Ivory Coast. The steps leading up to this map showing the spatial distribution of cereal crops in Côte d'Ivoire, depending on the severity of malnutrition, were data collection based on documentary research. Then a computer-assisted drawing software, in this case Adobe Illustrator, was used to draw the map by adding the icons representing the different cereal cultures.

### Results

Distribution of cereals and their price on the extent of the territory of Côte d'Ivoire.

The description of Table 1 shows a distribution of cereals with their price. Production quantities vary between 49,000 and more than 700,000 tonnes depending on the region and cereals.

Cereal distribution and prevalence of malnutrition over the extent of Côte d'Ivoire's territory.

Cereals	Regions	National quantity (tonne)	Cost per kg or litre FCA (April 2018)
Local paddy rice	West, Central West, Southwest	722609,0	375 - 500
Thousand	North	49316,0	325 - 475
Sorghum	North-East	48438,0	225 - 380
Corn	All regions	654738,0	175 - 280
Fonio	ND	ND	ND

**Table 1**

Source: Kouakou Egnon, 2017

ND: Undetermined

the Ivory Coast (except the city of Abidjan) where malnutrition is generally low or negligible.

The spatial analysis of the spatial distribution of cereal crops in Côte d'Ivoire reveals a paradox. Indeed, for areas where cereals are present in the minority as is the case for the centre and the south, which capitalize only two of the five cereals present nationally, the severity of malnutrition is less critical or even low. While the opposite situation produces a disturbing severity. This spatial distribution is strongly influenced by the North-South contrast resulting from climate segregation in Côte d'Ivoire.

**Discussion**

This study is based on the analysis of the map of Côte d'Ivoire associating cereals and the prevalence of malnutrition. Malnutrition is a real public health problem in Côte d'Ivoire [9].

The analysis reveals an inequality in the geospatial distribution of the prevalence's of global malnutrition in Côte d'Ivoire. This finding stems from the data collected in this study compared to international standards. The values of malnutrition recorded (plus40%) in the north and north-east of Côte d'Ivoire are considered critical. As for those registered in the West, North-West and Central Côte d'Ivoire (more than 30%) are considered serious. These values are much higher than in the South West and South outside Abidjan (Ivory Coast's Economic Capital). This could be justified on the one hand by the socio-political crises that Côte d'Ivoire has experienced with their destructive effects on health, water, hygiene, sanitation, as well as food security and nutrition [9]. These events have fostered precarious humanitarian conditions for vulnerable households resulting in outbreaks of child malnutrition in these areas (North, West, North-East, North-West and Central Côte d'Ivoire) are considered serious. These values are much higher than those found in the Southwest. On the other hand, the basic diet in these areas consists of a monotonous diet of cereals with various deficiencies [9].

Cereal protein is poor and the primary limiting amino acid is lysine [10,11]. In the case of maize, tryptophan also has a severe deficit and is the secondary limiting amino acid. The concentration of sulphur amino acids is higher in cereals than in legumes, hence the interest of the combination of cereals and legumes, which thus supplement each other [12]. Fats are relatively low in cereals, but they are extremely interesting because of the high proportion of unsaturated fatty acids. Cereals are also low in mineralized. Indeed, the phosphorus content is high while that of calcium is low, and not sufficient to neutralize all phytic acid [13]. Finally, with the exception of yellow corn and millet, which contain active carotenoids, cereals have no vitamin A activity. Vitamin C is also lacking.

Apart from these deficiencies, some cereals such as millet and sorghum are drought-resistant. They therefore ensure the food and nutrition security of millions of people. In the north, northwest and north-east areas where rainfall is comparable to those of Sahelian countries (less than 1200 mm/year),millet, due to its abil-

**Figure 1**

Source: National Development Plan 2015.

On this map, it is observed the trends in malnutrition that evolve from green to red. Green is an acceptable prevalence, red is a critical situation. For middle trends, yellow refers to a weak situation and orange a state of advanced malnutrition.

As far as cereal crops are concerned, we have five for the whole of Côte d'Ivoire. Indeed, there are Mil, Corn, Rice, Sorghum and Fonio in Côte d'Ivoire. Of all these crops, the most present are rice and maize because they are grown in all areas of Côte d'Ivoire, unlike sorghum and fonio exclusively found in the north of the country.

Then, in the centre of Côte d'Ivoire, two trends are competing for the territory. In fact, the majority of severe malnutrition is found in the centre, north-central and west, while in the centre-west and in the centre-east, the severity of malnutrition is low. Moreover, unlike in the north of the country, the central area is not rich in cereal crops since only two crops are recurrent in this area, namely maize and rice. The same is true in the southern area of

ity to withstand drought, is one of the main sources of nutritional intake [14]. Moreover, although millet is sometimes referred to as the "poor man's culture", it is the subject of a strong cultural and traditional attachment by the population in areas with low rainfall [14]. Millet is thus included in many basic dishes, including family dishes and complementary foods with an important source of iron and zinc [15].

The preponderance of millet and sorghum in cereal production areas in Sahelian Africa and particularly in northern, north-eastern and northwestern Côte d'Ivoire is due to the fact that these cereals have relatively good yields compared to other cereals on poor soils with rare and irregular rainfall. In this area, they are grown for their grains for human consumption in the form of pasta, porridge and traditional beverages [16]. For example, sorghum flour is mixed in different proportions with other flours to improve the nutritional value of traditional porridge [17].

Production of sorghum and millet in Côte d'Ivoire is estimated at 48438.0 tonnes and 49316 tonnes respectively. Prices per kilogram vary between 225 and 475 FCA depending on the season (ROAC, 2017).

Unlike other cereals, rice is a semi-aquatic grass. It is almost exclusively reserved for human food and is the staple food of more than half of the Ivorian population. Rice is grown on the extent of the Ivorian territory in very diverse geographical and climatic areas [18]. For example, since 1995, rice has been the world's largest cereal, ahead of wheat and maize [19]. Rice is an energy food of good nutritional value with a carbohydrate predominance. Rice starch, a major carbohydrate component, is characterized by high digestibility, which is why rice is used, usually in the form of flour, in infant foods [20].

Rice proteins are nutritionally among those that are the most balanced in lysine (limiting factor for cereal proteins) compared to other cereals [20]. In addition, rice differs from other cereals in its high content of glutens (soluble in diluted bases) and its low prolamins content (soluble in alcoholic solutions). Rice fats are mainly made up of unsaturated fatty acids. They are concentrated mainly at the seed and protein base. In addition, rice is a good source of B vitamins (thiamine, riboflavin and niacin), but contains little or no vitamins A, C and D. Most of the vitamins are found in the aleurone layer and germ, resulting in a significant vitamin loss due to processing. In addition to in terms of minerals, apart from silicon, rice contains quite large amounts of magnesium and potassium, but remains particularly low in sodium, making it a recommended food for deboned diets [20].

Côte d'Ivoire's annual rice production has been estimated at an average of 722609 tonnes since 2015 and covers less than 50% of the national consumption needs estimated at an average of 1,500,000 tonnes per year. The price varies from 300 to 700 FCFA depending on the quality and the session [21].

In order to improve nutritional qualities, preservation and machining, as well as its cooking ability, rice can be steamed. This process consists of a preliminary soaking of paddy rice in water, then a steaming passage, and finally a drying. These processes improve the nutritional quality of rice flour [22].

The original maize literally means what keeps it alive. Maize is used in the production of several dishes in Côte d'Ivoire and especially in the North, North East and North West. Grains are most often black, white or yellow or mixed. In human food, whole grain of maize can be used, mature or not. Maize can also be processed using dry-milling techniques to produce a relatively large number of by-products, such as corn kernels of various calibers, flours and corn semolina. In turn, these products find many applications in a wide variety of food products.

As for the protein quality of corn meal, it is comparable to that of wheat because of the large germ which has a high content [23]. The chemical composition after processing for consumption is an important aspect of nutritional value; it is affected by the physical structure of the grain, by genetic and environmental factors as well as by the transformation by other links in the food chain. In terms of nutrition, maize is therefore quite comparable to other cereals [14].

The average production of the Ivory Coast is 654738.0 tons and the price per kg varies between 150 and 300 Cfa francs per kilogram depending on the session (GRAL, 2017).

In fact, this study shows that, despite the high production of cereals in some areas, the prevalence of malnutrition remains pre-occupied. Human development is highly dependent on food and nutrition security [22]. As a result, monotonous consumption of cereals without outside input could affect children's nutritional status [24]. This understanding is consistent with our results. Indeed, there is an inverse relationship between nutritional insecurity and the nutritional status of children because the nutritional quality of meals, not the availability of cereals, the nutritional status of children. In other words, malnutrition is more pronounced among children in these different regions where cereal production is high (plus 480,000 tonnes) [25,26].

Although cereal production is not related to the prevalence of malnutrition in Côte d'Ivoire, the findings reveal that malnutrition persists in areas of high cereal production. Therefore, the problem of malnutrition is not the immediate result of a context of unavailability of cereals, but would be linked to financial or physical inaccessibility, coupled with poor nutritional practices.

These observations suggest that the availability of cereal production has little impact on the prevalence of malnutrition in Côte d'Ivoire.

## Conclusion

The prevalence factors of malnutrition are multiple and exceed cereal production. Cereals are grown throughout the Ivorian territory in a wide variety of geographical and climatic areas. Thus, due to the low rainfall of the northern, north-east and north-west areas, cereals find favorable development conditions, which are not analogous to the central and southern areas where high rainfall favors tubers rather than cereals. The studies consulted in relation to ours confirmed that these factors are related to the effects of climate change in other regions.

Notwithstanding the above, it has been found that of the five crops represented, all cereals are concentrated in the north, north, north-west, central Côte d'Ivoire area, where more than 40% of malnutrition occurs. This paradox suggests that the problem of malnutrition in these areas is not due to the unavailability of crops, but to their accessibility and use by populations.

In short, this study highlights the fact that awareness campaigns on good nutritional practices as well as massive investments to increase agricultural productivity are needed to significantly improve the nutritional quality of children's monotonous diet and their health and well-being.

## Study Limits

The data collected relate only to the availability of cereals and the prevalence of malnutrition throughout Côte d'Ivoire. It would therefore be important to conduct further studies to disprove or confirm the prevalence of malnutrition and the state of food and nutrition security of children in Côte d'Ivoire.

Moreover, as this study is descriptive in its case, it does not purport to show causal relationships. Finally, it must be recognized that this work has not been able to take into account all the factors that would be associated with the prevalence of malnutrition. Additional and more comprehensive studies could therefore take these other aspects into account.

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