SAVING LIVES
CHANGING LIVES

A landscape analysis of rice fortification in Côte d'Ivoire

WFP
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Acknowledgements

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The landscape analysis of rice fortification in Côte d'Ivoire was lead by Laouratou Dia (Regional Nutrition Officer at WFP). She conducted the data collection, analysis and wrote this report with the support of Josiane Koffi Attouo Ahoussi (STP-CNN researcher). Anne-Marie Nda Kouassi (WFP Nutrition Officer) and Clemence Maurin (WFP nutrition officer) contributed to the review of the analysis report. The final version of the report was translated from French to English by Marie Josiane Ogou and reviewed by Laouratou Dia and Christine Trudel (WFP junior nutrition officer). The report layout was prepared by Greta Kadende Claessens (WFP graphic designer).

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1. Analysis of the nutritional situation

a. Global nutritional problem

Malnutrition remains a major challenge for many countries. For more than three decades, the number of people suffering from hunger in the world has been decreasing, but for the last three consecutive years this number has unfortunately been on the rise [1].

Africa is the most affected continent and faces serious nutrition-related challenges [1]. Despite considerable improvements over the past two decades, stunting and micronutrient deficiencies remain high. Micronutrient deficiency affects about 1.5 billion people worldwide (more than 30 percent of the world's population), in particular vitamin A, iodine, iron and zinc deficiencies, among others, with serious public health consequences both socially and economically [1]. Malnutrition in all its forms can cause losses of up to 16.5 percent of Africa's Gross Domestic Product (GDP) due to increased mortality, absenteeism, costs associated with chronic diseases and lost productivity [2]. Also, the return on investment is enormous, as each dollar properly spent in nutrition programs would generate an average of $16 in terms of well-being and economic gain [2].

Malnutrition due to micronutrient deficiency is widespread in industrialized countries, but even more in developing countries. It affects all age groups, but the most at risk are young children, women of childbearing age and pregnant and lactating women.

From a public health perspective, micronutrient deficiencies are a concern not only because of the very large number of people who are affected by it, but also because, as a risk factor for many diseases, it can contribute to higher morbidity and even mortality rates. Micronutrient deficiencies have been considered to account for about 7.3 percent of the global burden of disease, with iron and vitamin A deficiencies among the 15 major causes of the global burden of disease [3].

b. Nutritional situation in Côte d'Ivoire

Overall, 21.6 percent of children under five suffer from chronic malnutrition, 12 percent of them in the severe form and 18 percent in the moderate form [4].

According to the Demographic Health Survey (2012), three out of four children aged 6-59 months (75 percent) are anaemic: 25 percent in the mild form, 46 percent in the moderate form and 3 percent in the severe form [5].

Among women aged 15-49 years, 54 percent are anaemic, 39 percent of whom are mild, 14 percent moderate and less than 1 percent severe [5].

As for men, the prevalence is highest among the youngest age groups (15-19 years old and 40-49 years old) and the oldest age groups (50-59 years old). Indeed, 43 percent of the 15-19 year old and 34 percent of the 40-49 as well as 37 percent of 50-59 year old are anemic [5].

TABLE 1: NUTRITIONAL SITUATION

Indicators	Target population	percent
Stunting	Children aged 6 – 59 months (2016)	21.6 %
Anaemia	Children aged 6 – 59 months (2012)	75 %
	Females aged 15 – 49 years old (2012)	54 %
	Male aged 15 - 49 years old (2012)	29 %

c. Ivorian Government's commitment to fight against malnutrition

Considering the malnutrition figures, the Ivorian Government continues to consider the fight against malnutrition as a national priority. Indeed, Côte d'Ivoire has joined the global Scaling Up Nutrition (SUN) movement in June 2013 and created its National Nutrition Council (NNC) chaired by the Prime Minister (per Decree No. 2014-433 of 16 July 2014), The NNC has a Permanent Technical Secretariat (PTS) and several committees:

- The Decisional Committee is composed of several ministers[1] and is chaired by the Prime Minister. Its role is to validate financial and strategic political orientations;
- The Technical Committee or multi-sectoral platform comprises representatives of these ministries and is chaired by the SUN focal point. It includes representatives from all networks, including the parliament and local authorities;
- The Regional Committees, chaired by the regional prefects, are responsible for monitoring compliance with the policy.

Côte d'Ivoire has also developed its national nutrition policy, in which it aims to "guarantee an optimal nutritional status to the entire population to improve their well-being and sustainable inclusive growth and development in the country". The policy commitments are defined in the National Multisectoral Plan for Nutrition 2016-2020 (NMPN), which is part of the National Development Plan 2016-2020, and specified as one of the key sectors for human development.

The NMPN proposes a set of interventions and activities with strategic objectives covering several sectors. One of the objectives of the plan is to reduce the prevalence of anaemia by 25 percent; from 75 percent to 57 percent in children and from 54 percent to 40.5 percent in women [7]. The plan is intended to serve as a reference for the government's action on nutrition to significantly reduce malnutrition problems by 2020. The interventions proposed in it are in line with the recommendations of the Second International Conference on Nutrition (ICN-2) in 2014, to which Côte d'Ivoire has signed the final declaration.

This strong political commitment is reflected in the reduction of the prevalence of stunting from 29.8 percent to 21.6 percent and global acute malnutrition (GAM) from 7.5 percent to 6 percent between 2012 and 2016.

d. Food fortification as a solution

For several decades, Côte d'Ivoire has been making efforts to reduce hidden hunger. Indeed, Côte d'Ivoire was one of the pioneering fortification countries in West Africa with the fortification of wheat flour, oil and salt. Moreover, fortification programs are integrated into national policies that aim to strengthen micronutrient fortification strategies, as is the case in output 1.2.3 of the 2016-2020 national multisectoral nutrition plan: "Target groups consume fortified and bio-fortified foods"[8].

In Côte d'Ivoire, micronutrient deficiencies in iron, vitamin A and iodine are widespread. The country has been involved in the process of mandatory fortification of foods since 1994 with the salt iodization, then the fortification of bread-making wheat flour with iron and folic acid; oil with vitamin A, and finally the complementary food with 11 vitamins and 9 minerals (Figure 1). The fortification of these foods targeted the entire population, including infants.

This initiative was intended to reach the following outcomes:

- 90 percent of households consume iodized salt;
- 80 percent of Ivorian households consume refined vegetable oil enriched with vitamin A and soft wheat flour enriched with iron and folic acid;
- 90 percent of children aged 6-24 months consume complementary foods enriched with 11 vitamins and nine minerals.

The Ivorian project for the promotion of fortified food (IPPFF) started with an acceptability study, followed by a baseline study that lasted two years, then by the establishment of a public-private partnership platform and finally the development of a regulatory and standards framework. It was followed by capacity building for processing: equipment, premix and capacity building of laboratories and other internal and external quality control and quality assurance control actors. Then, the monitoring and evaluation plan with a mid-term evaluation took place in 2010.Finally, the social marketing communication plan with the design of the logo and the official launch of the project through a caravan that travelled all over Côte d'Ivoire (Figure 2).

However, it is important to note that food fortification strengthens and supports nutritional improvement programs and should be considered as a distinct strategy embedded in a broader integrated approach, and as complementary to other public health approaches, such as the promotion of food diversity or supplementation.

1 When it was established in 2014, the DecisionalCommittee was composed of the Ministries of: Planning and Development; Social Affairs; Economy and Finance; Human Hydraulics; National Education and Technical Education; Trade; Scientific Research; Animal and Fisheries Resources; Health and AIDS Control; Agriculture; Industry; Family, Women and Children; and Budget.

FIGURE 1: CHRONOLOGY OF FORTIFICATION IN CÔTE D'IVOIRE

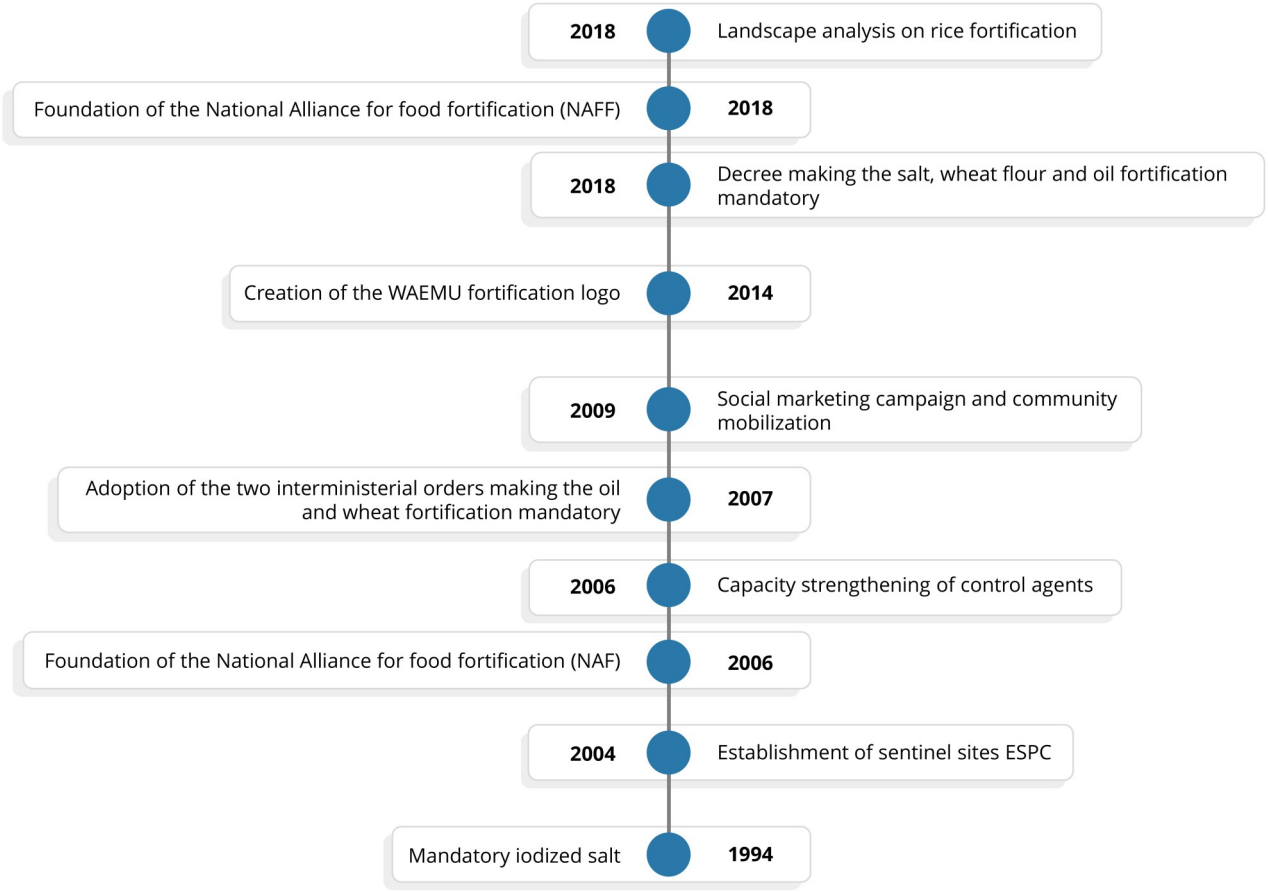


FIGURE 2: WEST AFRICAN ECONOMIC AND MONETARY UNION (WAEMU) FORTIFICATION LOGO

2. Landscape analysis framework

a. Background and justification

Fortifying the most commonly consumed staple foods (also called "vehicles", such as: salt, wheat flour, rice and oil) has proven to be a highly cost-effective strategy to address micronutrient deficiencies [8]. When properly implemented, food fortification programs have resulted in a reduction in disorders due to iodine deficiency, neural tube defects and, to a lesser extent, a reduction in iron and vitamin A deficiencies [9]. Food fortification has been identified by the World Health Organization (WHO), the Copenhagen Consensus, the Food and Agriculture Organization of the United Nations (FAO) and the World Food Programme (WFP) as one of the four main strategies to reduce hidden hunger [10]. A Cochrane study[2] was carried out between 2012 and 2017 to document the impact of rice fortification, mainly on the nutritional status of target populations (Annex 1).

Rice, with the fast urbanization and its culinary and economical advantage has become the main food for almost all the populations living in Côte d'Ivoire. Therefore, the Ivorian Government has written a national rice development strategy 2012-2020 (NRDS) through which it commits to achieve rice self-sufficiency and make Côte d'Ivoire a rice exporting country by 2020. The government had planned to achieve this objective by setting up new modern processing units[3] throughout the country, with processing capacities ranging from 0.2 to 10 tons per hour.

In view of the country's ongoing reform of the rice sector and the amount of knowledge on rice fortification, the government deemed appropriate to hold a landscape analysis on the feasibility and opportunities of rice fortification in Côte d'Ivoire.

b. Objective of the landscape analysis

The landscape analysis provides an overview of the nutritional situation, national policies and the rice sector industry. The overall objective is to provide strategic and technical guidance to the Ivorian Government for a better-informed decision making on rice fortification in the country. Specifically, the analysis provides information on the following: (i) rice production, processing, distribution and consumption; (ii) imports, (iii) exports and finally (iv) it assesses the feasibility of rice fortification at the national level, focusing on the potential of this public health strategy to improve the health of populations.

c. Methodology

The findings that are shown in the landscape study were collected through a literature review, individual interviews with key stakeholders and field observations. The analysis collected both quantitative and qualitative data. Besides, regarding the qualitative data, the structures and people participating in the interviews were selected based on rationale criteria; so that they were representative of the key stakeholders throughout the supply chain and that they were identified to be the best sources of information for the analysis. Quantitative data was mainly collected from the Rice Development Agency (RDA), the General Directorate for Foreign Trade (GDFT) and the National Institute of Statistics (NIS).

The preliminary findings of the analysis were presented to the main stakeholders of the rice sector during a workshop held in November in Abidjan, Côte d'Ivoire. (Annex 2).

2 Cochrane (formerly the Cochrane Collaboration) is an independent non-profit organization. The purpose of the collaboration is to gather scientifically validated data in an accessible and summarized manner. She conducts systematic reviews and meta-analyses of randomized controlled trials of health interventions.

3 In this document the terms "processing units" and "rice mills" are considered synonyms and will therefore be used in an interchangeable manner.

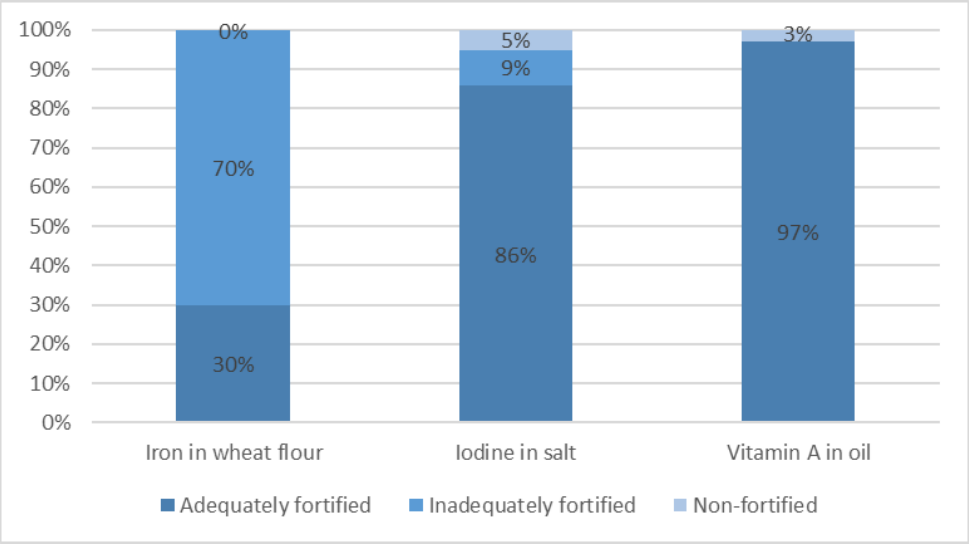
3. Study findings

a. National coverage of fortified foods

In the fight against micronutrient deficiencies, Côte d'Ivoire has made the fortification of salt, bread-making wheat flour, oil and complementary food mandatory.

According to a survey conducted by the Global Alliance for Improved Nutrition (GAIN) and Helen Keller International (HKI) from 2014 to 2015, the national situation of fortified foods, including wheat flour and refined oil, is summarized in Graph 1.

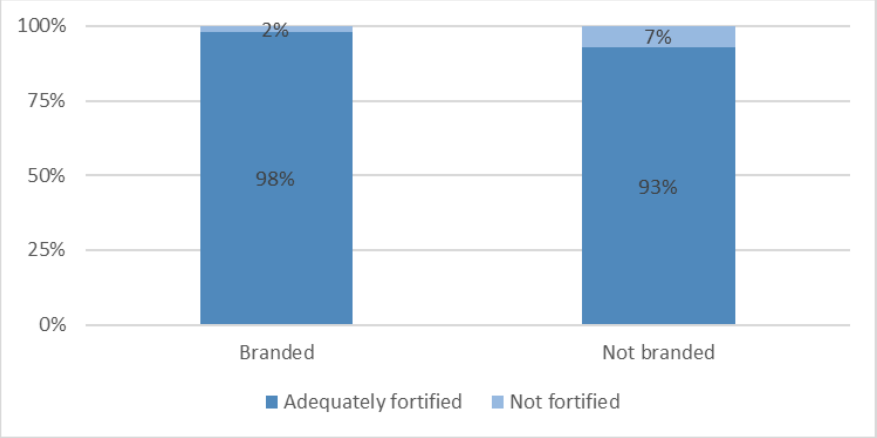
GRAPH 1: SUMMARY OF THE SITUATION OF THE FORTIFIED FOODS IN CÔTE D'IVOIRE



b. Fortification of oil with vitamin A

The results for oil revealed that 98 percent of Ivorian households consume refined palm oil, and 57 percent of households purchase reprocessed oil (oil that is not in its original packaging). In addition, 50 percent of the cooking oil that is sold cannot be identified in the household or point of sale, as there is no brand name and therefore nothing to ensure traceability. During the investigation, it was found that all tested samples of oils were fortified and 97 percent were adequately fortified. It could be noted that 98 percent of the oils in their original packaging were adequately fortified while 93 percent of the oils sold at retail shops were adequately fortified (Graph 1). It is also important to note that all the oil sampled were either adequately fortified or not fortified at all. The survey shows that fortified oil met the objectives initially planned when it was launched. Indeed, 98 percent of households consume oil and 98 percent of the available oil is adequately fortified, which is well above the established initial target of 80 percent.

GRAPH 2: OIL FORTIFICATION SITUATION



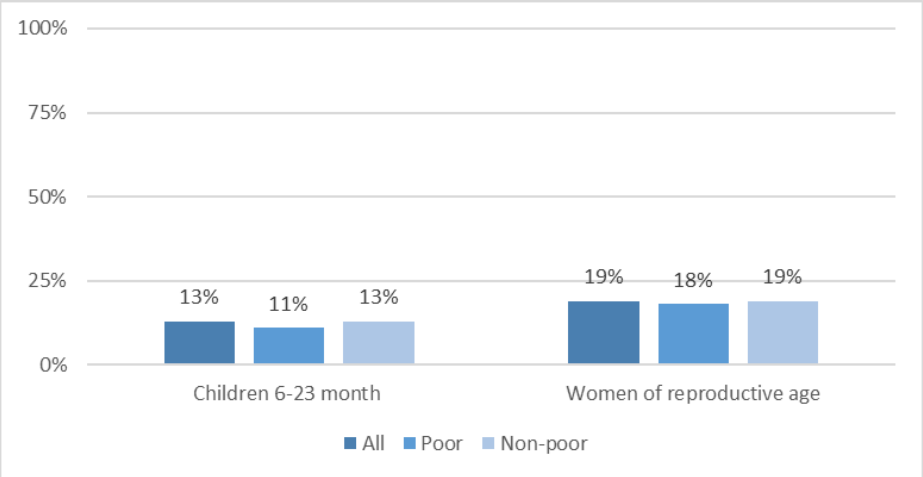
c. Fortification of wheat flour with iron

Concerning wheat flour, only 12 percent of households use wheat flour, however 85 percent of households consume bread, doughnuts or other products made from wheat flour. All the flour tested samples were fortified, but only one third were adequately fortified.

Fortified wheat flour contributes to 13 percent and 19 percent respectively of the Recommended Dietary Allowance (RDA) of iron for children 6-23 months of age and women of childbearing age (Graph 3).

In conclusion the fortified wheat flour initiative did not exactly meet the initial planned objectives, which raises questions both about 1) the choice of wheat flour as a good vehicle and 2) the quality control and quality assurance of the fortification process. The initial hypothesis that had been put forward when choosing to fortify wheat flour was that bread was a commodity widely consumed by Ivorians. Originally bread was made from wheat flour, but gradually cassava flour entered the bread making process, thus reducing the share of wheat flour. Therefore, today wheat flour is consumed by only 12 percent of the population and only one third of the available wheat flour is adequately fortified. Despite this, the consumption of fortified wheat flour contributes 19 percent of the Recommended Nutritional Allowance of iron for women of childbearing age, but a significant proportion of the needs remain to be covered. Therefore, the choice of rice as a new food vehicle to be fortified with iron and folic acid seems relevant to increase the RNA in iron and folic acid among populations, while ensuring that capacity building in terms of quality control and quality assurance is provided.

GRAPH 3: CONTRIBUTION OF IRON-FORTIFIED WHEAT FLOUR TO RDA



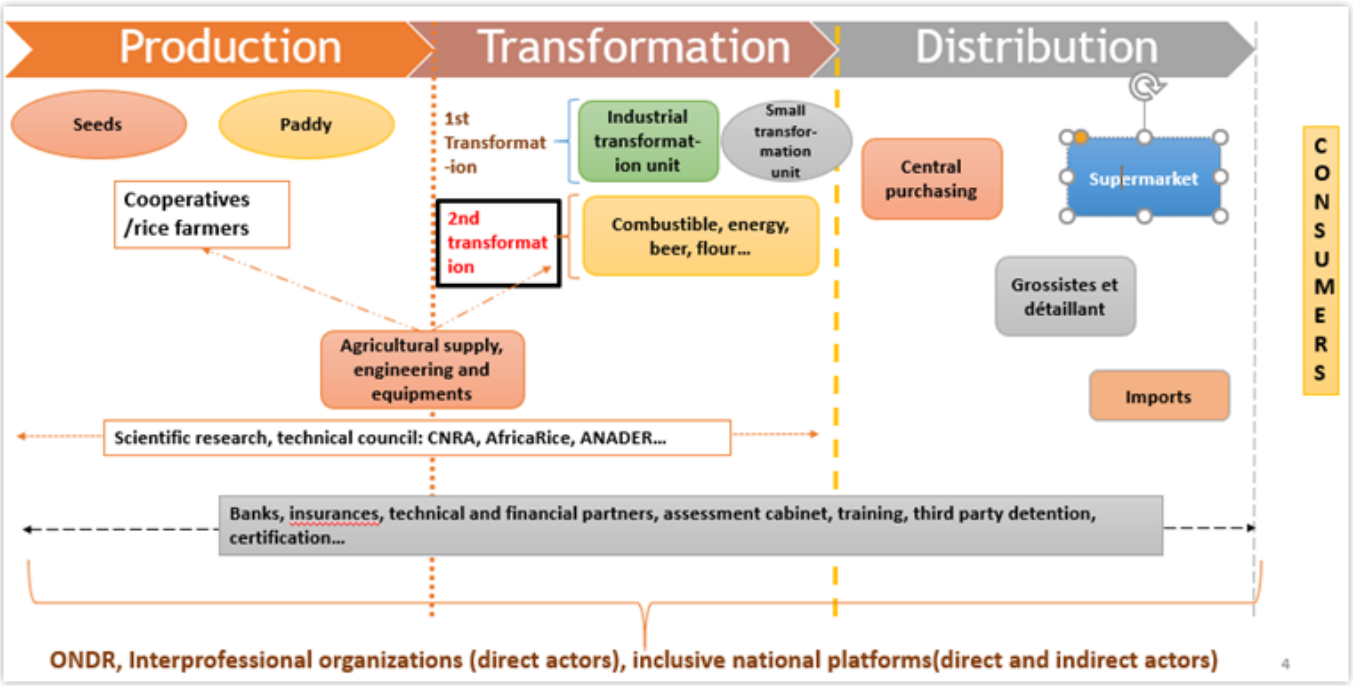
d. Rice fortification as strategy to fight micronutrient deficiencies

To continue the fight against micronutrient deficiencies, particularly of iron, zinc and B vitamins including folic acid, the government of Côte d'Ivoire is exploring the possibility of rice as a new vehicle for fortification. The choice of rice as new vehicle is justified by :

- The significant consumption of rice by almost the entire Ivorian population. Indeed, the National Statistical Institute estimated that rice consumption in Côte d'Ivoire in 2015 was 135g/c/d[4]. Knowing that the fortification of a food is recommended from a consumption higher than 75g/c/d, rice is a good choice.
- The structure of the rice industry (Figure 3): Although the country has many processing units (rice mills) of various sizes, the development of the sector is underway with the 2012-2020 NRDS. To date, all the rice produced is processed in mills with a capacity of at least 0.2 to 2 tons per hour. With the government's thirty new units of a capacity of 5 tons per hour coming into operation in 2019, fewer and fewer small units are expected to continue to process large quantities of paddy and giving way to the new medium-size units.
- Imports volume: Côte d'Ivoire imports about 1 300 000 tons of rice per year
- Evidence and fortifying techniques are well developed: Several countries have consumed fortified rice for several years; the United States, Costa Rica, Nicaragua, Panama, Philippines and Papua New-Guinea. Hence, there is a real opportunity to share experiences and to do some capacity building between governments. The 2 most commonly used techniques for rice fortification are coating and extrusion (c.f. glossary). A lot of equipment exists for both the fortification process and the quality control of fortified foods.

4 Consumption data for the year 2017 are currently being collected by the INS.

FIGURE 3: STRUCTURE OF RICE SECTOR IN CÔTE D'IVOIRE



4. The rice sector in Côte d'Ivoire

a. Local production

The Ivorian Government has made a strong commitment to boost the rice sector in the last few years with the SNDR 2012-2020. The objective was to be self-sufficient in rice production by 2016, and to become an exportation country by 2018. Even though Côte d'Ivoire is not yet self-sufficient, progress towards that goal are undeniable.

Rice cultivation

Côte d'Ivoire has the advantage of cultivating rice upland and in the lowlands, in all regions of the country. Three cultivation techniques are used: rainfed rice cultivation (in upland and lowland environments), irrigated rice cultivation and shifting rice cultivation [11].

In the case of rainfed upland and lowland rice cultivation, traditional farming practices prevail. Cultivation is done manually. Shifting cultivation and slash-and-burn cultivation of fallow land or new land clearing, are done with tools that are rudimentary. The soils are barely tilled, and sowing is done on the fly or in rarely aligned holes. In savannah areas, coupled cultivation allows better soil and seedling preparation with seed drills [11].

As for irrigated rice production, in the areas where lands are developed for rice cultivation, although manual methods remain, the use of power-driven tillers/cultivator is becoming more and more widely used. Transplanting after a nursery phase is the method of setting up crops. Manual weeding predominates in all environments/ ecologies; but rice farmers are increasingly using herbicides (especially post-emergent herbicides). Use of fertilizers is very low, except in irrigated farming and in the dense savannah region (Korhogo). The average size of cultivated fields is about 0.8 ha in rainfed rice rice-growing areas and 0.3 ha in irrigated cultivation [11].

Itinerant agriculture, practiced mainly on slash-and-burn, covers 86 percent of all cultivated areas. Only 14 percent of the area cultivated with rice can be considered as being stabilized and using fertilizers. These concern 9 percent of rainfed rice and 100 percent of irrigated rice [11].

National production

In 2016, domestic paddy production amounted to 2,054,535 tons, compared to 1,561,755 tons in 2012 and 606,310 tons in 2007 (Graph 4).

The sub-prefectures of Korhogo, Ferkessédougou, Minignan, Vavoua, and Man alone accounted for about 50 percent of the national paddy production (1,010,767 tons) (Table 2 and Figure 3).

In 2016, Côte d'Ivoire exported 6.5 percent of its national paddy production, i.e 135 196 tons. The quantity of paddy kept by producers for their own consumption represented 30 percent of the total paddy production (616,361 tons). The quantity of paddy collected by the processing units represented approximately 36 percent, i.e 738,571 tons. As for the remaining 27.5 percent (564,408 tons), they were stored by the professional agricultural organisations (PAOs) and intermediaries.

GRAPH 4: PROGRESS OF PADDY PRODUCTION

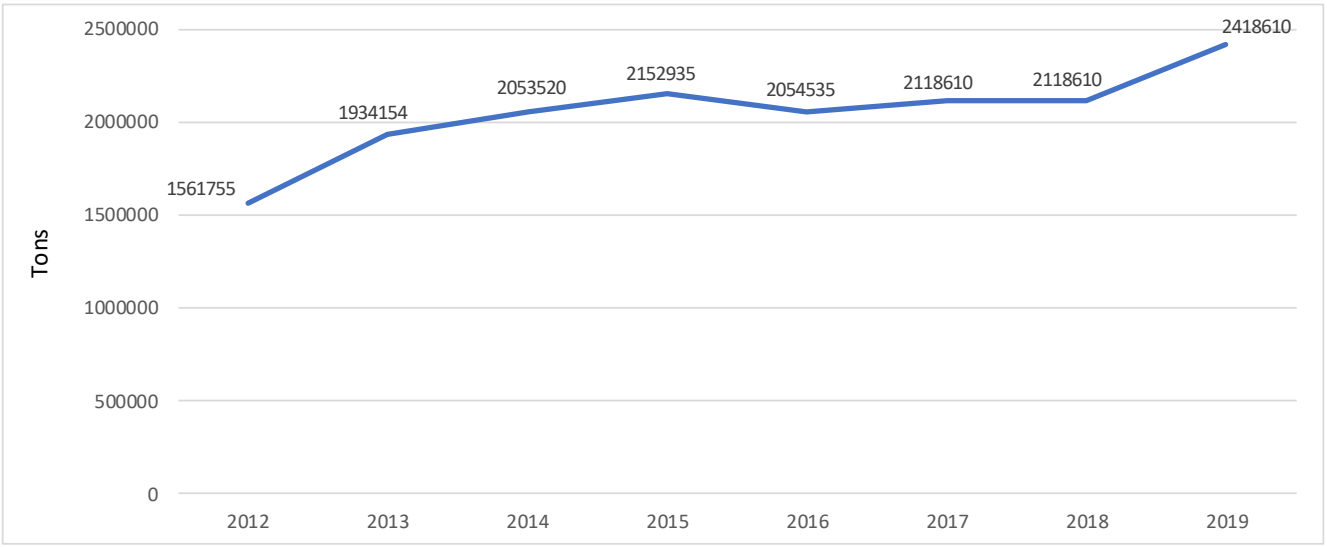
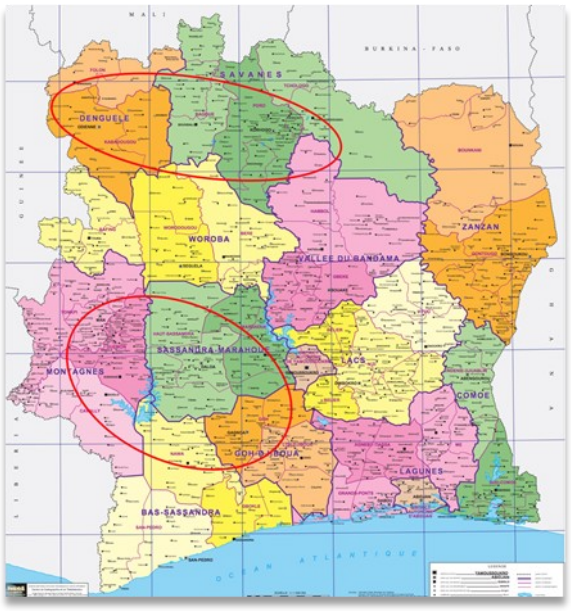


TABLE 2: MAIN PADDY PRODUCTION AREAS BY SUB-PREFECTURE

	Sub-Prefecture	Production in tons
1	Korhogo	321 277
2	Ferkessédougou	299 241
3	Minignan	151 261
4	Vavoua	128 689
5	Man	110 299
6	Duékoué	74 869
7	Katiola	71 139
8	Soubré	67 320
9	Gagnoa	66 466
10	Bouaflé	60 037

FIGURE 4: IMPORTANT AREAS OF PADDY PRODUCTION



The main varieties

The main varieties of rice produced locally are:

- "Danané" rice
- "Akadi" rice
- "Gbagbo" rice
- Melon and butterfly rice

The rice called “Danané” is the rice very well appreciated by the population with properties that is comparable to that of Thai rice (Photograph 2). Akadi rice is of a lower price range than Danané, but it is also very popular. It should be noted that these two varieties are more expensive than Gbagbo or melon/butterfly rice (Photograph 2), which are generally consumed by the population.

PICTURE 2: VARIOUS RICE VARIETIES: DANANE RICE, GBAGBO RICE, AND BUTTERFLY RICE (LEFT TO RIGHT)[5]

5 During the data collection the "Akadi" rice was not available.

Processing units

In 2016, Côte d'Ivoire had 2,635 rice mills with less than one ton per hour capacity, 283 rice mills with one to two tons per hour and six rice mills with more than two tons per hour (Figure 5). With these processing units, the total quantity of white rice produced was of 1,335,448 tons.

The one to two tons per hour units visited for this analysis were all equipped with: (i) elevator, (ii) cleanser, (iii) winnowing machine, (iv) decorator and (v) launderer.

Only one of the three rice mills that were visited was equipped with a dryer and another with a separator and sizer.

Rice mills that operated in 2017 processed a total of 738,751 tons of paddy. To date, the quantities of paddy handled by processing units of less than one ton per hour are very high and represent about 72 percent of the total processed paddy, compared to 26 percent for units of one to two tons per hour and only 2 percent for units with a capacity of more than two tons per hour (Table 3).

Within the framework of the NRDS, the government has begun to develop and modernize its rice mills throughout the country. Thus, it is planned to set up 2500 rice mills of a capacity of 0.2 to 2 tons per hour, thirty rice mills of 5 tons per hour and one rice mill of 12 tons per hour (Table 4).

TABLE 3: QUANTITY OF PADDY PROCESSED IN 2016 PER CAPACITY OF PROCESSING UNITS

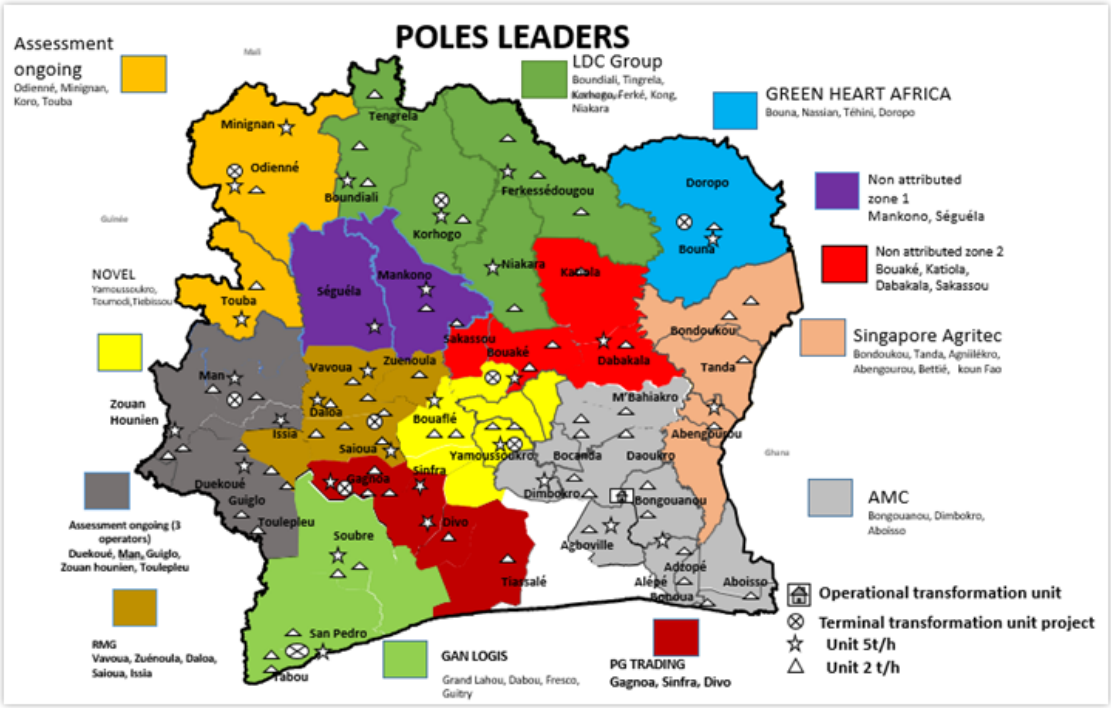
Size of rice processing mills	Number of units country-wide	Tons of paddy processed	Quantity of paddy processed (%)
Quantity of paddy processed per Mill of a capacity of less than 1T/h	2 635	534 158	72%
Quantity of paddy processed per Mill of a capacity of 1 à 2 T/h	283	192 024	26%
Quantity of paddy processed per Mill of a capacity of more than 2t/h	6	12 389	2%
TOTAL	**2 924**	**738 571**	**100%**

TABLE 4: PROJECTION FOR NEW UNITS

	1st level: 0.2 à 2mt/h	2nd level: 5mt/h	3rd level: 12mt/h
Property	2500 processing units, 63 of which are state-owned (public)	30	1
Implementation status	Out of 63 State-owned units, 40 are completed	12 are completed, 10 are being finished and 8 are ongoing.	Unit completed and operational (2)

These new processing units will be managed by private operators called "pole leaders", around whom medium and small capacity processors are associated in contractual relations with producers. Each pole leader is responsible for a production basin; the national territory is divided into ten production basins (also called rice development basins) with a production potential of at least 200,000 tons of milled rice per year. Each production basin is in turn divided into 48 rice development pools (Figure 5).

FIGURE 5: DISTRIBUTION OF PROCESSING UNITS THROUGHOUT THE COUNTRY



Main actors in the local rice sector

The rice sector in Côte d'Ivoire is composed of several groups of actors, each with its own specific roles.

- **Producers:**

The majority of producers in Côte d'Ivoire are smallholders. Once the paddy harvest is completed, several options are available to them: (i) part of the paddy is kept for self-consumption and will be processed later, (ii) part is purchased by the trackers and finally (iii) part is either sold directly to the processing units or processed by the units and given back to the farmers who will then sell the milled rice to wholesalers.

- **Trackers:**

Trackers are the intermediaries between producers and processors who have the advantage of being generally close to rice fields and have financial resources. They also provide financial and/or technical support to smallholder's farmers. Trackers can buy the paddy directly from the producers, who will then either process it themselves or store it.

- **Millers/processors:**

Millers depend on the supply of paddy from producers and trackers. Most of them have producers and trackers with whom they are used to work. There are generally two scenarios for processing, either they buy the paddy directly from the producers and trackers; or they only process the paddy that the producers and trackers send them. If they buy the paddy, they sell it to the various distributors, often under their own brand.

Millers must comply with national requirements relevant to rice processing in Côte d'Ivoire. These requirements are as follows:

- ♦ Paddy standards: 14 percent moisture, 0 percent impurity, less than 3 percent yellow grains .
- ♦ Technical machining yields: 65 percent- 68 percent
- ♦ Proportion of whole rice: 50 percent.
- ♦ Proportion of large broken grains: 10 percent.
- ♦ Proportion of medium broken grains: 5 percent-8 percent.
- ♦ Valorization of all by-products
  - ⇒ Low starch: 8 percent.
  - ⇒ Ball: 20 percent.
  - ⇒ Fine Broken grain: 4 percent.

- **Distributors:**

There are several categories of distributors: wholesalers, semi-wholesalers and retailers.

Wholesalers are groups such as Prosuma, or Carrefour (CFAO), semi-wholesalers are structures such as CDCI, SOCOPRIX and retailers include both market vendors and neighbourhood mini markets.

Concerning local rice, distributors get their rice supply directly from millers and from major importers for imported rice.

Cost and price of local rice

Although a more specific cost analysis will be conducted as part of the rice fortification implementation process in Côte d'Ivoire, this analysis provides a brief overview of rice cost and price structure.

The structure of rice production costs varies according to the cultivation technique: irrigated rice, lowland rice or rainfed rice. The elements considered in calculating the cost of production include inputs and services such as: cleaning, weeding, transplanting, spraying, harvesting, threshing/winnowing, drying, transportation to the factory, etc. The weight average cost of production for the three rice cultivation techniques was estimated at 138.9 CFA francs/kg paddy.

As for the processing cost, the average weight processing cost for small rice mills and industrial rice mills is 31.38 CFA francs/kg of paddy. This amount mainly includes cleaning, drying, paddy storage, direct processing charges, bagging, recycling of by-products and other costs.

The distribution cost was calculated at 22.42 CFA francs/kg of white rice. This cost represents transportation costs, loading/unloading, warehousing, taxes and personal charges.

Thus, in order to be competitive with imported rice, the actors in the rice sector have decided by consensus to set the price per kilogram of milled rice, which is mainly classified in the semi-luxury category (butterfly rice sold between 350 and 400 CFA francs) at 370 CFA francs.

This average price seems to be in line with actual practice, since during the analysis the prices mentioned in the interviews varied between 300 CFA francs and 400 CFA francs.

TABLE 5: COSTING STRUCTURE

Operations	Expenses paddy (CFA FRANCS/kg)	Milled rice expenses (CFA FRANCS/kg) for a yield of 65%.	Consensual selling price for largely consumed rice (semi-luxury) guaranteeing quality/price competitiveness (CFA FRANCS/kg)	Consensual margin distribution (CFA FRANCS/kg)	Producers' share on one kg of milled rice sold
Production	138,9	213,69		28,91	
Transformation	31,38	48,28		28,91	
Distribution		22,42	370	24,78	66 %
Joint Operations				3,00	
TOTAL		284,39		85,61	

b. Imports

Rice has become the main staple of Ivorian population. Although the government's objective is to achieve rice self-sufficiency by 2020, to date, the country continues to rely heavily on imports to meet the needs of its population.

In Côte d'Ivoire, rice imports are growing steadily. In 2017, imports reached a level never reached before; total rice imports amounted to 1,341,802 tons. Over the past seven years, imports have increased by more than 60 percent. Graph 5 shows the progress of imports, in terms of values and weight, from 2010 To 2017.

The country mainly imports white rice and 77 percent of this rice is imported in 50 kg bags. For the remaining 23 percent, data was not available. Upon arrival, only the luxury rice is repackaged and bagged in bags of less than 5 kg. The rice is then sold to wholesalers for distribution.

The particularity of Côte d'Ivoire is that, unlike its neighbours, it imports a wide variety of rice. The varieties most imported/consumed in Côte d'Ivoire are represented in Table 6.

GRAPH 5: PROGRESS OF RICE IMPORTS BETWEEN 2010 AND 2017

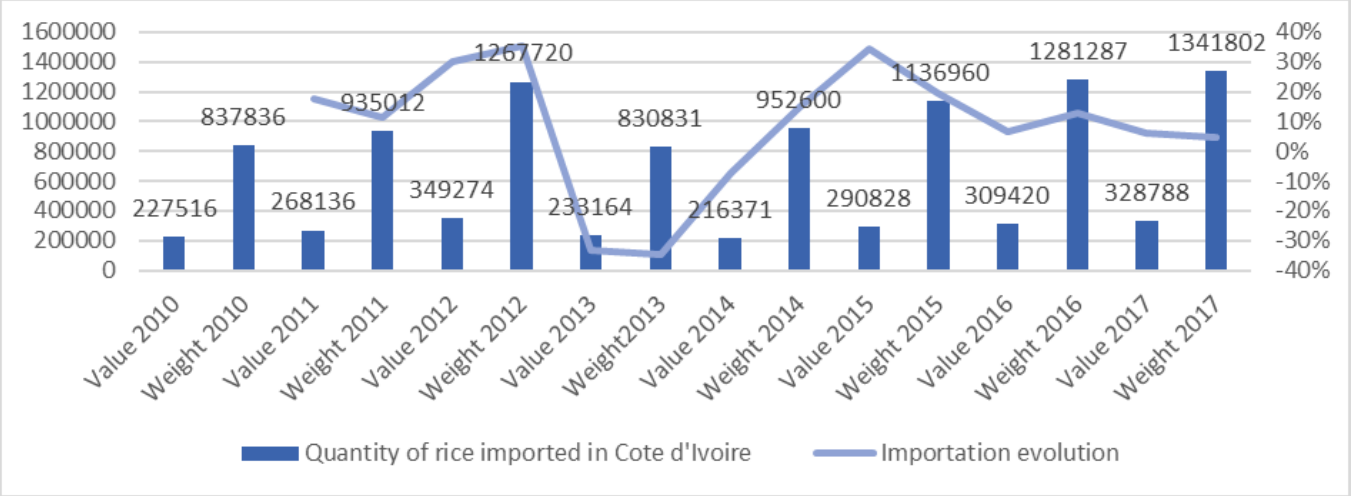


TABLE 6: SHARE IN PERCENTAGE OF DIFFERENT RICE VARIETIES IN IMPORTS

Désignations	Percentage re imports
Gbagbo rice - Vietnamese or Chinese butterfly rice with 16-35% broken. It's a low-end rice.	60 %
Premium luxury rice - 5 % of broken	20%
Rice 100% broken - 100% broken mainly from Thaïland	15%
Parboiled rice – so-called “malohoussou”.	5%

The main rice importers in Côte d'Ivoire are as follows:

- SDTM of the Carré d'Or group, which is mainly supplied by Louis Dreyfus Company and Olam[6] in Asia
- AGRIEX - phoenix
- Nouvelle GEDIS - General Distribution
- Export Trading Group
- Compagnie d’Investissements céréaliers - CIC

The SDTM group alone accounts for between 50-60 percent of the rice import market in Côte d'Ivoire, while the other companies share the remaining 40-50 percent.

In 2017, according to the DGCE's categorization (which is mainly as follows: husked rice, broken rice, bagged rice under 5 kg, bagged rice over 5 kg, straw rice and seed rice, etc.)[7] the main countries of origin of the imported rice are presented in Table 7. Graph 6 shows the evolution of imports by country since 2010. It shows that Thailand, Vietnam and India remain the three main import countries for all types of rice over the past seven years.

6 Olam withdrew from the rice sector in Côte d'Ivoire in 2017.

7 The category of bags of + 5 kg includes those of 50 kg. .

GRAPH 6: PROGRESS OF VOLUME OF RICE IMPORTED PER IMPORTING COUNTRY

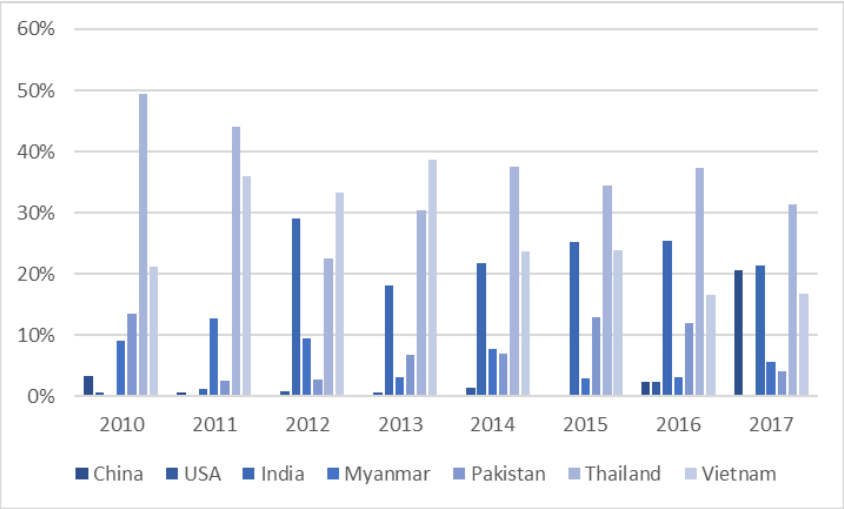


TABLE 7: MAIN IMPORTING COUNTRIES OF ALL VARIETIES OF RICE IN 2017

Countries	Percentage
Thailand	31%
India	21%
China	20%
Vietnam	17%

In 2017, rice imported in bags of more than 5 kg came from China (27 percent), India (27 percent), Vietnam (19 percent) and Thailand (15 percent) as shown in Table 7.

Graph 7 shows the progress of the main importing countries since 2010. Vietnam and India clearly stand out as the main rice importing countries.

GRAPH 7: PROGRESS OF THE MAIN IMPORTING COUNTRIES BETWEEN 2010 AND 2017

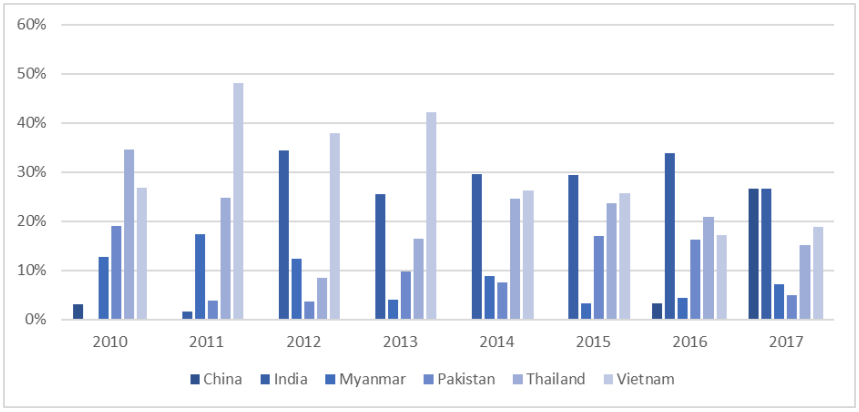


TABLE 8: MAIN IMPORTING COUNTRIES OF RICE IN +5 KG BAGS

Countries	Percentage
China	27%
India	27%
Vietnam	19%
Thailand	15%
Myanmar	7%

Purchase costs and selling prices of imported rice

Table 9 summarizes the purchase costs and selling prices of the most consumed varieties of imported rice.

TABLE 9: PURCHASE COSTS AND SELLING PRICES OF THE DIFFERENT VARIETIES OF IMPORTED RICE

Designation of variety of rice	Purchase cost in CFAF/kg	Selling price CFAF/kg
Thai Rice - Uncle Sam		
100% broken	*325*	*340*
Rice broken once	*472*	*500*
Broken 5%	*665*	*710*
Vietnamese rice - Rizière		
100% broken	*313*	*340*
Broken 5%	*522*	*555*
Riz papillon	*318*	*340*
Gbagbo rice		
Pakistani Rice Bella Luna	*261*	*280*
Indian Rice Bella Luna	*233*	*290*
Parboiled Rice	*323*	*345*
Chinese Rice 5%	*290*	*320*

Box 1: Import and local production

- The rice sector in Côte d'Ivoire is structured and tends to modernize and develop more each year due to the strong will of the government.
- National production of paddy and milled rice is constantly increasing from 1 500 000 tons in 2012 to more than 2 000 000 tons in 2017.
- Considering the number of rice mills of less than one ton per hour (2,635 in 2017), if all of them are to be equipped to fortify rice, the costs would be significant (cost of equipment, transport of premixes to all units, etc.).
- The quantity of imported rice is also increasing year after year, reaching one million three hundred and fifty thousand tons.

c. Exports

Côte d'Ivoire contributes to the supply of rice to several countries in the Sub-region. Both through locally produced paddy and imported rice exported to neighbouring countries. Nevertheless, the quantity of rice that is exported varies considerably from year to year depending on the national needs and also on the geo-political situation in the Sub-region (Table 9) [12].

Concerning locally produced paddy, exports amounted to 176,769 tons in 2017 [13].

The portion of imported rice that is intended for export is estimated at 6 percent of the total quantity of imported rice [14].

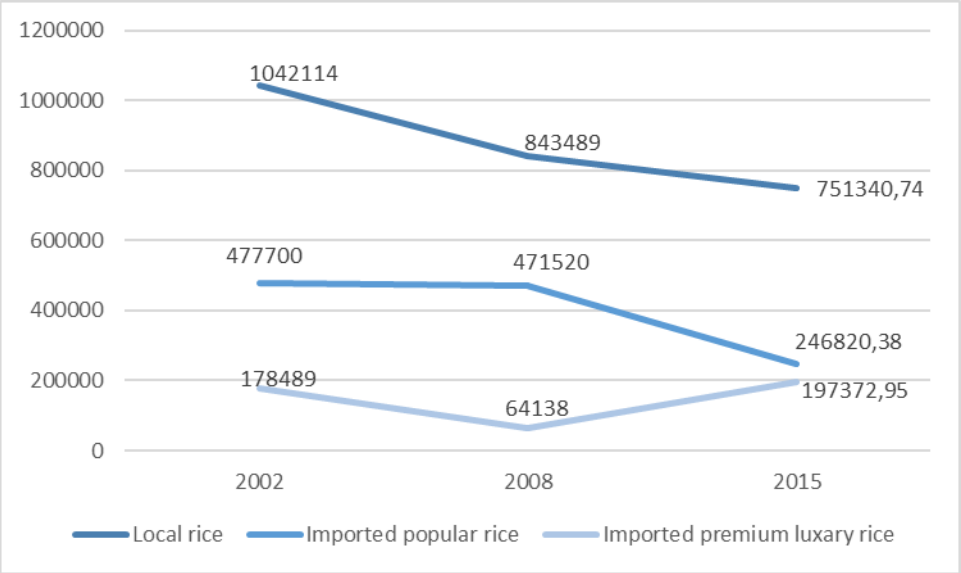
d. Consumption

Consumption data

In 2015, total rice consumption, both local and imported, amounted to 1,195,534 tons. The share of self-consumed rice represented 30 percent of rice consumption in 2015 (356,954 tons) [15].

Graph 8 illustrates the evolution of rice consumption according to local or imported rice [16].

GRAPH 8: PROGRESS OF RICE CONSUMPTION



Consumer preference

Based on 2013 data, urban populations were more likely to consume imported rice, whereas rural populations were consuming more local rice [16].

The most consumed rice was medium range (semi-luxury) rice with 16-35 percent broken grains. It was consumed by 34 percent of the population living in urban areas and 52 percent in rural areas [16].

Low-end rice is mainly consumed in urban areas by 12 percent of the population [16].

And finally, luxury rice was consumed exclusively by 2 percent of the urban population [16].

Characteristics of local rice

According to the Rice Development Agency, the National Institute of Statistics has conducted several surveys on the consumption pattern of local rice [17]. The results of these surveys revealed that the rice traditionally produced and the one that is preferred by the populations is:

- A husked and threshed rice free of any inedible foreign matter,
- A rice with appreciation criteria not linked to broken rates and the degree of of whitening, but rather to the freshness and taste of the rice [17].

Therefore, premium white rice, contrary to popular belief, is not related to the rates of broken grains, grain length and very white brightness. The reality of local eating habits shows that broken rice, usually considered a by-product on the international market, is paradoxically popular in some regions of Côte d'Ivoire.

It was therefore necessary to adapt the concept of premium to the realities of Côte d'Ivoire by developing a grade and quality standard under the name of the Codex Standard for Rice - CODEX STAN 198-1995.

The characteristics included in the standard are as follows:

- with nutrients (8 percent low starch)
- whole with incorporation of large and medium broken.
- free of fine and micro-broken (Grains less than 1.4 mm)
- free of all impurities and foreign matter (stones, straw, paddy, metals, insects)
- containing less than 3 percent yellow grains
- variety homogeneity
- from the new harvest

5. Rice fortification: technical feasibility

Since the Ivorian Government considers micronutrient deficiency as a public health priority, they are willing to establish a mandatory rice fortification policy. It is therefore with this in mind that the different feasibility options are presented.

a. Fortification of imported rice: The different options and their implications

There are several options for obtaining imported fortified rice in Côte d'Ivoire.

The first option is to import rice already fortified from countries with the capacity to produce enough fortified rice to meet the needs of the Ivorian market. As of today, 52 percent of rice importation is coming from India and Thailand, countries that have the capacity to produce fortified rice grains as well.

The second option is to import un-fortified rice from countries from which Côte d'Ivoire is accustomed to outsourcing and at the same time to import fortified kernels from manufacturers specialized in the production of fortified kernels. The fortified kernels and the white un-fortified rice would then be mixed in units in Côte d'Ivoire.

The main manufacturers specialized in the production of fortified kernels are: Royal DSM, a Dutch multinational, and the Wright Group, an American company.

A more in-depth analysis of the supply chain for imported rice (un-fortified and fortified) in both Côte d'Ivoire and countries of origin could be considered to assess potential import opportunities, feasibility and implications.

Box 2: Implications of options on locally produced rice

- Given the diversity of rice varieties imported into Côte d'Ivoire, it will be necessary to provide fortified kernels adapted to each of these varieties. It is therefore important to consider a stepwise approach to allow time for international production units to develop the necessary capacities to meet demand.
- To allow for quality control and quality assurance control, standards on fortified rice and fortified kernels (specifications, labelling, storage conditions, shelf life, etc.) should be defined.
- Regarding importations, it would be crucial to ensure that no un-fortified rice is distributed in any way on the market once the mandatory legislation is in force throughout the national territory. This will require a strict control mechanism at customs but also control at the various distribution points (wholesaler, semi-wholesaler and retailer) by strengthening both human and material capacities.
- With option 1, it seems important to question the bilateral trade relations between Côte d'Ivoire and the usual importing countries. What would happen if Côte d'Ivoire decided to import its rice only from one country and abandoned rice imported from other countries to guarantee its supply of fortified rice?
- Option 2 involves a mix on arrival, which would require a unit to be set up at an entry point in Abidjan. Collaboration with main importers having units in the port could be considered to install the necessary equipment for the mixing of fortified kernels with imported rice as well as for the quality control and quality assurance of the mixing.
- It will also be necessary to establish a time moratorium to allow economic operators to adapt to the new situation.

a. Fortification of locally produced rice: scenarios and implications

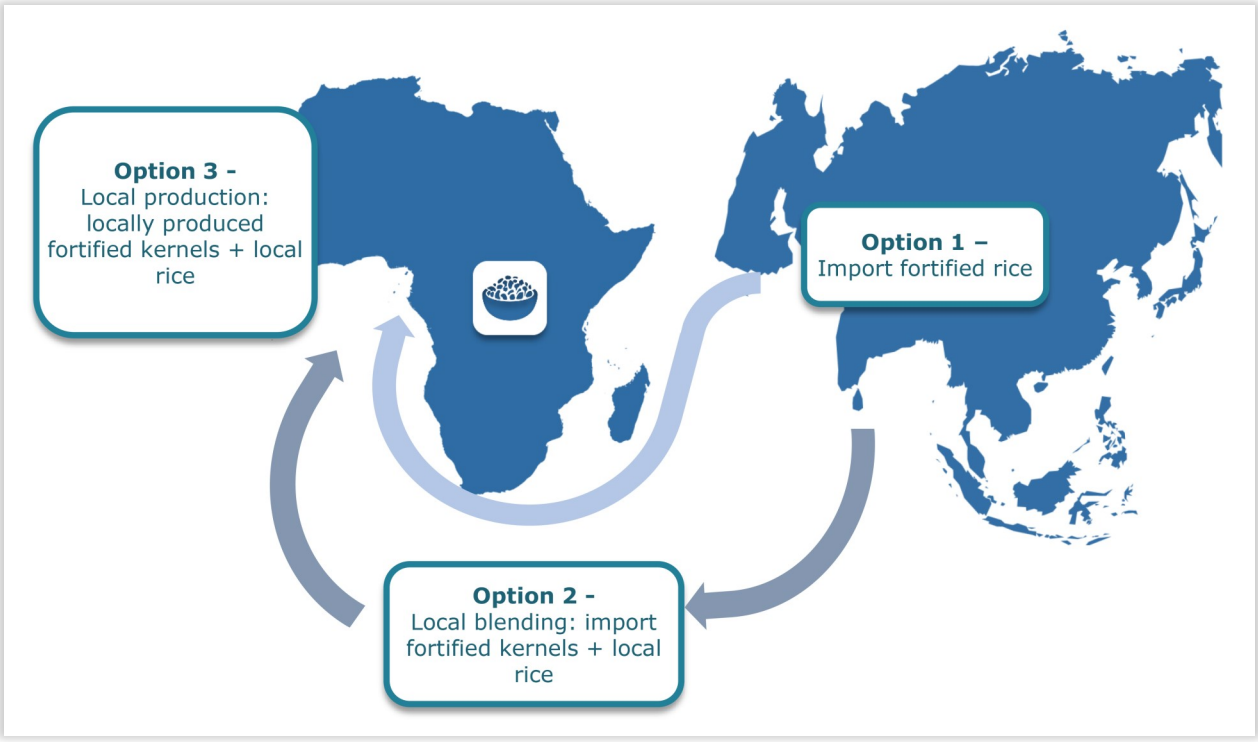
Like imported rice, there are also two likely options. The first option would simply be to import the fortified kernels and mix them locally; while the second would be to produce the fortified kernels locally and mix them locally; in other words, in this last option, everything is produced locally.

Box 3: Implications of options on locally produced rice

- Considering the varieties of rice produced locally, fortified kernels adapted to each of these varieties should be provided.
- Since option 1 involves a mix, the government must define the modalities of this option by considering at what level the processing units would be empowered to fortify locally produced rice (units with a capacity of more than two tons per hour could be targeted, for example). To date, the country has 6 units with a capacity of more than two tons per hour and 12 with a capacity of more than five tons per hour. With the 18 additional units of more than 5 tons under construction, and the unit with a capacity of more than 12 tons per hour, the country will have 37 units to equip for rice fortification.
- It will be necessary to accept that in a first phase the 30 percent of self-consumed rice will not be affected by industrial fortification. However, home fortification could be an option that the government may consider.
- As with imported rice, it will be essential to focus on quality control and quality inssurance to ensure that the blending is done adequately and that no unfortified rice is on the market (when the policy is applied throughout the national territory).
- Option 2 implies that an industrial company would have the capacity to locally produce fortified kernel. It will therefore be required to identify manufacturers able to deliver quality fortified kernels at the national or regional level, which could eventually help to reduce transportation costs.

Figure 6 maps the various options for fortified rice.

FIGURE 6: THE VARIOUS OPTIONS FOR FORTIFIED RICE



c. Projections for local rice production

Through the planned new units, milled rice production is expected to increase. It is assumed that units of more than five tons per hour will each produce 25,000 tons of milled rice. Thus, milled rice production would increase from 1,335,448 tons in 2016 to 1,635,448 tons when the 12 units are operational, and once the 30 units are completed and operational, milled rice production should reach 2,085,448 tons. Since Côte d'Ivoire had 2924 processing units as of 2017, it would neither be practical or efficient to equip all units for fortification. The cost of equipment, staff capacity building and the transportation of fortified kernels (which initially will be imported because there are no local manufacturers), and the quality control and quality assurance mechanism would be too expensive. Thus, for effectiveness, it is agreed that fortification is generally beneficial when it is carried out in processing units with a capacity of more than two tons per hour. Considering the expectations for the upcoming units, the percentage of rice processed by units over two tons would increase from 2 percent to 20 percent with the 18 units and then 37 percent with the 37 new units. Large rice mills would absorb a large proportion of the paddy currently being processed by small and medium-sized units. (Table 10).

TABLE 10: PROJECTION FOR QUANTITIES OF RICE PROCESSED BY THE VARIOUS UNITS PER SIZE

	2016	%	18 units	%	37 units	%
Total quantity of white rice (metric tons)	1 335 448		1 635 448		2 085 448	
Rice processed by units of less than 1MT/H	961 523	72%	961 523	59%	961 523	46%
Rice processed by units of 1-2MT/H	347 216	26%	347 216	21%	347 216	17%
Rice processed by units of more than 2MT/H	26 709	2%	326 709	20%	776 709	37%

Forecasts, based on information collected from specialized structures, such as ADERIZ and the Ministry of Commerce - the General Directorate of Foreign Trade, show that it is possible to estimate the amount of rice (locally produced and imported) that would be fortifiable. To this end, a projection was made to include the new units under construction. The projections have as baseline data, the quantity of locally produced white rice and imports. Table 11 shows that in the current situation, through the fortification of rice only processed by the six rice mills with a capacity of more than two tons per hour, the share of total fortified rice in Côte d'Ivoire would be 51 percent of the total white rice available. Considering the 12 additional units that have been completed, out of a total of 18 units, this proportion should be 56 percent. And finally, when all 36 units are in operation, this proportion should be 62 percent.

TABLE 11: PROGRESS OF THE SHARE OF FORTIFIABLE RICE ACCORDING TO THE NEW UNITS

	Processing unit of more than 2MT/H current situation	**Processing unit of more than 2MT/H** projections for 18 units	**Processing unit of more than 2MT/H** projections for 36 units
Quantity of imported rice (in tons)	1 341 802	1 341 802	1 341 802
Quantity of white rice produced locally (in tons)	1 335 448	1 635 448	2 085 448
Quantity of fortifiable* local rice (in tons) *Quantity of rice processed by units of more than 2T/H	26 709	326 709	776 709
Total amount of rice available	2 677 250	2 977 250	3 427 250
Total imported rice + local rice than can be fortified	1 368 511	1 668 511	2 118 511
Percentage of fortified rice	51%	56%	62%

d. Regulatory and legislative framework for fortification

Fortification legislation and regulations in Côte d'Ivoire

In Côte d'Ivoire, a first inter-ministerial decree was signed in 1994 for the fortification of iodized salt. Then in 2007, two additional inter-ministerial decrees on the fortification of oil and flour were signed. The first proposal for these decrees was first prepared by the Ministry of Health, which then involved the various ministries in charge of Industry, Communication, Trade and Small and Medium Enterprises (SMEs).

As Côte d'Ivoire was the pioneer in fortification in West Africa, when the other countries of the West African Economic and Monetary Union (WAEMU) began fortification, national standards had to be revised to harmonize them with those of WAEMU to facilitate the free trade of goods, with a view of strengthening the current regulatory framework and control mechanisms, this decree evolved into a decree that was signed in 2018[8]. Having a decree on fortification therefore has greater enforcement power than a ministerial order.

With the possibility of fortifying a new vehicle, i.e rice, two scenarios could be considered: either proposing an amendment to the decree justifying the reasons for adding a new vehicle or drafting a new decree.

Setting up standards

The setting up of standards is carried out by the National Standards and Certification Association called CODINORM, a non-profit public interest association.

Standards are developed with the concerned sectors and standardization committees are set up for each field of activity (agri-food, agriculture, hydrocarbons, etc.). There are three levels of committees and standardization:

- Technical Committee on Standards
- Standards Sub-committee
- Working Group[9]

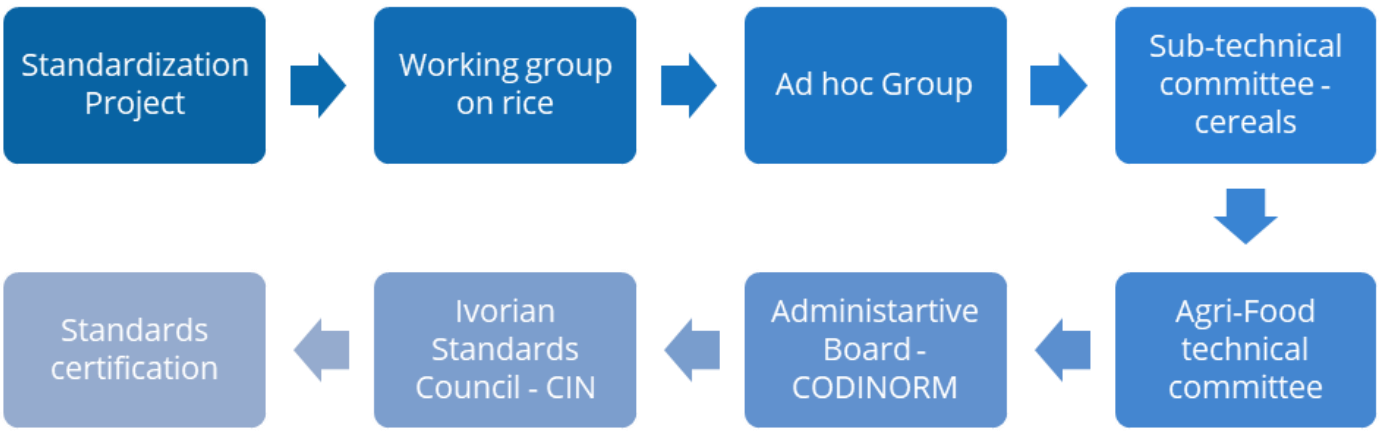
The Sub-Committee and the Technical Committee bring together stakeholders involved in the specific sector to consider each other's interests and reach consensus. It is mainly a group of managers focusing on elements such as cost, price, etc. so that the product/service remains available and accessible to the target population. The Sub-Committee and the Technical Committee are headed by a Chair.

The Working Group brings together experts on a given topic and is led by a facilitator. The experts prepare the first working document and then return it to the Sub-Committee or Technical Committee.

The first document prepared by the Working Group is submitted to the Sub-Committee or Technical Committee where it is discussed and amended (if necessary) and validated. This validated document is then presented to the CODINORM Board of Directors and then to the Ivorian Standards Council (ISC) for approval. Approval is received within a four-month time frame.

Once the standard has been approved, compliance to it must be ensured.

FIGURE 7: STANDARDS DEVELOPMENT PROCESS



8 Decree N 2018-512 of 30 May 2018 making it compulsory to fortify salt with iodine, flour with iron and folic acid and oil with vitamin

9 It may be that an ad-hoc group to the work group is formed to define specific technical values. In the context of rice fortification, this may be a group that will determine the values of each of the micronutrients identified for fortification. This group is not permanent and is dissolved as soon as its mission is fulfilled .

Concerning the application, there are two scenarios, as follows:

- Voluntary certification
- Regulatory or mandatory enforcement.

In the case of voluntary certification, a trader who wants to certify the conformity of his products, make use of CODINORM to carry out the inspection and issue a certificate of conformity or register the NI sign on each item sold.

In the mandatory approach, it is the provider who markets or makes the product/service available to the target population who is responsible for monitoring and proving the conformity of its products/services. It is therefore the various relevant ministries that are responsible for ensuring compliance with the standards and control.

About the importations, the government has chosen four operators to carry out border conformity verification: Bureau Veritas, SGS, Cotecna and Intertek. The goods must be provided with a certificate of conformity issued before shipment to the country.

6. Opportunities and challenges for fortification

a. Opportunities

Imports

There are many opportunities for the import of fortified rice. First, the high consumption of rice by the Ivorian population (135g/c/d). Secondly, the fact that the country imports about one million five hundred thousand tons of rice per year (1 500 000) from a limited number of operators would facilitate the management and control of incoming rice by these operators. Imports are expected to continue to grow as the population increases, particularly the urban population. By adopting a sub-regional (West African) approach, rice demand amounts to five million seven hundred thousand tons (5 700 000). By considering regional integration, therefore, the opportunity can be great both for governments that will offer their populations fortified rice, but also for the few industrial producers of fortified kernels, who will enter the new West African market.

Local production

The main opportunity for local production is the government's strong commitment to consolidate and modernize the local rice sector, with emphasis on the NRDS and the revitalization of the Rice Development Agency, among others. To this end, the government has made numerous efforts to structure and develop the sector (establishment of an industrial framework, dissemination across the country of processing units, and development of contractual frameworks with private operators, as well as the categorization of Côte d'Ivoire rice, etc.). The government has also set up a mechanism for fixing prices and standards for paddy collection. Finally, some units have modern equipment that can easily shelter the necessary equipment for fortification.

b. Challenges

Imports

These are main prerequisites to be considered for the implementation of a mandatory fortification legislation.

The first one would be to develop national standards for fortified rice (specifications, labelling, storage conditions, shelf life, etc.), but above all to harmonize these standards at the regional level to avoid the need to modify them later, as was the case with wheat flour and oil.

Alongsideh the development of standards, it would be essential to develop the regulatory framework and establish an effective quality assurance and quality control mechanism.

And finally, capacity building in quality control and quality assurance and compliance throughout the supply and distribution chain.

Local production

As mentioned earlier in the analysis, the variety of rice type produced in Côte d'Ivoire raises questions about how to ensure that the imported fortified kernels match with local varieties. The question raises the following: (i) the supply mechanism for fortified kernels, (ii) the logistics regarding the transfer of fortified kernels in the several mixing units throughout the country, (iii) the cost of the whole process and (iv) how this cost will be absorbed. These are issues to which answers needs to be provided as the fortification process progresses. Secondly, it will be important to identify needs for both material and human capacity building. Emphasis should be placed on integrating the amount processed by small units into the national fortification process.

There are also the more general challenges that concern both imports and local production:

- **Mobilization and sensitization:** As in all fortification strategies, having all stakeholders involved, particularly industrials, in the process is essential to the success of fortification;
- **Financial challenges:** In addition to the purchase of equipment for processing units, with mixers and the purchase of equipment for rice quality control, there is also the cost of the premix and its transfer to the processing units;
- **Human resources capacity building.** Once the units are equipped, it will be necessary to strengthen the capacities of the technicians who will operate them as well as those of the technicians responsible for quality control.

7. Conclusions and recommendations

The situational analysis on rice fortification in Côte d'Ivoire brings together available information on the rice sector from different stakeholders. As a result, the information presented in this report has been subject to: (i) the existing data, (ii) the availability of data by key informants, (iii) the reliability of the data provided, (iv) the time constraint and duration of the analysis.

Based on this analysis, it appears that the country is very committed to the fight against hidden hunger and is ready to implement the necessary strategies to meet the Zero Hunger challenge by 2025. The country has been a pioneer in the food fortification process in the sub-region, with a rather positive result considering the three fortified foods (salt, wheat flour and cooking oil). However, quality control and quality assurance should be strengthened, particularly concerning wheat flour for better results.

The local rice sector in Côte d'Ivoire is undergoing restructuration towards a more consolidated and transparent model. Medium-sized plants are being built throughout the country, some of which have been completed and are awaiting to be put into operation. Imports currently represent about 50 percent of total rice imports in the country with economic operators willing to support the fortification initiative through the import of enriched rice.

The findings of the analysis should be used as a starting point for discussions and consensus building on the next steps on the road to rice fortification.

The recommendations that emerge from this analysis are both institutional and operational.

Institutional recommendations

- **Setting standards and regulation:** Establish norms and standards for micronutrient contents of fortified rice and develop legislation making fortification of rice produced and marketed in Côte d'Ivoire mandatory.
- **Dynamization of the national alliance for food fortification (NAFF).** Make the NAFF active.
- **Advocacy with the government for a mandatory rice fortification policy.** This should include the development of a costing of the project and the look for potential funding.
- **Institutional partnership.** Develop and strengthen partnerships at country level with UNICEF, WHO, HKI, AfDB, FAO in order to mobilize additional financial resources.
- **Regional integration.** By adopting a regional approach to rice imports, the demand for rice in the region will increase considerably and can lead to scaling up and savings for suppliers of fortified rice/or of fortified kernels, and it is important to discuss with the Union of West African Monetary States (WAEMU) on norms and standards in order to harmonize standards so as not to hinder the free circulation/commercialization of rice in the region.
- **South-south cooperation.** Sharing experience with a country where the mandatory rice fortification policy is in place should be considered in order to build on the lessons learned.

Operational recommendations

- **Cost-benefit analysis.** A cost-benefit study would be essential to assess the impact of fortification on the selling price of rice and on public health benefits.
- **Needs assessments.** It will be necessary to assess the capacity building needs of local processing units (equipment, training, etc.)
- **Awareness and communication.** To have the support of the majority stakeholders, it would be important to organize a national workshop including all of them (consumers, civil society, Customs, Port of San Pedro, all the ministries involved...)
- **Quality control, quality assurance system and monitoring & evaluation.** The establishment and strengthening of a functional and reliable quality control and quality assurance system would both ensure that fortified rice complies with the values defined and that the rice made available to the population is adequately fortified.
- **Step-by-step implementation approach.** It would be essential to define a detailed and design phasing stages for the project. This could be a regional phasing for instance, etc .

Annexes

Annexes	Title	Type
Annex 1	Global evidence on the impact of rice fortification on micronutrient deficiencies	Text
Annex 2	List of participants at the workshop to report the findings of the situational analysis of the rice sector in Côte d'Ivoire	Table
Annex 3	The production process of fortified rice	Text + scheme
Annex 4	WHO Recommendations on Rice Fortification	Text

Annex 1: Global evidence on the impact of rice fortification on micronutrient deficiencies

A Cochrane systematic review was commissioned to document the effect of rice fortification on micronutrient status. This review included sixteen studies (14,267 participants) conducted in 2012 and updated in 2017. Twelve of these studies were randomized controlled trials (5,167 participants) with ten involving children in urban and rural areas and two studies involving non-pregnant women. Four studies were controlled before and after studies (9100 participants). The sixteen selected studies reported on iron fortification. Out of these, six studies on fortified rice only with iron; in ten studies, other micronutrients were added (iron, zinc and vitamin A and folic acid). In five studies, other B-complex vitamins were added. The control for all trials was un-fortified rice. Iron content 0.2 mg to 112.8 mg / 100 g un-cooked rice, administered for a period ranging from 2 weeks to forty-eight months. Twelve studies were randomized controlled trials (5,167 participants) and four were controlled before and after studies (1,100 participants). Four studies were conducted in India, three in Thailand, two in the Philippines, two in Brazil and one in Burundi, Cambodia, Indonesia, Mexico and the United States. All sixteen studies reported on iron fortification. The control for all trials was un-fortified rice.

The review concluded that iron fortification of rice alone or in combination with other micronutrients probably improves iron status, reducing the risk of iron deficiency by 35 percent and increasing average haemoglobin concentrations by nearly 2g/L, but may have little or no effect on the prevalence of anaemia in the general population aged over two years. In addition to iron, fortification of rice with vitamin A, zinc or folic acid and other micronutrients may have little or no impact on the risk of anaemia or iron deficiency. Fortification of rice with zinc and other micronutrients may slightly increase average haemoglobin concentrations. Rice fortification with vitamin A and other micronutrients can reduce vitamin A deficiencies. Only one study included showed an increase in serum folate concentrations. A randomized controlled trial indicated that participants taking iron-fortified rice and other micronutrients were more likely to be infected with hookworm.

Regarding the impact of different rice cooking methods on micronutrient conservation, it was found that overall conservation of iron, zinc, folic acid and vitamin B12 was between 75 percent and 100 percent regardless of the cooking method, while keeping of vitamin A was significantly affected by the cooking method.

About the different fortification technologies, all techniques to produce fortified grains gave similar results, showing that the coating method was not inferior to extrusion techniques. However, rice fortified by the same fortification methods (hot extrusion, cold extrusion and coating) and stored in two different environments (25 ± 5°C at 60 percent humidity and 40 ± 5°C at 75 percent humidity) for a period of one year showed that under mild conditions (25°C and 60 percent humidity), vitamin A losses ranged from 20 percent for cold extrusion to 30 percent for hot extruded rice and 77 percent for coated grains. At higher temperatures and humidity, vitamin A losses were 40 to 50 percent for extruded grains and 93 percent for coated grains after 6 months. Vitamin A is one of the vitamins most dependent on method of fortification, storage and cooking procedures.

Annex 2: List of participants at the workshop to report the findings of the situational analysis of the rice sector in Côte d'Ivoire

Name	Structure	Function
DR N'GORAN - THECKLY PATRICIA	**STP-CNN**	Coordinator
DR TRA BI CONSTANT	STP-CNN	Deputy coordinator
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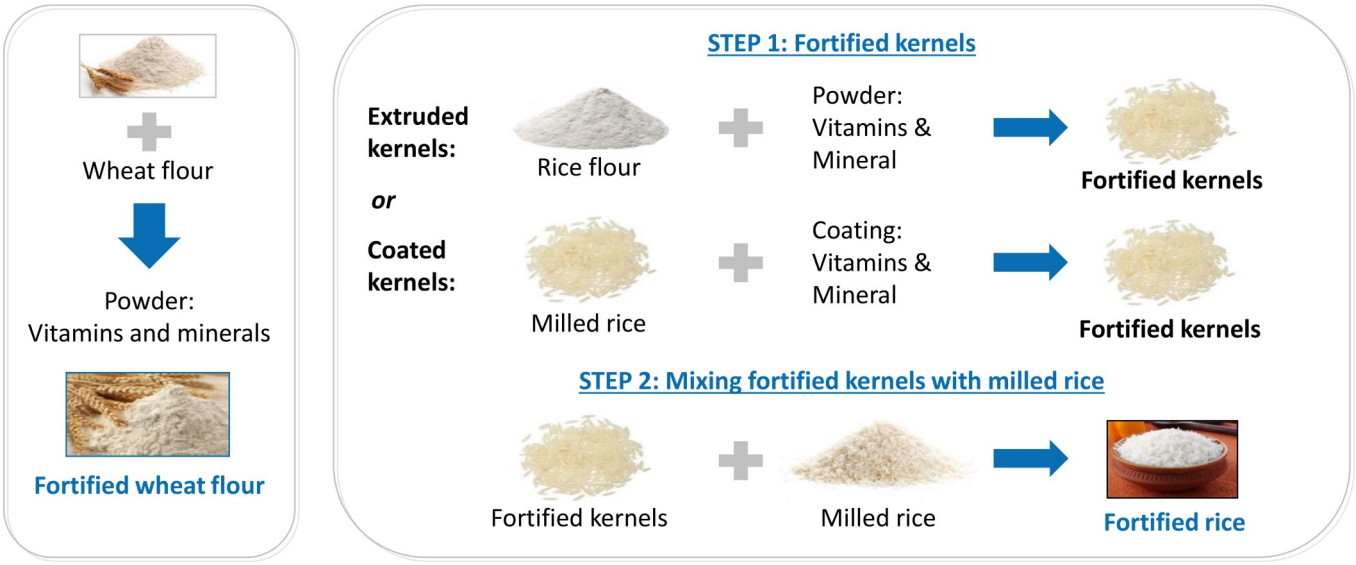
Annex 3: Production process of fortified rice

Rice fortification by extrusion or coating is a two-step process. The first is to produce fortified kernels, and the second is to mix fortified grains with un-fortified rice (Figure 8). Extrusion and rinse-resistant coating are the best technologies available to produce fortified kernels that remain stable under different storage conditions, preparation methods and cooking techniques and are acceptable to consumers.

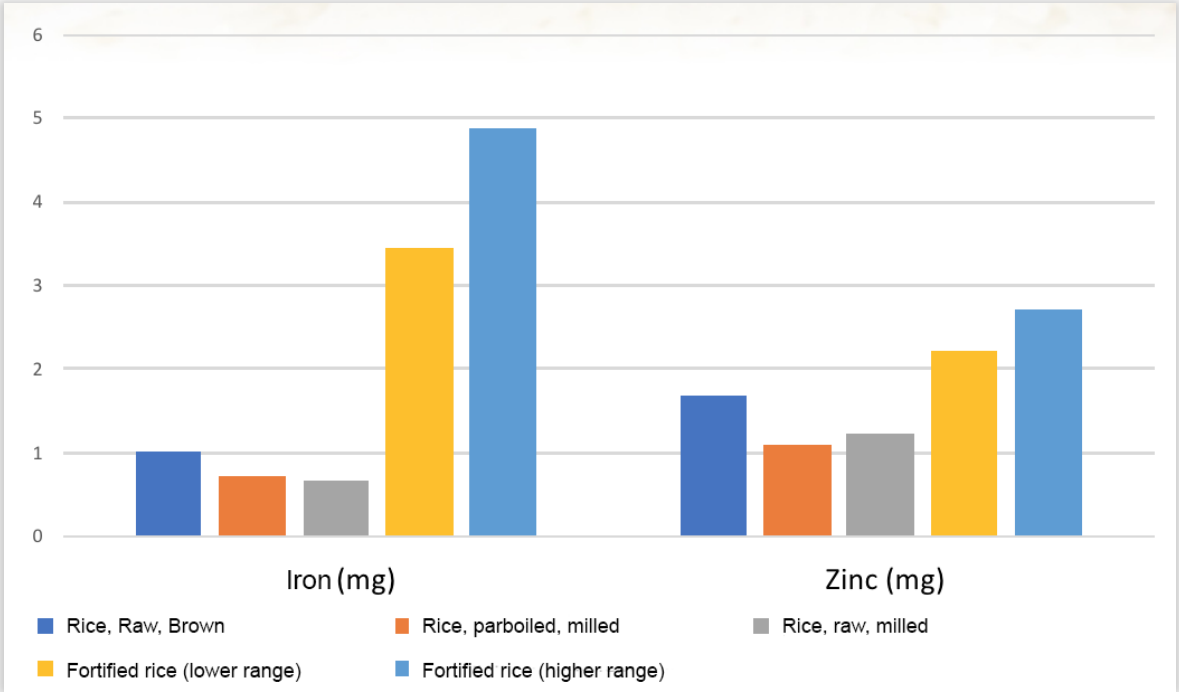
The vitamins and minerals recommended for rice fortification include those removed during processing, in addition to the micronutrients needed to fill nutritional gaps in the target population. In this regard, it is important to note that the nutritional value of brown rice is not comparable to that of fortified rice, particularly for iron and folic acid. (Graph 9 and 10). It is recommended to fortify with multiple micronutrients as micronutrient deficiencies frequently coexist.

The overall price increase depends on fortification levels, the type of micronutrients to be added, the price of rice (breakage rate), the mixing ratio and the fortification scale. In Costa Rica, for example, where nearly 100 percent of rice is fortified with 7 vitamins and minerals (iron absent), the retail price increase is 0.9 percent. In countries where fortification is voluntary or through social protection schemes, price increases are often higher and represent between 1 and 5 percent of the retail price, at least during the early programming period.

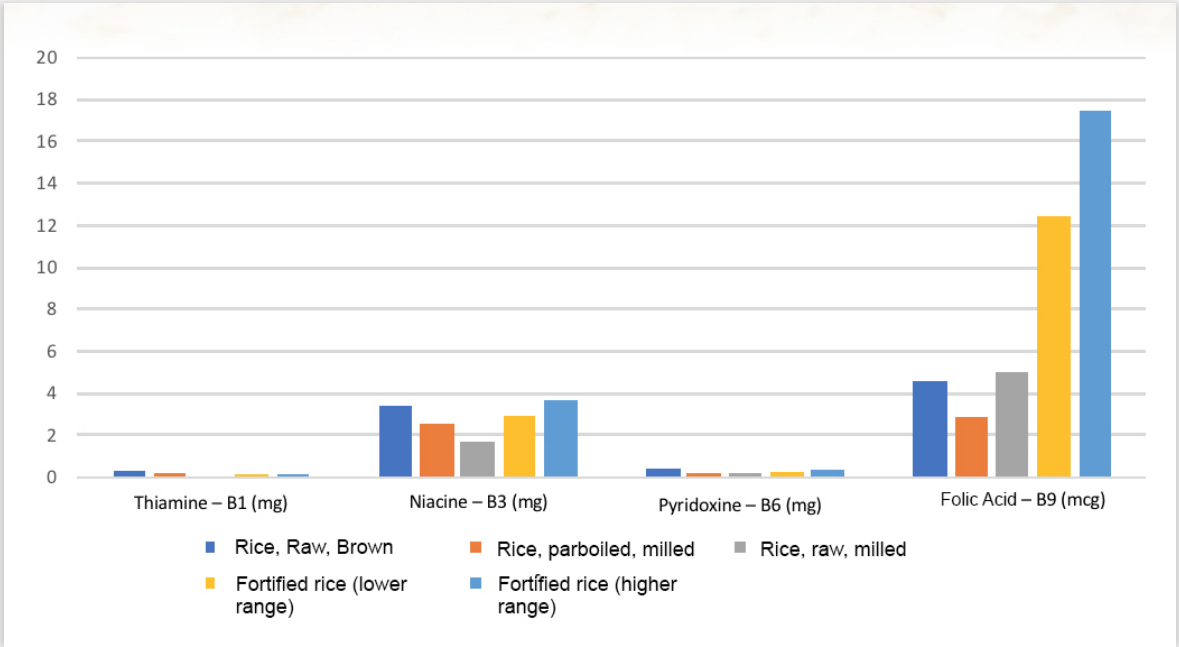
FIGURE 8: MANUFACTURE PROCESS OF FORTIFIED RICE



GRAPH 9: DIFFERENCE IN MICRONUTRIENT LEVELS BETWEEN UNFORTIFIED AND FORTIFIED RICE



GRAPH 10: DIFFERENCE IN VITAMINS LEVELS BETWEEN UNFORTIFIED AND FORTIFIED RICE



Annex 4: WHO recommendations on rice fortification

In 2018, the World Health Organization published guidelines on vitamin and mineral fortification of rice as a public health strategy[10]. This guideline provides global guidance on micronutrient fortification of rice as a strategy to improve the health status of populations based on an evidence-based approach. It is in line with the directive on micronutrient fortification of foods developed by WHO and FAO and the Pan American Health Organization document on iron compounds for food fortification: guidelines for Latin America and the Caribbean 2002.

The industrial fortification of rice with vitamins and minerals has been practiced for many years in several countries where rice is a regularly consumed staple food.

Rice grains can be fortified with several micronutrients, such as iron, folic acid and other B-complex vitamins, vitamin A and zinc - some are used to release intrinsic nutritional content before milling and others for fortification purposes. Their bioavailability will depend essentially on the treatment used to obtain the fortified rice grains.

The decisions regarding the nutrients to be added and the most appropriate amounts to be added to rice must be based on the nutritional needs and dietary deficiencies of the target populations; the usual level of fortifiable rice consumption; and the sensory and physical effects of the fortifying on rice grains; the fortification process used in the production of fortified cores; the availability and coverage of fortification of other staple food fortification carriers; population consumption of vitamin and mineral supplements; costs; the feasibility of implementation; and the acceptability to consumers.

The guidelines provide information on the health impact of micronutrient fortification of rice. To this end, a Cochrane systematic review was conducted to document the impact of rice fortification on micronutrient status. The main findings of this review are presented in section 2a of this report.

Three recommendations were developed in the guidelines:

- **Fortification of rice with iron** is advocated as a public health strategy to improve the iron status of populations in contexts where rice is a staple food (high recommendation, evidence of moderate certainty).
- **Fortification of rice with vitamin A** can be used as a public health strategy to improve the iron status and vitamin A intake of populations (a conditional recommendation, evidence of low certainty).
- **Fortification of rice with folic acid** can be used as a public health strategy to improve the folate-nutrition status of populations (a conditional), evidence of very low certainty.

WHO has attached remarks to the recommendations to suggest some guidelines for their implementation: The number and quantities of nutrients must be adapted to the needs of the country. If other fortification programs with other food carriers (e. g. wheat or maize flour) and other micronutrient interventions are being effectively implemented simultaneously, these suggested fortification levels should be lowered if necessary. A combined fortification strategy using several vehicles seems to be a satisfactory effective alternative to reach all population sub -groups. This means that there is no predefined WHO standard or nutritional values for fortification, this will depend on the context of each country.

- Several methods are available for rice fortification. The method chosen depends on the local technology available, costs and other preferences. The process of adding nutrients to rice by spraying reduces the number of nutrients consumed in environments where rice is generally washed before cooking.
- People's washing and cooking practices are important considerations in choosing a rice fortification method. For example, rinsing-resistant methods to ensure that nutrients are retained after washing will be important if rice is generally washed before cooking.
- The rice processing process entailed in the loss of a significant proportion of B vitamins and minerals, which are mainly found in the outer layers of the germ and bran. Nutrient losses during milling can be minimized by a process called parboiling, in which raw rice is soaked in water and partially steamed before drying and milling, causing some B vitamins to migrate into the grain.
- Since some layers that are high in fat and micronutrients are removed during rice milling, the restoration of thiamine, niacin, riboflavin and vitamin B6 in the fortification profile should remain a regular fortification practice.

10 The English version of the guide is available at: http://apps.who.int/iris/bitstream/handle/10665/272535/9789241550291-eng.pdf?ua=1

- The prevalence of vitamin B12 deficiency is high in all age groups and reaches 50 percent in some countries. The inclusion of vitamin B12 is recommended when staple foods are fortified with folic acid, in order to avoid the hidden effect of folic acid on vitamin B12 deficiencies.
- Iron fortification of rice is a challenge, as most of the bioavailable iron powders used in food fortification are color-tinted, resulting in changes in the appearance of fortified grains compared to unfortified grains. Ferric pyrophosphate was chosen for rice fortification because it is a white powder, although its bioavailability is low. In human intake studies, the addition of fortifying substances, such as citric acid and trisodium citrate mixtures, has shown an increase in iron intakes by ferric pyrophosphate.
- The mandatory rice fortification programs can only be effective if they are properly implemented and legislation is enforced.
- Food fortification should be regulated by national standards, with quality assurance and quality control systems that guarantee the quality of fortification. Continuous monitoring of the program should be in place as part of a process to ensure high quality implementation. The monitoring of consumption patterns and the assessment of micronutrient status in the population can provide insight into the adjustment of fortification levels over time.
- Fortifying rice on a national scale requires a significant, cost-efficient and sustainable supply of fortified grains.
- In malaria-endemic areas, the provision of iron through rice fortification as a public health strategy should be combined with public health measures to prevent, diagnose and treat malaria.
- The need for communication strategies for behaviour change may be necessary.

Finally, the WHO guidelines underline that fortification programs should include appropriate quality assurance and quality control programs in the mills, as well as regulatory and public health controls of the nutrient content of fortified foods and an assessment of the nutritional and health impacts of fortification strategies. There are also specific national or community-based contexts to assess and make decisions. For example, from a quality control perspective, it is recommended that the rice mill be located on several farms, although people who consume mainly locally produced and unprocessed rice are less likely to benefit from a large-scale industrial fortification program.

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Glossary

- **Food fortification:** Practice of deliberately increasing the content of essential micronutrient(s), (vitamins, minerals including trace elements), in a food, to improve the nutritional quality of the food supply and provide a public health benefit.
- **Mandatory fortification:** Mandatory and regulated fortification of specific food products by the government through legislation. All foods covered by the legislation must be fortified according to the prescribed specifications. Quality control measures must be set as well as legal sanctions/penalties in case of non-compliance or incorrect application of the fortification legislation. This is generally recognized as the most effective and sustainable option to implement fortification and reduce the national prevalence of micronutrient deficiencies. Most of the effective universal salt iodization and wheat flour fortification programs have been implemented on a mandatory basis.
- **Voluntary fortification:** A market-driven approach according to which food producers fortify their products without being required to by legislation. The fortified food is marketed as "added value" to the consumer. This approach, which is based on awareness, education, demand and the willingness of customers to pay a little more for the fortified product, does not generally benefit the population at large, unlike mandatory fortification, and is therefore much less likely to reach the most vulnerable populations. However, in the case where the food product is predominantly fortified, voluntary fortification can play a positive role in public health. Voluntary fortification approaches to reduce the risk of micronutrient deficiencies often require governments' regulations and standards.
- **Fortificant:** A selected essential micronutrient in a particular form to fortify a selected food (e. g. rice, flour, salt).
- **Premix or fortificant mix:** A mixture of one or more fortificants (essential micronutrient) and another ingredient, often of similar nature as the food to be fortified, added to the food carrier.
- **Fortified kernel:** Fortified rice-shaped kernels containing the fortificant mix (extrusion) or whole rice kernels coated with a fortificant mix (coating). Fortified kernels are blended with non-fortified rice in a ratio between 0.5 percent and 2 percent to produce fortified rice.
- **Coating:** Technology to make fortified kernels. Rice kernels are coated with a fortificant mix and ingredients such as waxes and gums. The micronutrients are sprayed onto the rice grain's surface. The coated rice kernels are blended with non-fortified rice in a ratio between 0.5 and 2 percent, as in the case of extrusion technology.
- **Extrusion:** technology to make fortified kernels. Rice-shaped reconstituted kernels are produced by passing rice flour dough, containing a fortificant mix, through an extruder. The extruded kernels, which are made to resemble rice grains, are then blended into non-fortified rice in a ratio between 0.5 and 2 percent, similar to the coating technology. Extrusion allows for the use of broken rice kernels as an input, and may be carried out under hot, warm, or cold temperatures, which influences the appearance of the final fortified kernel.
- **Dusting:** Technology to make fortified rice; polished milled rice kernels are dusted with a fortificant mix in powder form. This technology is only used in the United States and does not allow for washing, pre-cooking or cooking in excess water since this will wash out the micronutrients.
- **Non-fortified rice:** Milled rice without fortification.
- **Fortified rice:** Rice containing essential micronutrients added by coating, extrusion or spraying at a ratio of 0.5 to 2 percent; generally, 1 percent.
- **Paddy rice:** Rice kernels still in their inedible protective hull (raw rice).
- **Brown rice:** Rice from which only the outer, inedible hull has been removed. With the bran (fiber-filled layer) and germ (nutrient-rich core) intact, Brown rice is a source of vitamins B1, B3, B6 and E. Brown rice has a much shorter shelf life than milled rice.
- **Milled rice:** Polished and unfortified rice often called white rice. The outer hull, bran layer and germ have been removed as well as most vitamins.
- **Parboiled rice:** Rice that has been partially boiled in the husk. The three basic steps of parboiling are soaking, steaming and drying. Parboiling makes rice easier to process by hand, boosts its nutritional profile and changes its texture. Parboiling drives water-soluble nutrients from the bran to endosperm, hence parboiled white rice contains roughly half the water-soluble vitamins from brown rice and is more nutritious than regular milled rice. However, even if parboiled rice is more nutritious than non-fortified rice, it may not contain enough nutrients to treat micronutrient deficiencies in the population.

Acronyms

RDA:	Rice Development Agency
FAO:	Food and Agriculture Organization of the United Nations
FFI:	Food Fortification Initiative
GAIN:	Global Alliance for Improved Nutrition
GDFT:	General Directorate for Foreign Trade
HKI:	Helen Keller International
ICN-2:	Second International Conference on Nutrition
IPPFF:	Ivorian project for the promotion of fortified food
MINADER:	Ministry of Agriculture and Rural Development
NAFF:	National Alliance for Food Fortification
NCAR:	National Center for Agronomic Research
NIS:	National Institute of Statistics
NMPN:	Multisectoral National Nutrition Plan
NNC:	National Nutrition Council
NNP:	National Nutrition Program
NRDS:	National Rice Development Strategy
PAO:	Professional Agricultural Organisations
PTS:	Permanent Technical Secretariat
PU:	Processing Unit
RDA:	Recommended Dietary Allowance
SUN:	Scaling Up Nutrition
WAEMU:	West African Economic and Monetary Union
WFP:	World Food Programme
WHO:	World Health Organization

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- Picture page 11: Rice plantation, Man, Côte d'Ivoire/Khaled Al Nashar
- Picture page 13: AMC rice factory, Bongouanou, Côte d'Ivoire/ Laouration Dia
- Picture page 17: AMC rice transformation unit, Bongouanou, Côte d'Ivoire/Laouration Dia
- Picture page 27: AMC rice factory, Bongouanou, Côte d'Ivoire/ Laouration Dia
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