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# FEASIBILITY STUDY OF IRON FORTIFICATION OF RICE IN SUB-SAHARAN AFRICA

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# Feasibility Study of Iron Fortification of Rice in Sub-Saharan Africa

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## ABSTRACT

The burden of feeding a growing population while improving health outcomes has reinvigorated the exploration of fortification of staple commodities in many countries. While many commodities such as wheat have been successfully fortified, and introduced into markets around the world, large scale implementation of rice fortification faces many roadblocks including taste and consumer acceptability of fortified kernels and difficulty in entering highly fragmented value chains. To better understand the potential for rice fortification (with iron and possibly additional micronutrients), this report shares findings from a desk study completed by the Agriculture & Food Systems Institute in support of ILSI Japan's Center for Health Promotion. This report contains information on the current health situation, rice production and distribution systems, and potential partners in ten countries in Sub-Saharan Africa.

## KEY WORDS

Rice Fortification · Sub-Saharan Africa · Iron Fortification · Iron Deficiency · Anemia

## INTRODUCTION

As global food systems face the increasing burden of feeding a growing population while improving health outcomes, fortification of staple commodities is gaining renewed attention in many countries.

This report specifically addresses the potential for iron fortification of rice in Sub-Saharan Africa, which is facing high rates of anemia in many locations, and where consumption and production

of rice is highly variable. Despite the narrow scope of this report, information where available is presented on overall micronutrient status. It presents findings on a variety of indicators that illustrate the status of national health landscapes, and rice value chains to help further inform discussions about using rice as a vehicle for micronutrient fortification in Sub-Saharan Africa. As such, it provides a useful complement to the recent rice fortification feasibility and coverage study published by FFI and GAIN (2016).

## APPROACH

This report summarizes information from a desk study conducted by the Agriculture & Food Systems Institute to assist ILSI Japan's Center for Health Promotion (CHP) as it considers the feasibility of a new project proposal to pursue iron fortification of rice in Sub-Saharan Africa. The study followed an outline provided by CHP and was completed in two phases.

Phase I compiled preliminary information for 47 countries in Sub-Saharan Africa, specifically rice consumption, prevalence of anemia, government leadership on nutrition, and local network and partner organizations. These four criteria were outlined by ILSI Japan Center for Health Promotion to frame the feasibility study. Based on the Phase I analysis, it was recommended that Phase II of the feasibility study focus on the eight countries with the highest consumption of rice and prevalence of anemia in infants and women (used as proxies for the general population for whom data was unavailable): Sierra Leone, Guinea, Guinea-Bissau, Liberia, Senegal, Gambia, Côte d'Ivoire,

and Mali. Two additional countries, Madagascar and Tanzania, were added to this list in response to a request from CHP.

Phase II included a detailed examination of the literature and other publicly available resources for each of the ten countries. Information and data were sought for the topics below:

1. Population and demography
2. Health needs assessment
  - a. Anthropometric indicators by sex and age group e.g., the prevalence of stunting, wasting and underweight according to z-scores; and the prevalence of underweight, overweight and obesity according to BMI etc.
  - b. Prevalence of anemia (determined by hemoglobin level) by sex and age group
  - c. Prevalence of neural tube defects
  - d. Nutrient adequacy by sex and age group
  - e. Micronutrients that might be added to rice and that might contribute to nutritional improvements of the population
3. Rice supply
  - a. Annual production of rice over the past three years
  - b. Geographic sources of rice by region or province
  - c. Domestic rice purchasing programs by region or provincial government
  - d. Annual import of rice over the past three years (including country of origin, use, price structure and import barriers)
  - e. Rice consumption per capita nationally and by region or province
4. Rice consumption patterns
  - a. Representative cooking methods
  - b. How rice is eaten with other foods
  - c. Representative purchasing preferences
5. Rice production and distribution system
  - a. Size of rice millers e.g., number of millers, a large centralized rice milling industry or a small fragmented milling industry, capacity of milling (tons/hour<sup>2</sup>), government or private operation
  - b. Representative rice distribution system from rice farmers to consumers (the number and size of wholesalers and traders, distribution routes, where consumers purchase rice)
  - c. Representative price structure of rice for farmers, millers, rice dealers and consumers
  - d. The percentage of rice coming from self-production
6. Relevance to other health and agriculture programs
  - a. Policy and regulatory framework for on-going food fortification programs and supplementation programs (e.g., mandatory, voluntary or social safety nets, coverage, and government leadership)
  - b. Existing rice distribution programs such as subsidized programs, social safety net programs and school meal programs (e.g., target population, annual quantity of distributed rice, and number of beneficiaries)
  - c. Initiatives on rice fortification, whether any tests or trials have been conducted on rice fortification
  - d. Policies supporting distribution of fortified rice (e.g. mandatory, voluntary or social safety nets)
  - e. National and international programs that attempt to increase domestic rice production
7. Partners

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<sup>2</sup> Small mills: below 1-2 tons/h, Medium-sizes mills: 2-5 tons/h, Large mills: greater than 5 tons/h

- a. Recommend scientific partners for the project who can best work for and support the rice fortification project
  - b. Recommend government offices which can assist and collaborate on the rice fortification project
8. Potential barriers of rice fortification
- a. Potential barriers related to other health programs<sup>3</sup> (e.g. malaria-endemic areas, insecticide-treated bed net coverage, and parasite infection)
  - b. Potential barriers related to other micronutrient-fortified foods or micronutrient supplementation programs (e.g. whether iron-fortified rice can still contribute to the reduction of anemia)
  - c. Potential barriers to rice production and distribution

## RESULTS

Summary results are presented below. Country-specific findings are available in Appendices 1-10 of this document. TBD indicates where information or data for specific topics could not be found.

### *Population and Demography*

Of the ten countries studied, four have population sizes under ten million, while only three exceed twenty million. The rural/urban population distribution is fairly consistent across all countries; eight of the ten have rural populations greater than fifty percent. Tanzania has the highest rural concentration while The Gambia has the highest urban concentration. GDP per capita ranges from 411.82 USD in Madagascar to 1,398.69 USD in Côte d'Ivoire. The additional indicators, fertility rate and percentage of population ages 0-14, were selected to provide a clearer picture of the two groups for whom data on anemia prevalence is regularly available, and to whom interventions

are most often targeted.

### Health Needs Assessment

Table 2 presents the most recent statistics on stunting, anemia, and micronutrient consumption for children 6-59 months. Of the selected countries, only three had data on the prevalence of iron deficiency and iron deficiency anemia collected within the past ten years. Recent surveys in Tanzania and Sierra Leone have provided greater detail into the causes of high anemia rates; specifically, the percentage of anemia attributable to iron deficiency. In Sierra Leone, only 4% of anemia in children 6-59 months is attributable to iron deficiency (Ministry of Health and Sanitation (Sierra Leone) et. al, 2015), while in Tanzania it is 40.9% (Tanzania Food and Nutrition Centre, 2014). A 2007 study of preschool age children and pregnant women in Côte D'Ivoire found that 16.7% of women were anemic, and 11.6% of the anemia was caused by iron deficiency (Rohner et. al, 2013). Anemia rates for both populations were significantly higher according to the 2011-2012 DHS report; however, data for the rates of iron deficiency and iron deficiency anemia were not available.

Table 3 presents information on anthropometrics and micronutrient consumption of women aged 15-49 years. Short stature is defined as having height of less than 145cm, and like low body mass (BMI less than 18.5 kg/m<sup>2</sup>), is proven to have "adverse effects on pregnancy outcomes" (World Health Organization, 2012).

As in Table 2, data on iron deficiency and iron deficiency anemia were scarce, and only available for Côte d'Ivoire, Senegal and Tanzania. In the Senegalese study, 70% of study participants were reported as iron deficient and 33% were IDA (Seck and Jackson, 2011).

### *Rice Supply, Consumption Patterns, Production, and Distribution Systems*

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<sup>3</sup> At least half of anemia is originated from other causes that include other micronutrient deficiencies (e.g. folic acid and vitamins B12), acute chronic infections (e.g. malaria, hookworms and HIV), and inherited disorders (sickle cell traits).

As shown in Table 4, four of the ten countries produced less than one million tons of paddy rice, and none exceeded four million. Imports varied from 1,250,000 tons in Côte d'Ivoire to 140,000 tons in Guinea-Bissau. For nine of the ten countries, daily per capita rice consumption exceeded 500 kcals (approximately 25% of a 2000 kcal/day diet).

Information on representative preparation and cooking methods was quite limited. Most of the available information was specific to consumption in West African countries, where rice is commonly eaten alongside fish and/or sauce. Limited information on rice preference (broken grain vs. whole) as well as consumer awareness and acceptance of local rice is included in the country briefs.

Statistics for the number of rice mills and/or processing units were found for Côte d'Ivoire, Madagascar, Mali, and Sierra Leone only. Of these four, only two had a breakdown of operational vs. non-operational status, and three reported the existence of at least two thousand mills/processing units in the country (all except Sierra Leone).

#### *Relevance to Other Health and Agriculture Programs*

#### *and Partners*

While school feeding programs exist in all 10 study countries, the presence of other social protection programs seems limited (see country briefs for further details). Most study countries acknowledge and specifically target anemia as a severe public health problem via their official health and nutrition, or general development strategy.

In addition to FFI and GAIN (mentioned above), AfricaRice, Coalition for African Rice Development (CARD), and the Scaling Up Nutrition (SUN) Network were identified as key collaborators in most of the study countries. AfricaRice, a CGIAR center, has four research programs: genetic diversity and improvement; sustainable productivity enhancement; policy, innovation systems and impact assessment; and rice sector development. Country members include Côte d'Ivoire, The Gambia, Guinea, Guinea Bissau, Liberia, Madagascar, Mali, Senegal, and Sierra Leone. AfricaRice also has an existing relationship with Japan International Research Center for Agricultural Sciences (JIRCAS). CARD, a consultative group of African, international, bilateral and multilateral donors (including Japan International Cooperation Agency), includes all

**Table 1: 2015 Population and Demography**

Note: Figures marked with ^ are from 2014.

Source: World Bank

Country	Population Size	Rural/Urban Distribution	GDP per capita (in current USD)	Fertility rate (births per woman)	% of population ages 0-14
Côte d'Ivoire	22,701,556	45.82% / 54.18%	1398.69	5.001 <sup>^</sup>	42.47
The Gambia	1,990,924	40.37% / 59.63%	441.29 <sup>^</sup>	5.72 <sup>^</sup>	46.2
Guinea	12,608,590	62.84% / 37.16%	531.32	5.01 <sup>^</sup>	42.53
Guinea-Bissau	1,844,325	50.67% / 49.33%	573.03	4.84 <sup>^</sup>	40.79
Liberia	4,503,438	50.3% / 49.7%	455.87	4.72 <sup>^</sup>	42.3
Madagascar	24,235,390	64.9% / 35.1%	411.82	4.41 <sup>^</sup>	41.71
Mali	17,599,694	60.08% / 39.92%	744.35	6.23 <sup>^</sup>	47.53
Senegal	15,129,273	56.28% / 43.72%	910.79	5.09 <sup>^</sup>	43.8
Sierra Leone	6,453,184	60.06% / 39.94%	693.41	4.63 <sup>^</sup>	42.36
Tanzania	53,470,420	68.39% / 31.61%	864.86	5.15 <sup>^</sup>	45.2

**Table 2: Anthropometric, Anemia Prevalence, and Dietary Analysis of Children 6-59 months (unless otherwise identified)**

Note: Consumption of iron-rich foods within the past 24 hours only sampled from children 6-23 months who were living with their mothers. In the case of Tanzania, the range was increased to children 6- 35 months. DHS = Demographic and Health Survey, MIS = Malaria Indicator Survey, MICS = Multiple Indicator Cluster Survey, MS = Micronutrient Survey

Country	Year	Source	Stunting	Anemia	IDA	Iron Supplementation in past 7 days	Consumed iron-rich foods in past 24 hours
Côte d'Ivoire	2011-2012	DHS	30%	75%		13.4%	56.5%
	2007	Survey		71.8%	12%		
The Gambia	2013	DHS	25%	73%		16.5%	42.3%
Guinea	2012	DHS	31%	77%		11.5%	21.8%
Guinea-Bissau	2014	MICS	27.6%				
	2011	World Bank		71.3%			
Liberia	2013	DHS	32%			26.7%	44.8%
	2011	MIS		63%			
Madagascar	2008-2009	DHS	50%	51%		3.8%	45.7%
Mali	2013	DHS	38%	82%		25.4%	48.8%
Senegal	2015	DHS	21%	66%		62.7%	12.8%
Sierra Leone	2013	DHS	38%	76.3%	3.8%	36.1%	31.9%
Tanzania	2015-2016	DHS	34.4%	57.6%			
	2010	MS		35.3%	40.9%		
		DHS					1.4%

**Table 3: Anthropometric, Anemia Prevalence, and Dietary Analysis of Women 15-49 years**

Note: Figure marked with ^ is an estimate from WHO 2011 Global Prevalence of Anaemia report. Figure in italics was taken from a study of exclusively pregnant women. DHS = Demographic and Health Survey, MIS = Malaria Indicator Survey, MICS = Multiple Indicator Cluster Survey, MS = Micronutrient Survey

Country	Year	Source	Short Stature (under 145 cm)	Underweight (BMI <18.5 kg/m <sup>2</sup> )	Anemia	IDA	Took 90+ days of iron supplements during pregnancy of last birth	Consumed iron-rich foods in past 24 hours (and have child under age 3 living with them)
Côte d'Ivoire	2011-2012	DHS	1%	15%	54%		25%	
	2007	Study			49.9%	11.6%		
The Gambia	2013	DHS	0.2%	17%	60%		44.6%	
Guinea	2012	DHS	1%	12%	49%		41.5%	
Guinea-Bissau	2011	WHO			44%^			
Liberia	2013	DHS	2.2%	7.4%			21.2%	
	2012	USAID			33%			
Madagascar	2008-2009	DHS	7.2%	17%	35%		7.6%	48.7%
Mali	2013	DHS	0.5%	12%	51%		18.3%	
Senegal	2010-2011	DHS	0.2%	22%	54%		62.6%	
	2011	Study			39%	33%		
Sierra Leone	2013	DHS	2.1%	9.1%	44%		30%	
Tanzania	2015-2016	DHS			44.7%			
	2010	MS			40.1%	14.3%		
		DHS	3.4%	11.4%			3.5%	35%

the study countries except for Guinea Bissau and Liberia.

Additional suggestions for country-specific partnerships may be found in the briefs.

## ANALYSIS

The feasibility study was conducted without prescription as to the preferred fortification approach. Table 6 identifies the different logistical options available.

Option A requires intense investment in milling, extrusion, and blending technologies as well as quality control standards. Option C faces similar challenges. Option D is the most immediately actionable with a limited need for domestic capacity scale-up; however, the sustainability of this model is subject to price variability for inputs as well as transport costs. Option B necessitates investment in domestic milling and blending infrastructure but does not require the same intensity as Option A.

Within the limitations of the information evaluated for this report, it appears that none of the study countries are candidates for immediate large-scale rice fortification in the absence of significant capacity development and investment.

As countries continue to place a priority on rice production, evidenced by the multitude of rice

development plans enacted, domestically-produced rice provides ample opportunity for fortification<sup>9</sup>. Of the countries assessed in this feasibility study, Côte d'Ivoire and Mali stood out as two countries with recent documented increases in local rice production which also have high per capita consumption rates<sup>10</sup> (no disaggregation between domestic and imported), and availability of data on the rice value chains (albeit more limited in the case of Côte d'Ivoire). Mali is also home to the first rice fortification facility on the continent (Feed the Future, 2015). Finally, for Mali, there is a documented preference for local rice, while for Côte d'Ivoire, some data is available for iron-deficiency anemia in key populations.

## CONCLUSIONS AND RECOMMENDATIONS

Many of the study countries have highly fragmented rice value chains, which historically have led to issues implementing fortification in-country (Sight and Life & World Food Programme, 2014). Additionally, the actors in these value chains appear to have limited technical capacity to process rice (fortified or otherwise) at a large, reliable scale. The FFI/GAIN report (2016) advises reframing rice fortification as a regional initiative; “compared to the global consumption of rice in Asia, fortification of rice in one or two of the identified countries will not significantly change the economics [...]”

**Table 4: National Rice Production and Consumption**

Note: All figures are from 2015 unless otherwise indicated.

Sources: Production and Imports (USDA), Availability (FAOSTAT)

Country	Production - Paddy (000 t)	Production - Milled (000 t)	Imports (000 t)	Availability (kcal/capita/day)
Côte d'Ivoire	2,825	1,836	1,250	577 [2013]
The Gambia	69	45	150	664 [2011]
Guinea	2,047	1,351	450	977 [2011]
Guinea-Bissau	170	102	140	916 [2011]
Liberia	295	186	270	910 [2011]
Madagascar	3,722	2,382	250	1040 [2013]
Mali	2,331	1,515	170	571 [ 2011]
Senegal	918	624	985	715 [2013]
Sierra Leone	1,271	801	200	909 [2011]
Tanzania	2,652	1,750	180	204 [2013]



**Table 5: Official Policies**

Country	Official Development Plan for Rice	Presence of anemia in Official Health or Nutrition Strategy	Social Program (entry point)
Côte d'Ivoire	Y [2012-2020]	Y [2016-2020]	School Feeding
The Gambia	Y [2014]	Y [2010-2020]	School Feeding
Guinea	Y [2009]	Y [2015-2024]	School Feeding
Guinea-Bissau	TBD	TBD	School Feeding
Liberia	Y [2012]	Y [2008]	School Feeding; 25% local procurement for gov't activities
Madagascar	Y [2010]	TBD	School Feeding
Mali	Y [2009]	2012-2017 (Poverty Reduction Strategy)	School Feeding; Cereal Banks
Senegal	Y [2009]	TBD	School Feeding
Sierra Leone	Y [2009]	Y [2012-2016]	School Feeding
Tanzania	Y [2009]	Y [2011-2016]	School Feeding

regional action will have the greatest likelihood of bringing fortified rice to the tables of 130 million people living in Africa”.

In addition to supply side fragmentation, few government programs exist for purchase of fortified rice. Nevertheless, government procurement and distribution channels may be the most suitable avenue for distribution. Distribution via a social safety net program “provides opportunities to establish the effectiveness and acceptability of fortified rice among domestic consumers [...] [while requiring] the social safety net implementer to make a policy decision and to establish or adopt a standard for fortified rice” (Sight and Life & World Food Programme, 2014).

Selection and/or creation of a social safety net program for fortified rice distribution will necessitate the identification of a target group. As described in the literature and evidenced by the collection of regular DHS data, key groups

vulnerable to micronutrient deficiencies include children under five, women of reproductive age, and pregnant-and-lactating women. While this study focused on assessing the feasibility of exclusively iron fortification of rice, it is evident that rice fortification should be examined as a platform to address multiple micronutrient deficiencies. Limited data were found for dietary intake (population-wide, as well as for vulnerable groups) and for prevalence of other micronutrient deficiencies, such as zinc. Additionally, differences between rural and urban populations, specifically their access to rice markets, dietary intake, and consumption preferences, merit further investigation. As described in the FFI/GAIN report, fortification of imported rice is most able to reach urban populations. Efforts to target rural populations, especially subsistence farmers, will prove even more challenging. A recent presentation on rice fortification programming in Vietnam highlighted the difficulties of targeting subsistence

**Table 6: Fortification Logistic Options**

	Domestic Rice	Imported Rice
Domestically-produced Fortified Kernels	Option A	Option C
Imported Fortified Kernels	Option B	Option D

<sup>9</sup> For further analysis of countries which might benefit from imported fortified rice, please see the FFI/GAIN report

<sup>10</sup> Defined as >550 kcal per capita per day

farmers through rice exchanges and incentives (Van Thuy, 2016).

Finally, standard setting in countries where no mandatory (rice) fortification exists, as well as the establishment and/or support of quality control mechanisms for rice fortification are additional constraints to be addressed.

To complement the findings of Phase II, additional research on the following topics for Côte d'Ivoire and Mali is advised:

- Costing data on expenses for:
  - o Importation of fortified kernels
  - o Milling and blending infrastructure development/refurbishing
  - o In-country transportation/distribution
- Data on prevalence of macro-and-micronutrient deficiencies
  - o Iron deficiency as well as IDA
  - o Zinc deficiency
  - o B-vitamin deficiencies
  - o Lysine deficiency (potentially)
- Dietary intake data
  - o For key target groups: school-aged children<sup>11</sup>, women of reproductive age/adolescents, urban and/or rural populations
  - o For specific micronutrients to inform standards setting for the level of fortification (see deficiencies above)
- Political stakeholder analysis
  - o To identify fortification champions in relevant ministries
  - o To identify regulatory barriers to implementation
  - o To identify how many metrics tons are being provided by existing social safety nets and opportunities to scale up

- Private sector stakeholder analysis
  - o To identify fortification champions in production and milling enterprises
  - o To identify partnerships among private-public entities which would facilitate knowledge transfer to hasten and support scale-up

Acknowledging the limited resources for Phase III, consultation with the authors of the recent FFI/GAIN report is strongly advised as the report analyzed nine of the ten countries targeted in this report; Tanzania was the only country not included. Additional in-country consultation may be required.

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<sup>11</sup> School-aged children rather than children under 5 years old were selected as their consumption is higher than their younger counterparts, and they could be reached by social safety net programs such as school feeding.

## **Appendix 1: CÔTE D'IVOIRE**

### ***Population and Demography*** (World Bank, 2016)

1. Population size: 22,701,556 (2015)
2. Urban/rural distribution
  - a. Rural: 45.8% (2015)
  - b. Urban: 54.2% (2015)
3. Age distribution: 42.5% of population 0-14, 54.5% of population 15-64, 3.0% of population 65+ (2015)
4. GDP per capita in current USD: 1398.7 (2015)
5. Fertility rate: 5.0 births/woman (2014)
6. Life Expectancy:
  - a. Women: 52.4 (2014)
  - b. Men: 50.7 (2014)
7. Education:
  - a. Literacy rate:
    - i. Females (age 15+): 32.7% (2015)
    - ii. Males (age 15+): 53.3% (2015)
  - b. Years of compulsory education: data not available
  - c. Children out of school (% of primary school age children who are not enrolled in primary or secondary school)
    - i. Female: 29.2% (2015)
    - ii. Male: 20.4% (2015)

### ***Health Needs Assessment***

1. Anthropometric indicators by sex and age group (INS & ICF International, 2012)
  - a. Children (6-59 months)
    - i. Stunting: 30%
    - ii. Wasting: 8%
    - iii. Underweight: 15%
  - b. Women (15-49 years)
    - i. Short stature: 1% of women have height <145cm
    - ii. Underweight BMI: 8%
    - iii. Normal BMI: 67%
    - iv. Overweight/obese BMI: 26%
2. Prevalence of anemia by sex and age group
  - a. Children (6-59 months)
    - i. 75% are anemic (INS & ICF International, 2012)
      1. 74.9% male vs. 74.7% female (INS & ICF International, 2012)
      2. 67.2% urban vs. 79.3% rural (INS & ICF International, 2012)
    - ii. A 2007 study found that 15.5% of children 6-59 months were iron deficient while 12% were iron deficient anemic (Rohner et. al, 2013)
  - b. Women (15-49 years)
    - i. 54% of women 15-49 years are anemic (INS & ICF International, 2012)
    - ii. A 2007 study found that 16.7% of women 15-49 years were iron deficient while 11.6% were iron deficient anemic (Rohner et. al, 2013)
  - c. Men (15-59 years)

- i. 29% of men 15-49 years are anemic (INS & ICF International, 2012)
- 3. Prevalence of neural tube defects
  - a. 27 per 10,000 births (2012 estimate) (FFI, 2016)
- 4. Dietary Analysis (including supplementation)
  - a. Children (6-59 months) (INS & ICF International, 2012)
    - i. 57% of children 6-23 mos had consumed foods rich in iron in the 24 hours preceding the survey
    - ii. 11.3% of children 6-23 mos fed from 4+ food groups
    - iii. 40.2% of children 6-23 mos meet minimum meal frequency
    - iv. 59.8% of children 6-23 mos (who live with their mothers) consumed foods rich in vitamin A in past 24 hours
    - v. 56.5% of children 6-23 mos (who live with their mothers) consumed foods rich in iron in the past 24 hours
    - vi. 60.8% of children 6-59 mos given vitamin A supplements in past 6 months
    - vii. 13.4% of children 6-59 mos given iron supplements in past 7 days
    - viii. 36.7% of children 6-59 mos given deworming medication in past 6 months
    - ix. 90.9% of children 6-59 mos living in households tested for iodized salt, lived in households with iodized salt
  - b. Women (15-49 years) (INS & ICF International, 2012)
    - i. 52.4% of women 15-49 with a child born in the past five years received vitamin A dose postpartum (within first 2 months of giving birth)
    - ii. 34.4% of women 15-49 with a child born in the past five years took iron tablets for <60 days during their pregnancy of last birth
    - iii. 25% of women 15-49 with a child born in the past five years took iron tablets for 90+ days during their pregnancy of last birth (recommended)
    - iv. 37.2% of women 15-49 with a child born in the past five years took deworming medication during pregnancy of last birth
    - v. 91.8% women 15-49 with a child born in the last five years, who living in households tested for iodized salt, lived in households with iodized salt
  - c. Other Micronutrients
    - i. 33.4% of population at risk of inadequate zinc intake (FFI, 2016; Wessells & Brown, 2012)
    - ii. Hidden Hunger Index score<sup>1</sup> of 44 (16<sup>th</sup> out of top 20 highest burden countries) (Sight and Life, 2013)

### ***Rice Supply***

1. Annual production of rice over the past three years

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<sup>1</sup> Hidden Hunger Index Score is calculated as the average of zinc deficiency prevalence (as measured using stunting as a proxy) iron deficiency (as measured by anemia due to iron deficiency), and vitamin A deficiency (as measured by low serum retinol) – all prevalences are equally weighted

**Table A1.1: Annual Rice Production in Côte d'Ivoire (2012-2016)**

Source: (International Rice Research Institute, 2016)

	FAO		USDA	
	Paddy (000 t)	Milled (000 t)	Paddy (000 t)	Milled (000 t)
2016			3000	1950
2015			2825	1836
2014	2053.52		2062	1340
2013	1934.15	1290.08	1846	1200
2012	1561.9	1041.79	1538	1000

## 2. Geographic sources of rice

- a. "Largest commercial rice-production is 90-180 km north of the sprawling Abidjan metropolitan area [...] this rice supplied wholesale and retail markets in Abidjan's districts of Abobo, Adjamé, Marcory, Port-Bouët, and Yopougon" (Becker & Yoboué, 2009)

## 3. Domestic rice purchasing programs (TBD)

## 4. Annual import of rice over the past three years

**Table A1.2: Annual Rice Imports to Côte d'Ivoire (2012-2016)**

Sources: FAO, USDA and WTO (International Rice Research Institute, 2016), OEC (The Observatory of Economic Complexity, 2016)

	FAO		USDA	OEC	WTO
	Imports (000 t)	Import Value (000 \$)	Imports (000 t)	Top 4 Countries of Origin and Percentage of Imports	Import Tariff
2016			1200		
2015			1250		
2014			1150	Thailand 39%; Vietnam 25%; India 21%; Burma 6.5%	Same as 2012
2013	808.25	480201	950	Thailand 39%; Vietnam 33%; India 16%; Pakistan 8.2%	Same as 2012
2012	1685.83	1138525	830	Thailand 32%; Vietnam 30%; India 25%; Burma 6.8%	\$10/kg (broken rice); \$10/kg (husked or brown rice); \$5/kg (paddy rice); \$8.75/kg (rice (no type)); \$10/kg (semi-milled rice)

## 5. Rice availability (as a proxy for consumption) per capita

- a. 2013: 63.56 kg/capita/year; 577 kcal/capita/day; 1291/1677 (-77%) of total supply is used for food (FAOSTAT, 2016)

***Rice Consumption Patterns***

1. 25% broken rice is the predominant consumer preference (Elbehri et. al, 2013)
2. Rice has the largest share of the cereals consumed in urban markets, at 92% (Elbehri et. al, 2013)
3. 70% of population in the rural area consumes 16-25% broken rice compared with 4% of urban population, which consumes up to 15% broken; 25% of total population consumes >25% broken (USDA FAS, 2013)

***Rice Production and Distribution System***

1. 5% of the area planted, and 20% of total production are from irrigated rice compared to rainfed rice, which is 95% of the area planted and 80% of total production (USDA FAS, 2015)
2. Three production systems: rainfed, irrigated, and flooded (Boansi, 2013)
3. As of 2009, there were approximately 2 million producers organized into four informal cooperatives/ groups (Rep.of Ivory Coast Min. of Agriculture, National Rice Development Office, 2012)
4. Production cycle

**Table A1.3: Rice Production Cycle in Côte d'Ivoire**

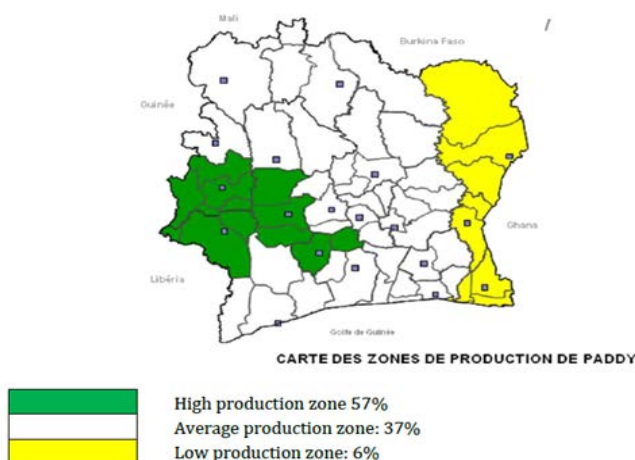
Source: (Ricepedia, 2014)

	Planting	Harvesting
Main, North	May-Jun	Oct-Dec
Main, South	Apr-May	Sep-Nov
Off	Dec-Feb	Apr-Jun

5. The figure below shows the different production zones across the country

**Figure A1.1: Rice production zones in Côte d'Ivoire**

Source: (Rep.of Ivory Coast Min. of Agriculture, National Rice Development Office, 2012)



6. As of 2015, there were 2,152 rice processing factories; ~ 25% of which were modern (USDA FAS, 2015)
7. Four rice processing factories, each with a 2 ton per hour capacity, were built in 2014; 30 more with capacities of 5 tons per hour, were planned by the GOCI for 2015 (USDA FAS, 2015)
8. The table below describes characteristics of 75 rice mills studied in 2002 (Becker & Yoboué, 2009)

**Table A1.4: 2002 Study of 75 rice mills in Côte d'Ivoire**

Source: (Becker & Yoboué, 2009)

Variable	Finding
Average number of year-round employees	2.6
Size of machines.	Micromills able to dehusk 2-5 tons of paddy rice per day: 61%
	Minimills able to dehusk 6-15 tons of paddy rice per day: 39%
Age of machines	2 years old or younger: 27%
	3-5 years old: 53%
	6 years old or older: 20%
Manufacturer of machines	China
Cost of machines	The equivalent of U.S. \$5,517-\$12,000 for a minimill
	The equivalent of U.S.\$3,172-\$4,138 for a micromill
Type of purchase	Machines purchased on credit: 80%
	Full amount paid for machines: 20%
Wholesale role of mills	Buy paddy: 8%
	Do not paddy: 92%
Mills as credit providers	Provide credit in contracts: 37%
	Do not provide credit in contracts: 63%
Transportation role of mills	Own means to transport rice: 24%
	Do not own means to transport rice: 76%

9. Rice market includes 80% semi-luxury rice (40% local/40% imported), 20% low quality, 2% luxury (USDA FAS, 2015)
10. Advertised price for paddy rice is \$0.30/kg; indicative price for milled is \$0.7/kg (USDA FAS, 2015)
11. Côte d'Ivoire became a rice importer after 2000 (Elbehri et. al, 2013)
12. Top importer with 46% of the market is Lebanese-owned Societe de Distribution de Toutes Marchandises (SDTM) ((USDA FAS, 2015; USDA FAS, 2013)
  - a. Approximately ten major rice importers (USDA FAS, 2013)
  - b. Rice is imported prepackaged in 5/25/50 kg bags or in bulk (USDA FAS, 2013)
13. In January 2013, Louis Dreyfus Commodities signed an agreement to invest \$60 million in rice production; this agreement included a lease for 100,000-200,000 ha (USDA FAS, 2013)
14. Leading rice distributor is Establishment Sylla et Frères (ESF); offers different types of packaging depending on the type of rice, and in a range of sizes from bags of 5x5 kg to 50 kg (USDA FAS, 2013)

#### ***Relevance to Other Health and Agriculture Programs***

1. PIPAF (Project Ivorien pour la promotion des aliments fortifies)
  - a. Beginning in 2005, large-scale fortification of oil with Vitamin A ; public-private partnership with Helen Keller International (HKI), GAIN, Unilever, and Cosmivoire (GAIN, 2009)
2. National Multisectoral Nutrition Plan 2016-2020 cites evidence of iron deficiency as a driver of high levels of anemia (République de Côte d'Ivoire, 2016)
3. World Food Programme
  - a. School Feeding for 571,000 children (WFP, 2016)
  - b. Quarterly take-home rations (or equivalent cash transfer) for 25,000 girls with an 80% or better attendance rate in grades 4 and 5 (WFP, 2016)



- c. Distribution of micronutrient powder for 102,000 school children in Zanzan district (WFP, 2016)

### ***Partners***

1. AfricaRice (including outreach station)
2. International Center for Tropical Agriculture (CIAT)
3. French Agricultural Research Centre for International Development (CIRAD)
4. International Relief & Development (IRD)
5. International Rice Research Institute (IRRI)
6. Japan International Research Center for Agricultural Sciences (JIRCAS)
7. Consortium of International Agricultural Research Centers (CGIAR)
8. United Nations agencies
9. CAB International (CABI)
10. Coherence in Information for Agricultural Research for Development (CIARD)
11. International Center for Development-Oriented Research in Agriculture (ICRA)
12. Helen Keller International (HKI)
13. Global Alliance for Improved Nutrition (GAIN)
14. Groupe LOUIS DREYFUS, Franco-American multinational company
  - a. Working to improve production including collection, processing, and marketing in a project area in the northern zone regions of Pôro (Korhogo), Tchologo (Ferkessedougou), and Bagoué (Boundiali and Tingrela) (New Alliance for Food Security & Nutrition, 2012)
15. OLAM
  - a. Investing \$50 million in local rice production (New Alliance for Food Security & Nutrition, 2012)
16. Groupe Mimran, French agro-industrial group working in wheat processing – local affiliate is Grands Moulin d'Abidjan
  - a. Interested in quality seed development, promotion of mechanization, processing and marketing – all beginning with improving irrigation schemes (New Alliance for Food Security & Nutrition, 2012)
17. Groupe CEVITAL, Algerian industrial group
  - a. Established a partnership with CICA for development of projects where it provides supports for production and mechanization (New Alliance for Food Security & Nutrition, 2012)
18. La compagnie d'Investissements Céréaliers (CIC)
  - a. Support local production through promotion of mechanization, processing, and marketing (New Alliance for Food Security & Nutrition, 2012)
19. Export Trading Corporation (ETG), Singaporean industrial group
  - a. Public-private partnership for production of paddy rice (New Alliance for Food Security & Nutrition, 2012)
20. NOVEL GroupSA
  - a. Public-private partnership with AGCO and Syngenta Foundation to create agroindustrial units for production and processing of 15,000 ha (New Alliance for Food Security & Nutrition, 2012)
21. Sud Industries SA
  - a. Developed rice production program which supervises 32,000 rice producers and mechanizes operations (New Alliance for Food Security & Nutrition, 2012)

### ***Potential Barriers to Rice Fortification***

1. Lack of centralized value chain

2. Lack of consolidation of milling enterprises
3. Limited/no government programs for purchase of domestic rice

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## Appendix 2: The Gambia

### *Population and Demography* (World Bank, 2016)

1. Population size: 1,990,924 (2015)
2. Urban/rural distribution
  - a. Rural: 40.4% (2015)
  - b. Urban: 59.6% (2015)
3. Age distribution: 46.2% 0-14, 51.5% 15-64, 2.3% 65+ (2015)
4. GDP per capita in current USD = 441.3 (2014)
5. Fertility rate: 5.7 (2014)
6. Life Expectancy:
  - a. Women: 61.6 (2014)
  - b. Men: 58.9 (2014)
7. Education:
  - a. Literacy rate
    - i. Females (age 15+): 47.6% (2015)
    - ii. Males (age 15+): 63.9% (2015)
  - b. Years of compulsory education: 9 (2014)
  - c. Children out of school (% of primary school age children who are not enrolled in primary or secondary school)
    - i. Female: 28.1% (2014)
    - ii. Male: 33.8% (2014)

### *Health Needs Assessment* (GBOS and ICF International, 2014)

1. Anthropometric indicators by sex and age group (GBOS and ICF International, 2014)
  - a. Children (6-59 months)
    - i. Stunting: 25%
      1. 26% male vs. 23% female
      2. 34% of children 24-35 months are stunted
      3. 9% of children 6-8 months are stunted
    - ii. Wasting: 12%
    - iii. Underweight: 16%
    - iv. Overweight: 3%
  - b. Women (15-49 years)
    - i. Short Stature: 0.2% <145 cm
    - ii. Underweight BMI: 16.7%
      1. Women age 15-19 are more likely to be underweight (27%) than women age 40-49 (9.7%)
      2. Women living in rural areas are more likely to be underweight (19.5%) compared to women in urban areas (14.4%)
    - iii. Normal BMI: 60.7%
    - iv. Overweight/obese BMI: 22.6%
      1. Women in urban areas are more likely to be overweight or obese (27.2%) compared to women in rural areas (16.9%)
2. Prevalence of anemia by sex and age group (GBOS and ICF International, 2014)
  - a. Children (6-59 months)
    - i. 73% of children 6-59 months suffer from anemia

1. 74% male vs. 72% female
2. Rural 78% vs. 67% urban
- b. Women (15-49 years)
  - i. 60% of women 15-49 are anemic
    1. Women 20-29 (63%), women who have given birth to 6 or more children (64% and pregnant women (68%)
3. Prevalence of neural tube defects
  - a. 27.1 per 10,000 births (2012 estimate) (FFI, 2016)
4. Dietary Analysis (including supplementation)
  - a. Children (6-59 months) (GBOS and ICF International, 2014)
    - i. 13.1% of children 6-23 mos fed from 4+ food groups
    - ii. 57.5% of children 6-23 mos meet minimum meal frequency
    - iii. 47.7% of children 6-23 mos (who live with their mothers) consumed foods rich in Vitamin A in past 24 hours
    - iv. 42.3% of children 6-23 mos (who live with their mothers) consumed foods rich in iron in the past 24 hours
    - v. 68.7% of children 6-59 mos given vitamin A supplements in past 6 months
    - vi. 16.5% of children 6-59 mos given iron supplements in past 7 days
    - vii. 33.9% of children 6-59 mos given deworming medication in past 6 months
    - viii. 75.8% of children 6-59 mos living in households tested for iodized salt, lived in households with iodized salt
  - b. Women (15-49 years) (GBOS and ICF International, 2014)
    - i. 84.9% of women 15-49 with a child born in the past five years received vitamin A dose postpartum (within first 2 months of giving birth)
    - ii. 31.7% of women 15-49 with a child born in the past five years took iron tablets for <60 days during their pregnancy of last birth
    - iii. 44.6% of women 15-49 with a child born in the past five years took iron tablets for 90+ days during their pregnancy of last birth (recommended)
    - iv. 40.3% of women 15-49 with a child born in the past five years took deworming medication during pregnancy of last birth
    - v. 76.2% women 15-49 with a child born in the last five years, who living in households tested for iodized salt, lived in households with iodized salt
  - c. Other Micronutrients
    - i. 34.9% of population at risk of inadequate zinc intake (FFI, 2016; Wessells & Brown, 2012)
    - ii. Hidden Hunger Index score of 43.7 (17<sup>th</sup> out of top 20 highest burden countries) (Sight and Life, 2013)

### ***Rice Supply***

1. Annual production of rice over the past three years (see table below)

**Table A2.1: Annual Rice Production in The Gambia (2012-2016)**

Source: (International Rice Research Institute, 2016)

	FAO	USDA	
	Paddy (000 t)	Paddy (000 t)	Milled (000 t)
2016		92	60
2015		69	45
2014	46.67	48	31
2013	69.7	71	46
2012	54.22	54	35

2. Geographic sources of rice (TBD)
3. Domestic rice purchasing programs by region or provincial government (TBD)
4. Annual import of rice over the past three years

**Table A2.2: Annual Rice Imports to The Gambia (2012-2016)**

Sources: FAO, USDA and WTO (International Rice Research Institute, 2016), OEC (The Observatory of Economic Complexity, 2016)

	FAO		USDA	OEC	WTO
	Imports (000 t)	Import Value (000 \$)	Imports (000 t)	Top 4 Countries of Origin and Percentage of Imports	Import Tariff
2016			150		The import tax on rice was eliminated in 2008 in response to the global food price spike (Republic of The Gambia, 2011)
2015			150		
2014			125	Brazil 38%; Pakistan 18%; India 16%; Thailand 10%	
2013	69.70	31623	185	Brazil 42%; Pakistan 25%; India 19%; Switzerland 3.7%	
2012	90.62	44124	155	Brazil 33%; Uruguay 14%; Pakistan 12%; India 9.7%	

5. Rice availability (as a proxy for consumption) per capita
  - a. 2011: 67.88 kg/capita/year; 664 kcal/capita/day; 118000/148000 (79.7%) of total supply is used for food (FAOSTAT, 2016)

***Rice Consumption Patterns***

1. As rice is commonly consumed as a porridge, the quality of the milling (mechanical or mortar and pestle) is less important than flavor – consumers will pay a higher price for local rice of a preferred flavor (Reece et. al, 2011)

***Rice Production and Distribution System***

1. In 2013, upland and lowland areas under cultivation were both ~1000 ha (Development Management Consultants International, 2014)
2. Increase in number of rice growers acting alone or in groups since the 2001/02 introduction of NERICA (New Rice for Africa) rice (Development Management Consultants International, 2014)
  - a. Larger groups include Jahal Rice Farmers' Cooperative Society, Souhali Rice Growers Association, and "NAFA" NERICA Farmers' Association of Upland River Region (URR) Basse (Development Management Consultants International, 2014)
3. Few modern processors with threshing and milling facilities (Development Management Consultants

- International, 2014)
4. In 2005, there were 41,000 subsistence farm units nationwide (not exclusively rice) (African Development Fund, 2005)
  5. NERICA project:
    - a. Purchased threshing and milling machines – at least one thresher and one milling machine were given to the six NERICA focal villages (Development Management Consultants International, 2014)
  6. Women using traditional methods on farms are responsible for the bulk of milling domestic rice which leads to low milling ratios of whole rice (Development Management Consultants International, 2014)
  7. Association mills report a milling percentage of 60%; these mills have high milling charges (~0.5% in-kind) and so are underutilized (Development Management Consultants International, 2014)
  8. Gambia Commercial Agriculture and Value Chain Management Project (GCAVMP) – Environmental and Social Management Framework (ESMF) Jan 2014 (Republic of The Gambia, Ministry of Agriculture, 2014)
    - a. Components include irrigation infrastructure rehabilitation, and support to agricultural production and market access for rice and horticulture
      - i. Subcomponent 1.1 includes rehabilitation of 3000ha of existing tidal irrigation schemes for intensive rice cultivation
      - ii. Subcomponent 1.3 leverages private investment through demand-drive, public private partnerships with targeted beneficiaries, including producer organizations, professional associations of agro-processors and other relevant small- and medium-scale agribusiness enterprises (SMEs) to increase domestic production and processing capacities for high-quality rice [...] for urban markets
      - iii. Helps promote linkages with local rice traders for distribution of processed rice to urban markets
      - iv. Supports investments, including support for upgrading or construction of rice processing facilities
  9. Projects under the National Agricultural Investment Plan (GNAIP) (Republic of The Gambia, 2011)
    - a. Farmer Managed Rice Irrigation Project (FMRIP)
    - b. Irrigated Rice Development Project (IRRIDEP)
    - c. Action Aid provided support to the rice mill at Jahally CRR South, and the farmer organizations operating it
  10. NERICA Rice Dissemination Project
    - a. 2012 report found that equipment procured in 2008 for production and post-harvest by certain countries (Ghana, The Gambia) were “for the most part, broken down, as a result of their intensive use for production rather than for tests and the training of beneficiaries” (African Development Bank Group, 2012)
  11. African Development Bank approved \$8.5 million for Livestock Value Chain and Rice Value Chain production (2015) (Nyockeh, 2015)
  12. Production seasons

**Table A2.3: Rice Production Cycle in The Gambia**

Source: (Ricepedia, 2014)

	Planting	Harvesting
Main	May-Jun	Oct-Nov
Off	Jan-Feb	May-Jun

***Relevance to Other Health and Agriculture Programs***

1. Catholic Relief Services – Rice Value Improvement Project targeted women farmers in food production (Gavrilovic & Dibba)
2. Freedom from Hunger Campaign – to increase income and food security, rice-growing project target assisted female farmers with seed germination (Gavrilovic & Dibba)
3. World Food Programme – School Feeding
  - a. In 2014, WFP and GoTG procured >60 MT of rice from smallholder farmer groups (Njai, 2014)
  - b. In 2012, WFP and GoTG agreed to transition school feeding program to national ownership by 2020 (World Food Programme, 2014)
  - c. School feeding is the largest social protection safety net intervention with an annual budget of > 2 million USD targeting over 350 schools (>100,000 children) (Jallow, 2016)
4. Joined Scaling Up Nutrition network in 2011 (Scaling Up Nutrition, 2015)
5. National Nutrition Policy 2010-2020: Objective 4.5: to reduce the morbidity and mortality rates related to iron deficiency anemia in all age groups using an integrated community-based anemia control programme (Republic of The Gambia, 2010)
6. Social Protection Minimum Package was validated in 2015. Other development documents include the National Social Protection Implementation Plan 2015-2020, the National Social Protection Policy, and the Social Protection Mapping Report (The Daily Observer, 2015)
  - a. No publicly available copies were found
  - b. 5th National Social Protection Forum was held in 2016 (Jallow, 2016)
7. In September 2016, the Government of Japan contributed \$21.6 million to WFP for food and nutrition assistance to the most vulnerable in 11 countries; The Gambia received \$1.3 million (World Food Programme, 2016)

***Partners***

1. AfricaRice
2. African Development Bank (AfDB)
3. World Food Programme (WFP)

***Potential Barriers to Rice Fortification***

1. National Rice Development Strategy highlights six input-related constraints. In descending order of priority, they are 1) access to and use of post-harvest equipment, 2) access to and use of land preparation equipment, 3) access to and use of chemical fertilizer, 4) access to improved varieties, 5) access to and use of pesticides, and 6) labor shortage during pick farm operation (Development Management Consultants International, 2014)
2. Unclear status of National Social Protection Policy
3. Limited/no government programs for purchasing of domestic rice

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### **Appendix 3: GUINEA-BISSAU**

#### ***Population and Demography*** (World Bank, 2016a)

1. Population size: 1,844,325 (2015)
2. Urban/rural distribution:
  - a. Urban: 49.3% (2015)
  - b. Rural: 50.7% (2015)
3. Age distribution:
  - a. 40.8% 0-14 (2015)
  - b. 56.0% 15-64 (2015)
  - c. 3.2% 65+ (2015)
4. GDP per capita current USD: 573 (2015)
5. Fertility rate: 4.8 (2014)
6. Life Expectancy:
  - a. Women: 57.0 (2014)
  - b. Men: 53.4 (2014)
7. Education
  - a. Literacy rate:
    - i. Women 15+: 48.1% (2015)
    - ii. Men 15+: 71.7% (2015)
  - b. Years of compulsory education: 9 (2014)
  - c. Children out of school
    - i. Girls: 32.5% (2010)
    - ii. Boys: 29.1% (2010)

#### ***Health Needs Assessment***

1. Anthropometric indicators by sex and age group
  - a. Children (6-59 months) (Ministério da Economia e Finanças, 2015)
    - i. Stunting: 27.6%
    - ii. Wasting: 6%
    - iii. Underweight: 17%
    - iv. Overweight/obese: 2.3%
2. Prevalence of anemia by sex and age group
  - a. Children (6-59 months) (World Bank, 2016b)
    - i. 71.3% (2011)
  - b. Women (15-49 years) (World Health Organization, 2011)
    - i. 44% of non-pregnant women
3. Prevalence of neural tube defects
  - a. 27 per 10,000 births (2012 estimate) (FFI, 2016)
4. Dietary Analysis (including supplementation)
  - a. Children (6-59 months)
    - i. 12.7% of children 6-23 mos fed from 4+ food groups (Ministério da Economia e Finanças, 2015)
    - ii. 56.7% of children 6-23 mos meet minimum meal frequency (Ministério da Economia e Finanças, 2015)
    - iii. 8.3% of breastfed children 6-23 mos who met minimum acceptable diet (Ministério da Economia e Finanças, 2015)

- iv. 5.8% of non-breastfed children 6-23 mos who met minimum acceptable diet (Ministério da Economia e Finanças, 2015)
- v. 79.4% of children 6-59 mos given vitamin A supplements in past 6 months (Ministério da Economia, 2011)
- vi. 13.3% of households consume iodized salt (Ministério da Economia e Finanças, 2015)
- b. Other Micronutrients
  - i. 27.1% of population at risk of inadequate zinc intake (FFI, 2016; Wessells & Brown, 2012)

### ***Rice Supply***

1. Annual production of rice over the past three years

**Table A3.1: Annual Rice Production in Guinea-Bissau (2012-2016)**

Source: (International Rice Research Institute, 2016)

	FAO	USDA	
	Paddy (000 t)	Paddy (000 t)	Milled (000 t)
2016		190	114
2015		170	102
2014	183	183	110
2013	209.72	210	126
2012	198.5	198	119

2. Geographic sources of rice
  - a. Produced in three ecosystems- mangrove, rainfed uplands, and lowlands (irrigated and rainfed) - traditional slash-and-burn practiced in all zones (Kyle, 2015)
    - i. Upland: Typical practice is multiple cropping of roots, fruits, grains, maize, leguminous cultures, and grains along with rice; land is cultivated for 1 year then either planted with cashew or remains fallow for 5-15 years (dependent on availability of surrounding arable land and population density) – this is bad for biological diversity; loss of vegetation cover; Estimated less than 40,000 upland rice farms encompassing ~26,000 ha yields 400-600kg per ha (Kyle, 2015)
    - ii. Mangrove: Widely practiced in coastal regions; building anti-salt dykes to retain fresh water for rice paddies; 50,000 of >106,000 potential ha have been reclaimed; yields 1,800-2,600 kg/ha; despite historical success, currently accounts for <25% of national production (Kyle, 2015)
    - iii. Lowland: Dominates Eastern agro-ecological zone; 27,000 of 200,000 potential ha are cultivated – yields 800-1,200 kg/ha (Kyle, 2015)
3. Domestic rice purchasing programs by region or provincial government (TBD)
4. Annual import of rice over the past three years

**Table A3.2: Annual Rice Imports to Guinea-Bissau (2012-2016)**

Sources: FAO, USDA and WTO (International Rice Research Institute, 2016), OEC (The Observatory of Economic Complexity, 2016)

	FAO		USDA	OEC	WTO
	Imports (000 t)	Import Value (000 \$)	Imports (000 t)	Top 4 Countries of Origin and Percentage of Imports	Import Tariff
2016			140		
2015			140		
2014			120	Pakistan 44%; India 30%; Uruguay 11%; Senegal 9.7%	\$10/kg (broken rice); \$10/kg (husked or brown rice); \$5/kg (paddy rice); \$8.75/kg (rice (no type)); \$10/kg (semi-milled rice)
2013	76.19	29264	120	India 41%; Vietnam 28%; Pakistan 20%; United States 4.5%	Same as 2014
2012	69.99	29485	130	Pakistan 32%; India 24%; Senegal 16%; Vietnam 13%	Same as 2014

5. Rice availability (as a proxy for consumption) per capita
  - a. 2011: 91.49 kg/capita/year; 916 kcal/capita/day; 149000/163000 (91.4%) of total supply used for food (FAOSTAT, 2016)

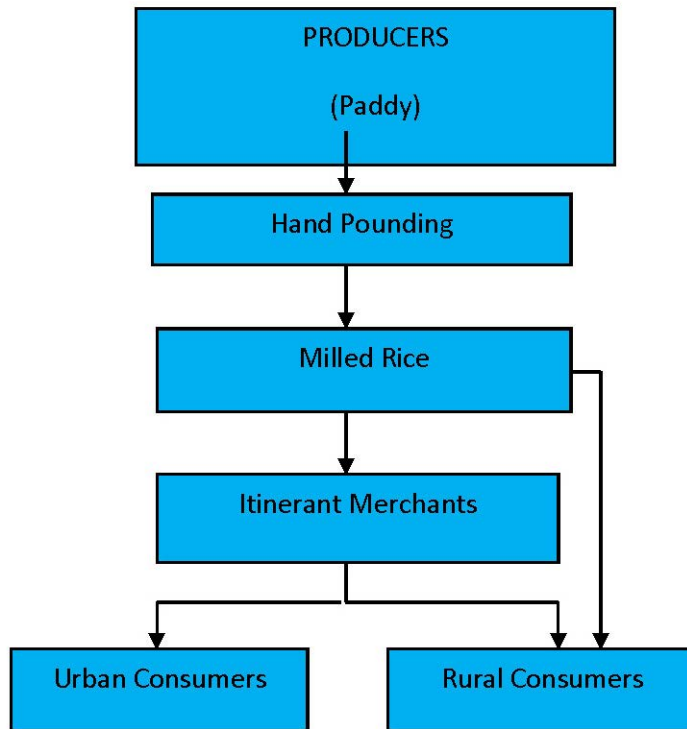
#### ***Rice Consumption Patterns***

1. No country-specific information was found; presumably rice is consumed in similar ways to other West African countries.

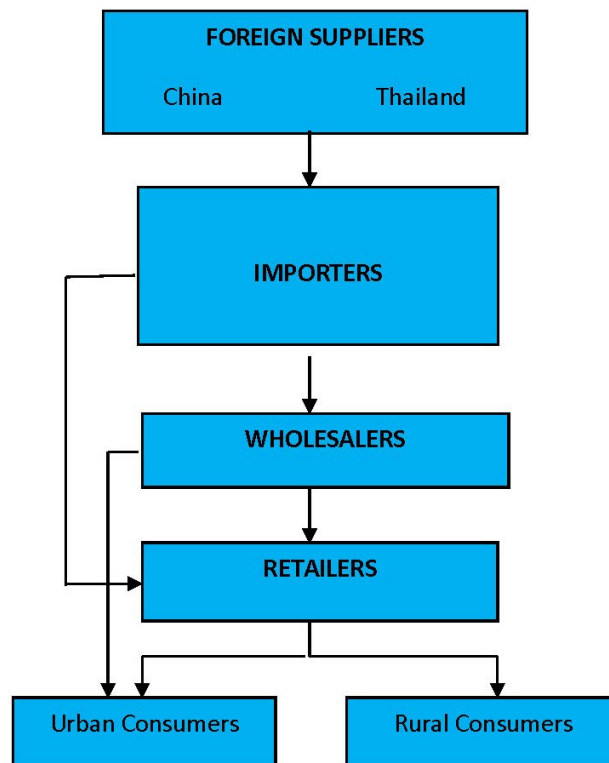
#### ***Rice Production and Distribution System***

1. Cashew and rice market are heavily linked; “In many cases this results in an entirely non-monetized transaction in which the price of cashew is implied in terms of trade offered for the barter for rice [...] the cashew trade [...] has a direct link to the rural price of rice” (Kyle, 2015)
2. Most rice growers consume and do not sell a significant share; estimated that 50-70% of imported rice used for barter trade with cashews (Spencer & Djata, 2008; Kyle, 2015)
  - a. For rice producers who do not sell their goods (approximately 2/3 of all producers), the price of rice in urban settings is in the short term practically irrelevant. “They each exist in economic isolation from the rest of the country and cannot respond to production incentives because they never see these incentives” (Kyle, 2015)
3. The Government in consultation with the importers sets standard nationwide retail price
  - a. “For the 60-70% of imported rice that is used in the cashew barter trade, a change in the rice price is the same thing as a change in the barter terms of trade and ends up affecting the whole in much the same manner as a cashew levy or tax on another stage of the process, or simply a higher price” (Kyle, 2015)
4. As Figures A3.1 and A3.2 show, the production and distribution of domestic rice is straightforward (and underutilized) while the imported rice value chain hinges on importers transporting milled rice from their warehouses to warehouses of retail customers (in most urban areas) using their own trucks; these trucks return full of cashews (Kyle, 2015)

**Figure A3.1: Marketing channels for domestic rice in Guinea-Bissau**  
Source: (Kyle, 2015)



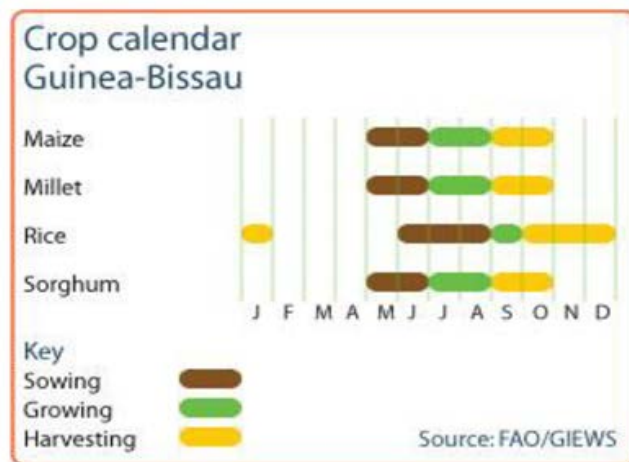
**Figure A3.2: Marketing channels for imported rice in Guinea-Bissau**  
Source: (Kyle, 2015)



5. Market Analysis
  - a. “Lack of an effective marketing system is the single most important characteristic of the market for locally produced rice” (Kyle, 2015)
  - b. As of early 2016, real cashew prices were falling while rice prices had increased; this ratio of cashew to rice prices indicates “the most meaningful interpretation of the terms of trade in Guinea-Bissau – has fallen” (Hanusch, 2016)
  - c. The current bartering system has allowed the rural economy to remain mostly non-monetized (Kyle, 2015)
  - d. Figure below illustrates annual growing season for rice

**Figure A3.3: Growing seasons for rice in Guinea-Bissau**

Source: (FAO GIEWS, 2016)



### ***Relevance to Other Health and Agriculture Programs***

1. World Food Programme
  - a. In April 2016, WFP reported providing over 173,000 hot meals to school children; take-home rations are also provided to encourage attendance among female students (World Food Programme, 2016)
  - b. In September 2016, the Government of Japan contributed \$21.6 million to WFP for food and nutrition assistance to the most vulnerable in 11 countries; Guinea-Bissau received \$1.3 million (World Food Programme, 2016)
2. UN Development Programme
  - a. India Brazil South Africa (IBSA) Fund partnered with UNDP on Support for Lowland Rehabilitation and for Agricultural and Livestock Processing (Project III) which works in 24 villages to rehab 600ha of lowland for farming activities (United Nations Development Programme)

### ***Partners***

1. World Food Programme (WFP)
2. Ministry of Basic and Secondary Education
3. United Nations Development Programme (UNDP)
4. Japan International Cooperation Agency (JICA)

### ***Potential Barriers to Rice Fortification***

1. Dysfunctional marketing (Kyle, 2015)

2. Poor rural road infrastructure (Kyle, 2015)
3. Need for improved varieties (Kyle, 2015)
4. Political instability (most recent coup in 2012)
  - a. World Bank just reengaged in 2015 (World Bank, 2016c)
5. Lack of consolidation of milling enterprises
6. Limited/no government programs for purchasing of domestic rice

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## Appendix 4: GUINEA

### *Population and Demography* (World Bank, 2016a)

1. Population size: 12,608,590 (2015)
2. Urban/rural distribution:
  - a. Rural: 62.8% (2015)
  - b. Urban: 37.2% (2015)
3. Age distribution:
  - a. 42.5% 0-14 (2015)
  - b. 54.4% 15-64 (2015)
  - c. 3.1% 65+ (2015)
4. GDP per capita current USD: 531.3 (2015)
5. Fertility rate: 5.0 births per woman (2014)
6. Life expectancy:
  - a. Women: 59.2 (2014)
  - b. Men: 58.3 (2014)
7. Education
  - a. Literacy rate
    - i. Female ages 15+: 22.9% (2015)
    - ii. Male ages 15+: 38.1% (2015)
  - b. Years of compulsory education: 6 (2014)
  - c. Children out of school
    - i. Female: 27.8% (2014)
    - ii. Male: 16.3% (2014)

### *Health Needs Assessment*

1. Anthropometric indicators by sex and age group (Institut National de la Statistique et al, 2013)
  - a. Children (6-59 months)
    - i. Stunting: 31%; 14% severe
      1. Stunting rates have dropped since 2005 DHS – 35% to 27% (2012)
      2. 33% male vs. 30% female
      3. Highest prevalence (40%) in children 36-47 months
    - ii. Wasting: 10%
      1. Rates have remained the same since 2005 DHS
      2. Highest prevalence (20%) in children 12-17 months
    - iii. Underweight: 18%
      1. Rates have slightly decreased since 2005 DHS 26% to 22% (2012)
      2. Highest prevalence (22%) among children 18-23 months
      3. Overweight/obese: 4%
  - b. Women (15-49 years)
    - i. Short stature: 1% <145 cm
    - ii. Underweight BMI: 12%
      1. 14% rural vs. 10% urban
    - iii. Normal BMI: 69%
    - iv. Overweight/obese BMI: 19% are overweight, 5% are obese
      1. 32% urban vs 11.9% rural
      2. Percentage has increased from 14% in 2005 DHS

2. Prevalence of anemia by sex and age group (Institut National de la Statistique et al, 2013)
  - a. Children (6-59 months)
    - i. 77% are anemic; 24% slight, 45% moderate, 8% severe
    - ii. 76% male vs. 77.3% female
    - iii. 79% rural vs. 69% urban
    - iv. Overall anemia rate is slightly (1% pt) higher than 2005 DHS
  - b. Women (15-49 years)
    - i. 49% are anemic; 36% slight; 13% moderate; 1% severe
    - ii. 65% of pregnant women are anemic, 52% of breastfeeding moms vs. 45% of non-pregnant/lactating women
    - iii. 52% rural vs. 44% urban
    - iv. Overall anemia prevalence has decreased from 2005 DHS 53% to 49%
  - c. Men (15-59 years)
    - i. 26% are anemic
    - ii. 37% of men 15-19 years, 21% of men 20-29 years, 18% of men 30-39 years, 32% of men 50-59 years
    - iii. 28% rural vs 21% urban
3. Prevalence of neural tube defects
  - a. 27 per 10,000 (2012 estimate) (FFI, 2016)
4. Dietary Analysis (including supplementation) (Institut National de la Statistique et al, 2013)
  - a. Children (6-59 months)
    - i. 7.6% of children 6-23 mos fed from 4+ food groups
    - ii. 30.1% of children 6-23 mos meet minimum meal frequency
    - iii. 27.1% of children 6-23 mos (who live with their mothers) consumed foods rich in vitamin A in past 24 hours
    - iv. 21.8% of children 6-23 mos (who live with their mothers) consumed foods rich in iron in the past 24 hours
    - v. 40.8% of children 6-59 mos given vitamin A supplements in past 6 months
    - vi. 11.5% of children 6-59 mos given iron supplements in past 7 days
    - vii. 28.5% of children 6-59 mos given deworming medication in past 6 months
    - viii. 65.8% of children 6-59 mos living in household tested for iodized salt, lived in household with iodized salt
  - b. Women (15-49 years)
    - i. 29.1% of women 15-49 years with a child born in the past five years received vitamin A dose postpartum (within first 2 months of giving birth)
    - ii. 24.9% of women 15-49 years with a child born in the past five years took iron tablets for <60 days during their pregnancy of last birth
    - iii. 41.5% of women 15-49 years with a child born in the past five years took iron tablets for 90+ days during their pregnancy of last birth (recommended)
    - iv. 29.4% of women 15-49 years with a child born in the past five years took deworming medication during pregnancy of last birth
    - v. 66.4% women 15-49 years with a child born in the last five years, who living in household tested for iodized salt, lived in household with iodized salt
  - c. Other Micronutrients
    - i. 19.6% of population at risk of inadequate zinc intake (FFI, 2016; Wessells & Brown, 2012)

## ***Rice Supply***

1. Annual production of rice over the past three years

**Table A4.1: Annual Rice Production in Guinea (2012-2016)**

Source: (International Rice Research Institute, 2016)

	FAO	USDA	
	Paddy (000 t)	Paddy (000 t)	Milled (000 t)
2016		2083	1375
2015		2047	1351
2014	1971	1971	1301
2013	2053	2053	1355
2012	1919	1920	1267

2. Geographic sources of rice (TBD)
3. Domestic rice purchasing programs
  - a. World Food Programme has purchased 900 tons of local parboiled rice (World Food Programme)
4. Annual import of rice over the past three years

**Table A4.2: Annual Rice Imports to Guinea (2012-2016)**

Sources: FAO, USDA and WTO (International Rice Research Institute, 2016), OEC (The Observatory of Economic Complexity, 2016)

	FAO		USDA	OEC	WTO
	Imports (000 t)	Import Value (000 \$)	Imports (000 t)	Top 4 Countries of Origin and Percentage of Imports	Import Tariff
2016			400		
2015			450		
2014			350	India 55%; Thailand 22%; Pakistan 12%; United Arab Emirates 5.4%	
2013	363.76	163870	380	India 62%; Pakistan 22%; Vietnam 12%; United States 2.1%	
2012	369.11	158811	360	India 67%; Vietnam 16%; Pakistan 12%; Thailand 3.4%	\$10/kg (broken rice); \$10/kg (husked or brown rice); \$5/kg (paddy rice); \$10/kg (rice (no type)); \$15/kg (semi-milled rice)

5. Rice availability (as a proxy for consumption) per capita
  - a. 2011: 96.32 kg/capita/year; 977 kcal/capita/day; 1075000/1353000 (79.45%) of total supply is used for food (FAOSTAT, 2016)

## ***Rice Consumption Patterns***

1. Consumer preference for domestically produced rice priced at 4,000-4,500/kg compared with 3,500 Guinean Franc (GNF)/kg for imported (Kula et al, 2015)
2. Consumer preference for par-boiled rice over polished; par-boiled has higher concentration of protein and other nutrients (Kula et al, 2015)

## ***Rice Production and Distribution System***

1. As of 2015, there was no large-scale irrigated rice production; FAO reports that as of 2001, 95,000 ha were equipped for irrigation (Kula et al, 2015)
2. Average paddy yields = 1.5 tons/ha; irrigated perimeter paddy yields are highest; recessionary lowlands should be able to attain (or exceed) yields of 3 tons/ha (Kula et al, 2015)
  - a. Average paddy yields were 1.17 tons/ha in 2015 (Government of Guinea et al, 2015; Kula et al, 2015)
3. Rice is produced in multiple ecosystems: mangrove, recessionary lowlands, and upland (Kula et al, 2015)
  - a. Distribution of total cultivated paddy rice land: upland (63%), non-irrigated flooded lowlands (19.5%), non-irrigated plains (10%), mangroves (4.2%), irrigated lowlands (3.2%), irrigated plains (0.3%) (Kula et al, 2015)
  - b. “Land under rice cultivation has increased by over 10% annually” (Government of Guinea et al, 2015; Kula et al, 2015)
  - c. Small-scale farmers producing on less than 1 ha of land constitute almost all of paddy rice production in Guinea (Kula et al, 2015)
4. “Most paddy farmers in the plains or lowlands cultivate two crops a year; rotating rice with maize, potatoes and/or groundnuts” (Kula et al, 2015)
5. “In >2/3 of cultivated rice land in the four prefectures included in the assessment, farmers cultivate by hand [...] the Kankan prefecture had the highest level of mechanical cultivation at 51%” (Government of Guinea et al, 2015; Kula et al, 2015)
6. Nationally, 84% of all rice farmers reported that they did not use fertilizers, while 69% reported that they did not use any crop protection inputs (Government of Guinea et al, 2015; Kula et al, 2015)
7. 0.2% of rice farmers reported using improved seed (Kula et al, 2015)
8. Most harvesting and threshing is manual – this leads to high amounts of broken grains along with foreign matter and stones (Kula et al, 2015)
9. Production seasons

**Table A4.3: Rice Production Cycle in Guinea**

Source: (Ricepedia, 2014)

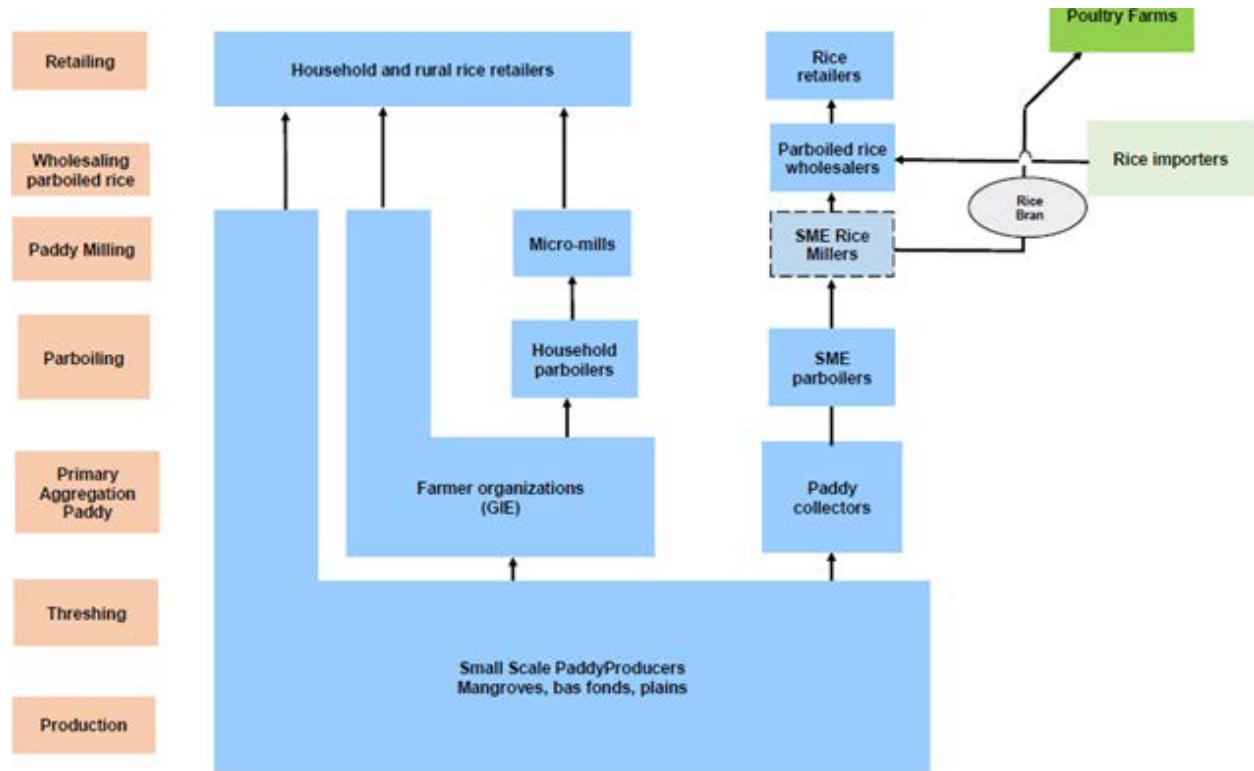
	<b>Planting</b>	<b>Harvesting</b>
Main	Apr-Jun	Sep-Nov
Off	Dec-Feb	Apr-Jun

10. There are no large-scale rice mills in Guinea (Kula et al, 2015)
  - a. Most rice milling is accomplished by simple mills without sorters or cleaners; typically, these mills’ capacity is 1-2 tons/hour, though most don’t achieve that as they operate by milling in small batches for private clients (Kula et al, 2015)
  - b. “Most rice mills are very small scale using small diesel mills that can process 500 to 1000 kg/hour [...] rice milled in these mills requires substantial manual winnowing after milling” (Kula et al, 2015)
  - c. Rice-producing Groupement d’Interests Economique (farmer group) operates a medium scale mill (Kula et al, 2015)
11. Many women engage in traditional parboiling of rice (Kula et al, 2015)
12. The following figures display the rice value chain (Fig. A4.1) and the market flow throughout Guinea (Fig. A4.2). (Kula et al, 2015)

### Figure A4.1: A map of the rice value chain in Guinea

Source: (Kula et al, 2015)

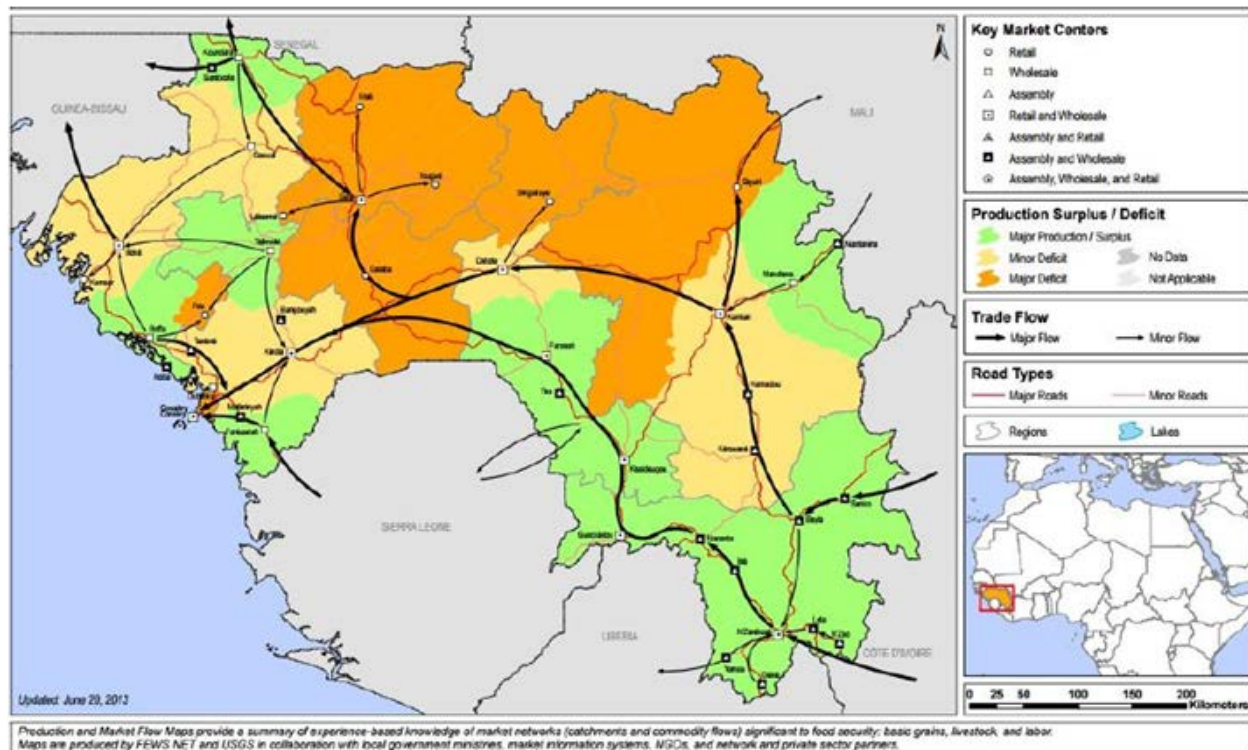
Note: “The dashed line in the map for commercially SME millers (8 to 20 MT/hr. capacity) indicates that the LEO team could not identify any, though SME and large-scale millers are often the key change driver in the rice value chain” (Kula et al, 2015)



**Figure A4.2: A map of the rice trade flow in Guinea**

Source: (Kula et al, 2015)

Note: The colors indicate the presence of production surpluses (green) or deficits (major deficit = orange, minor deficit = yellow) of rice. The trade flows are marked by thick black arrows (major flows) and thin black arrows (minor flows).



### ***Relevance to Other Health and Agriculture Programs***

1. National Health Development Plan: focus on prevention and treatment of anemia in women (Republique de Guinee Ministere de la Sante, 2015)
2. School Feeding Programs
  - a. World Bank reports that as of September 2016, 7,847 beneficiaries had been reached (World Bank, 2016b)
3. In September 2016, the Government of Japan contributed \$21.6 million to WFP for food and nutrition assistance to the most vulnerable in 11 countries; Guinea received the highest single-country allowance, \$3.8 million (World Food Programme, 2016)

### ***Partners***

1. Federation des Unions de Producteur de Riz (FUPRORIZ) founded in 2009 with six producer unions; currently has 39,000 members; members typically manage two ha each; government and private sector partners, including the Ministry of Agriculture (Kula et al, 2015)
  - a. Under Local Purchases Program, sold rice to the World Food Program, which distributed the rice to those displaced as a result of the Ebola crisis (Kula et al, 2015)
2. “Farm Lands of Africa Ltd., from India, is planning the development of agro-processing facilities to accompany large-scale production-rice mills [...] all products will be sold into the domestic market, or to neighboring West African countries” (Kula et al, 2015)

### ***Potential Barriers to Rice Fortification***

1. In recovery period post-Ebola outbreak

2. Lack of consolidation of milling enterprises
3. Limited/no government programs for purchasing of domestic rice

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## **Appendix 5: LIBERIA**

### ***Population and Demography*** (World Bank, 2016)

1. Population size: 4,503,438 (2015)
2. Urban/rural distribution
  - a. Rural: 50.3% (2015)
  - b. Urban: 49.7% (2015)
3. Age distribution: 42.3% of population 0-14, 54.7% of population 15-64, 3% of population 65+ (2015)
4. GDP per capita in current USD = 455.9 (2015)
5. Fertility rate: 4.7 births/woman (2014)
6. Life Expectancy:
  - a. Women: 61.9 (2014)
  - b. Men: 59.9 (2014)
7. Education:
  - a. Literacy rate:
    - i. Females (age 15+): 32.8% (2015)
    - ii. Males (age 15+): 62.4% (2015)
  - b. Years of compulsory education: 6 (2014)
  - c. Children out of school (% of primary school age children who are not enrolled in primary or secondary school)
    - i. Female: 62.9%
    - ii. Male: 60.9%

### ***Health Needs Assessment***

1. Anthropometric indicators by sex and age group (Liberia Institute of Statistics and Geo-Information Services et al, 2014)
  - a. Children (6-59 months)
    - i. Stunting: 32%
      1. 42% of 36-47 mos, 35% of 48-59, 17% of 24-35 mos are severely stunted
    - ii. Wasting: 6%
      1. 15% of 6-8 mos (highest prevalence)
    - iii. Underweight: 15%
      1. 23% of 9-11 mos (highest prevalence)
    - iv. Overweight/obese: 3%
    - v. Males more likely to be malnourished than females (across all indicators)
  - b. Women (15-49 years)
    - i. Short Stature: 2.2% <145 cm
    - ii. Underweight BMI: 7.4%
    - iii. Normal BMI: 66%
    - iv. Overweight/obese BMI: 25%
  - c. Men (15-59 years)
    - i. Underweight BMI: 10.6%
    - ii. Normal BMI: 80%
    - iii. Overweight/obese: 9.4%
2. Prevalence of anemia by sex and age group
  - a. Children (6-59 months)

- i. 63% anemic (National Malaria Control Program et al, 2012)
    - 1. Severe anemia: 8%, highest prevalence in 9-35 mos (National Malaria Control Program et al, 2012)
  - ii. 33% (USAID, 2012)
- 3. Prevalence of neural tube defects
  - a. 28 per 10,000 births (2012 estimate) (FFI, 2016)
- 4. Dietary Analysis (including supplementation)
  - a. Children (6-59 months) (Liberia Institute of Statistics and Geo-Information Services et al, 2014)
    - i. 11.3% of children 6-23 mos fed from 4+ food groups
    - ii. 30.2% of children 6-23 mos meet minimum meal frequency
    - iii. 66.5% of children 6-23 mos (who live with their mothers) consumed foods rich in Vitamin A in past 24 hours
    - iv. 44.8% of children 6-23 mos (who live with their mothers) consumed foods rich in iron in the past 24 hours
    - v. 60.2% of children 6-59 mos given vitamin A supplements in past 6 months
    - vi. 26.7% of children 6-59 mos given iron supplements in past 7 days
    - vii. 56.1% of children 6-59 mos given deworming medication in past 6 months
    - viii. 98.7% of children living in households tested for iodized salt, lived in households with iodized salt
  - b. Women (15-49 years) (Liberia Institute of Statistics and Geo-Information Services et al, 2014)
    - i. 62.3% of women 15-49 with a child born in the past 5 years received vitamin A dose postpartum (within first 2 months of giving birth)
    - ii. 44.6% of women 15-49 with a child born in the past 5 years took iron tablets for <60 days during their pregnancy of last birth
    - iii. 21.2% of women 15-49 with a child born in the past 5 years took iron tablets for 90+ days during their pregnancy of last birth (recommended)
    - iv. 57.9% of women 15-49 with a child born in the past 5 years took deworming medication during pregnancy of last birth
    - v. 98.6% women 15-49 with a child born in the last five years, who living in households tested for iodized salt, lived in households with iodized salt
  - c. Other Micronutrients
    - i. 35.2% of population at risk of inadequate zinc intake (FFI, 2016; Wessells & Brown, 2012)
    - ii. Hidden Hunger Index<sup>1</sup> score of 45.3 (15<sup>th</sup> out of top 20 highest burden countries) (Sight and Life, 2013)

### ***Rice Supply***

1. Annual production of rice over the past three years

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<sup>1</sup> Hidden Hunger Index Score is calculated as the average of zinc deficiency prevalence (as measured using stunting as a proxy) iron deficiency (as measured by anemia due to iron deficiency), and vitamin A deficiency (as measured by low serum retinol) – all prevalences are equally weighted

**Table A5.1: Annual Rice Production in Liberia (2012-2016)**

Source: (International Rice Research Institute, 2016)

	FAO	USDA	
	Paddy (000 t)	Paddy (000 t)	Milled (000 t)
2016		300	189
2015		295	186
2014	237	267	168
2013	270	270	170
2012	291	290	183

2. Geographic sources of rice
  - a. Three counties (Nimba, Bong, Lofa) account for ~60% of domestic rice production (Tsiboe et al, 2016)
  - b. According to a 2010 comprehensive food security and nutrition survey, “counties that have witnessed substantial investment in agricultural production in the last three years, including Lofa and Bong, are now able to meet at least three-quarters of local requirements” (Ministry of Agriculture et al, 2010)
3. Domestic rice purchasing programs by region or provincial government
  - a. Ministry of Commerce and Industry’s Initiative to support local micro, small, and medium enterprises (MSMEs) requires 25% of public procurement to be reserved for Liberian businesses (Ministry of Commerce and Industry, 2014)
4. Annual import of rice over the past three years

**Table A5.2: Annual Rice Imports to Liberia (2012-2016)**

Sources: FAO, USDA and WTO (International Rice Research Institute, 2016), OEC (The Observatory of Economic Complexity, 2016)

	FAO		USDA	OEC	WTO
	Imports (000 t)	Import Value (000 \$)	Imports (000 t)	Top 4 Countries of Origin and Percentage of Imports	Import Tariff
2016			310		
2015			270		
2014			280	India 94%; United States 2.7%; Pakistan 1.2%; Benin 0.99%	
2013	270.62	128275	300	India 93%; United States 5.2%; Pakistan 1.5%; Thailand 0.6%	Same as 2012
2012	242.32	125937	310	India 43%; United States 31%; Vietnam 11%; Pakistan 4.8%	\$2.5/kg (husked or brown rice); \$2.5/kg (paddy rice); \$2 .5/kg (rice (no type))

- a. Conflicting information on the dominant type of rice imported:
  - i. 90% of rice imports are low-quality “butter rice” (USAID EAT, 2015)
  - ii. Parboiled long-grain rice is the dominant imported rice type at 94% of imports; before latter half of 2011, butter rice was dominant (Tsiboe et al, 2016)
5. 20% increase in consumer rice price estimated to increase poverty rate by 4.2% (Tsiboe et al, 2016; Tsimpo and Wodon, 2008)

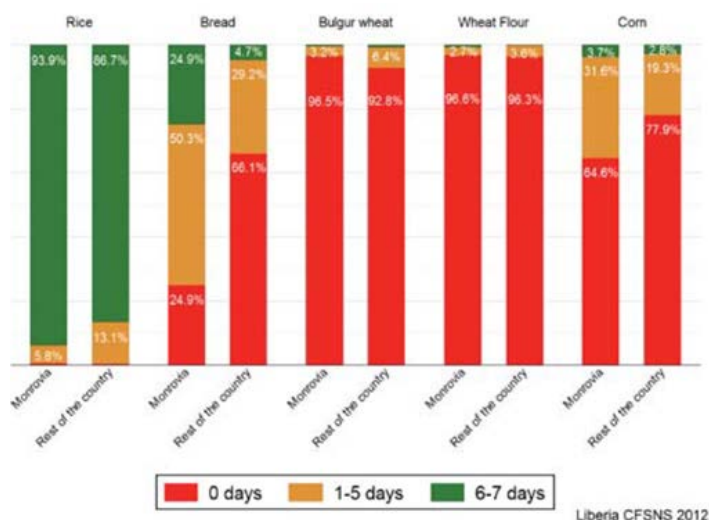
- a. Import process
  - i. >75% of all imports are handled by three private firms (Tsiboe et al, 2016)
  - ii. Import structure aided by: (Tsiboe et al, 2016; FAO et al, 2008)
    1. Domestic banks are not competitive compared with international banks on interest rates
    2. Permit requirements for importers mandate that national reserves are maintained in their warehouses
    3. Financial institutions (in Liberia) are unable to provide traders with “letters of credit” which enable purchases from exporters
6. Rice availability (as a proxy for consumption) per capita
  - a. 2011: 90.46 kg/capita/year; 910 kcal/capita/day; 369,000/434,000 (85%) of total supply is used for food; 40.43% of daily caloric consumption (2251 kcal/day) (FAOSTAT, 2016)

### ***Rice Consumption Patterns***

1. Domestic rice is “less attractive from a quality standpoint than imported par-boiled rice” (USAID EAT, 2015)
2. Figure below illustrates the slight difference in rice consumption between those in the capital city of Monrovia, and the rest of the country

**Figure A5.1: Weekly cereals consumption in Monrovia versus the rest of Liberia**

Sources: (Liberia Comprehensive Food Security and Nutrition Survey, 2013)



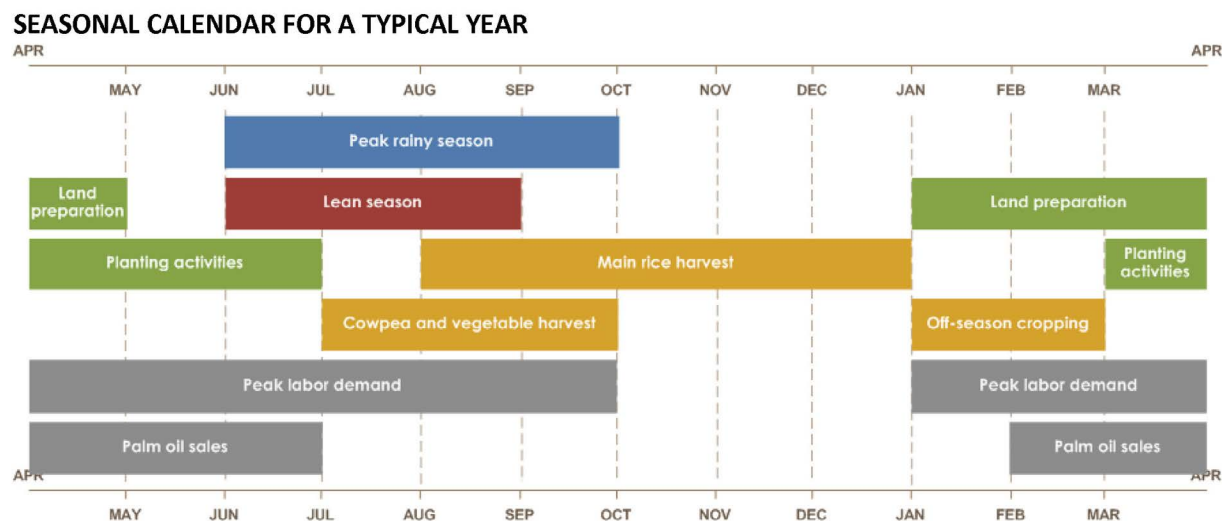
### ***Rice Production and Distribution System***

1. Ministry of Agriculture (MOA) in Liberia no longer maintains a statistics department, and there is a significant lack of timely and accurate market data for livestock, and most industrial and food crops (USAID EAT, 2015)
  - a. In October, the Government of Liberia through the MOA signed an MOU with FAO to “support the statistics and management systems of MOA” (Food and Agriculture Organization, 2016)
2. Priorities of the national food security policy are to avoid civil strife and keep the cost of food affordable (USAID EAT, 2015)
3. Rice is imported duty-free (USAID EAT, 2015)
4. In response to a GOL proposal to increase the price of imported rice, riots occurred in 1979 (USAID EAT, 2015)

- a. In 2008, in response to the food price spike, GOL declared a zero tariff and limit on wholesale margins 1USD/50kg bag. This is still in place today - smallholder farmers cannot compete with imported rice price (USAID EAT, 2015)
5. Domestic rice is predominantly upland rice – mainly harvested using slash-and-burn practices, generating one crop/year during the rainy season (USAID EAT, 2015)
6. Figure below displays production year

**Figure A5.2: Seasonal calendar for a typical production year**

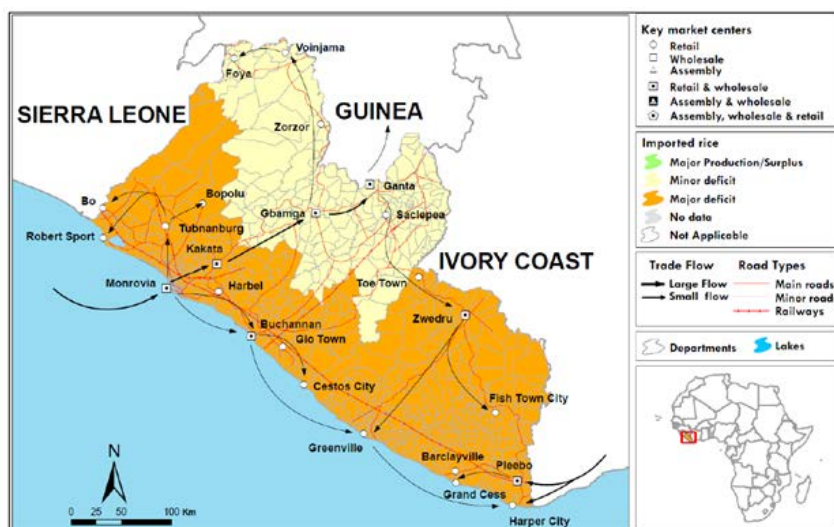
Sources: (FEWS NET, 2016)



7. Productivity = 0.8 MT/ha (upland), 1.2 MT/ha (lowland, rainfed) (USAID EAT, 2015)
8. In 2013, 71% of farming households engaged in rice production (Liberia Comprehensive Food Security and Nutrition Survey, 2013)
  - a. Production fell by 76% from 1987 to 2005 (Liberia Comprehensive Food Security and Nutrition Survey, 2013)
9. Rainy season May-October; NW harvests rice Nov/Dec, SE harvests in Sept/Oct (Liberia Comprehensive Food Security and Nutrition Survey, 2013)
10. Market flow (as seen in Figure A5.3 below) begins at Red-Light market in Monrovia (principal depot for imported rice) where rice is sold in USD to wholesalers; Wholesalers sell in USD to retailers in regional markets; Retailers sell in Liberian dollars to “micro-retailers”, mainly women, who sell rice by the cup to the final consumer” (Tsiboe et al, 2016; FAO et al, 2008)
  - a. Mean retail price of imported rice from Jan 2009-Dec 2014 across 8 markets (Buchanan, Gbarnga, Pleebo, Red-Light, Saclepea, Tubmanburg, Voinjama, Zwedru) was 40.53L\$/kg (standard deviation of 3.68 L4/kg) (Tsiboe et al, 2016)
    - i. In the South-East, rice is 56% more expensive due to high transport costs (FAO et al, 2008)

**Figure A5.3: Imported rice market flow map for Liberia**

Sources: (Tsiboe et al, 2016)



11. Moderate market integration (Tsiboe et al, 2016)

**Relevance to Other Health and Agriculture Programs**

1. National Nutrition Strategy specifically lists food fortification as worthy of support (Government of Liberia, 2008)
2. WFP Livelihood Asset Rehabilitation (LAR): food for work provided to smallholder farmers to rehabilitate agricultural assets with a focus on rice production (World Bank, 2012)
3. USAID Liberian Agricultural Upgrading Nutrition and Child Health (LAUNCH) Program: food distribution (World Bank, 2012)
4. WFP Immediate Emergency Response Operation (IR-EMOP): in-kind food transfers to refugees and vulnerable host population groups (World Bank, 2012)
5. USAID Food and Enterprise Development (FED) Program
6. WFP Purchase for Progress (P4P) Initiative: create market opportunities for smallholder farmers by purchasing rice surpluses for projects (i.e. school feeding) (World Bank, 2012)
  - a. Initially, worked with two farmer organizations (FOs) in 2009; this increased to 26 in 2013; the 2013 default rate for FOs selling to WFP was 1.7% (World Food Programme, 2014)
  - b. WFP (partnering with FAO and UNDP) constructed/rehabilitated 14 warehouses, and provided 19 rice mills and accessories to FOs (World Food Programme, 2014)
7. In September 2016, the Government of Japan contributed \$21.6 million to WFP for food and nutrition assistance to the most vulnerable in 11 countries; Liberia received \$2.3 million (World Food Programme, 2016)

**Partners**

1. Fabrar Liberia
  - a. Liberian-owned, created in 2009, purchases domestic rice (Tamba, 2015)
  - b. Home of Liberia's first automated rice milling line (Feed the Future, 2014)
2. Government of Liberia Ministry of Agriculture
3. Government of Liberia Ministry of Commerce and Industry
4. World Food Programme (WFP)
5. United States Agency for International Development (USAID)

## 6. Rights and Rice Foundation

### ***Potential Barriers to Rice Fortification***

1. Production
  - a. Lack of equipment
    - i. Recommendations included providing rice-producing farmers' organizations with mechanical tools (tractors, parboiling, milling machines etc.) in food basket counties of Bong, Lofa, and Nimba (Liberia Comprehensive Food Security and Nutrition Survey, 2013); increased availability of inputs - specifically fertilizers and improved varieties (USAID EAT, 2015)
    - ii. Reduce pre-and-post harvest losses with training and equipment to small scale producers in Lofa, Nimba, Bong and River Gee counties (Liberia Comprehensive Food Security and Nutrition Survey, 2013)
  - b. Focus on supplemental irrigation for swamp/lowland rice for dry season (USAID EAT, 2015)
2. Opportunities for niche markets (i.e. red rice produced by Fabrar Rice) (USAID EAT, 2015)
3. Access to markets/road infrastructure
4. In recovery period post-Ebola outbreak

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## **Appendix 6: MADAGASCAR**

### ***Population and Demography*** (World Bank, 2016a)

1. Population size: 24,235,390 (2015)
2. Urban/rural distribution:
  - a. Rural: 64.9% (2015)
  - b. Urban: 35.1% (2015)
3. Age distribution: 41.7% 0-14, 55.5% 15-64, 2.8% 65+ (2015)
4. GDP per capita current USD: 411.8 (2015)
5. Fertility rate: 4.4 births/woman (2014)
6. Life Expectancy:
  - a. Women: 66.6 (2014)
  - b. Men: 63.6 (2014)
7. Education
  - a. Literacy rate:
    - i. Women 15+: 62.6% (2015)
    - ii. Men 15+: 66.7% (2015)
  - b. Years of compulsory education: 5 (2014)
  - c. Children out of school (% of primary school age children who are not enrolled in primary or secondary school)
    - i. Girls: 22.4% (2003)
    - ii. Boys: 22.7% (2003)

### ***Health Needs Assessment***

1. Anthropometric indicators by sex and age group:
  - a. Children (6-59 months)
    - i. Stunting: 50%; 24% moderate, 26% severe (INSTAT & ICF, 2010)
      1. 24% of children <6 mos are stunted (INSTAT & ICF, 2010)
      2. 52.9% male vs. 47.3% female (INSTAT & ICF, 2010)
    - ii. Wasting: 14% of children <36 mos; 3% severe (INSTAT & ORC, 2005)
      1. 16.3% male vs. 12.2% female (INSTAT & ORC, 2005)
      2. Underweight: 40% of 6-59 mos; 12% severe (INSTAT & ORC, 2005)
        - a. 41.2% male vs. 37.8% female (INSTAT & ORC, 2005)
  - b. Women (15-49 years) (INSTAT & ICF, 2010)
    - i. Short stature: 7.2% <145 cm
    - ii. Underweight BMI: 17%; 10% moderate or severe
    - iii. Normal BMI: 67%
    - iv. Overweight/obese BMI: 5% overweight, 1% obese
2. Prevalence of anemia by sex and age group
  - a. Children (6-59 months) (INSTAT & PNL, 2013)
    - i. 51% are anemic; 25.2% mild, 24.3% moderate, 1.4% severe
    - ii. 76.1% of 6-11 mos
    - iii. 51% male vs. 50.9% of female
    - iv. 53.9% urban vs. 50.8% rural
  - b. Women (15-49 years) (INSTAT & ICF, 2010)
    - i. 35% are anemic; 29% mild, 6% moderate, 0.4% severe
    - ii. 38% of pregnant women vs. 39% of lactating women vs. 33% non-pregnant/lactating

- c. Men (15-59 years) (INSTAT & ICF, 2010)
  - i. 33% are anemic
  - ii. 40% of men 15-19 and 41% of 50-59
  - iii. 34% rural vs 17% urban
- 3. Prevalence of neural tube defects
  - a. 13 per 10,000 (2012 estimate) (FFI, 2016)
- 4. Dietary Analysis (including supplementation)
  - a. Children (6-59 months) (INSTAT & ICF, 2010)
    - i. 62.8% of children 6-23 mos fed from at least 3 - 4 food groups
    - ii. 3.9% of children 6-23 mos meet minimum meal frequency
    - iii. 78.7% of children 6-35 mos (who live with their mothers) consumed foods rich in Vitamin A in past 24 hours
    - iv. 45.7% of children 6-35 mos (who live with their mothers) consumed foods rich in iron in the past 24 hours
    - v. 72.2% of children 6-59 mos given vitamin A supplements in past 6 months
    - vi. 3.8% of children 6-59 mos given iron supplements in past 7 days
    - vii. 69.1% of children 6-59 mos given deworming medication in past 6 months
    - viii. 46.6% of children 6-59 mos living in households tested for iodized salt, lived in households with iodized salt
  - b. Women (15-49 years) (INSTAT & ICF, 2010)
    - i. 84.7% of women 15-49 with a child under 3 years had consumed Vitamin A rich foods in the past 24 hours
    - ii. 48.7% of women 15-49 with a child under 3 years had consumed iron rich foods in the past 24 hours
    - iii. 43.1% of women 15-49 with a child born in the past five years received vitamin A dose postpartum (within first 2 months of giving birth)
    - iv. 42.6% of women 15-49 with a child born in the past five years took iron tablets for <60 days during their pregnancy of last birth
    - v. 7.6% of women 15-49 with a child born in the past five years took iron tablets for 90+ days during their pregnancy of last birth (recommended)
    - vi. 39.4% of women 15-49 with a child born in the past five years took deworming medication during pregnancy of last birth
    - vii. 49.1% of women 15-49 with a child born in the last five years, who living in households tested for iodized salt, lived in households with iodized salt
  - c. Other Micronutrients
    - i. 16% of population at risk of inadequate zinc intake (FFI, 2016; Wessells & Brown, 2012)
    - ii. Hidden Hunger Index score<sup>1</sup> of 43 (19<sup>th</sup> out of top 20 highest burden countries) (Sight and Life, 2013)

### ***Rice Supply***

1. Annual production of rice over the past three years

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<sup>1</sup> Hidden Hunger Index Score is calculated as the average of zinc deficiency prevalence (as measured using stunting as a proxy) iron deficiency (as measured by anemia due to iron deficiency), and vitamin A deficiency (as measured by low serum retinol) – all prevalences are equally weighted

2. Geographic sources of rice (TBD)
3. Domestic rice purchasing programs by region or provincial government, if any (TBD)

**Table A6.1: Annual Rice Production in Madagascar (2012-2016)**

Source: (International Rice Research Institute, 2016)

	FAO		USDA	
	Paddy (000 t)	Milled (000 t)	Paddy (000 t)	Milled (000 t)
2016			3700	2368
2015			3722	2382
2014	3978		3978	2546
2013	3610.63	2408.29	3611	2311
2012	4550.65	3035.28	4552	2913

4. Annual import of rice over the past three years

**Table A6.2: Annual Rice Imports to Madagascar (2012-2016)**

Sources: FAO, USDA and WTO (International Rice Research Institute, 2016), OEC (The Observatory of Economic Complexity, 2016)

	FAO		USDA	OEC	WTO
	Imports (000 t)	Import Value (000 \$)	Imports (000 t)	Top 4 Countries of Origin and Percentage of Imports	Import Tariff
2016			310		No information found via World Rice Statistics Online Query Facility (IRRI, 2016)
2015			270		
2014			280	Pakistan 51%; India 45%; Thailand 2.3%; Vietnam 1.2%	
2013	388.7	128275	300	India 45%; Pakistan 38%; Vietnam 15%; United States 0.82%	
2012	193.08	125937	310	Pakistan 46%; India 34%; Burma 11%; United States 5.1%	

5. Rice availability (as a proxy for consumption) per capita
  - a. 2013: 102.53 kg/capita/year; 1040 kcal/capita/day; 2,350,000/2,906,000 (~80.9%) of total supply used for food (FAOSTAT, 2016)

### ***Rice Consumption Patterns***

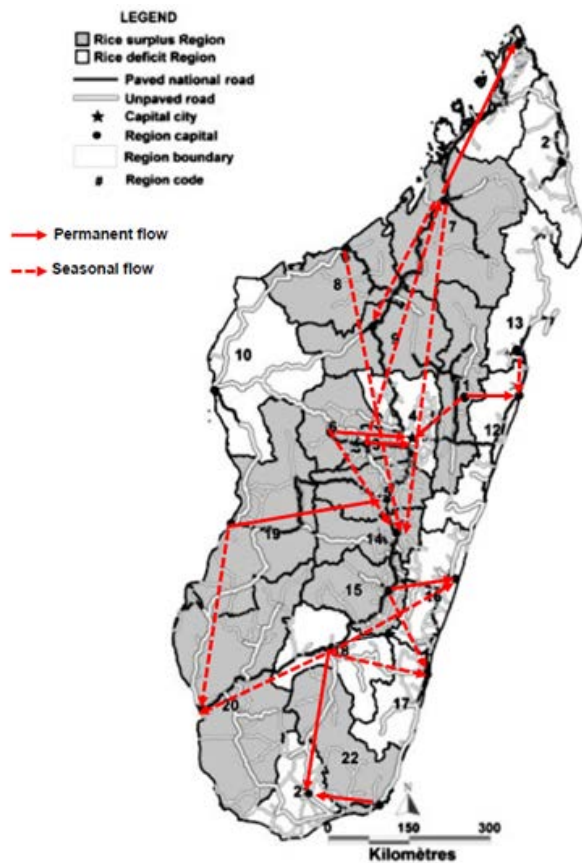
(TBD)

### ***Rice Production and Distribution System***

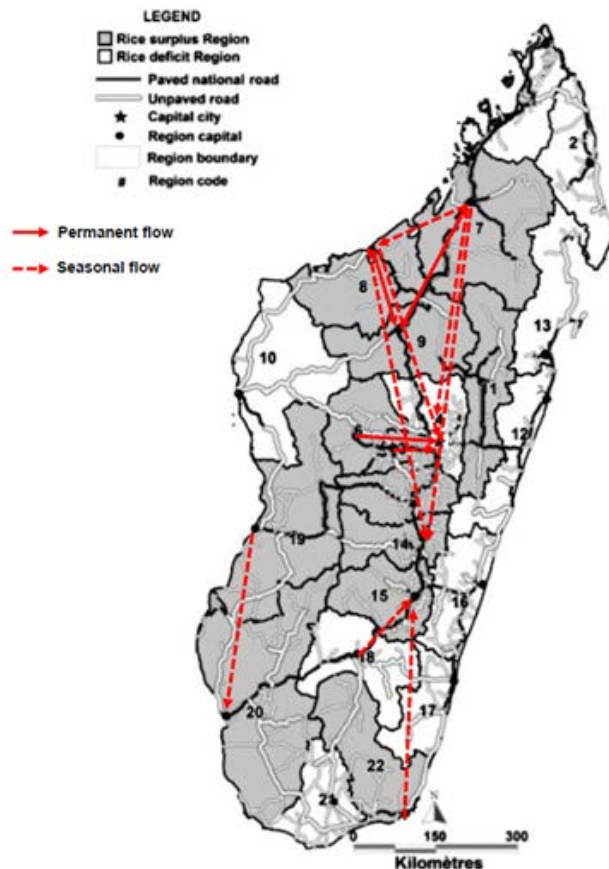
1. Per the 2004-2005 agricultural census, 85% of farmers grow rice – over 2 million households with an average of 5.51 people to 0.87 ha (CARD, 2010)
2. For the 40 years preceding 2007, rice productivity stagnated, with yields of 2 MT/ha (Maret, 2007)
  - a. In key rice-growing areas between 2008 and 2014, productivity increased to 4.8 T/ha from 2.5/ha; this directly benefitted 8,300 farming families (World Bank, 2016b)
3. There are three principal types of rice production in Madagascar: water, rainfed, and slash and burn (CARD, 2010)
4. 73% of rice area is randomly transplanted; 9.4% is transplanted in rows; 12.6% is directly sown; only 0.34% is grown using System of Rice Intensification (SRI) and System of Improved Rice (SRA) techniques (CARD, 2010)

5. Starting in 1972, Madagascar became a net importer of rice (Maret, 2007)
6. Despite initial international competitiveness thanks to low labor costs and minimal use of inputs, Malagasy rice suffers from large marketing costs attributed to a value chain plagued by multiple actors, and transport costs (Maret, 2007; Dostie et al, 1999)
7. Two harvest periods per year: the first is Nov-March, the second is May-Nov (JICA, 2012)
8. According to estimates, 80% of produced rice is consumed on farm (Maret, 2007)
9. Because rice is milled with producer consumption in mind, milling quality is not a stringent requirement (JICA, 2012)
10. Most rice farmers use basic equipment for threshing: rock, drum or timber with plastic sheeting (JICA, 2012)
11. In 1999, there were approximately 2,300 small-scale rice processing units in Madagascar; these units employed about 10,000 laborers, and processed 200-1,100 MT/year (European Cooperative for Rural Development, 2012)
  - a. The existence of so many small-scale rice processing units creates competition for large-scale rice processors (European Cooperative for Rural Development, 2012)
12. 100 wholesalers across the country are responsible for 5,000-10,000 MT in sales (per wholesaler) (European Cooperative for Rural Development, 2012)
13. Estimated 23,800 operators/retailers in country with an aggregate storage capacity of 56,000 MT (European Cooperative for Rural Development, 2012)
14. Manual pounding of rice is still commonplace, though some processors are involved in parboiling and husking (CARD, 2010)
15. Figures below illustrate the flow of two of the three main domestically-produced varieties; these two varieties (vary gasy and tsipala) made up 84% of the observations in a 2015 analysis (Ralandison et al, 2015)

**Figure A6.1:** Localization of inter-regional flows of vary gasy variety  
Source: (Ralandison et al, 2015)



**Figure A6.2:** Localization of inter-regional flows of tsipala variety  
Source: (Ralandison et al, 2015)



### ***Relevance to Other Health and Agriculture Programs***

1. Anemia not identified as a priority in the National Nutrition Plan 2012-2015 (World Health Organization, 2016)
2. World Food Programme
  - a. School feeding: supports 250,000 children – 1,200 schools in the south (World Food Programme, 2016)
  - b. Home Grown School Feeding: links school feeding to smallholder farmers’ production – piloting during 2016/2017 school year (World Food Programme, 2016)
  - c. Purchase for Progress (P4P): has benefited 4,000 famers in the south (World Food Programme, 2016)
3. In September 2016, the Government of Japan contributed \$21.6 million to WFP for food and nutrition assistance to the most vulnerable in 11 countries; Madagascar received \$2.3 million (World Food Programme, 2016 (Japan))

### ***Partners***

1. Government of Madagascar's L'observatoire du Rix (OdR)

2. AfricaRice
3. World Food Programme (WFP)
4. World Bank

### ***Potential Barriers to Rice Fortification***

1. Lack of centralized value chain
2. Lack of consolidation of milling enterprises
3. Historical politicization of rice
4. Limited/no government programs for purchasing of domestic rice

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## Appendix 7: MALI

### *Population and Demography* (World Bank, 2016)

1. Population size: 17,599,694 (2015)
2. Urban/rural distribution
  - a. Rural: 60.1% (2015)
  - b. Urban: 39.9% (2015)
3. Age distribution: 47.5% of population 0-14, 50% of population 15-64, 2.5% of population 65+ (2015)
4. GDP per capita in current USD = 744.4 (2015)
5. Fertility rate: 6.2 births/woman (2014)
6. Life Expectancy at birth:
  - a. Women: 57.8 (2014)
  - b. Men: 58.2 (2014)
7. Education:
  - a. Literacy rate:
    - i. Females (age 15+): 22.2% (2015)
    - ii. Males (age 15+): 45.1% (2015)
  - b. Years of compulsory education: 9 (2014)
  - c. Children out of school (% of primary school age children who are not enrolled in primary or secondary school)
    - i. Female: 40% (2014)
    - ii. Male: 33% (2014)

### *Health Needs Assessment*

1. Anthropometric indicators by sex and age group (CPS/SSDSPF et al, 2014):
  - a. Children (6-59 months)
    - i. Stunting: 38%
    - ii. Wasting: 13%
    - iii. Underweight: 26%
  - b. Women (15-49 years)
    - i. Short stature: 0.5% <145cm
    - ii. Underweight BMI: 12%;
      1. 12% rural vs. 9% urban
    - iii. Normal BMI: 70% of women 15-49 have normal BMI,
    - iv. Overweight/obese BMI: 18%; 5% are obese
2. Prevalence of anemia by sex and age group (CPS/SSDSPF et al, 2014)
  - a. Children (6-59 months)
    - i. 82% are anemic; 21% slightly, 52% moderate, 9% severe
      1. 77% of 36-47 mos, 73% of 48-59 mos
      2. 82.8% of male vs. 80.4% of female
      3. 85% rural vs 68% urban
        - a. 55% of rural children are moderately anemic, 11% are severely anemic
  - b. Women (15-49 years)
    - i. 51% are anemic
    - ii. 56% of mothers of 4-5 children
3. Prevalence of neural tube defects



- a. 27 per 10,000 births (2012 estimate) (FFI, 2016)
- 4. Dietary Analysis (including supplementation)
  - a. Children (6-59 months) (CPS/SSDSPF et al, 2014)
    - i. 49% of children 6-23 mos consumed iron-rich foods during the 24 hours preceding the survey; 59% urban vs. 46% rural
    - ii. 21.6% of children 6-23 mos fed from 4+ food groups
    - iii. 27.9% of children 6-23 mos meet minimum meal frequency
    - iv. 54.6% of children 6-23 mos (who live with their mothers) consumed foods rich in Vitamin A in past 24 hours
    - v. 48.8% of children 6-23 mos (who live with their mothers) consumed foods rich in iron in the past 24 hours
    - vi. 60.8% of children 6-59 mos given vitamin A supplements in past 6 months
    - vii. 25.4% of children 6-59 mos given iron supplements in past 7 days
    - viii. 31.4% of children 6-59 mos given deworming medication in past 6 months
    - ix. 95.4% of children 6-59 mos living in households tested for iodized salt, lived in households with iodized salt
  - b. Women (15-49 years) (CPS/SSDSPF et al, 2014)
    - i. 50.2% of women 15-49 years with a child born in the past five years received vitamin A dose postpartum (within first 2 months of giving birth)
    - ii. 28% of women 15-49 years with a child born in the past five years took iron tablets for <60 days during their pregnancy of last birth
    - iii. 18.3% of women 15-49 years with a child born in the past five years took iron tablets for 90+ days during their pregnancy of last birth (recommended)
    - iv. 27.2% of women 15-49 years with a child born in the past five years took deworming medication during pregnancy of last birth
    - v. 95.2% women 15-49 years with a child born in the last five years, who living in households tested for iodized salt, lived in households with iodized salt
  - c. Other Micronutrients
    - i. 22.3% of population at risk of inadequate zinc intake (FFI, 2016; Wessells & Brown, 2012)
    - ii. Hidden Hunger Index score<sup>1</sup> of 46 (14<sup>th</sup> out of top 20 highest burden countries) (Sight and Life, 2013)

### ***Rice Supply***

- 1. Annual production of rice over the past three years

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<sup>1</sup> Hidden Hunger Index Score is calculated as the average of zinc deficiency prevalence (as measured using stunting as a proxy) iron deficiency (as measured by anemia due to iron deficiency), and vitamin A deficiency (as measured by low serum retinol) – all prevalences are equally weighted

**Table A7.1: Annual Rice Production in Mali (2012-2016)**

Source: (International Rice Research Institute, 2016)

	FAO	USDA	
	Paddy (000 t)	Paddy (000 t)	Milled (000 t)
2016		2538	1650
2015		2331	1515
2014	2166.83	2168	1409
2013	2211.92	2212	1438
2012	1914.87	1923	1250

2. Geographic sources of rice
  - a. Rice is produced in seven regions: Gao, Kayes, Koulikoro, Mopti, Segou, Sikasse, and Tombouctou (Caffey and Velupillai, 2004)
3. Domestic rice purchasing programs
  - a. Cereal Banks stock millet, sorghum and rice. Until 2008/09, the Food Security Secretariat procured stock for all 759 banks from local markets (Cherrier et al, 2011)
    - i. Current focus is banks in the most vulnerable 166 communes (Cherrier et al, 2011)
4. Annual import of rice over the past three years

**Table A7.2: Annual Rice Imports to Mali (2012-2016)**

Sources: FAO, USDA and WTO (International Rice Research Institute, 2016), OEC (The Observatory of Economic Complexity, 2016)

	FAO		USDA	OEC	WTO
	Imports (000 t)	Import Value (000 \$)	Imports (000 t)	Top 4 Countries of Origin and Percentage of Imports	Import Tariff
2016			310		
2015			270		
2014			280	Senegal 89%; Cote D'Ivoire 6.9%; United States 1.6%; Thailand 0.95%	Same as 2012
2013	108.56	50706	300	Vietnam 43%; Thailand 27%; Cote D'Ivoire 15%; United States 9.7%	Same as 2012
2012	421.13	87939	310	India 26%; Senegal 15%; Pakistan 13%; Vietnam & Burma 11% each	\$10/kg (broken rice); \$10/kg (husked or brown rice); \$5/kg (paddy rice); \$8.75/kg (rice (no type)); \$10/kg (semi-milled rice)

5. Rice availability (as a proxy for consumption) per capita
  - a. 2011: 57.6 kg/capita/year, 571 kcal/capita/day; 830000/1427000 (58.16%) of total supply used for food (FAOSTAT, 2016)

**Rice Consumption Patterns**

1. "Virtually all value chain studies produced over the last five years claim that Malian consumers prefer the taste of local rice" (USAID, 2009)

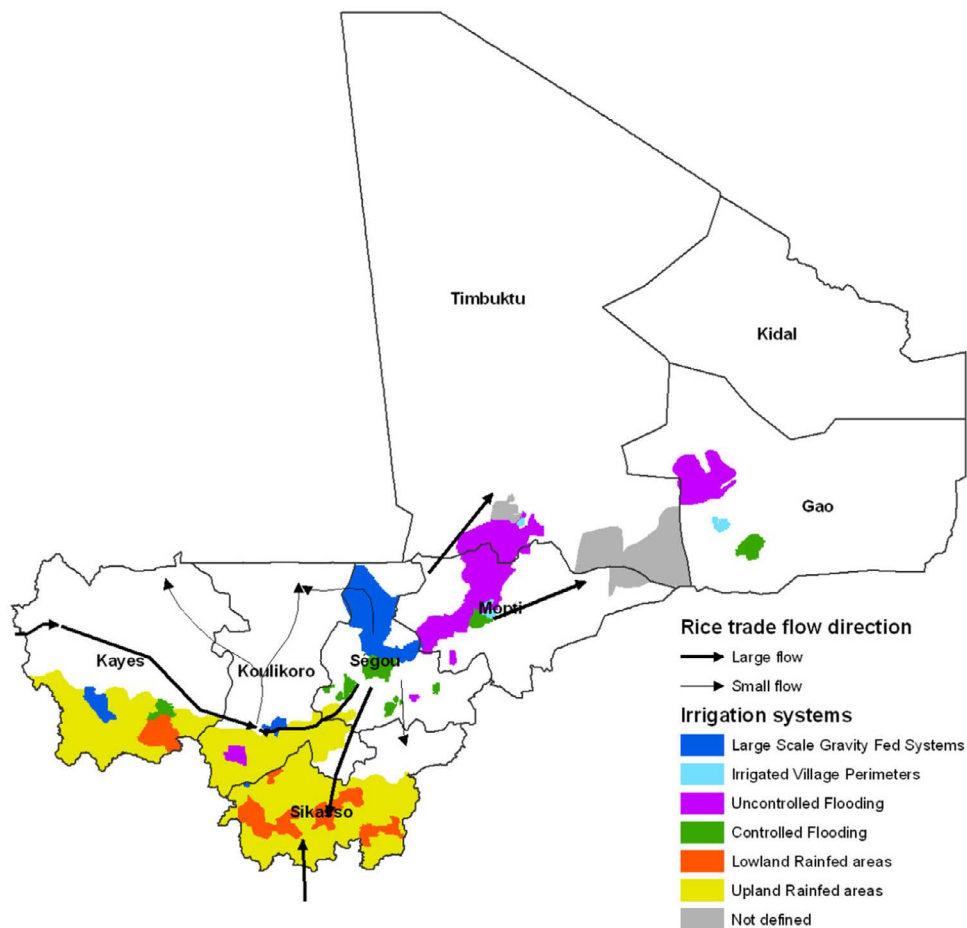
2. “Consumers widely proclaim that imported rice – particularly broken – may gain more volume when cooked (which is seen as a positive factor for big families and consumers preparing celebrations), but that its taste characteristics are vastly inferior to local rice” (USAID, 2009)
3. The Gambiaka variety is the most popular of the domestically produced varieties; it is the dominant variety produced in “full-control irrigated areas” – comprises approximately 90% of the Office du Niger (IFDC, 2008)
4. 25% broken rice is the predominant consumer preference (Elbehri et al, 2013)

***Rice Production and Distribution System***

1. Six main production systems: rainfed on upland areas, rainfed with small-scale water retention structures in lowlands (designed to “enhance natural land contours and permit the controlled use of surface water”), traditional uncontrolled planting, “irrigated village perimeters”, large-scale gravity-fed, and controlled flooding (USAID, 2009)
2. Figure below illustrates trade flows as well as the locations of the different production systems

**Figure A7.1: Trade flows and production systems of rice in Mali**

Source: (USAID, 2009)



3. Table (on next page) provides additional detail about each of the major rice production systems

**Table A7.3: Major Rice Production Systems in Mali**

Source: IFPRI/Harvest Choice; ON Rapports de Campagne; Lamissa Diakit , "Note Technique sur la fili re rix au Mali," 2009; Lansana Tour , Probl matique de la maitrise de l'eau pour l'agriculture, G nie Rurale; GTZ/Programme Mali Nord pour le d veloppement de la petite irrigation; L'irrigation en chiffres, FAO; team estimates for production (USAID, 2009)

Productive System	Geographic Zone	Current Areas	Current Production Estimates (paddy)	Average Farm Size	Potential for Expansion	Yields with Improved Methods (paddy)	Non-Improved Yields (paddy)	Cost of Production (CFA/kg)	Estimated Cost of Water Infrastructure Construction
Large-Scale Gravity-Fed Systems	ON/Segou, Baguin�da, Seling�	90,000 ha	405,000 MT	1-2 ha	900,000 ha	6-10 MT/ha	2-3.5 MT/ha	130 CFA/kg	3-3.5 Million CFA/ha
Small-Scale Village Irrigated Perimeters	Timbuktu, Mopti	3,300 ha	19,800 MT	0.3 ha	30,000 ha	6-7 MT/ha	0-5 MT/ha	159 CFA/kg	700,000-1 Million CFA/ha
Controlled Flooding	Mopti, Segou	75,000 ha	111,000 MT	2.5-10 ha	150,000-300,000 ha	2-3 MT/ha	0.8 MT/ha	192 CFA/kg	50,000-1.6 Million CFA/ha
Uncontrolled Plain Flooding	Mopti	150,000-300,000 ha	225,000 MT	10 ha		1.2 MT/ha	0.8 MT/ha	181 CFA/kg	
Rainfed Systems with Small-Scale Water Retention Structures ("bas fonds")	Sikasso, Cotton Zone	5,000 ha	10,000 MT	Less than 0.5 ha	300,000 ha	3 MT/ha	0.8 MT/ha	96 CFA/kg	600,000 CFA/ha
Rainfed upland systems	Sikasso, Cotton Zone	14,000 ha	28,000 MT	Less than 0.5 ha	300,000-800,000 ha	2-3 MT/ha	0.8 MT/ha	130 CFA/kg	

#### 4. Production seasons

**Table A7.4: Rice Production Cycle in Mali**

Source: (Ricepedia, 2014)

	Planting	Harvesting
Main	May-Jul	Oct-Dec
Off	Jan-Mar	May-Jul
Deepwater rice	Jul-Aug	Dec-Jan

5. It takes 125-140 days from planting to harvest time in the irrigation areas (Caffey and Velupillai, 2004)
6. Historical consolidation of mills; in the 1980s liberalization of the rice sector led to privatization of mills; a report in 2008 stated existence of 2000 village mills – 700 of which are in the Office du Niger (IFDC, 2008)
  - a. When the rice milling sector was formally privatized in 1991, 8 large mills (total capacity of 115,000 MT/year) were sold; as of November 2004, 6 of the 8 were closed (Caffey and Velupillai, 2004)
  - b. There is one exception; in S gou, the Grand Distributeur Cerelier du Mali (GDCM) processes 10,000 tons/year (IFDC, 2008)

- c. In 2008/09, Groupe AMI began purchasing 2,000 tons of paddy rice for processing in its 5 40 ton per day capacity mills. This was in preparation for the launch of a line of local high-quality rice (USAID, 2009)
- 7. Typical village mill fees are 11 FCFA/kg (IFDC, 2008)
- 8. >90% (estimate) of rice farmers belong to an operational and organized local group; this translates to >2 million producers across Mali (N'krumah et al, 2013)
  - a. Main role of these organizations is to establish credibility to work with microfinance institutions. Additional roles include handling of marketing and processing as well as advocacy in state dialogues (N'krumah et al, 2013)
- 9. “Traditional, small-scale trade represents the largest channel handling 80 percent of the total trade” (USDA FAS, 2013)
- 10. Malô, a organization created in 2013 by brothers, purchases domestically produced rice (sourcing from smallholder farmers) and fortifies it in-country. It is the first rice fortification facility in Africa (Feed the Future, 2015)
  - a. Malô works with a cooperative of 30,000 farmers, and it's first facility has the capacity to meet the needs of 25,000 people per year (Feed the Future, 2013)
  - b. Processing model uses extrusion technology to mix rice flour (from grains which fail to meet quality control standards) with micronutrients like iron, folate and Vitamin B12 and create fortified rice kernels. These kernels are blended in a 1:100 ratio with rice (Malô, 2014)

#### ***Relevance to Other Health and Agriculture Programs***

- 1. Anemia is identified in the CSCRP (national poverty reduction strategy) (Republique du Mali, 2011)
- 2. World Food Programme
  - a. Purchase for Progress (P4P) purchasing began in 2012 (Food and Agriculture Organization, 2016)
  - b. From 2011-2012, 2,080 MT of local paddy rice were procured by WFP (Food and Agriculture Organization, 2016)

#### ***Partners***

- 1. Path
- 2. AfricaRice (including outreach station)
- 3. International Center for Tropical Agriculture (CIAT)
- 4. French Agricultural Research Centre for International Development (CIRAD)
- 5. International Relief & Development (IRD)
- 6. International Rice Research Institute (IRRI)
- 7. Japan International Research Center for Agricultural Sciences (JIRCAS)
- 8. Consortium of International Agricultural Research Centers (CGIAR)
- 9. CAB International (CABI)
- 10. Coherence in Information for Agricultural Research for Development (CIARD)
- 11. International Center for Development-Oriented Research in Agriculture (ICRA).
- 12. United States Agency for International Development (USAID), Enabling Agricultural Trade (EAT) Project
  - a. Fintrac Inc.
- 13. World Food Programme (WFP)
- 14. United States Department of Agriculture (USDA) – Food for Progress
  - a. Aga Khan Foundation (AKF)

b. ACDI/VOCA

***Potential Barriers of rice fortification (production/distribution)***

1. Poor access, availability, and high costs of inputs (IFDC, 2008)
2. Limited access to finance and high interest rates (IFDC, 2008)
3. Lack of consolidation of milling enterprises
4. “Unpredictable and protectionist policy constrains development of all aspects of the rice value chain from processing to seed production and is only partially countered by the GoM’s Initiative Riz interventions in the supply of inputs.” (USAID Enabling Agricultural Trade, 2012)

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## **Appendix 8: SENEGAL**

### ***Population and Demography*** (World Bank, 2016)

1. Population size: 15,129,273 (2015)
2. Urban/rural distribution
  - a. Rural: 56.3% (2015)
  - b. Urban: 43.7% (2015)
3. Age distribution: 43.8% 0-14, 53.3% 15-64, 2.9% 65+ (2015)
4. GDP per capita in current USD = 910.79 (2015)
5. Fertility rate: 5.1 (2014)
6. Life Expectancy:
  - a. Women: 68.3 (2014)
  - b. Men: 64.5 (2014)
7. Education:
  - a. Literacy rate:
    - i. Females (age 15+): 43.8% (2015)
    - ii. Males (age 15+): 68.5% (2015)
  - b. Years of compulsory education: 11 (2014)
  - c. Children out of school (% of primary school age children who are not enrolled in primary or secondary school)
    - i. Female: 24.1% (2014)
    - ii. Male: 30.2% (2014)

### ***Health Needs Assessment***

1. Anthropometric indicators by sex and age group
  - a. Children (6-59 months) (ANSD and ICF, 2015)
    - i. Stunting: 20.5%; 5.2% severe
      1. 26.3% of 24-35 mos are stunted
      2. 22.5% male vs. 18.5% of female
      3. 23.9% rural vs. 14.3% urban
    - ii. Wasting: 7.8%; 1.4% severe
      1. highest prevalence is among 12-17 mos at 11%
      2. 8.3% male vs. 7.4 female
      3. 6.5% urban vs. 8.6% rural
    - iii. Underweight: 15.5%; 3.2% severe
      1. 18.3% rural vs. 10.4% urban
      2. 16.8% male vs. 14.2% female
  - b. Women (15-49 years) (ANSD and ICF, 2012)
    - i. Short stature: 0.2% of women have height <145cm
    - ii. Underweight BMI: 22%
    - iii. Normal BMI: 56.7%
    - iv. Overweight/obese BMI: 21.3%
2. Prevalence of anemia by sex and age group
  - a. Children (6-59 months)
    - i. 66% are anemic (ANSD and ICF, 2015)
      1. 69% male vs. 64% of female (ANSD and ICF, 2015)
      2. 57% urban vs. 71% rural (ANSD and ICF, 2015)



- ii. 2014 DHS reports that 60% are anemic; 26% slightly, 65% moderately, 2% severely; 12-23 mos were most affected 76% (ANSD and ICF, 2015)
  - b. Women (15-49 years) (ANSD and ICF, 2012)
    - i. 54% are anemic; 39% mild, 14% moderate, 2% severe
    - ii. 55% in women 15-29
    - iii. Pregnant women 61% vs. breastfeeding women 49% vs. neither pregnant nor breastfeeding 56%
  - c. Men (15-59 years) (ANSD and ICF, 2012)
    - i. 31% are anemic
    - ii. 54% of 15-19 years vs. 21-25% for all other groups
- 3. Prevalence of neural tube defects
  - a. 27 per 10,000 births (2012 estimate) (FFI, 2016)
- 4. Dietary Analysis (including supplementation)
  - a. Children (6-59 months)
    - i. Only 10% of children 6-23 mos achieved minimum acceptable diet (ANSD and ICF, 2015)
    - ii. 21% of children 6-23 mos fed from 4+ food groups (ANSD and ICF, 2015)
    - iii. 35% of children 6-23 mos meet minimum meal frequency (ANSD and ICF, 2015)
    - iv. 62.7% of children 6-23 mos (who live with their mothers) consumed foods rich in Vitamin A in past 24 hours (ANSD and ICF, 2012)
    - v. 47.8% of children 6-23 mos (who live with their mothers) consumed foods rich in iron in the past 24 hours (ANSD and ICF, 2012)
    - vi. 78.4% of children 6-59 mos given vitamin A supplements in past 6 months (ANSD and ICF, 2012)
    - vii. 12.8% of children 6-59 mos given iron supplements in past 7 days (ANSD and ICF, 2012)
    - viii. 55.5% of children 6-59 mos given deworming medication in past 6 months (ANSD and ICF, 2012)
    - ix. 41.5% of children 6-59 mos living in households tested for iodized salt, lived in households with iodized salt (ANSD and ICF, 2012)
  - b. Women (15-49 years)
    - i. 45.4% of women 15-49 with a child born in the past five years received vitamin A dose postpartum (within first 2 months of giving birth) (ANSD and ICF, 2012)
    - ii. 13.3% of women 15-49 with a child born in the past five years took iron tablets for <60 days during their pregnancy of last birth (ANSD and ICF, 2012)
    - iii. 62.6% of women 15-49 with a child born in the past five years took iron tablets for 90+ days during their pregnancy of last birth (recommended) (ANSD and ICF, 2012)
    - iv. 24.9% of women 15-49 with a child born in the past five years took deworming medication during pregnancy of last birth (ANSD and ICF, 2012)
    - v. 42.8% women 15-49 with a child born in the last five years, who living in households tested for iodized salt, lived in households with iodized salt (ANSD and ICF, 2012)
    - vi. 2011 study of pregnant women found that while 39% of the women were anemic, 70% were iron deficient. IDA prevalence was 33% (Seck and Jackson, 2011)
  - d. Other Micronutrients
    - i. 24.6% of population at risk of inadequate zinc intake (FFI, 2016; Wessells & Brown, 2012)

### ***Rice Supply***

1. Annual production of rice over the past three years

**Table A8.1: Annual Rice Production in Senegal (2012-2016)**

Source: (International Rice Research Institute, 2016)

	FAO	USDA	
	Paddy (000 t)	Paddy (000 t)	Milled (000 t)
2016		1000	680
2015		918	624
2014	559.02	559	380
2013	436.15	435	296
2012	469.65	471	320

## 2. Geographic sources of rice

- a. Principal production zones: Senegal River Valley, Lower Casamance (Ziguinchor region), Upper and Middle Casamance (Kolda region), and small amounts from Koalack and Fatick (USAID, 2009)

## 3. Domestic rice purchasing programs by region or provincial government, if any (TBD)

## 4. Annual import of rice over the past three years

**Table A8.2: Annual Rice Imports to Senegal (2012-2016)**

Sources: FAO, USDA and WTO (International Rice Research Institute, 2016), OEC (The Observatory of Economic Complexity, 2016)

	FAO		USDA	OEC	WTO
	Imports (000 t)	Import Value (000 \$)	Imports (000 t)	Top 4 Countries of Origin and Percentage of Imports	Import Tariff
2016			990		
2015			985		
2014			990	India 53%; Thailand 24%; Brazil 7.8%; Argentina 4.2%	Same as 2012
2013	1123.55	460206	960	India 59%; Thailand 18%; Brazil 7.6%; Pakistan 6.7%	Same as 2012
2012	1040.8	450500	902	India 52%; Vietnam 12%; Thailand 11%; Brazil 8.1%	\$10/kg (broken rice); \$10/kg (husked or brown rice); \$5/kg (paddy rice); \$8.75/kg (rice (no type)); \$10/kg (semi-milled rice)

## 5. Rice availability (as a proxy for consumption) per capita

- a. 2013: 715 kcal/capita/day; 1022000/1109000 (-92.16%) of total supply used for food (FAOSTAT, 2016)

**Rice Consumption Patterns**

1. In urban areas, rice represents 54% of cereal consumption compared with 24% in rural areas (USAID, 2009)
  - a. Rice represents a quarter of household spending in rural areas compared with 18% in urban (USAID, 2009)
2. Most paddy production is used for home consumption outside of the Matam and Saint-Louis regions (USAID, 2009)

3. When purchasing rice, consumers prize the following: taste, ease of preparation, absence of foreign objects, and “a high rate of swelling”; in addition, urban consumers appreciate the visual presentation and cleanliness of rice (USAID, 2009)
  - a. “Consumers generally recognize that cheaper prices correspond with lower quality and tend to remain loyal to their preferences when prices increase, as long as it is still within their means. Historically imports have split equally between fragrant and non-fragrant rice” (USAID, 2009)
4. 95% of imports are broken rice (USAID, 2009)
  - a. Preference is more concentrated in urban areas (Dakar specifically) (USAID, 2009)
  - b. Despite preference for broken rice, “most consumers regularly purchase both broken and whole-grain rice” (USAID, 2009)
    - i. Demand is likely driven by recipe: mafé uses whole grain while thieboudienne (the national dish) uses broken (USAID, 2009)
5. In rural areas, imports are <10% of total consumption; preference is for whole grains (USAID, 2009)
6. Only 60% of consumers in the capital know about local rice (USAID, 2009; Rutsaert, 2009)
7. Table below details regional demand preferences

**Table A8.3: Regional differences in demand preferences for rice in Senegal**

Sources: (USAID, 2009; Rutsaert, 2009)

Rice Type	Ross-Béthio	Podor	Saint-Louis	Dakar
Local whole	60%	54%	35%	4%
Local intermediate	21%	19%	8%	1%
Local broken	19%	6%	35%	1%
<b>Total Local</b>	<b>100%</b>	<b>79%</b>	<b>78%</b>	<b>6%</b>
Imported whole	0%	4%	1%	6%
Imported intermediate	0%	9%	0%	1%
Imported broken	0%	8%	21%	88%
<b>Total Imported</b>	<b>0%</b>	<b>21%</b>	<b>22%</b>	<b>95%</b>

### *Rice Production and Distribution System*

1. Irrigated rice = 70% of production (yields 5-6 MT/ha) (USAID, 2009)
  - a. 50,469 ha in Matam and Saint-Louis regions bordering Senegal River; 2,810 ha in Anambé Basin in Kolda region (USAID, 2009)
  - b. Consistent strong yields are attributed to use of improved seed, prevalence of mechanized operations, application of fertilizers and herbicides, and predictable water levels (USAID, 2009)
  - c. Production costs estimated to be \$0.15/kg in Saint-Louis region to \$0.25/kg in Anambé Basin (USAID, 2009)
2. Rainfed = 30% of production (yields 1-2 MT/ha) (USAID, 2009)
  - a. Concentrated in the Casamance (Ziguinchor and Kolda regions); 95% of rainfed production occurs in this area (USAID, 2009)
  - b. 90% of population lives in rainfed production zones (USAID, 2009)
3. Smallholder farmers are almost exclusively responsible for rice production (USAID, 2009)
4. In a sample of 245 rice-producing households representative of the Delta region of the Senegal River Valley, the average rice production per year was 11 MT, with over half of the farmers reporting cultivation of an area <1.5 ha (Colen et al, 2013)
5. Table below lists practices in the different production areas

**Table A8.4: Comparison of farming practices among rice-producing areas in Senegal**

Source: (USAID, 2009)

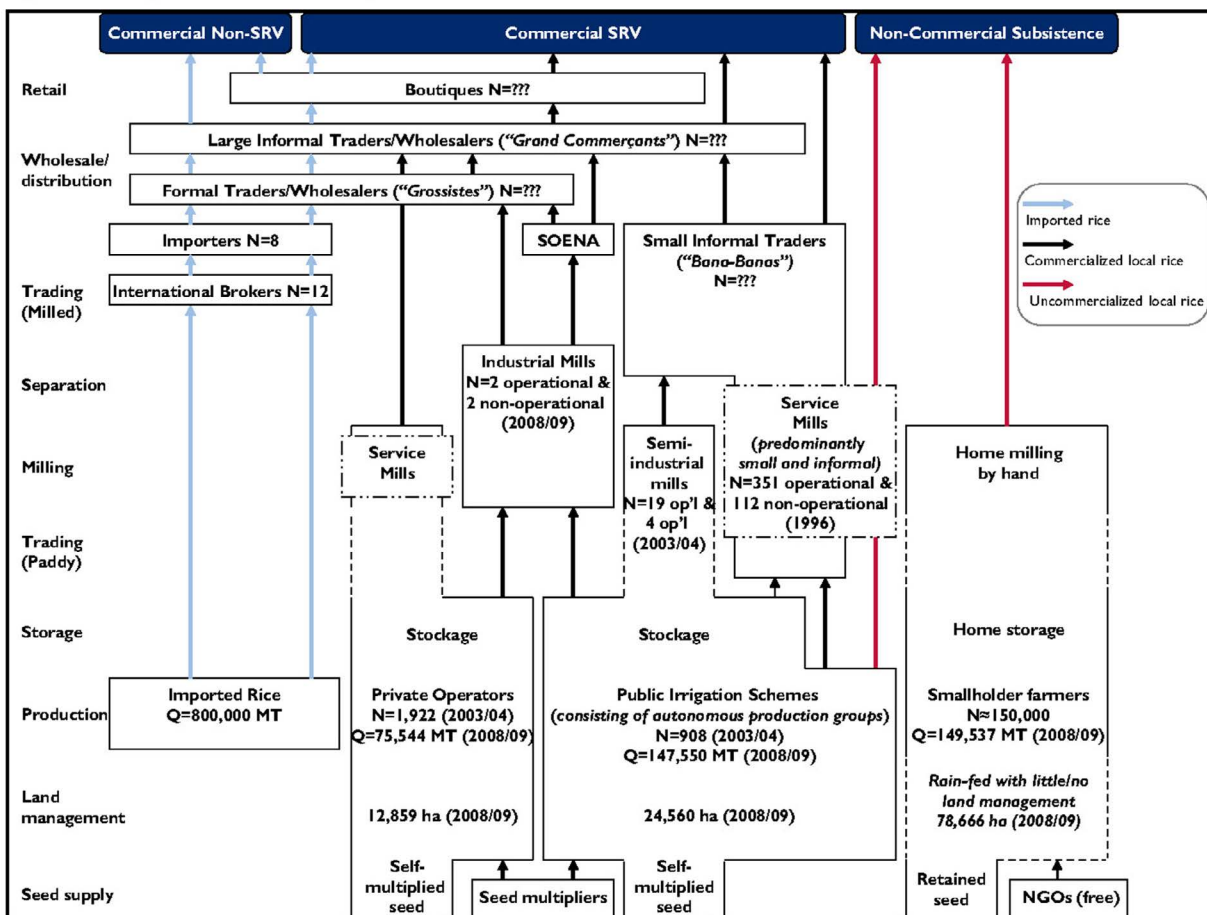
	Saint-Louis & Dagana	Podor & Matam	Fatick	Kolda	Ziguinchor
<b>Rice as staple food</b>	Primary	Primary	Secondary	Secondary	Primary
<b>Season</b>	Jun/Aug–Oct/Dec Jan/Feb–Apr/May	Jun/Aug–Oct/Dec	Jul/Aug–Sep/Oct	Jul–Oct	Jul–Oct
<b>Varieties</b>	High-yielding (improved)	High-yielding (improved)	Local varieties (partly improved)	Local varieties	Local varieties
<b>Farming environment</b>	Irrigated lowland	Irrigated lowland	Rain-fed lowland	Rain-fed lowland	Rain-fed lowland/upland
<b>Parcel size</b>	Large (>1 ha)	Medium (>0.25 ha)	Small (<0.1 ha)	Small (<0.1 ha)	Small (<0.1 ha)
<b>Main cultivators</b>	Men	Men & women	Women	Women	Men & women
<b>Land preparation</b>	Mechanized	Mechanized	Manual	Manual	Manual
<b>Fertilizer dosage</b>	High	High	None to minimum	Low	None to minimum
<b>Herbicide use</b>	Common	Common/None	None	None	None
<b>Harvesting</b>	Mechanized, manual	Manual, mechanized	Manual	Manual	Manual
<b>Threshing</b>	Mechanized	Manual, mechanized	Manual	Manual	Manual
<b>Average yield</b>	>5 MT/ha	>4 MT/ha	1-2 MT/ha	1-2 MT/ha	1-2 MT/ha
<b>Destination</b>	Consumption, sale	Consumption, sale	Consumption	Consumption	Consumption

Source: JICA 2006, “Study Reorganization Rice Senegal.”

6. Rice industry was liberalized in the 1990s (USAID, 2009)
7. Grande Offensive Agricole pour la Nourriture et l’Abondance (GOANA) is a “strategic emergency program to achieve complete food self-sufficiency by 2015” (USAID, 2009)
8. Local rice is rarely available in domestic markets between November and January (USAID, 2009; JICA and Government of Senegal, 2006)
9. Figure below is a map of the rice value chain

**Figure A8.1: Map of Rice Value Chain in Senegal**

Source: (USAID, 2009)



10. Four importers control 66% of all imports; the remaining market share is controlled by approximately 4 others (USAID, 2009; World Food Programme, 2008)
  - a. Large importers deal through a group of 12 brokers in Switzerland; they then store imports in their warehouses in Dakar (USAID, 2009)
  - b. Smaller importers work in “container-sized transactions” compared to shiploads, which are distributed shortly upon arrival (USAID, 2009)
11. In the Senegal River Valley, there are 2 parallel processing systems: 1) small, informal mills typically at village level – remove husk 2) larger semi-industrial mills (Colen et al, 2013)
12. In southern Senegal, most processing is manual, as there is limited availability of small mechanical mills (Colen et al, 2013)
13. Nationwide there are 2 large industrial mills in operation (USAID, 2009)
14. Production seasons

**Table A8.5: Rice Production Cycle in Senegal**

Source: (Ricepedia, 2014)

	Planting	Harvesting
Main	Jun-Jul	Oct-Dec
Off	Feb-Mar	Jun-Jul

***Relevance to Other Health and Agriculture Programs***

1. National Nutrition Policy (2013-2018) includes oil and flour fortification, and salt iodization (USAID 2014)
2. World Food Programme
  - a. School Feeding
    - i. In approximately 260 schools across the country, canteens are supplied with cash vouchers for local food procurement (World Food Programme, 2015)
    - ii. In pilot phase, nearly 1,000 MT of rice, millet, maize, salt, cowpeas and other items were locally purchased (World Food Programme, 2015)

***Partners***

1. PAA Senegal (part of Purchase from Africans for Africa)
  - a. Promotes South-South exchanges in partnership with Brazil to support linkages between school feeding programmes and local food production (PAA Senegal, 2015)
2. World Food Programme
3. AfricaRice
4. GAIN
5. National Food Fortification Alliance (Cosfam)
6. USAID
  - a. Feed the Future
7. Générale Alimentaire Africaine (GAA)
  - a. Created in 2008, working to actively develop value chain through installation of rice processing facilities – specifically in the Saint Louis region (New Alliance for Food Security & Nutrition, 2013)
  - b. Additional funding for “increased processing and commercialization of rice by-products, specifically the installation of industrial complexes consisting of rice hulling stations” (New Alliance for Food Security & Nutrition, 2013)
8. Comptoir Commercial Mandiaye Ndiaye (CCMN)
  - a. Rice import company working in Saint Louis region on a rice processing facility (60 MT/day capacity) (New Alliance for Food Security & Nutrition, 2013)
9. Continental Foods Company (subsidiary of The Teylium Group)
  - a. Investing in double cropping rice with another variety “through the irrigation pivots and gravity system” (New Alliance for Food Security & Nutrition, 2013)
10. AfricaGraines (Senegalese subsidiary of French group, Agreenoval)
  - a. US\$2M investment in production of rice, cowpea, maize, green beans, and guar bean seeds (New Alliance for Food Security & Nutrition, 2013)
11. Export Trading Group (ETG)
  - a. Supply chain management company investing in establishing a rice, groundnut, and maize processing plant (5,000 MT/year capacity) (New Alliance for Food Security & Nutrition, 2013)
12. Novel Group SA

- a. Specialized in the production and trade of soft commodities particularly rice – planning investments in training of SMEs (New Alliance for Food Security & Nutrition, 2013)

### ***Potential Barriers to Rice Fortification***

1. Production
  - a. Needs more private sector/government collaboration (USAID, 2009)
  - b. Lack of inputs and equipment (small-scale rice mills)
  - c. Lack of consolidation of milling enterprises
  - d. Increase productivity in southern rainfed production (Colen et al, 2013)
2. Access to markets/road infrastructure
3. Create greater space for local rice in urban markets
  - a. Upgrade quality to appeal to urban consumer (Colen et al, 2013)
4. Limited/no government programs for purchasing of domestic rice

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## **Appendix 9: SIERRA LEONE**

### ***Population and Demography*** (World Bank, 2016)

1. Population size: 6,453,184 (2015)
2. Urban/rural distribution
  - a. Rural: 60.1% (2015)
  - b. Urban: 39.9% (2015)
3. Age distribution: 42.4% 0-14, 55% 15-64, 2.7% 65+ (2015)
4. GDP per capita in current USD = 693.4 (2015)
5. Fertility rate: 4.6 births per woman (2014)
6. Life Expectancy:
  - a. Women: 51.4 (2014)
  - b. Men: 50.4 (2014)
7. Education:
  - a. Literacy rate:
    - i. Females (age 15+): 38.2% (2015)
    - ii. Males (age 15+): 59% (2015)
  - b. Years of compulsory education: 9 (2014)
  - c. Children out of school (% of primary school age children who are not enrolled in primary or secondary school)
    - i. Female: 1.3% (2012)
    - ii. Male: 0% (2012)

### ***Health Needs Assessment***

1. Anthropometric indicators by sex and age group
  - a. Children (6-59 months) (SSL and ICF, 2014)
    - i. Stunting: 38%; 18% severe
      1. 49% of 18-23 mos; 38.9% boys vs. 36.9% girls
      2. Increased from 36% in 2008 DHS
    - ii. Wasting: 9%
      1. 10.7% male vs. 8% female
    - iii. Underweight: 16%; 6% severely
      1. 17.6% male vs. 15.4% female
      2. Decreased from 21% in 2008
    - iv. Overweight/obese: 2%
      1. Down from 4% in 2008 DHS
  - b. Women (15-49 years) (SSL and ICF, 2014)
    - i. Short stature: 2.1% <145cm
    - ii. Underweight BMI: 9.1%
    - iii. Normal BMI: 72.6%
    - iv. Overweight/obese BMI: 18.3%
2. Prevalence of anemia by sex and age group
  - a. Children (6-59 months) (Ministry of Health and Sanitation et al, 2015)
    - i. 76.3% are anemic
      1. 88.1% of 6-11 mos old are anemic
    - ii. 78.3% male vs. 74.5% female
    - iii. 67.7% urban vs. 81.6% rural

- iv. 5.2% of children 6-59 months are iron deficient vs. 3.8% are iron deficient anemic
- b. Women (15-49 years) (SSL and ICF, 2014)
  - i. 44.8% are anemic; 35% mild, 10% moderate, <1% severe
  - ii. 36.8% urban vs. 49.2% rural
  - iii. Prevalence of 50% among women 15-19 years
- c. Men (15-59 years) (SSL and ICF, 2014)
  - i. 32.5% are anemic
    - 1. 39.1% of 50-59 years, 31.8% of 15-49 years; of the 15-49 year age bracket, 36.3% rural vs. 24.4 urban
- 3. Prevalence of neural tube defects
  - a. 27 per 10,000 births (2012 estimate) (FFI, 2016)
- 4. Dietary Analysis (including supplementation)
  - a. Children (6-59 months)
    - i. 16.1% of children 6-23 mos fed from 4+ food groups (SSL and ICF, 2014)
    - ii. 38.9% of children 6-23 mos meet minimum meal frequency (SSL and ICF, 2014)
    - iii. 45.7% of children 6-23 mos (who live with their mothers) consumed foods rich in Vitamin A in past 24 hours (SSL and ICF, 2014)
    - iv. 31.9% of children 6-23 mos (who live with their mothers) consumed foods rich in iron in the past 24 hours (SSL and ICF, 2014)
    - v. 83.2% of children 6-59 mos given vitamin A supplements in past 6 months (SSL and ICF, 2014)
    - vi. 36.1% of children 6-59 mos given iron supplements in past 7 days (SSL and ICF, 2014)
    - vii. 57.6% of children 6-59 mos given deworming medication in past 6 months (SSL and ICF, 2014)
    - viii. 79.6% of children 6-59 mos living in households tested for iodized salt, lived in households with iodized salt (SSL and ICF, 2014)
    - ix. 40.5% of children 6-59 mos were given iron tablets or syrup in the past six months (Ministry of Health and Sanitation et al, 2015)
    - x. 81.4% of children 6-59 mos were given a vitamin A capsule in the past six months (Ministry of Health and Sanitation et al, 2015)
    - xi. 58.4% of children 12-59 mos were given deworming medication during the last health week (Ministry of Health and Sanitation et al, 2015)
  - c. Women (15-49 years) (SSL and ICF, 2014)
    - i. 76.9% of women 15-49 with a child born in the past five years received vitamin A dose postpartum (within first 2 months of giving birth)
    - ii. 28.2% of women 15-49 with a child born in the past five years took iron tablets for <60 days during their pregnancy of last birth
    - iii. 30% of women 15-49 with a child born in the past five years took iron tablets for 90+ days during their pregnancy of last birth (recommended)
    - iv. 72.4% of women 15-49 with a child born in the past five years took deworming medication during pregnancy of last birth
    - v. 80% women 15-49 with a child born in the last five years, who living in households tested for iodized salt, lived in households with iodized salt
  - d. Other Micronutrients

- i. 27.2% of population at risk of inadequate zinc intake (FFI, 2016; Wessells and Brown, 2012)
- ii. Hidden Hunger Index score<sup>1</sup> of 50 (6<sup>th</sup> out of top 20 highest burden countries) (Sight and Life, 2013)

### ***Rice Supply***

1. Rice is considered a critical staple crop for Sierra Leone. The land is suitable for rice production with over 90% of the lowland area arable (Conteh et al, 2012)
2. Annual production of rice over the past three years

**Table A9.1: Annual Rice Production in Sierra Leone (2012-2016)**

Source: (International Rice Research Institute, 2016)

	FAO	USDA	
	Paddy (000 t)	Paddy (000 t)	Milled (000 t)
2016		1100	693
2015		1271	801
2014	1155	1156	728
2013	1255.56	1256	791
2012	1141.42	1141	719

3. Geographic sources of rice
  - a. Five Northern Growth Pole (NGP) districts [Port Loko, Bombali, Tonkolili, Western Area and Kambia] account for 45% of national production (Spencer and Fornah, 2014)
4. Domestic purchasing programs by region or provincial government, if any
  - a. Despite disturbances from the Ebola epidemic, WFP purchased >68 MT of local rice in 2014 for distribution in the Port Loko district (Bakalilou and Ortiz, 2015)
5. Annual import of rice over the past three years.

**Table A9.2: Annual Rice Imports to Sierra Leone (2012-2016)**

Sources: FAO, USDA and WTO (International Rice Research Institute, 2016), OEC (The Observatory of Economic Complexity, 2016)

	FAO		USDA	OEC	WTO
	Imports (000 t)	Import Value (000 \$)	Imports (000 t)	Top 4 Countries of Origin and Percentage of Imports	Import Tariff
2016			280		
2015			200		
2014			220	Brazil 24%; Uruguay 18%; Pakistan 15%; India 13%	
2013	259.44	103287	290	Brazil 28%; Pakistan 24%; India 23%; Uruguay 18%	
2012	231.14	101434	255	Brazil 40%; Pakistan 28%; India 20%; Thailand 5%	\$10/kg (husked or brown rice); \$8.33/kg (paddy rice); \$7.08/kg (Rice (no type)); \$10/kg (semi-milled rice)

<sup>1</sup> Hidden Hunger Index Score is calculated as the average of zinc deficiency prevalence (as measured using stunting as a proxy) iron deficiency (as measured by anemia due to iron deficiency), and vitamin A deficiency (as measured by low serum retinol) – all prevalences are equally weighted

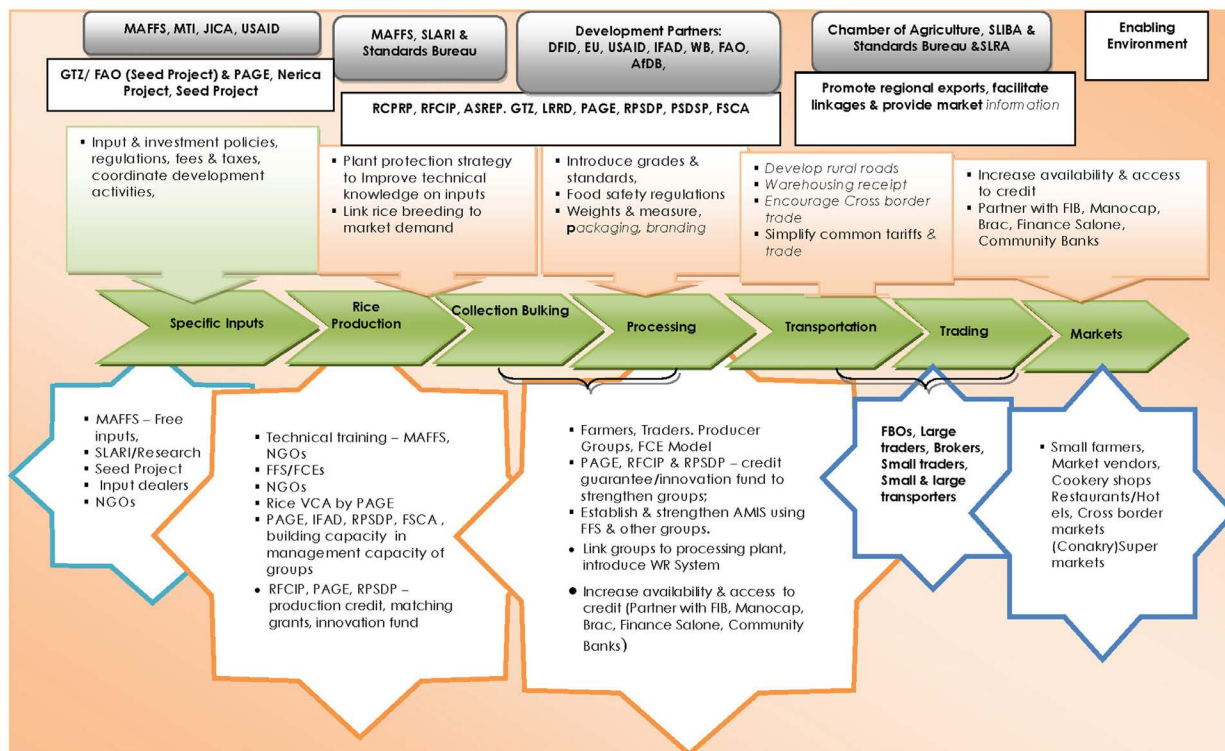
6. Rice availability (as a proxy for consumption) per capita
  - a. 2011: 98.11 kg/capita/year; 909 kcal/capita/day; 575000/722000 (79.6%) of total supply used for food (FAOSTAT, 2016)

**Rice Consumption Patterns**

1. 2015 survey by SPRING found varied feeding practices among households in Tonkolili and Bombali; rice is typically prepared with a sauce made from palm oil, seafood and potato, cassava or krain-krain leaves. Fish added to the sauce is typically only to provide flavor and does not substantially add to protein intake. Animal sources of protein are rarely consumed (SPRING, 2015)
2. Rice production and distribution system
  - a. 2014 estimates place the land area under rice cultivation between 550,000 ha and 850,000 ha. This is approximately double the land area under cultivation in 1978/9 (Spencer and Fornah, 2014)
  - b. 2010 study conducted in the Northern Growth Pole (NGP) area reported the few rice farmers employ fertilizers, though >80% have access to and employ improved rice varieties (Spencer and Fornah, 2014; Spencer, 2010)
  - c. Average rice yields are less than 1.5 MT/ha (Spencer and Fornah, 2014)
  - d. Figure below shows the trajectory of the rice value chain

**Figure A9.1: Rice Value Chain in Sierra Leone**

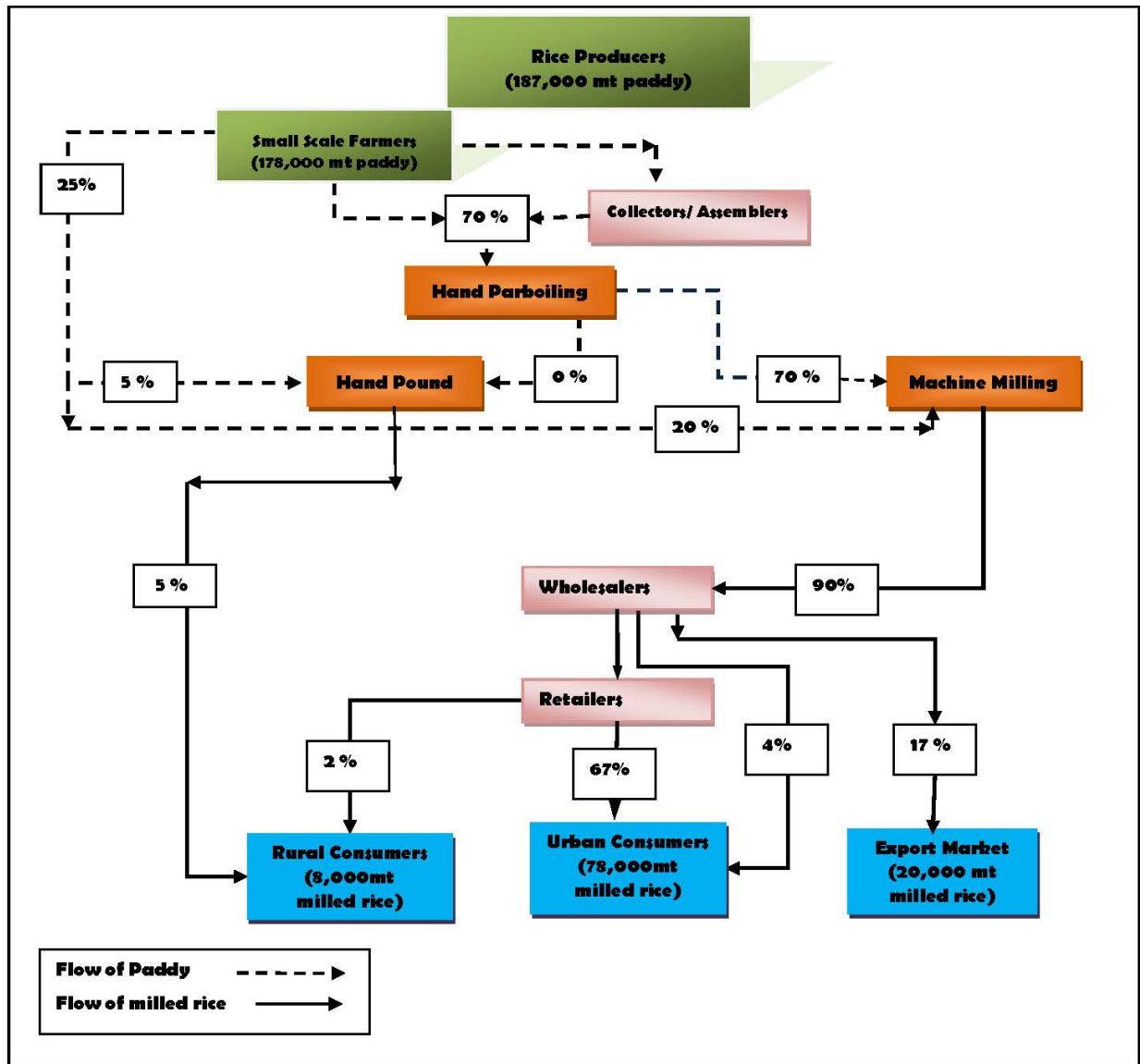
Sources: Roberts & Fornie, 2010 (Spencer et al, 2014)



3. Figures on following pages depict the traditional and emerging market channels for domestic rice, respectively. The emerging market channel represents approximately 5-10% of the current domestic rice trade (Spencer and Fornah, 2014)

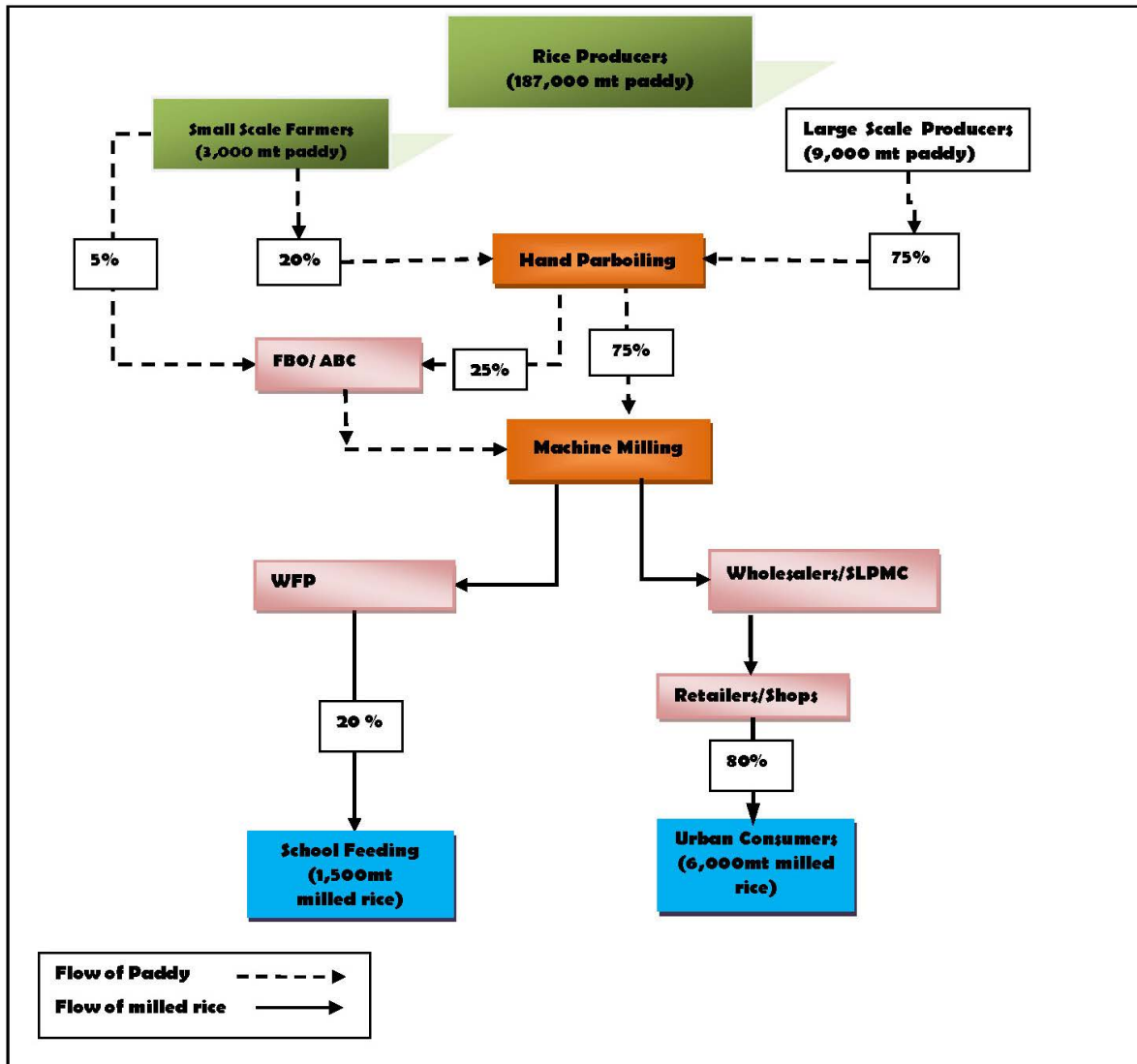
**Figure A9.2: Traditional rice marketing channels in Sierra Leone**

Sources: (Spencer and Fornah, 2014)



**Figure A9.3: Emerging rice marketing channels in Sierra Leone**

Sources: (Spencer and Fornah, 2014)



- The table on the following page details the location, ownership and condition of the 401 rice mills across the country. Ownership of rice processing machinery and facilities in Sierra Leone typically falls under one of the following entities: State Sponsored Project Mills; Agribusiness Centres (ABC) funded under the Smallholders Commercialization Project (SCP); Rural and Private Sector Development Programme Mills (RPSDP, World Bank funded); Government-owned mills slated for privatization; NERICA Dissemination Project mills; NGOs and development partners donated mills; privately owned mills (Spencer and Fornah, 2014)

**Figure A9.4: Location, ownership, and condition of rice mills in Sierra Leone, by District**

Sources: (Spencer and Fornah, 2014)

District	No of Mills	SCP - ABCs		RPSDP - FBOs			Private	
		Small	Small	Med	Large	Small	Large <sup>1</sup>	
<b>Operational</b>								
Kambia	59	13	3	17	-	25		
Port Loko	67	11	2	10	-	44	-	
Tonkolili	29	15	-	11	-	3	-	
Bombali	30	16	-	10	-	3		
<b>Total in NGP Total</b>	<b>185</b>	<b>55</b>	<b>5</b>	<b>48</b>	<b>0</b>	<b>75</b>	<b>0</b>	
Bonthe	13	8	-	-	-	5	-	
Kailahun	34	14	-	8	-	12	-	
Moyamba	18	10	-	8	-	-	-	
Pujehun	22	14	-	1	-	7	-	
Bo	17	14	1	2	-	-	-	
Koinadugu	23	11	3	9	-	-	-	
Kenema	24	13	-	11	-	-	-	
Kono	22	13	1	8	-	-	-	
Western Area	5	1	1	3	-	-	-	
<b>Sub Total</b>	<b>363</b>	<b>153</b>	<b>11</b>	<b>98</b>	<b>-</b>	<b>99</b>	<b>0</b>	
<b>Not Operational</b>								
Kambia	8	2	1	1	3		1	
Port Loko	9	4	-	2	3	-		
Tonkolili	2	2	-	-	-	-		
Bombali	2	2	-	-	-	-	1	
<b>Total in NGP</b>	<b>21</b>	<b>10</b>	<b>1</b>	<b>3</b>	<b>6</b>	<b>-</b>	<b>2</b>	
Bonthe	-	-	-	-	-	-	1	
Kailahun	2	1	-	-	-	1		
Moyamba	3	3	-	-	-	-		
Pujehun	1	1	-	-	-	-		
Bo	2	2	-	-	-	-	1	
Koinadugu	1	-	-	1	-	-		
Kenema	5	3	-	2	-	-	1	
Kono	3	2	-	1	-	-		
Western Area	-	-	-	-	-	-		
<b>Sub Total</b>	<b>38</b>	<b>22</b>	<b>1</b>	<b>7</b>	<b>6</b>	<b>1</b>	<b>5</b>	
<b>Grand Total</b>	<b>401</b>	<b>175</b>	<b>12</b>	<b>105</b>	<b>6</b>	<b>100</b>	<b>5</b>	

Sizes:

Small = < 500Kg/hr

Med = 500-999 Kg/hr

Large = 1000Kg+ Kg/hr

Source: Spencer et. al. (2014)

- Recent national inventory of rice mills reported existence of approximately 401 rice mills across the country. This was a large increase from previously estimated 53 operational before the civil war. Of

- these 401 mills, 38 (9.5%) of the mills were not operational, largely attributed to breakdowns, or lack of proper business planning (Spencer et al, 2014)
6. Rice mill concentrations exist in the major rice producing Districts: Port Loko District has 67 operational mills, Kambia has 59 (Spencer et al, 2014)
    - a. 25% of mills are privately owned and operated - all are small capacity (Spencer et al, 2014)
    - b. The 5 integrated rice milling plants - each with a capacity of 1 ton per hour - are in Bo, Kenema, Makeni, Torma Bum and Mambolo (Spencer et al, 2014)
  7. As of 2014, >80% of all rice imports in the past 2 years were handled by the 6 largest importers (Spencer et al, 2014)
  8. Government policy of “modernizing” rice sector has resulted in a system where private mills experience less capital investment than institutional ones. During the average months of operation (7-9 per year), private mills operate longer than their RPSDP- or ABC-established counterparts (Spencer et al, 2014)
  9. “Domestic rice prices are now lower than that for imported rice in the urban areas of the hinterland of Sierra Leone [...] indicating that transportation costs of imported rice to provincial towns is now enough to move the slight competitive advantage that imported rice may still have in Freetown” (Spencer et al, 2014)
  10. Production Seasons

**Table A9.3: Rice Production Cycle in Sierra Leone**

Source: (Ricepedia, 2014)

	Planting	Harvesting
Main	Apr-Jul	Sept-Jan

***Relevance to Other Health and Agriculture Programs***

1. World Food Program
  - a. A bilateral Japanese project (JBP) links P4P with Food Assistance for Assets (FFA) – this provides support across the rice value chain. Under FFA, in exchange for food assistance, program participants work to improve rice production infrastructure (Bakalilou and Ortiz, 2015)
  - b. In September 2016, the Government of Japan contributed \$21.6 million to WFP for food and nutrition assistance to the most vulnerable in 11 countries; Sierra Leone received \$1.9 million (World Food Programme, 2016)
2. Food and Nutrition Security Implementation Plan 2012-2016 strategies include increasing the number of ABCs from 192 to 650 to facilitate the acquisition of inputs such as fertilizers, and improved rice seeds by FBOs and Mother support groups (Government of Sierra Leone, 2012)
  - a. Fortification of rice with iron and zinc was identified as a potential strategy to improve consumption; further research is requested to determine bioavailability after cooking, and feasibility of large scale fortification (Government of Sierra Leone, 2012)
  - b. Physical stockpiling of rice or its cash equivalent to smooth production shocks/rapid food price inflation (Government of Sierra Leone, 2012)
3. A food fortification alliance was formed to lead advocacy for fortification; currently the primary focus is on Vitamin A (Government of Sierra Leone, 2013)

***Partners***

1. Ministry of Agriculture, Forestry, and Food Security (MAFFS)
  - a. Smallholder Commercialization Program (SCP)
  - b. NERICA (New Rice for Africa)



- c. PVS (Participatory Variety Selection Plots)
2. ABC (Agricultural Business Centre) Development
3. Action Aid
4. Japan International Cooperation Agency (JICA)
5. Sierra Leone Research Institute (SLARI) (Hoogh et al, 2011)
6. Njala University (Hoogh et al, 2011)
7. Rural and Private Sector Development (RPSDP)
8. Promoting Agriculture, Governance and the Environment (PAGE)
9. World Food Programme (WFP)
10. Scaling Up Nutrition network (joined in 2012) (Scaling Up Nutrition, 2015)

#### ***Potential Barriers to Rice Fortification***

1. The 2013 micronutrient survey reported that iron deficiency in key populations (young children and non-pregnant women) was relatively uncommon and not associated with anemia – instead strong associations were found between malaria, inflammation, diarrhea (in children only), vitamin A deficiency (in children only), and anemia (Ministry of Health and Sanitation et al, 2015)
2. In recovery period post-Ebola outbreak
3. Limited/no government programs for purchasing of domestic rice

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## **Appendix 10: TANZANIA**

### ***Population and Demography*** (World Bank, 2016)

1. Population size: 53,470,420 (2015)
2. Urban/rural distribution
  - a. Rural: 68.4% (2015)
  - b. Urban: 31.6% (2015)
3. Age distribution: 45.2% 0-14, 51.6% 15-64, 3.2% 65+ (2015)
4. GDP per capita in current USD: 864.9 (2015)
5. Fertility rate: 5.2 (2014)
6. Life Expectancy:
  - a. Women: 66.4 (2014)
  - b. Men: 63.5 (2014)
7. Education:
  - a. Literacy rate:
    - i. Females (age 15+): 76.1% (2015)
    - ii. Males (age 15+): 84.8% (2015)
  - b. Years of compulsory education: 7 (2014)
  - c. Children out of school (% of primary school age children who are not enrolled in primary or secondary school)
    - i. Female: 17.7% (2013)
    - ii. Male: 18.5% (2013)

### ***Health Needs Assessment***

1. Anthropometric indicators by sex and age group:
  - a. Children (6-59 months) (MoHCDGEC et al, 2016)
    - i. Stunting: 34.4%; 11.7% are severe
      1. 44.4% of children 24-35 months
      2. 37.8% in rural vs. 24.7% urban
    - ii. Wasting: 4.5%; 1.2% severe
      1. 9.7% of 9-11 mos
      2. 5.2% male vs. 3.8% female
      3. 4.7% rural vs. 3.8% urban
    - iii. Underweight: 13.7%; 2.7% severe
      1. 14.1% male vs. 13.2% female
      2. 15.2% rural vs. 9.1% urban
  - b. Women (15-49 years) (NBS and ICF, 2011)
    - i. Short stature: 3.4% of women have height below 145cm
      1. 3.4% urban/3.4% rural
    - ii. Underweight BMI: 11.4%
      1. rural 12.8% vs 8.1% urban
    - iii. Normal BMI: 67.1%
    - iv. Overweight/obese BMI: 21.5%
      1. 36.3% urban vs 15.2% rural
2. Prevalence of anemia by sex and age group
  - a. Children (6-59 months)
    - i. 57.6% are anemic; 26.4% mild, 29.5% moderate, 1.6% severe (MoHCDGEC et al, 2016)

1. 59.5% male vs. 55.7% female (MoHCDGEC et al, 2016)
2. 58.9% rural vs. 53.8% urban (MoHCDGEC et al, 2016)
- ii. 79% of 6-11 mos, 56.7% of 24-35 mos (MoHCDGEC et al, 2016)
- iii. In 2010, 35.3% were iron deficient compared with 58.7% who were anemic (NBS and ICF, 2011)
  1. 24% had iron deficiency anemia (IDA) (NBS and ICF, 2011)
  2. 40.9% of anemia was attributable to IDA (NBS and ICF, 2011)
- b. Women (15-49 years)
  - i. 44.7% are anemic – 32.7% mild, 11% moderate, 0.9% severe (MoHCDGEC et al, 2016)
    1. 44.5% urban vs. 44.8% rural (MoHCDGEC et al, 2016)
  - ii. In 2010, 29.9% were iron deficient compared with 40.1% who were anemic (NBS and ICF, 2011)
    1. 14.3% had IDA (NBS and ICF, 2011)
    2. 35.4% of anemia was attributable to IDA (NBS and ICF, 2011)
3. Prevalence of neural tube defects
  - a. 13 per 10,000 births (2012 estimate) (FFI, 2016)
4. Dietary Analysis (including supplementation)
  - a. Children (6-59 months)
    - i. 8% of 6-23 mos met criteria for minimum acceptable diet (MoHCDGEC et al, 2016)
    - ii. 56.4% of children 6-23 mos fed from 3+ or 4+ food groups (NBS and ICF, 2011)
    - iii. 34.1% of children 6-23 mos meet minimum meal frequency (NBS and ICF, 2011)
    - iv. 61.5% of children 6-35 mos (who live with their mothers) consumed foods rich in Vitamin A in past 24 hours (NBS and ICF, 2011)
    - v. 29.8% of children 6-35 mos (who live with their mothers) consumed foods rich in iron in the past 24 hours (NBS and ICF, 2011)
    - vi. 60.8% of children 6-59 mos given vitamin A supplements in past 6 months (NBS and ICF, 2011)
    - vii. 1.4% of children 6-59 mos given iron supplements in past 7 days (NBS and ICF, 2011)
    - viii. 49.6% of children 6-59 mos given deworming medication in past 6 months (NBS and ICF, 2011)
    - ix. 55.2% of children 6-59 mos living in households tested for iodized salt, lived in households with iodized salt (NBS and ICF, 2011)
  - b. Women (15-49 years) (NBS and ICF, 2011)
    - i. 72% of women 15-49 with a child under age 3 living with them consumed Vitamin A rich foods<sup>1</sup> in the 24 hours preceding the survey
    - ii. 35% of women 15-49 with a child under age 3 living with them consumed iron-rich foods in the 24 hours preceding the survey
    - iii. 25.8% of women 15-49 with a child under age 5 received vitamin A dose postpartum (within first 2 months of giving birth)
    - iv. 48.9% of women 15-49 with a child under age 5 took iron tablets for <60 days during their pregnancy of last birth

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<sup>1</sup> Includes meat, liver, fish, poultry, eggs, pumpkin, carrots, red sweet potatoes, ripe mango or papaya, passion fruit, any dark green leafy vegetables (spinach/amaranth/cassava) and other locally grown yellow/orange-color fruits or vegetables

- v. 3.5% of women 15-49 with a child under age 5 took iron tablets for 90+ days during their pregnancy of last birth (recommended)
- vi. 56.4% women 15-49 with a child born in the last five years, who living in households tested for iodized salt, lived in households with iodized salt
- c. Other Micronutrients
  - i. 34.1% of population at risk of inadequate zinc intake (FFI 2016; Wessells and Brown, 2012)

### ***Rice Supply***

1. Annual production of rice over the past three years

**Table A10.1: Annual Rice Production in Tanzania (2012-2016)**

Source: (International Rice Research Institute, 2016)

	FAO		USDA	
	Paddy (000 t)	Milled (000 t)	Paddy (000 t)	Milled (000 t)
2016			2727	693
2015			2652	801
2014	2621.03		2621	728
2013	2194.75	1463	2197	791
2012	1800.55	1200.97	1802	719

2. Geographic sources of rice
  - a. 6 major rice-producing regions: Mbeya, Iringa, Ruvuma, Rukwa, Morogoro, Kigoma; other important regions are Mwanza, Shinyanga, Tabora (European Cooperative for Rural Development, 2012)
  - b. The following regions produce >100,000 tons each: Morogoro, Tabora, Mbeya, Mwanza, Shinyanga, Arusha, and the Coast (Wilson and Lewis, 2015)
3. Domestic rice purchasing programs by region or provincial government, if any (TBD)
4. Annual import of rice over the past three years

<sup>1</sup> Includes meat, liver, fish, poultry, eggs, pumpkin, carrots, red sweet potatoes, ripe mango or papaya, passion fruit, any dark green leafy vegetables (spinach/amaranth/cassava) and other locally grown yellow/orange-color fruits or vegetables

<sup>2</sup> Includes meat (and organ meat), fish, poultry, eggs

**Table A10.2: Annual Rice Imports to Tanzania (2012-2016)**

Sources: FAO, USDA and WTO (International Rice Research Institute, 2016), OEC (The Observatory of Economic Complexity, 2016), East Afrocam Community (Aderibigbe, 2014)

	FAO		USDA	OEC	East African Community (EAC)
	Imports (000 t)	Import Value (000 \$)	Imports (000 t)	Top 4 Countries of Origin and Percentage of Imports	Import Tariff
2016			150		35%
2015			180		
2014			190	Vietnam 36%; Thailand 32%; Pakistan 14%; Rwanda 12%	
2013	284.79	128436	185	Pakistan 74%; Vietnam 10%; Rwanda 4.7%; India 4.5%	25%
2012	197.52	94681	200	Pakistan 42%; Vietnam 23%; India 21%; Brazil 4.2%	

5. Rice availability (as a proxy for consumption) per capita
  - a. 2013: 21.01 kg/capita/year; 204 kcal/capita/day; 1035/1178 (87.86%) of total supply is used for food (FAOSTAT, 2016)
  - b. 60% of national consumption comes from consumers in urban area of greater Dar es Salaam (Wilson and Lewis, 2015)

#### ***Rice Consumption Patterns***

1. Consumer preference for aromatic long grain rice; long white grain rice is also in demand (Wilson and Lewis, 2015)
2. Value added products (ie. Thai-produced rice crackers) do not seem to have a stake in the Tanzanian market (Wilson and Lewis, 2015)
3. Differences in quality are assessed according to the percentage of broken rice present (% whole grain vs. % broken), local vs. imported, and aromatic vs. non-aromatic (Wilson and Lewis, 2015)
  - a. Generally, a mix of 80% whole grain – 20% broken is preferred (Wilson and Lewis, 2015)
  - b. Additionally, as there is little demand for non-perfumed rice, it is typically mixed with perfumed (Wilson and Lewis, 2015)
4. Preferences exist for rice produced in certain regions with Kyela rice surpassing Mbeya, Morogoro, and Shinyanga; the latter of which is associated with being of particularly low quality (Wilson and Lewis, 2015)

#### ***Rice Production and Distribution System***

1. Estimated 18% of farming households produce rice (European Cooperative for Rural Development, 2012)
2. 2010 rice-growing area = 720,000 ha; 90% of which was managed by smallholder farmers who held 0.5-3 ha each (European Cooperative for Rural Development, 2012)
3. Smallholder farmers producing for home consumption and/or direct surplus sale to cooperatives and/or directly to consumers constitute the majority of rice producers. Very few have organized into producer associations (European Cooperative for Rural Development, 2012)
4. Average growth rate for production was 13.1% each year between 1997-2010 (European Cooperative for Rural Development, 2012)

5. Yields vary from 1.2-2.4 MT/ha (European Cooperative for Rural Development, 2012)
  - a. This low yield is attributed to drought, low soil fertility, weed infestations, prevalence of insect pests, birds, diseases, and use of low-yielding varieties (European Cooperative for Rural Development, 2012)
6. Table below shows rice production, trade and food supply between 1997-2008

**Table A10.3: Rice production, trade, and food supply in Tanzania (1997-2008)**

Source: (European Cooperative for Rural Development, 2012)

Year	Area (ha)	Yield (Hg/ha)	Seed (MT)	Production unmilled rice (MT)	Imported milled rice (MT)	Imported milled rice 1000\$	Exported milled rice (MT)	Exported milled rice 1000\$	Food supply milled rice (MT)	Food supply quantity milled rice (kg/capita/yr)
1997	439300	12513	30810	549700	53489	14073	804	272	493973	15.61
1998	654500	12973	31625	849100	164426	67753	11552	4500	534777	16.48
1999	379100	19219	32461	728600	58749	25259	15350	5462	537716	16.16
2000	415600	18805	33320	781538	109267	33209	4454	1304	616084	18.05
2001	405860	21379	50904	867692	55629	12910	5791	2270	647276	18.48
2002	565600	17408	55872	984615	19523	3097	3155	479	618470	17.2
2003	620800	17669	55182	1096920	60273	8608	3501	483	727300	19.69
2004	613130	17263	63179	1058460	77950	21900	165	25	753583	19.86
2005	701990	16634	57039	1167690	26550	7050	3717	697	775092	19.87
2006	633770	19543	50218	1238560	31200	8350	48	11	820398	20.45
2007	557981	24048	59820	1341850	6874	2310	15131	2305	780496	18.91
2008	664667	20256	81406	1346340	16180	9857	4410	1357		
2009	904508	14748	64800	1334000	13046	7750	214	144		
2010	720000	15346	64800	1104890						

7. In 2008, annual consumption of milled rice had a self-sufficiency ratio of 84.5% (European Cooperative for Rural Development, 2012)
8. When competing with imports, domestic production is not very price-competitive due to high transaction and production costs (Wilson and Lewis, 2015)
9. Market domination by blended products which provide adequate nutrition at the lowest price (European Cooperative for Rural Development, 2012)
10. Though previously controlled by parastatals, the rice milling sector today is privatized. This followed the privatization of the National Milling Corporation and National Agricultural and Food Corporation (European Cooperative for Rural Development, 2012)
  - a. Accounting for >90% of milling operations, most mills have a 5-20 ton/day capacity (Wilson and Lewis, 2015)
  - b. Typically operating for 5 months out of the year, larger millers have a capacity of up to 120 tons per day (Wilson and Lewis, 2015)
  - c. The difference in quality of milled rice between large and small mills is: small=30-50% broken aka 'standard quality' vs. large = <15% broken aka 'Grade One' (Wilson and Lewis, 2015)
11. Milling charges range from 60-70 Tanzanian shillings/kg (Wilson and Lewis, 2015)
12. Figure on following page provides information about the four largest players in the rice value chain

**Table A10.4: Four largest players in rice value chain in Tanzania**

Source: (Wilson and Lewis, 2015)

Region	Supplier Name	Description
Mbeya	Mtenda Kyela Rice Supply	an export trading company working with contract farmers. It provides training and inputs to over 10,000 smallholders, and distributes milled rice (from the Wela mill) to wholesalers in Dar es Salaam.
	Kapunga Rice Farm (Southern Highland Estates)	a production and processing company with the largest rice farm in the region and has plans to launch an outgrower scheme.
	Mbarali Rice Farm	a production and processing company with the second largest rice farm in the region.
Kilombero District	Kilombero Plantations Limited	<p>a production and processing company that distributes milled rice to wholesalers in Dar es Salaam. With 4,700 ha it is Tanzania's largest rice producer. It has 1,500 outgrowers, and that number is expected to increase to 5,000 by 2016. It provides inputs, training, finance, storage, and milling for smallholders along with R&amp;D.</p> <p>Large-scale production linked to outgrowers is expected to expand in the future not only through existing businesses but also via new entrants. In the second category Intrasia has already purchased 30,000 ha and the Korea Rural Community Corporations some 100,000 ha for rice production.</p>

13. Private sector participation in production occurs in the Mbeya Region at large-scale rice farms at Kapunga and Mbarali (European Cooperative for Rural Development, 2012)
  - a. <1% of rice comes from large-scale production (European Cooperative for Rural Development, 2012)
14. As of 2009, 306,745 ha were under irrigation (European Cooperative for Rural Development, 2012)
  - a. Most rice produced is rainfed, leaving it vulnerable to flooding or drought (European Cooperative for Rural Development, 2012)
15. Only 10% of farmers use improved seeds (European Cooperative for Rural Development, 2012)
16. Per the 2002-2003 National Sample Census of Agriculture, when compared with maize (28% of product is marketed) and sorghum (18%), rice is much more commercialized at 42% (Wilson and Lewis, 2015)
17. In 2005, a duty of 75% was imposed on imports; this resulted in 1) a drop in imports 2) increase in domestic production (Wilson and Lewis, 2015)
18. An analysis of rice prices concluded that the highest local prices can be found in rice-deficient markets and in the capital, Dar es Salaam, while the lowest are in Songea (a surplus zone), and Singia (near 2 production zones: Shinyanga and Mwanza). The difference between prices in Dar and Songea can be nearly US\$ 100/ton (Wilson and Lewis, 2015)
19. Consumer demand is expected to triple between 2010 and 2020 due to continued urbanization (7% per year), population growth (3% per year), and increasing affluence (economic growth of 7% per year) (Wilson and Lewis, 2015)
20. Production seasons



**Table A10.5: Rice Production Cycle in Tanzania**

Source: (Ricepedia, 2014)

	Planting	Harvesting
Main	Dec-Feb	May-Jul
Off	Jun-Jul	Nov-Dec

***Relevance to Other Health and Agriculture Programs***

1. National Agricultural Input Voucher Scheme (NAIVS)
  - a. Began in 2008-2009 planting season; final round was 2013-2014 (Knowles, 2015)
  - b. Targeted efficiency of rural farmers via 50% subsidy on inorganic fertilizer and improved seed (maize and rice) (Knowles, 2015)
  - c. Farmers who received a voucher in 2008-2009 on average experienced a statistically significant 34% decrease in technical inefficiency (Knowles, 2015)
2. National Five Year Development Plan 2016-2017 to 2020-21:
  - a. Specifies reduction of anemia from current levels by 25% among women of reproductive age (Ministry of Finance and Planning (2016)
3. World Food Programme
  - a. Home Grown School Feeding pilot program launched in 2015 facilitates local food procurement from smallholder farmers (World Food Programme, 2016)

***Partners***

1. AfricaRice (including outreach station)
2. International Center for Tropical Agriculture (CIAT)
3. French Agricultural Research Centre for International Development (CIRAD)
4. International Relief & Development (IRD)
5. International Rice Research Institute (IRRI)
6. Japan International Research Center for Agricultural Sciences (JIRCAS)
7. Consortium of International Agricultural Research Centers (CGIAR)
8. United Nations agencies
9. CAB International (CABI)
10. Coherence in Information for Agricultural Research for Development (CIARD)
11. International Center for Development-Oriented Research in Agriculture (ICRA).
12. CARD (Coalition for African Rice Development)
13. World Bank
14. Agrica (large-scale sustainable agribusiness)
  - a. Working to complete the irrigation system at Kilombero Plantations Limited, a 5,000 ha commercial rice producer (New Alliance for Food Security and Nutrition, 2012)
15. Tanseed International, Ltd., private seed company
  - a. Committed to improving adoption and availability of high-quality seed varieties and increasing yields through crop management practices (New Alliance for Food Security and Nutrition, 2012)
16. Syngenta, global agricultural inputs company
  - a. Working to establish “centers of expertise for Rice, Soya and Vegetables” (New Alliance for Food Security and Nutrition, 2012)

***Potential Barriers to Rice Fortification***

1. Preponderance of low yield varieties (European Cooperative for Rural Development, 2012)

2. Lack of inputs/mechanization
3. Fragmented value chain
4. Limited consolidation of milling enterprises - 4 large mills; 90% of milling operations are small-scale (Wilson and Lewis, 2015)
5. Limited/no government programs for purchasing of domestic rice

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