



Study on Landscape Analysis and Potential Fortification in Ghana

Report

Prepared by CSIR-Savanna Agricultural Research Institute, Tamale
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Collaborating Institutions



CSIR-Savanna Agricultural Research Institute

The Savanna Agricultural Research Institute (SARI) is one of the 13 research institutes that make up the Council for Scientific and Industrial Research (CSIR) – a semi-autonomous organization that operates under the ambit of the Ministry of Education, Science, Technology and Innovation. The institute is mandated to provide farmers in the Northern, Upper East and Upper West regions of Ghana with appropriate technologies to increase their food and fibre crop production, based on a sustainable production system which maintains and/or increases soil fertility. Its vision is to become a lead research and development (R&D) institution by making agricultural research responsive to farmer needs and national development. The Socioeconomics section of the CSIR-SARI backstop the breeders and agronomist in terms of conducting economic analysis and evaluation of newly developed technologies for upscaling. The Socioeconomics collaborates with both local and international institutions to conduct specialized studies relating to impact evaluation of agricultural technologies, gender, natural resource management, innovation platforms for technology dissemination, and agricultural commercialization studies.



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For more information please contact:

Nutrition Division World Food Programme
Systems Analysis for Nutrition
Via C.G. Viola, 68/70, 00148, Rome, Italy
Email: nutrition@wfp.org

World Food Programme Ghana
No 7 7th Rangoon Close Cantonments
Accra, Ghana
PO Box GP 1423
wfp.accra@wfp.org

Executive Summary

Rice is a major staple in Ghana and is used in the country's flagship home-grown school feeding program. This provides a great opportunity to introduce fortified rice to substantially improve the nutrition and overall wellbeing of school-aged children. At the moment, the Government of Ghana and its development partners have not yet fully explored the option of addressing malnutrition, especially among women and children, through the fortification of locally milled rice to enhance their nutritional quality. To have a broader understanding of the rice value chain and the crucial role of processors, the World Food Program (WFP) engaged the Savanna Agricultural Research Institute (SARI) of the Council for Scientific and Industrial Research (CSIR) to conduct both a landscape analysis on local rice production in Ghana and the potential for fortification.

The main highlights of the study indicate that only 40% of the national demand for rice is met through domestic production, thus the bulk of domestic demand is met through importation (Ouédraogo et al., 2021). Agro-input dealers (seed, fertilizers, protectants) play a critical role in domestic rice production. In 2020, about 1.9 million smallholder farmers benefitted from the Government's subsidy program (USDA, 2022). Smallholder farmers, who usually produce on less than five hectares of land, are responsible for the bulk of domestic rice output in Ghana. These farmers produced about 600,000 MT of rice in 2022.

Paddy rice production increased from 2018 to 2021, and this increasing trajectory is projected to continue partly due to the Government's flagship program Planting for Food and Jobs (PFJ)". Ghana witnessed an extraction rate (paddy to milled rice) of 69% between 2012 and 2020 and an extraction rate of 63% in 2021 (MoFA, 2022). Between 2019 to 2020, about 40% of the domestic demand (1,174,200 kg) was met through local production (474,200 kg) while the level of import was estimated at 700,000 kg. In 2030, Ghana's population is projected to increase to 37.7 million while total rice demand, local rice production, and imported rice projected to increase to 1,506,677 kg, 1,115,243 kg, and 391,434 kg, respectively (Ouédraogo et al., 2021). Based on the projections, Ghana is expected to be only 74% self-sufficient in rice production.

Local rice millers source the majority of their raw materials from local rice producers. It is not uncommon for rice traders (millers or wholesalers) to provide financial support to farmers at the onset of the farming season who in turn supply their produce to the miller or wholesaler at a negotiated price. The rice processed by both small and large millers (approximately 572,000 MT over the past three years) (GCB Strategy and Research,

2022) are supplied to wholesalers and retailers who then sell them to rural and urban consumers. In 2022, about 950,000 MT of rice was imported to Ghana from Vietnam, Thailand, India and Pakistan. The imported wholesalers aggregate the rice and sell them to urban and rural retailers. Urban markets in Ghana constitute the largest share (80%) of total rice consumption and traits such as aromatic long-grain and white rice is preferred by consumers (GCB Strategy and Research, 2022). About 62% of the market shares of imported rice are controlled by Olam Ghana, Three Hills Ghana Ltd, Sika Krobea Company Ltd, Tradepass Ltd, MOI foods Ghana Ltd, and Wilmar Africa Ltd. Most consumers in the urban areas have developed a taste for imported rice over locally produced rice. Nonetheless, consumption of local rice is based on preferences, perceived good nutritional quality, and relatively low price (Ayeduvor, 2018; Diako et al., 2010). Price data from Esoko show that, on the average, the price of imported rice is higher than local rice (Esoko, 2022).

The results of the study show that 90% of rice processors are males who manage the processing firm with the highest level of education for 26% of the processors being either middle/junior high school or secondary school education. The majority (86%) of the sampled processors engage in rice processing as their primary occupation with 53% belonging to an association. The majority of processors are adults (76%). About 53% of the processors have received training in cleaning, drying, parboiling, and storage. The average years of experience in rice processing is 10 years and the rice varieties preferred by processors are AGRA, Jasmine 85, Mandi, Salimasa, Togo Marshall, Ayofula, Afefe and NERICA. Preference is usually based on uniformity of the grains and colour after milling, availability, fragrance, ease to dry, good taste, long shelf-life, and easy milling with minimal brokenness. The spatial location of local rice processing concentration is in northern Ghana.

The results further show that 12% of the processors purchase parboiled rice from other actors within the rice value chain. The average quantity (MT) of parboiled rice processed annually is 1,393 MT. Based on gender disaggregation, the quantity of parboiled rice processed by the males (1,457 MT) is twice that of the females (752 MT). About 67% of consumers prefer straight-milled rice to parboiled rice.

The majority of the processors are willing to improve the nutritional value of their rice with micronutrients such as zinc, calcium, iron, manganese, folic acid, etc. However, some processors are unsure of the type of micronutrients to include in rice processing. Generally, there is low awareness of rice fortification among

the sampled processors but 82% of the sample are willing to undertake rice fortification if they have the requisite training and support. The low awareness of rice fortification serves as an entry point for further engagement and sensitization of local rice processors on the nutritional benefits of local rice fortification. Training local processors is key to successfully implementing rice fortification in Ghana. The processors are willing to make a profit of GHS6 per kilo of fortified rice. More research is required in this area to ascertain the profitability of local rice fortification. The dynamics in terms of the willingness to pay and sell a kilogram of fortified rice suggest the need to do more detailed market segmentation of processors to identify their differential risk levels and willingness to invest in fortified rice processing.

Following from the study, the following recommendations are made: (1) There is the need to prioritize the promotion of sustainable intensive cultivation of rice in Ghana. (2) The rice seed system, which forms an integral component of the rice value chain, must be strengthened. (3) Existing financing options must be scaled up to include the participation of rural, community, and commercial banks as well as informal

financial options that provide financial support to rural farmers. (4) The capacity of all actors in the rice value chain must be built with an emphasis on producers, aggregators and processors. (5) Rice processing associations must be promoted and strengthened to improve their bargaining position and access to inputs and services (e.g., bulk purchasing of inputs, marketing, and extension) at a relatively lower cost. (6) Rice fortification efforts must target AGRA and other varieties such as Gbewa or Jasmine 85 due to the high demand of such varieties. (7) The miller's association must be strengthened to enhance their efficiency. (8) To ensure that local rice processors buy into the rice fortification agenda, the WFP can lead in organizing a regional and national multi-stakeholder discussion about the prospects and sustainability of rice fortification in Ghana. (9) A public-private partnership (PPP) is required to make the equipment available to local processors at an affordable price. The WFP can support the small to medium local processors (especially the youth and women) to acquire the equipment at a subsidized price. (10) The database of local rice processors should be updated periodically and validated to reflect current processing capacity for planning purpose.





Ghana Fortification | REPORT

Introduction

Rice production in Ghana is considered an important food and cash crop as it provides producers income and an important nutrient source to producers and consumers in urban and rural households. Rice is dominantly cultivated in North East Savannah, Northern, Upper East, Volta, Oti, Ashanti, and Eastern regions (GAIN, 2018). The increase in rice production is a direct response to increasing demand due to population growth, urbanization, increasing income, and, most importantly, consumer habits (MoFA 2017). The yearly per capita rice consumption is estimated at 38 kg between 2019 and 2020 and is projected to increase to 40 kilograms beyond 2020 (Ouédraogo et al., 2021). According to IDH Sustainable Trade Initiative (2023), rice consumption in Ghana currently stands at 1.4 million metric tonnes which translates to 36.8 kilograms per capita rice consumption.

Despite the increase in rice production, the sector is faced with climate change and rice importation due to trade liberalization across sub-Saharan Africa (Terdo

and Feola 2016). The current importation of rice stands at GHS6.87 billion (equivalent to US\$560million at current market rates) from 2017 to 2020 (GCB Strategy and Research, 2022). The major rice importers in Ghana are Olam Ghana, Three Hills Ghana Ltd, Sika Krobea Company Ltd, Stallion Industries & Investment Ltd etc. Olam controls about 17% of the market share in terms of import. Ghana's rice market consists of both imported and locally produced rice. Imported rice is mainly consumed in urban centres (Angelucci et al. 2013), as against locally produced rice which is mostly consumed in rural areas. The market share for locally produced rice in urban centres is only 20 percent (Angelucci et al. 2013). The competitiveness of imported rice in Ghanaian markets against locally produced rice is due mainly to consumers' preferences based on quality attributes (fragrance, texture, cooking time, and colour). The perceived quality attributes influence the purchasing decisions of rice by consumers. It is the foremost reason consumers prefer imported rice (Ayeduvor 2018).

However, the current production of local rice is inadequate to match total domestic demand thus making it difficult to ban imported rice. With the right investment in terms of input subsidy on fertilizer, seed, complimentary inputs as well as capacity building of farmers, local rice production and its commercialization will be more competitive.

The continuous popularity of rice among consumers is further explained by the less time it takes to cook than maize. In addition, the increasing number of urban dwellers tends to consume food away from the household (Stryker 2010). Therefore, rice is an essential crop in addressing poverty among various actors within the rice value chain and economic growth at the national level. Policy strategies for rice sector development have primarily aimed at increasing rice production to address food security and poverty reduction. For example, the main target of Food and Agriculture Sector Development Policy (FASDEP) II was to reduce rice imports by 30 percent by the year 2018. This was achieved by increasing rice output by 370,000 tons per year (MoFA 2019). An output of 769,000 tons of rice was achieved in 2018 as against 391,000 tons in 2009 (MoFA 2019). Tremendous progress has been made in this regard despite increasing threat of climate change and declining soil fertility to rice production systems.

Rice is a major staple used in Ghana's home-grown school feeding program, providing a great opportunity for the introduction of fortified rice which has a huge potential of improving nutrition and wellbeing of the school aged children. Adding premium to milled local rice through fortification to enhance its nutritional quality is not fully explored by government to address malnutrition especially among women and children in Ghana. Given the enormous benefits of rice fortification in addressing child malnutrition, the United Nations World Food Program (WFP) Ghana, a leading humanitarian organization seeks to collaborate with the Savanna Agricultural Research Institute (SARI) of the Council for Scientific and Industrial Research (CSIR) and some state institutions to undertake a fortified

rice project. To have a broader understanding of the rice value chain and the crucial role of processors, WFP engaged CSIR-SARI to conduct a landscape analysis on local rice production in Ghana and the potential for fortification. The outcome of the study was to build a deep understanding of the rice value chain especially around the production in terms of mapping, capacity and identify the gaps with a view to induce fortification.

The main objective of this study is to provide deeper understanding/information on local rice production in Ghana and the potential for fortification to serve as the basis for establishing partnerships with private businesses for fortified rice projects to help improve school meals programs. The specific objectives of the study are to:

1. Conduct value chain analysis (VCA) for local rice production in Ghana. This includes describing how the process is structured (map of the process), the various actors in local rice production and their roles, access to markets, millers, information, finance, the gender dimension, among others, and how local rice production can be improved by identifying constraints, entry points/interventions, and key partnerships for rice value chain development.
2. Conduct analysis of local rice milling in Ghana. This includes describing the geographical distribution of rice millers (mapping of the millers), their production capacities, types of equipment are used, the challenges/gaps that exist, and what potentials exist for local fortified rice production/milling.
3. Generate detailed stakeholder mapping on all the actors involved in local rice production and milling in Ghana and their specific roles, linking production and milling.
4. Provide clear recommendation(s) for millers with the capacity for locally fortified production/milling for consideration.

Methodology

2.1 Research approach

This study employed a participatory approach to the assignment to involve all relevant stakeholders in the planning, implementation, and review of all tasks in the assignment. Experience in both the public and private sectors has established in clear terms that quick and more lasting results are obtained when the Client (WFP) and key stakeholders are closely involved right from the beginning, where dialogue meeting is sustained throughout the lifespan of the project. Therefore, the involvement of WFP and other key stakeholders is critical for successfully developing an efficient and cost-effective implementation of the proposed assignment. Such participation of the Client and the other key stakeholders not only make them understand, appreciate and own the product but, more importantly, ensures that we agree with them every step of the way.

An important aspect of assignments of this nature is the methodology employed in executing the task. Before the commencement of the assignment, CSIR-SARI attended a virtual orientation meeting organised by WFP. The orientation meeting enabled CSIR-SARI to give a thorough debriefing on the assignment to WFP and discuss all assignment requirements and deliverables. The proposed timetable for executing the assignment, workshops, and other field visits was discussed during the meeting, and communication modalities were finalized.

The study employed both qualitative (Key Informant Interviews) and quantitative (semi-structured questionnaire) methods to obtain and analyse the data. The approach is based on standard assessment methodologies. A structured questionnaire was administered to the leaders of millers to ascertain their strengths, weaknesses, constraints, opportunities, and threats. Based on experience, the research tasks were categorised into three sections. First section is the Inception meeting and reporting, followed by Desk Review, Fieldwork and Data Collection, Data Analysis and lastly, the Report Writing.

2.1.1 Prepare Inception Report

After signing the contract to undertake the assignment, several post-contract activities were undertaken. These activities range from desk reviews to consultations with major project stakeholders at national and sub-national levels. The insight and further understanding acquired from these exercises revealed specific dynamics of the tasks. The desk review contributed to the identification of the processors and their locations across Ghana. This necessitated revisions to some aspects of the specific functions of the assignment. The output of the initial task was used to prepare an inception report. The report clearly defined the updated approach

to executing the tasks and the Client and other institutions involved in implementing various aspects of the assignment.

2.1.2 Desk Review

An extensive desk review of the project report and documents (refer to Appendix 1A) were undertaken. The literature review revealed the local rice value chain in Ghana regarding the structure of the value chain, the actors involved, and their role and linkages with market, processing, and service providers (financial, transport operators, packaging, etc.). The literature review identified the constraints local rice producers and other relevant actors face within the value chain and the potential entry points for partnerships for rice value chain development. An in-depth review of the local rice millers in Ghana was conducted to determine their location within Ghana, the facility they control in processing, their main clients, the constraints they face, and the opportunities available to them.

2.1.3 Field Data Collection and Analyses

This entails the fieldwork involving Focus Group Discussions (FGDs), Key Informant Interviews (KII), and individual interviews. Key informant interviews were conducted using semi-structured questionnaires so that respondents, especially processors of the rice value chain, could express their thoughts. Open-ended questions were also used to elicit detailed information from the respondents. The categories of individuals and groups interviewed are presented in Appendix.

The interaction also captured possible linkages (weak and strong) among the value chain actors, including the upstream, mid-stream, and upstream links. The supporting or service providers of the value chains were identified to assess their significant roles and possible challenges (opportunities) that need to be strengthened (encouraged). In all the assessments, gender issues were identified, such as land access for rice production, credit access, use of modern technologies in production, time use, and commercialization of rice, and processing.

In addition, the study assessed local processing rice mills in Ghana to ascertain the conditions of their facilities and the production capacity and ability to undertake fortification. This was done by undertaking scoping visits to the rice milling facilities to assess the equipment and the operation scale and the millers' opportunities and challenges. The scoping visit team employed a snowball sampling approach to identify all the major local rice millers in Ghana. Based on the literature review, the list of all the identified local rice millers was validated based on the list generated from the scoping visits. The local rice millers were engaged to determine their capacity and willingness to participate in the fortification of local rice to enhance children's nutrition. Finally, a spotlight interview was conducted

on financial institutions directly involved in funding the private sector to ascertain their willingness to support local rice millers to undertake rice fortifications financially. Table 1 shows the distribution of sampled rice processors across the study area. The largest distribution of rice processors was sampled from the

Northern Region which constitute about 25% of the total sample. Volta Region constitute about 22% of the sample followed by Ashanti (16%), Oti (11%), Greater Accra (9%), Upper East (6%), Bono East (4%), Bono (2%), Eastern (2%), North East (2%), Upper West (1%), and Savannah (1%).

Table 1: Sampled rice processors in Ghana

Region	Frequency	Percent
Ashanti	29	15.68
Bono East	4	2.16
Bono	3	1.62
Eastern	4	2.16
Greater Accra	17	9.19
Northern	47	25.41
North East	3	1.62
Oti	21	11.35
Savannah	2	1.08
Upper East	12	6.49
Upper West	2	1.08
Volta	41	22.16
Total	185	100

2.1.4 Analysis and Report Writing

The data generated from the fieldwork was cleaned to eliminate all forms of distortions. Further engagement with the stakeholders was carried out to clarify issues and information obtained from the fieldwork to ensure consistency and reliability both in the process and the outcome. The data was collated based on thematic

topics. Descriptive statistics (tables and graphs) were used to present the results for easy visualisation. A thematic diagram showing the local rice value chain was developed with all the support services and their strengths, weaknesses, opportunities, and threats. A spatial map of the rice millers was provided as part of the deliverables.

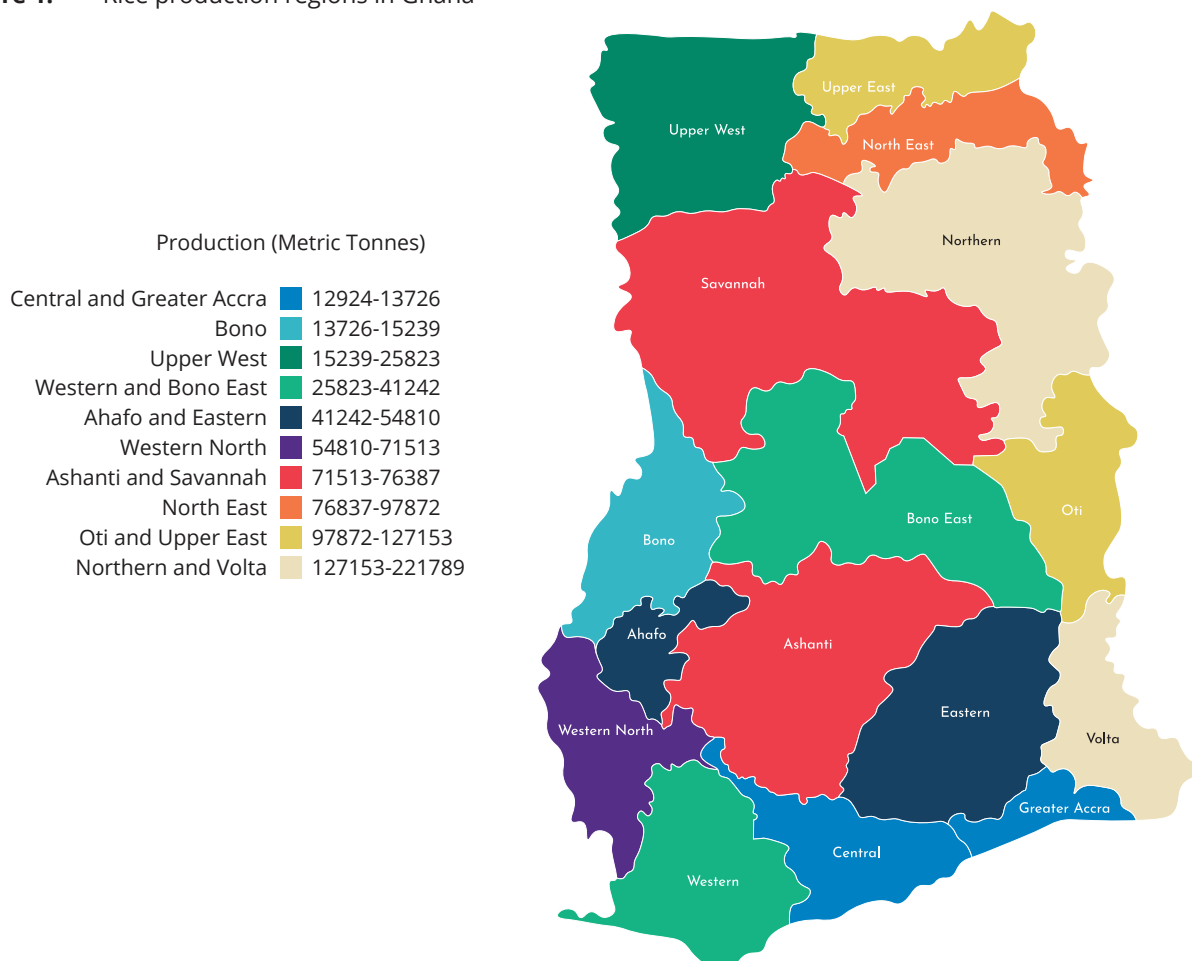


2.2 Study setting

The landscape analysis focuses on all the rice-producing regions in Ghana. Figure 1 shows the local rice production regions in Ghana based on 2021 production data from the Statistics, Research and Information Directorate (SRID) of MoFA. Comparatively, Northern

and Volta regions recorded the highest rice production for the 2021 cropping year followed by Upper East, Oti, North East, Savannah, Ashanti, Western North, Eastern, Ahafo, Bono East, Western, Upper West, Bono, Central, and Greater Accra regions.

Figure 1: Rice production regions in Ghana



2.3 Sampling

Given that the rice millers are clustered within the country, we employed multi-stage sampling technique which combines both clustered, purposive, and snowball sampling methods. The purposive sampling allows researchers to rely on their own judgment when choosing members of the population to participate in their surveys. The snowball sampling method usually begins with one or more study participants which then continues on the basis of referrals from those participants. This process continues until you reach the desired sample, or a saturation point. We find this approach useful in the study given that there is no database of rice millers across the country from which the millers can be sampled.

In such circumstances, we identify some millers who led us to other millers within the same geographical area.

The processors were zoned into clusters based on their locations in the region. In every cluster, processors were purposively sampled based on their capacity of rice processing, functional processing unity, accessibility, and availability to be interviewed. Given that the research team did not have access to the list of all the processors within a cluster, a snowball sampling method was employed to locate the processors within the clusters. In all, a total of 185 processors were interviewed across all the clusters within the regions of rice producing areas in Ghana.

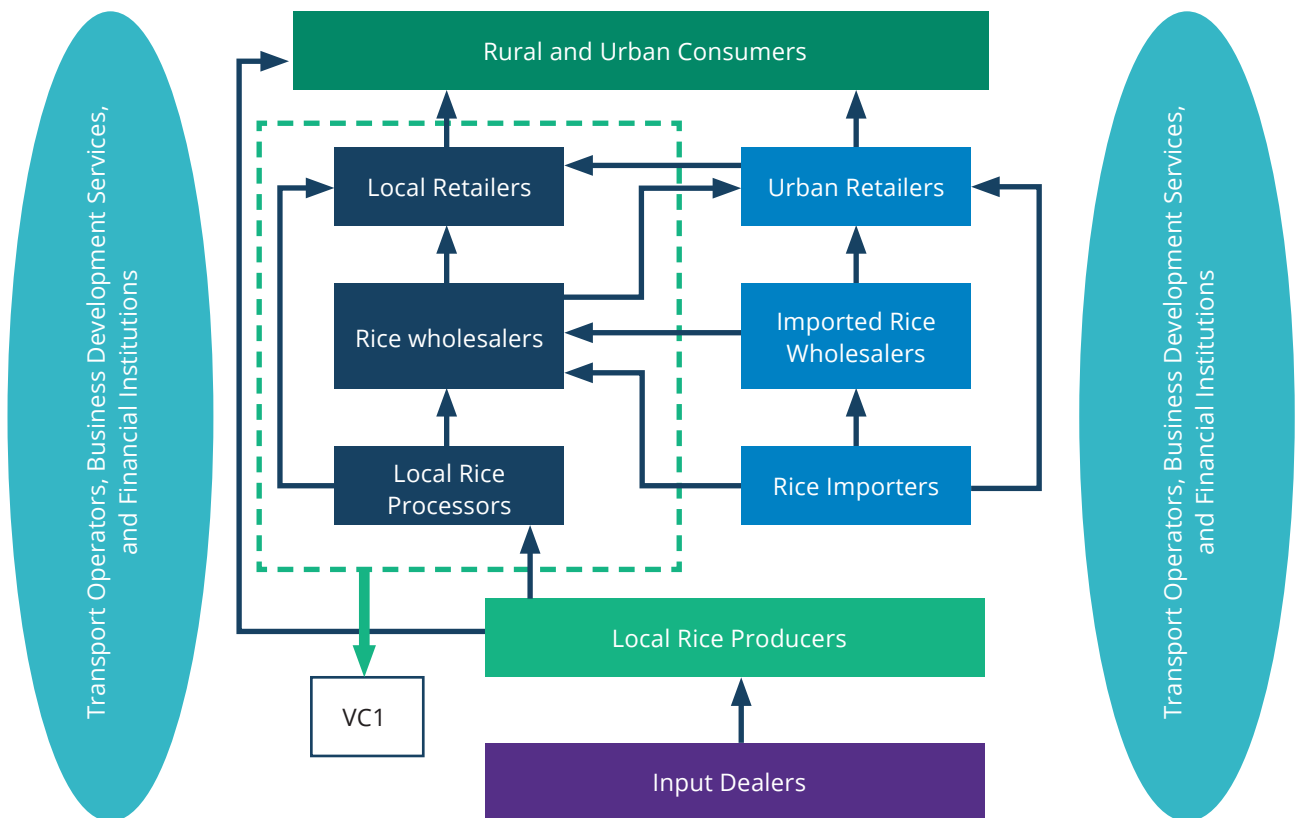
Rice Value Chain in Ghana

3.1 Rice value chain actors

Ghana's rice production is an essential source of income generation for farmers and an important staple in the diet of most Ghanaians. Rice importation forms the largest share of the domestic demand for rice, while only 40% of the domestic demand is met through domestic production (Ouédraogo et al., 2021). Any market shocks (price volatility and seasonality of price) in the rice sector can adversely disrupt domestic consumption and may result in high food insecurity (Amolegbe et al., 2021). The value chain analysis enables effective policy formulation by identifying the prominent linkages (weak and strong) among actors and how such linkages can be deployed to ensure sustained growth and the overall welfare of all actors.

Figure 2 shows the rice value chain in Ghana. The rice production process begins with the input suppliers (seed, fertilizers, protectants) who supply inputs to the farmers. In 2020, about 1.9 million smallholder farmers obtain input support from government subsidy programs (USDA 2022), while others buy the inputs from the open markets. The figure was projected to increase but due to the COVID-19 pandemic and Russia-Ukraine war, there was a decline in the subsidy fertilizer to farmers. Under the Planting for Food and Jobs Program (PFJ), resource poor smallholder farmers are provided with 50% subsidy for the price of fertilizer. Payment for fertilizer under the program was initially made flexible, allowing beneficiaries to pay 25% of the fertilizer price (50% of the subsidized price) at the time of collecting the fertilizer and the final amount paid at the time of harvest.

Figure 2: The Rice value chain in Ghana



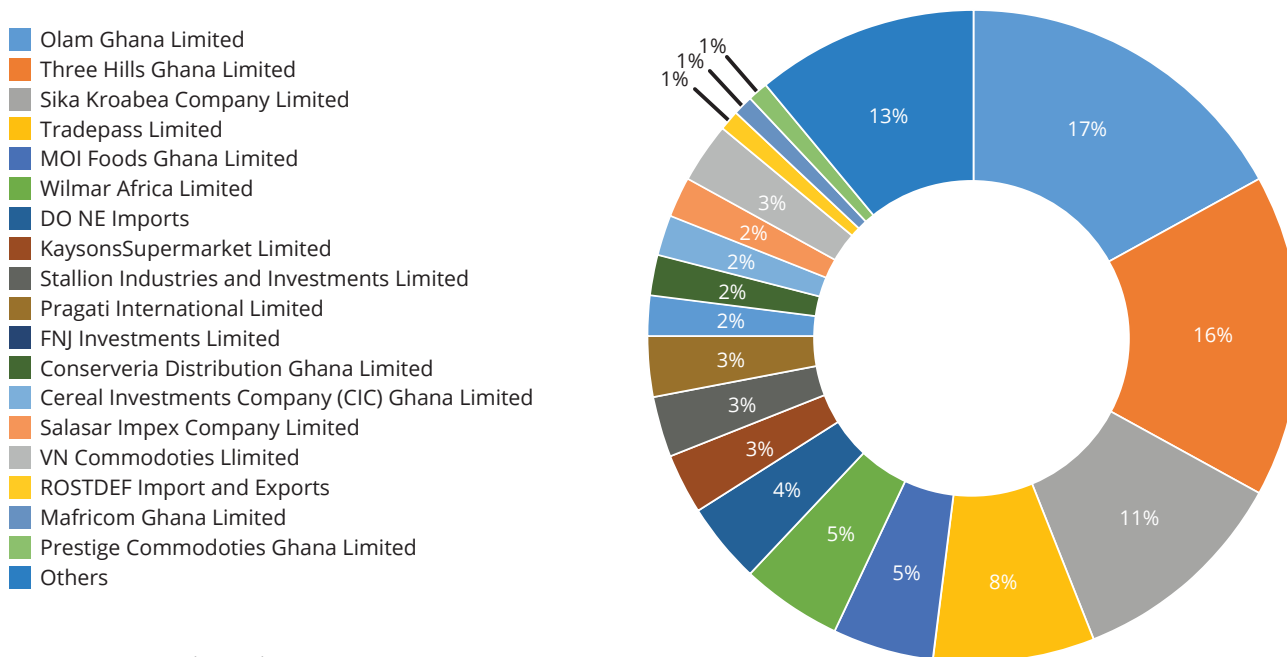
The producers are primarily smallholders and commercial farmers. The smallholder farmers control less than five hectares with projected aggregated domestic rice production of 600,000 MT in 2022. Ghana's potential rice yield is 6 MT per hectare while the national average is around 3.34 MT per hectare (MoFA, 2022). Local rice producers are the leading

suppliers of rice to local rice millers. Depending on access, scale of operation, the small local rice producers use traditional threshing and winnowing techniques and sun drying on mats and concrete floors to process their rice and sell directly to rural and urban consumers. It is a common practice for farmers to sell their paddy rice to millers located

within the same communities or at the market centres. However, due to high risk of losses during processing and cost of processing, farmers generally sell paddy rice to wholesalers, itinerant traders, and retailers at the farm or market gate. A common arrangement among farmers and traders (millers or wholesalers) is the financial support provided by the wholesalers or millers to farmers at the onset of the farming season who in turn supply their rice to the miller or wholesaler at a negotiated price. This type of contractual agreement is based on trust but not formalized in terms of written contract so there is the tendency for farmers to side-sell when postharvest price is relatively higher than what was agreed ex-ante. The wholesalers and itinerant traders record high volumes (GCB Strategy and Research, 2022) of paddy rice aggregation from farmers. They either sell the paddy rice to large millers or process the paddy rice and sell to both urban and rural retailers. The rice processed by small and large millers (approximately 572,000 MT over the past three years) (GCB Strategy and Research, 2022) are supplied to wholesalers and retailers and sold to rural and urban consumers.

On the other hand, imported rice to Ghana (70% of domestic rice consumption) is supplied to both local rice and imported rice wholesalers. In 2022, about 950,000 MT of rice is imported to Ghana from Vietnam, Thailand, India and Pakistan who are the major rice suppliers to Ghana (GCB Strategy and Research, 2022). The imported wholesalers aggregate the rice and sell it to urban and rural retailers. The retailers sell the imported to rural and urban consumers. Urban markets in Ghana constitute the largest share (80%) of total rice consumption and traits such as aromatic long-grain and white rice is preferred by consumers which constitute 20% of total imports (GCB Strategy and Research, 2022). The major importers of rice in Ghana are presented in Figure 3. Olam Ghana constitute the largest share (17%) of the market share while 62% of the market shares are controlled by the top six firms (Olam Ghana, Three Hills Ghana Ltd, Sika Kroabea Company Ltd, Tradepass Ltd, MOI foods Ghana Ltd, and Wilmar Africa Ltd). Some of the imported rice includes fragrant Vietnamese rice, Thai rice, U.S long grain rice, Cindy, Gino, Lele, fortune, Royal Aroma, Basmati, Uncle Ben, Sultana, Royal Feast, Jasmine, and CIC rice.

Figure 3: Market shares of major imported rice companies



Source: GCB Strategy and Research, 2022

The supporting services to the rice value chain are transport operators, business development services, financial services, advertisement, and warehouse support services. The transport service providers are mainly individual transport operators who render transport services to any of the actors in the value chain at a cost. The agreed cost of transportation is based on the distance, quantity of rice transported, and

cost of fuel and spare parts. It is a common practice for wholesalers and millers to make arrangements for transport services after aggregating the paddy rice either at the farm or market gate. Farmers who sell at the market gate transport their paddy rice in a motor tricycle at an agreed cost. Business development services (BDS) are non-financial services provided to smallholder farmers' enterprises to improve their

efficiency and grow their businesses to contribute to economic growth, employment generation, and poverty alleviation. The BDS includes Market access, Input supply, Technology, and product development, Training and technical assistance, Policy or advocacy, Infrastructure, and Equity financing. Per the value chain concept, the services rendered by the BDS are centered on the input suppliers, producers, processors, wholesalers, and retailers. Institutions that provide BDS include Commec Ghana Ltd, Pinnacle Investment Group Ltd, Institute for Entrepreneurial and Professional Development, African Entrepreneurship Academy, Centre for Research and Business Development, and EMPRETECH Ghana, MADE Ghana, Rural enterprise desk under the district and municipal assemblies.

Financial institutions (FIs) provide financial liquidity for the smooth running of the value chain activities. The economic system in Ghana falls into three main categories: formal, semi-formal and the informal sector provides financial services under Bank of Ghana regulation. The semi-formal and informal sector consists of rural banks, savings and loans companies, and semi-formal and informal financial systems that finance agriculture informal (Quartey et al., 2012). The FIs provide services to all the actors in the rice value chain. The mode of financial services differs significantly across the FIs and the actors. The formal financial institutions are incorporated and licensed by the Bank of Ghana (BoG) under the Banking Law 1989 or Non-banking financial institution law 1993 to provide financial services under Bank of Ghana regulation (Quartey et al., 2012). According to IFPRI (2010), financial institutions have demonstrated lack of interest in advancing agricultural credits to farmers due to high default rate, weather and climate risks, and the remote location of farmers making access and effective monitoring extremely difficult.

Recently, some financial institutions have developed index-based insurance schemes, microfinance, community banking, and use of modern communication technologies to provide financial services.

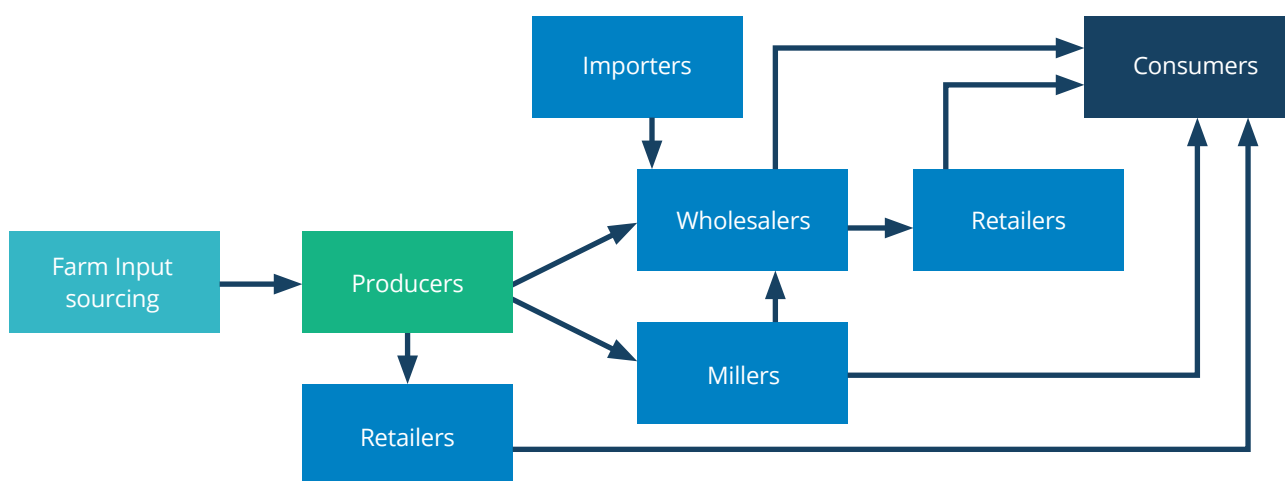
3.2 Rice supply chain

Figure 4 shows the rice supply chain in Ghana. Local rice producers source inputs (fertilizer and seeds) from the agro-input dealers or through the input subsidy program under the PFJ program. The producers are smallholders (70%) and commercial farmers (30%). After harvest, the paddy rice is supplied to wholesalers (resident or itinerant wholesalers), processors, and retailers. About 90% of the paddy rice is supplied to both wholesalers and processors. According to the GCB Strategy and Research (2022), the estimated local rice production in 2022 was 600,000 MT. Out of the 600,000 MT, about 572,000 MT is processed (pre-cleansed, husk, milled, and bagged). The milled rice is usually undertaken by the processors or wholesalers. Farmers process small quantities of the local rice and subsequently sell to local retailers in the same community. Wholesalers, consumers, and millers sell the milled rice to consumers (urban and rural).

Rice importers complement the local rice production with imported rice. About 30% of rice consumption is sourced through local production while 70% is sourced from import. The imported rice is sold to wholesalers and retailers and subsequently sold to consumers.

In the subsequent sections, the landscape analysis focuses on the highlighted portion of the value chain (VC1). We further discuss the local rice production system in Ghana and consumers to provide a holistic analysis of the local rice value chain in Ghana and explore potential pathway for rice fortification.

Figure 4: Local rice supply chain



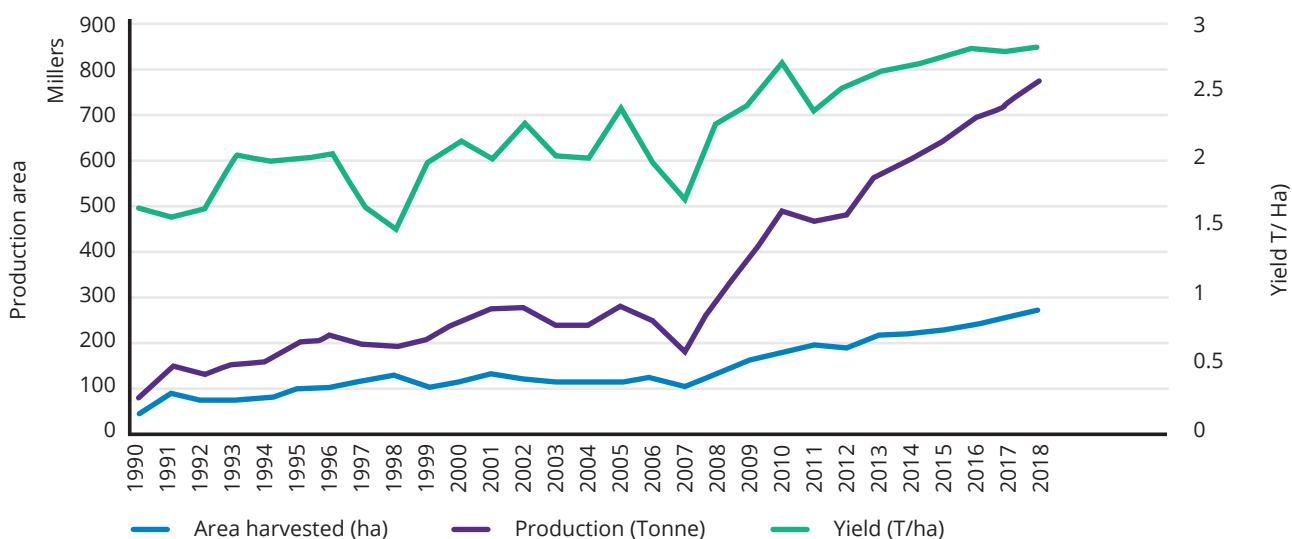
3.2.1 Local rice production

Local rice is produced in the entire regions of Ghana with regional variations due to the agroecological differences. The majority of local rice production comes from Volta, Northern, Upper East, Ashanti, and Western regions. Rice is grown once per year except for areas with irrigation. However, the growing seasons vary across regions. For example, in Volta Region, the growing seasons are April/May (planting) and July/August (harvesting) for Volta, Ashanti and Eastern Regions. In the Northern and Upper East, producers will mostly plant in July/August and harvest in October/November (GCB Strategy and Research, 2022).

Figure 5 shows the trend in rice production in Ghana (1990-2018). Ghana witnessed an increase in paddy rice production between 1990 and 2018. However, production was stable between 1990 and 2008 until the sharp increase from 2008 to 2018. The increase in production was mainly due to extensification (increase

in land area) and not intensification. The expansion in area under rice cultivation may due to increase in demand for food and increasing urban preference for rice consumption. Secondly, the increase support for rice development projects may have contributed to the increase in rice production. Third, growing entrepreneurial middleclass, a rapidly growing tourism sector, and an increase in women working outside the home. Fourth, increasing number of restaurants and fast-food vendors in major cities and towns (GCB Strategy and Research, 2022). According to Ouédraogo et al. (2021), the renewed interest in increasing paddy rice production due to the price hikes in 2008 contributed to the growth observed in the rice sector. The global price hikes led to an increase in the price of imported rice relative to the locally produced rice. The investment in the rice sector in terms of input subsidy program led to an increase in the yield of rice. For example, rice yield increased from 1.7 tonnes per hectare in 2008 to 2.8 tonnes per hectare in 2018.

Figure 5: Trend of rice production and yield in Ghana (1990-2018)



Source (Ouédraogo et al., 2021)

Figure 6 shows the trend in paddy rice production between 2018 and 2021. Paddy rice production increased from 2018 to 2021, and it is further projected to grow beyond 2021 due to the government flagship program "Planting for Food and Jobs (PFJ)". Under the program, the government supply improved rice seeds and fertilizers to farmers to boost their production. The inputs are complemented with extension service support and market opportunities. Ghana witnessed an extraction rate (paddy to milled rice) of 69% between 2012 and 2020 and an extraction rate of 63% in 2021 (MoFA, 2022). There is a need to improve the processing of milled rice and minimize the losses by building the capacity of processors and linking them to financial services to access credit. Such financial credit may enable processors to invest in new equipment to make them more efficient in processing.

Despite the growth in the rice sector, local production is not able to meet domestic demand and reduce the country dependence on rice import. Table 2 shows the projected trend of rice demand and supply in Ghana. Between 2019 to 2020, about 40% of the domestic demand (1,174,200 kg) was met through local production (474,200 kg) while the level of import was estimated at 700,000 kg. Import accounted for 60% of domestic demand and the per capita rice consumption is 38 kg per year. Based on the computation, Ghana is 40% self-sufficient in rice in 2019. In 2030 Ghana's population is projected to increase to 37.7 million while total rice demand, local rice production, and imported rice are projected to increase to 1,506,677 kg, 1,115,243 kg, and 391,434 kg, respectively (Ouédraogo et al., 2021). Based on the projections, Ghana is expected to be 74% self-sufficient in rice production while the deficit of 26%

will be met through rice import. There is a need to double rice production if this target is to be achieved and a target of 9% production growth for the next ten years is plausible for the country to reach the 74% of rice self-sufficiency by 2030.

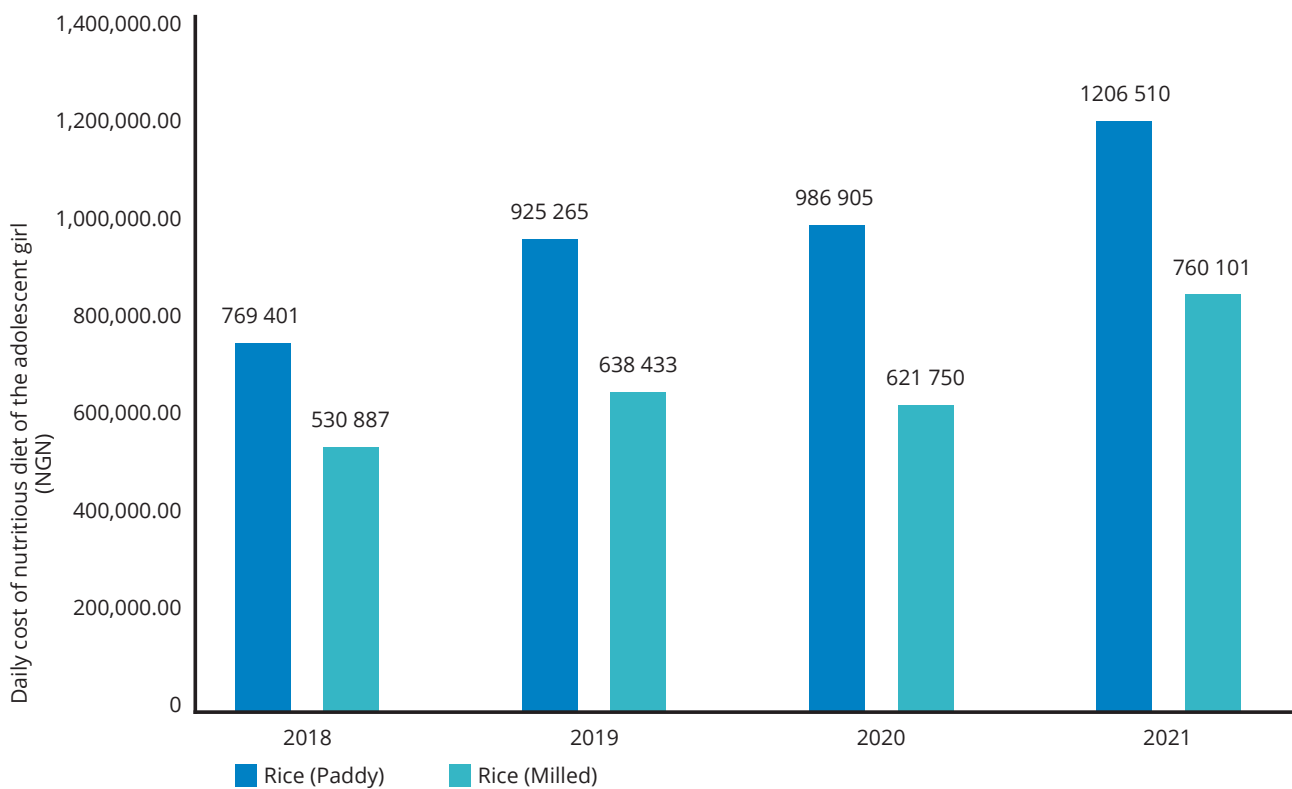
to meet the current demand, given that the high reliance on imports serves as a threat to the development of domestic rice production and food insecurity. This shows that with the right investment in the rice sector, Ghana can achieve higher production and reduction in rice imports.

Table 2: Projected trend of rice and supply in Ghana

	2019-2020	Self-sufficiency /import	2030	Self-sufficiency /Import	Growth 2020-30
Rice consumption per capita (kg per year)	38		40		0.5%
Ghana population (million)	30.9		37.7		2.0%
Total rice consumption	1,174,200 Kg		1,506,677 Kg		2.5%
Rice local production	474,200 Kg	40%	1,115,243 Kg	74%	8.9%
Rice imports	700,000	60%	391,434	26%	-5.6%

Source (Ouédraogo et al., 2021)

Figure 6: Trend of paddy rice production in Ghana (2018-2021)



Source (MoFA, 2021)

Ghana's main ecologies of rice production are upland rain-fed rice, lowland rain-fed rice, and irrigated rice (Figures 7-9). The lowland rain-fed ecology constitutes the largest share (78%) of the arable, followed by irrigated ecology (16%), and upland rain-fed (6%). The main challenge with the lowland rainfed ecology is water management (frequent flooding from groundwater and precipitation). However, the yield in the lowland rainfed ecology can be substantially improved if the ecology is well developed (through simple water management techniques) and mechanized. The main varieties developed in the lowland rainfed ecology are GRUG7, GR 18, GR 17, GR 19, GR 20, and GR 21. The upland rain-fed ecology depends on rainfall, and the main challenge are weed competition, low soil fertility, and pest damage. Short-duration and drought-tolerant rice varieties are well suited for upland rainfed ecologies.

The main varieties developed for the upland ecologies are NERICA 1 and NERICA 2 (both from AfricaRice), Emo teaa (early maturing, long grain, from AfricaRice), and Otoo mmo (resistant to weed and disease, from AfricaRice). The irrigated ecology records the highest rice yields due to high technology utilization relative to the other ecologies. The leading technologies and practices adopted include improved land preparation, use of improved varieties, fertilizer application, and weed control through water management. The most widely cultivated rice variety in the irrigated ecologies is AGRA rice. Other varieties, such as Jasmine 85 and TOX 3109 do well under the irrigated ecology. Recently, new varieties of rice (IR841, Togo Marshal, Savanna rice, Malimali, and (Exbaika) Legon rice 1) released by CSIR-SARI have been demonstrated under the irrigated ecology.

Figure 7: Irrigation rice ecology



Figure 8: Lowland rain-fed rice ecology



Figure 9: Upland rain-fed rice ecology



The producers of paddy rice are the poor and marginal farmers, small and viable scale farmers, and commercial farmers. The first category of farmers lacks the resources to produce a surplus. They operate at the level of subsistence. The second category of farmers has for both home consumption and market. They usually face constraints such as weather risks, market access, and poor infrastructure. The third category of farmers operates vast farms, uses modern technologies in their production, and produce mainly for the market (Ouédraogo et al., 2021). Smallholder farmers have different arrangements (contract versus non-contract) with their buyers in terms of who they sell to and the price at which they sell the rice. Generally, farmers input support. Past studies show that more than 50% of the rice produced is commercialized

Ghana has observed tremendous growth in the rice sector due to the numerous development interventions such as the Rural Enterprise Project (REP), Rice Sector Support Project (RSSP), Inland Rice Valley Development Project (IRVDP), Project for Sustainable Development of Rain-fed Lowland Rice Production in the Republic of Ghana, Agricultural Value Chain Mentorship Project (AVCMP), AGRA Soil Health Project (SHP), Agricultural Technology Transfer Project (ATTP), Commercial Agriculture Project (GCAP), and the PFJ program. However, some challenges still exist—for example, the land tenure system influences access and security. The strict land tenure system tends to limit landholding size and investment in land improvement. Women have limited access to land for agricultural production. Most of the lowland rainfed ecology suitable for rice production is not developed. Limited access to credit among women, impedes their cultivation of rice, and a low literacy level affects the adoption of improved rice technologies. Limited access to modern inputs, extension services, high cost of labour, high cost of

farm inputs, lack of farm machinery-ploughs, power tillers, harvesters, and lack of market for local rice.

3.2.2 Rice processing in Ghana

Rice processing is an integral component of the rice value chain in Ghana. To sustain production and ensure food security, there is a need to reduce postharvest losses by processing paddy rice. The capacity of rice processors in Ghana varies significantly across firms. The locations of the firms are strategically positioned (rice production hubs) to ensure a regular supply of paddy rice from local rice producers. A study by Appiah et al. (2011) show that the SB30 milling machine was more efficient and produced 67.3 percent head grains compared to SB10 (50 percent) and the locally manufactured machine (47.3 percent). Large-scale mills in Ghana use one-pass type milling machines manufactured in Japan or China. In contrast, other mills use Engelberg-type milling machines manufactured in India or Ghana. Electric motors drive the one-pass milling machines, and the Engelberg type is operated by diesel engines. Sakura et al. (2006) find that the one-pass mill type are more efficient and produces more quality milled rice than the Engelberg type mills.

It is a common practice for some processors to provide loans to farmers (at no or relatively low interest rate) at the onset of the farming season with the intention that farmers will supply paddy rice directly to them. Farmers make decision on rice processing based on transportation cost, milling fee and the expected sale price of milled rice (Sakurai et al., 2006). Processors sell milled rice directly to wholesalers or retailers when purchasing paddy rice directly from the local producers. This type of marketing arrangement generates high profit for the processors given that they benefit from both the profit from the rice processing fee and the profit from the distribution and marketing fee.

Due to limited capital, most millers render services to wholesalers rather than buying paddy rice to process. However, there are large millers who buy paddy rice from the farmers and mill and subsequently sell to retailers or other aggregators of milled rice. For local rice to compete with imported rice, there is the need to process paddy to a nationally acceptable standard through the provision of standard rice mills. Standard mills can reduce the percentage of brokenness. Second, investment in postharvest handling such as pre-cleaning of paddy, husking, milling and bagging may improve the overall quality of the grain. This must be complemented with good storage facilities, drying platforms, and parboiling equipment to improve the quality of parboiled rice due to its high nutritious value over polished rice, and low glycemic index, and higher swelling capacity. Due to the high temperatures especially in northern Ghana, about 80% of the rice is parboiled to avoid breaking of the paddy during milling.

3.2.3 Rice wholesaling and retailing

Rice wholesalers and retailers serve as the intermediaries between the production and consumption phase of the rice value chain in Ghana. The wholesalers consist of two types – itinerant and resident wholesalers. The wholesalers serve as intermediaries between wholesalers from the south (Kumasi and Accra) and farmers in the north. The resident wholesalers are traders located within a specific location in the rice production hubs who aggregate paddy rice at the farm gate or farmer-based organisations and other process to resell to other aggregators or retailers in the consumption locations. The itinerant wholesalers from the south also sell to processors. Itinerant wholesalers aggregate paddy rice from different farm locations in Ghana. Comparatively, itinerant wholesalers incur higher transaction costs (searching, bargaining, transportation, aggregation, and storage) than resident wholesalers (negotiation, storage, and transportation) because they lack the tacit knowledge of the region and incur higher transport and storage costs. As a result, itinerant prices of goods sold are higher, which are passed along to buyers in the non-production locations. Price of locally produced rice is determined by forces of demand supply. Lack of effective information flow between markets creates arbitrage opportunities. This can be reduced through efficient information flow of prices across markets. While resident wholesalers benefit from lower costs, they lack the tacit knowledge and market linkages of southern buyers and thus face weaker demand and lower prices. The open market retailers buy processed rice directly from established wholesalers in markets close to production areas.

It is a common practice for some wholesalers to buy paddy from production centres and process it at different locations based on cost and profitability.

However, most of the milling occur at the communities with relatively large milling firms. In contrast, other retailers purchase rice at the local markets from itinerant traders who bring rice from production areas to the local markets. According to Ayeduvor (2018), the main varieties of local rice purchased by wholesalers from Kumasi are Jasmine 85, Togo Marshal, AGRA Rice, Gbewa, Jet 3, Rita 8, and Rita 9. The wholesalers and retailers are predominantly women who dry the paddy rice, mill, winnow, and occasionally manually pick of stones and other foreign materials in the processed rice. In northern Ghana, the wholesalers parboil the paddy, mill, winnow, and sort it (Ayeduvor, 2018).

Martey and Goldsmith (2020) find that while the dominant market structure is highly competitive, there are low-level non-verbal contractual arrangements between the itinerant and resident wholesalers and the producers that cannot be enforced legally but are based entirely on trust. Reneging can occur on these soft contacts due to the non-binding nature of the agreement as farmer information improves about the state of the harvest and prices paid elsewhere, for example, when supply becomes short, and prices rise. The wholesalers wield much power in terms of pricing over the consumer and producer prices. They determine how much they will pay producers based on their expectations about retail market prices. The lack of consistent information across the supply chain on market prices allows the wholesalers to take advantage of spatial arbitrage.

3.2.4 Rice consumption

Due to the relative convenience in the preparation, consumption, and variety of recipes, rice is increasingly a significant part of Ghanaians' diets. Rice is the second most important staple in Ghana after maize (Taylor, 2018; MoFA, 2016). The per capita rice consumption is estimated at 38 kg between 2019 and 2020 and is expected to increase further to 40 kg in subsequent years (Ouédraogo et al., 2021). The high rice consumption can be attributed to increasing urbanization, a large and growing expatriate community, a growing entrepreneurial middle class, a rapidly growing tourism sector, and an increase in women working outside the home (Taylor, 2018). Consumers in the urban areas of Ghana account for about 70% of national consumption (Angelucci et al., 2013). Despite the increase in domestic rice production, there is low competitiveness of domestic rice due to low quality and poor packaging compared to imported rice (Addison et al., 2015). Most consumers in the urban areas have developed a taste for imported rice over locally produced rice due to limited awareness or knowledge of domestic rice availability and the quality characteristics (presence of stones and other foreign materials in milled rice) associated with it, but consumption of local rice is based on preferences, perceived good nutritional quality, and relatively low

price (Ayeduvor, 2018; Diako et al., 2010). Price data from Esoko show that on average the price of imported rice is higher than local rice (Esoko, 2022).

Diversity exists in terms of rice preferences across consumers in Ghana's rural and urban areas. A study by Ayeduvor (2018) indicates that consumer preferences for particular rice types are influenced by factors such as physical appearance, ease of cooking, aroma, absence of foreign material, percentage of broken rice, perception of nutrient content, and origin influence consumer

preferences for particular types of rice. Angelucci et al. (2013) find that rural and urban consumers prefer long grain aromatic varieties, mostly imported. Wealthier and highly educated consumers in urban areas tend to purchase high quality rice based on their perceived nutritional content. Rice branding plays a significant role in consumers' preferences for local rice consumption. Thus, building consumers' loyalty to branded rice will increase the demand and build the competitiveness of local rice (Jo and Marie-Aude, 2012). The Ghana Rice Inter-Professional Body (GRIB) was established to revamp the local rice industry by developing raw milled aromatic rice markets for larger consumer markets. The major aromatic rice varieties currently promoted in Ghana include AGRA, "Togo marshall", "Ex-baika", "Aromatic Short", "Basmati Pusa" and "Jasmine 85".

3.3 Entry points and key partnerships for transforming the rice supply chain to rice value chain

The analysis of the rice value chain actors identified specific challenges faced by each actor. A major challenge with the rice value chain is the lack of financing for value chain activities and standards. High-interest charges and collateral requirements on loan creates a disincentive for actors to access loan. This influences the scale of rice operations despite the huge potential for rice production and consumption. For example, farmers inability to access loans limits the acreage under rice cultivation which subsequently affects the volume of rice supplied within the supply chain. The low volume of rice supplied creates incentives for local importers to engage in rice importation to supplement demand. High competition between local and imported rice has a direct negative impact on the local supply chain through a reduction in income and a long-term impact on poverty. Lack of rice production and marketing quality standards is a major threat to the sustainability of the value chain. Even when quality standards are provided, there is no legal enforcement thus, producers are not able to recoup their investment in quality rice production given that consumers do not pay a premium price

for locally produced rice. The lack of consistent price information across actors creates opportunistic behaviour such as spatial and temporal arbitrage. Weak linkages among actors due to mistrust and lack of contract enforcement are a disincentive for the local rice value chain development. The high cost of transporting rice across actors within the region (intra-regional movement) coupled with high cost of non-tariff measures (for example., custom checkpoints) results in an increase in the price of locally produced rice thus making local rice less competitive. Access to improved rice varieties continues to be a challenge among smallholder farmers although Ghana has made significant strides in increasing farmers' access to modern inputs through donor-funded and government-funded projects and programs.

In terms of the entry points and partnership for rice value chain development, the following are proposed:

- There is the need to continue to foster strong collaboration between research institutions and the private seed sector to ensure that improved varieties developed are upscaled and make accessible to farmers through the PFJ program. This will make farmers to be competitive at world prices, which would expand national supply, reduce price volatility and levels, raise rural incomes, and allow the national government to use scarce hard currency on more essential imported goods
- Facilitating access to finance for value chain actors at relatively low interest rate by the government and other private financial development agencies will ensure a boost in the production and supply of rice.
- Improving access to consistent market information across the markets in Ghana will reduce market uncertainties, enhance effective price transmission and reduction in the tendencies for spatial arbitrage. Currently, Esoko is the main platform that provide consistent market information on commodity prices in Ghana. SRID of MoFA can partner with Esoko to collate and share price information for actors to aid in planning.
- Building the capacity of producers to invest in quality rice production is key to ensuring that the local price is competitive against the imported rice. Establishment of a price-quality connections will incentivize actors to investment in quality rice production and marketing leading to efficient market development. The agricultural extension departments of the department of crop service must partner with BDS to support farmers in terms of capacity building to increase the quality of rice production. Consumers of local rice have demonstrated their willingness to pay premium for local rice with quality features such as aroma, less breakage, less or no foreign materials, and short cooking time, inter alia.

Analysis of Local Rice Milling in Ghana

4.1 Characteristics of local rice processors

Figure 10 shows the spatial location of the processors. The primary respondents interviewed are chief executive officers, managers, deputy managers, head of production, lead technicians, engineers, quality control officers, sales managers, supervisors, and operations managers.

Figure 11 shows the demographic characteristics of the local rice processors in Ghana. About 90% of the processors are males who manage the processing firm. Regarding education, 26% of the processors have attained middle/Junior high school and secondary school education, while 25% and 22% have achieved

tertiary and primary school education, respectively. The majority (86%) of the sampled processors stated rice processing as their primary occupation. At the same time, the rest are primarily engaged in other businesses such as farming, commercial driving, teaching, input distribution, and digital marketing. The result shows that 53% of the processors belong to an association. The main functions of the association, as described by the processors, include access to finance, market access, assistance in regulating milling price, support members to mill quality rice, training of members on marketing and use of improved rice technologies, provision of information on improved rice varieties, and promotion of the milling business. However, the processors who are not members of association cited reasons such as disunity among members, mistrust, relatively new in the rice milling business, non-existent of association, limited functions of the existent association, and non-functional association.

Figure 10: Map of the study area

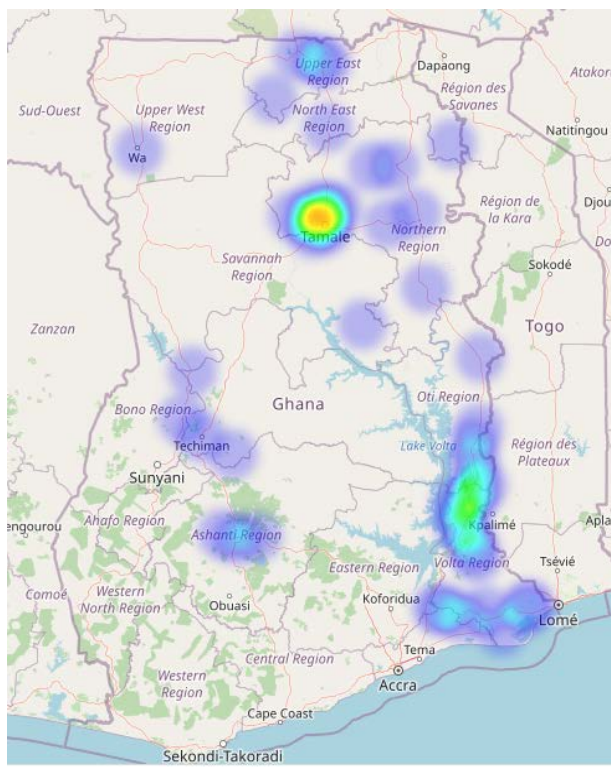
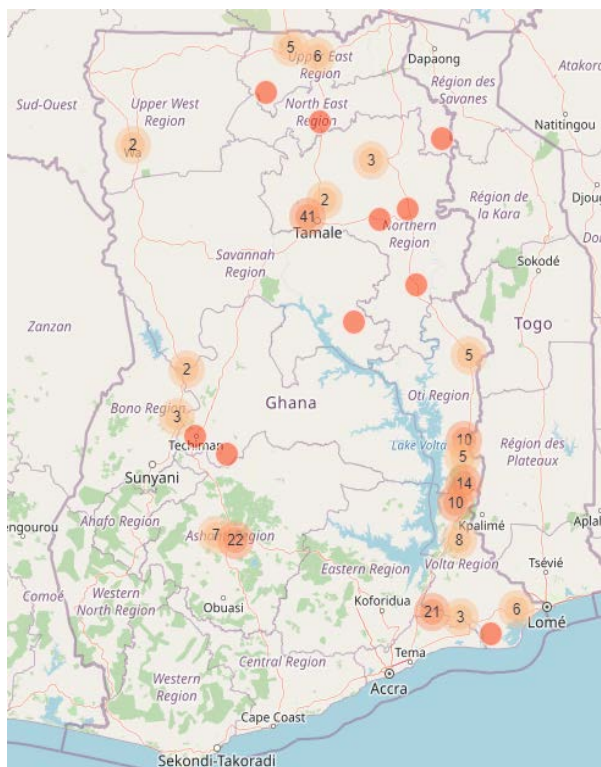
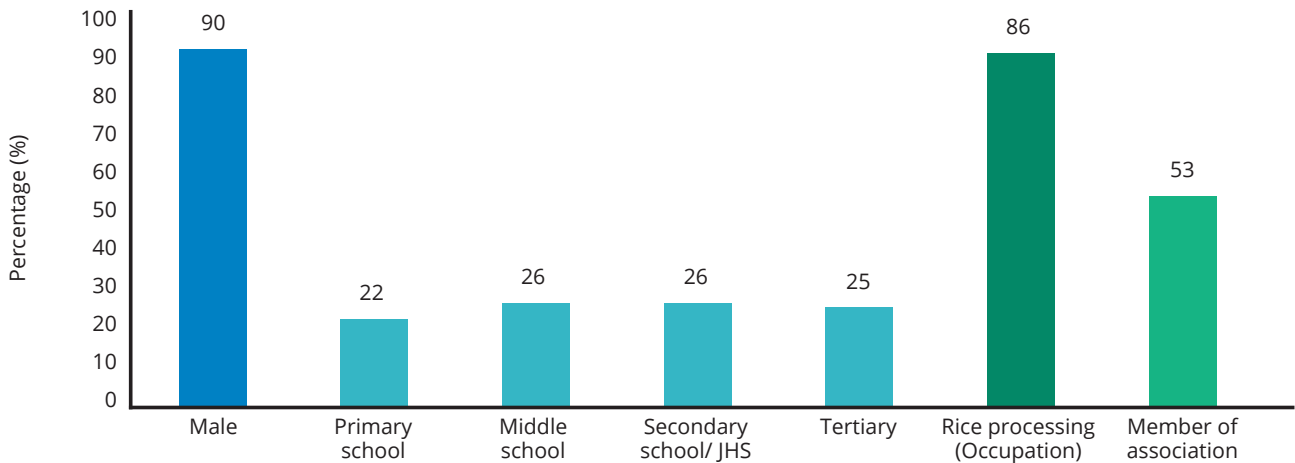




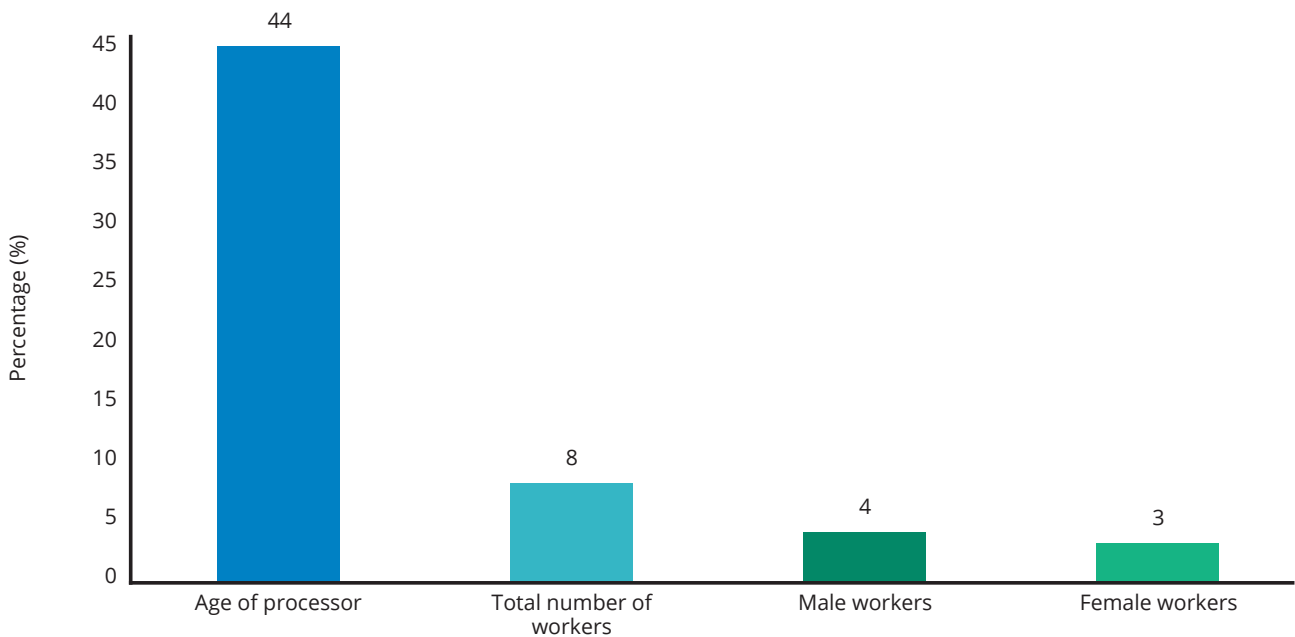
Figure 11: Demographic characteristics of sampled processors



The processors' age and total workforce is reported in Figure 12. The results show that the sampled processors are relatively young (44 years), which indicates that with the suitable investment, the processors can work actively for the next two decades. About 24% of the sampled processors are youth while

76% are adults. The total number of workers employed by a processing firm in our sample is eight, of which males and females constitute about 50% each. The result reveals that local rice processing firms are somewhat gender balanced.

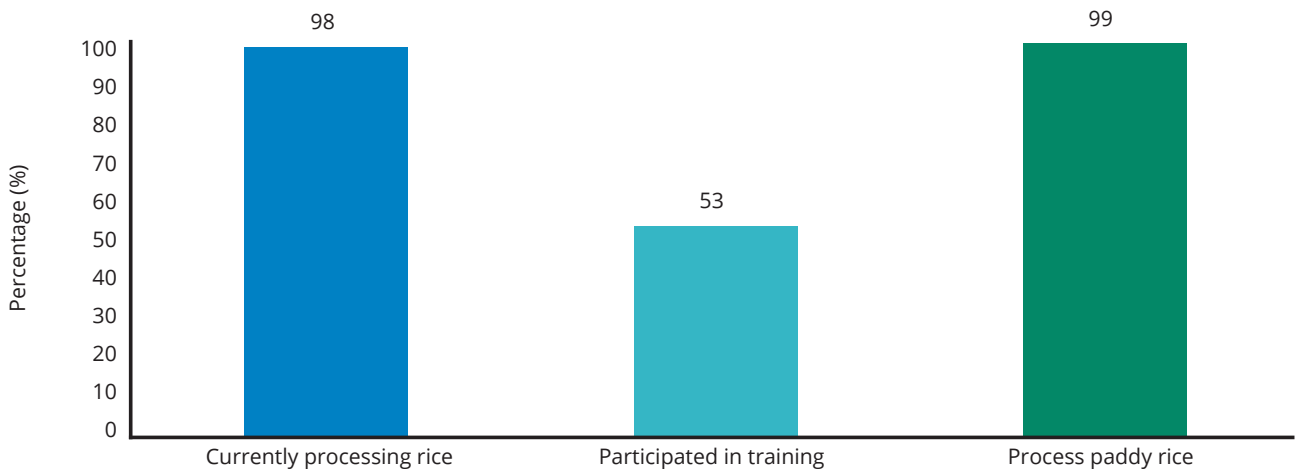
Figure 12: Age and total workforce



The study further ascertained whether processors are still involved in rice processing and the issue of capacity building (Figure 13). The results show that 98% and 53% of the processors are still in the rice processing business and have received training in cleaning, drying, parboiling, and storage, while 99% process paddy. For those currently not processing, they stated reasons such as the non-availability of paddy, rehabilitation of the processing facility, and farmers' non-appreciation of the processing machine. According to processors who are not processing, there are plans to service their equipment or replace them in the long term. The sampled processors have been

processing local rice for almost 10 years on average, and the last time they participated in local rice training was seven years ago. The results highlight the need to build the capacity of the processors to improve their efficiency. The rice processing training providers consist of public and private institutions. However, about 20% of the processors were trained by their relatives and friends on cleaning, drying, parboiling, storage, and bagging. There is a need for research institutions and other development practitioners in the rice value chain who are responsible for capacity building to train processors to enhance their efficiency.

Figure 13: Rice processing and training

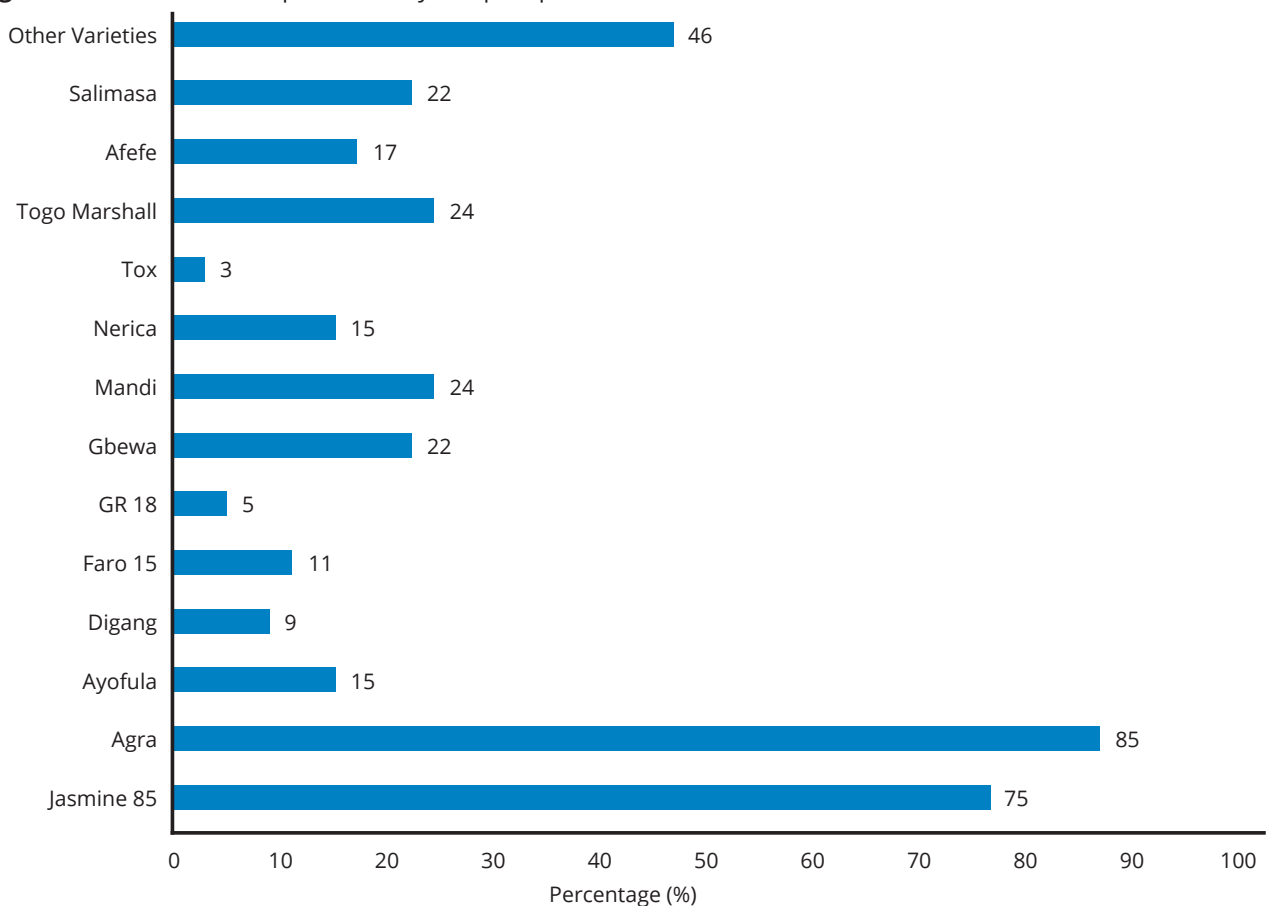


4.2 Rice varieties processed and preferred rice varieties

Figure 14 shows multiple responses of the rice varieties processed by the sampled processors. AGRA rice variety

is mostly processed according to 85% of the processors, followed by Jasmine 85 (75%) and other varieties (46%). Some of the other rice varieties processed include red rice, "X-baika", "Amankwatia", "La peas", "Viwornor", "Agbamevor" etc.

Figure 14: Rice varieties processed by sampled processors



The study shows a variation between the varieties of rice processed and the preferred rice varieties to process. Figure 15 shows the preferred rice varieties processed by the sampled rice processors. The results show that 56% of the processors prefer AGRA, followed by Jasmine 85 (30%) and other rice varieties (30%), Mandi (8%), Salimasa (6%), Togo Marshall (6%),

Ayofula (2%), Afefe (1%), NERICA (1%), and Gbewa (1%). The main reasons for choosing a select variety include the uniformity of the grains and colour after milling, availability, fragrance, buyers' and consumers' preferred variety, ease to dry, good taste, long shelf-life, easy milling with minimal brokenness, fewer alternatives, etc.

Figure 15: Preferred rice varieties processed by sampled processors

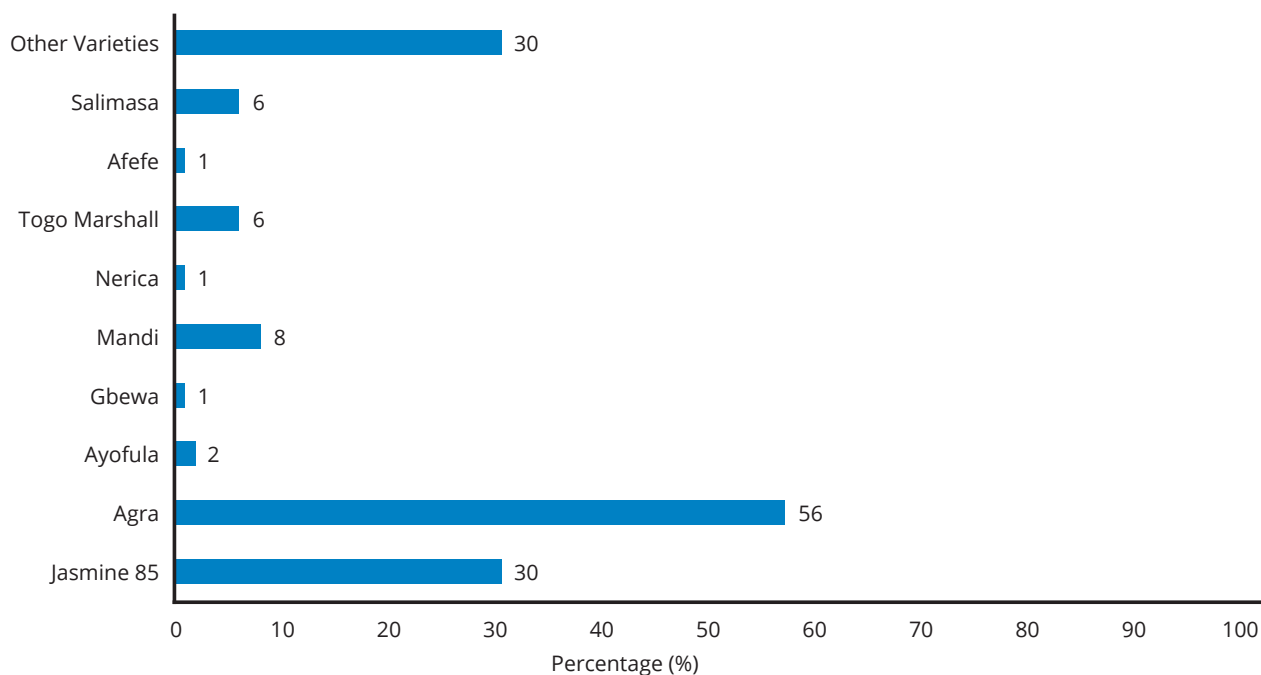


Table 3 reports the sampled processors quantity of paddy cultivated, purchased, and sold annually. The results show that 36% of the sampled processors cultivate their rice paddy with an average quantity cultivation of 339 MT per annum. About 51% of the sampled processors purchase rice paddy. The average rice paddy purchased and processed annually are

1043 MT and 1169 MT, respectively. The percentage of broken rice after milling is 22%, while the proportion of customers who prefer broken rice is 28%. Interaction with the processors indicate that broken rice is cheap and mostly used to prepare rice balls. On average, the sample rice processors have been selling processed rice to buyers for eight years.

Table 3: Rice cultivated, purchased, and processed annually

Variable	Observation	Mean	Standard deviation	Minimum	Maximum
Grow own paddy rice (1=yes)	185	0.36	0.48	0	1
Quantity (MT) of paddy grown	67	339.34	1039.31	1	6615
Purchase paddy rice (1=yes)	185	0.51	0.50	0	1
Quantity (MT) of paddy bought	95	1043.27	3865.52	0.3	25000
Quantity (MT) of paddy processed annually	184	1168.69	3645.65	1	30000
Percentage of broken rice after milling	185	21.72	12.77	1	60
Proportion of customers who prefer broken rice	182	28.03	23.62	0	100
Longevity of selling to buyers	184	7.93	8.13	0	33

4.3 Parboiled and straight-milled rice

Figure 16 highlights the sampled processors' experience with rice parboiling. The results show that 12% of the processors purchase parboiled rice from other actors within the rice value chain. For those who do not purchase, they cited reasons such as lack of funds, high preference for straight milling, difficulty in processing, non-availability, not common practice, low demand especially among urban consumers, uninformed about rice parboiling, non-delicious relative to straight-milled rice, etc. The results suggest that parboiling is site-specific and will be necessary for more awareness creation on the nutritional benefits of rice parboiling. The sampled processors who buy parboiled rice do so mostly from farmers (32%), aggregators (32%), other processors (18%), local parboilers (14%), and farmer associations (5%).

About 20% of the sampled rice processors engage in rice parboiling. These processors are primarily located in northern Ghana. For those who engage in rice parboiling, their main targeted customers are aggregators (54%), consumers (23%), government institutions such as school and hospitals (9%), others (9%), and other processors (6%). Figure 17 shows the quantity of parboiled rice processed annually. The average quantity (MT) of parboiled rice processed annually is 1,393 MT. Based on gender disaggregation, the quantity of parboiled rice processed by the males (1,457 MT) is twice that of the females (752 MT). Based on the results, it can be concluded that men dominate processing of parboiled rice in northern Ghana in terms of volumes. This may be attributed to the lack of capital for women to engage in high volumes of parboiled rice processing.

Figure 16: Purchase and selling of parboiled rice

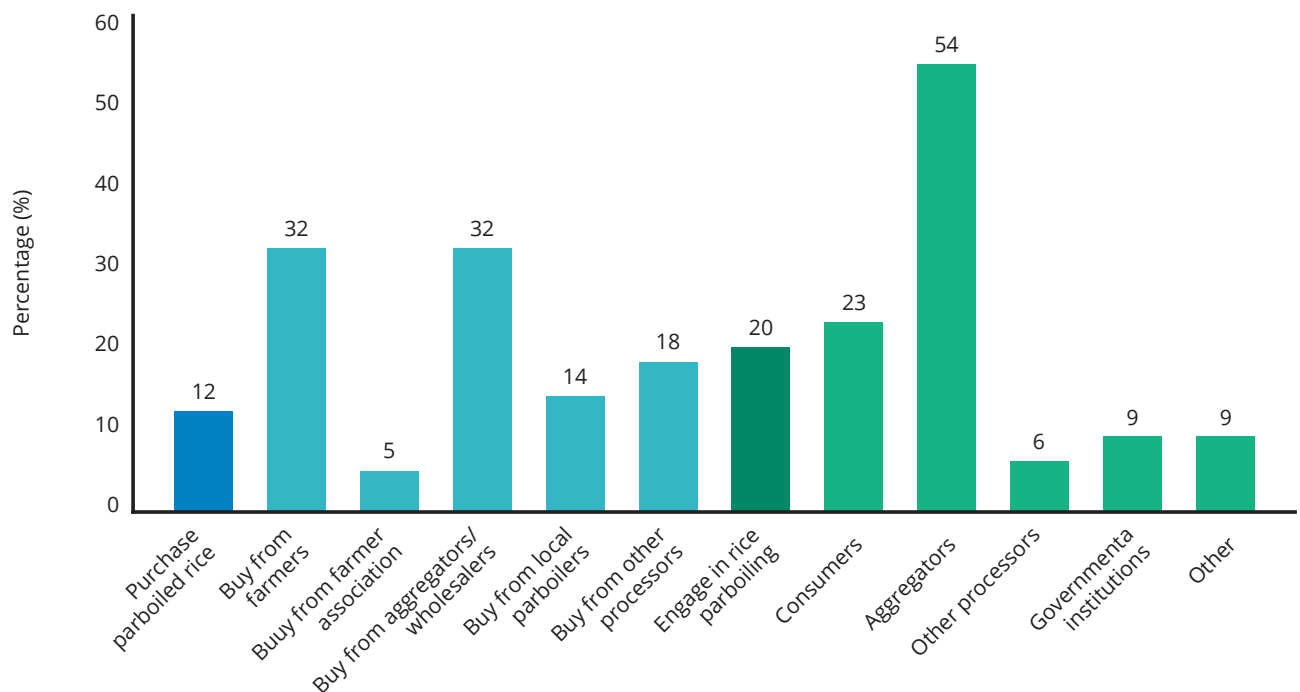


Figure 17: Quantity (MT) of parboiled rice processed annually by gender

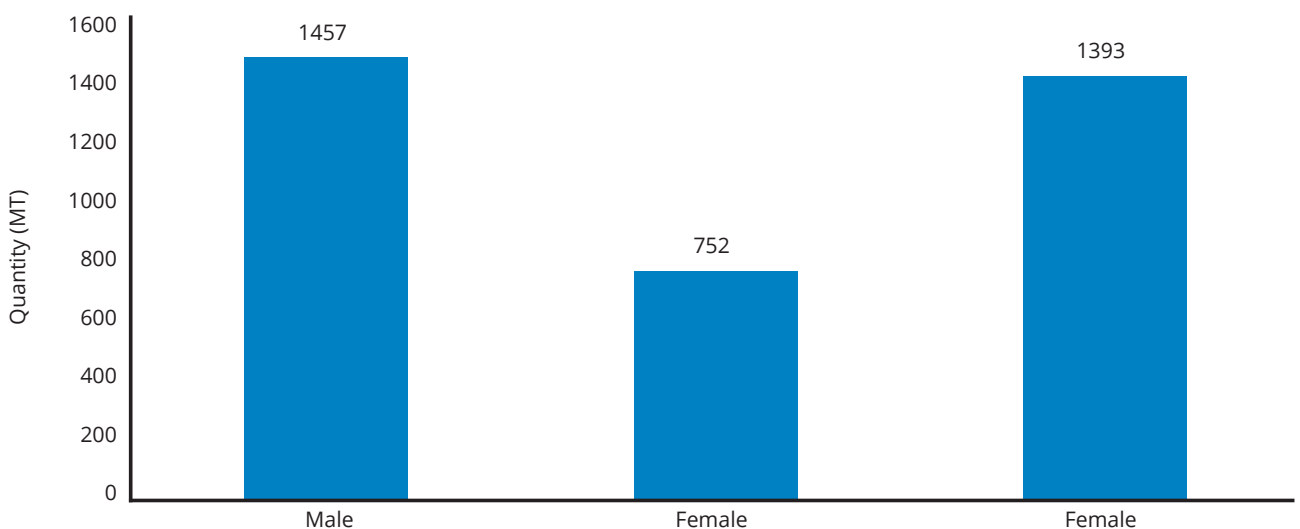
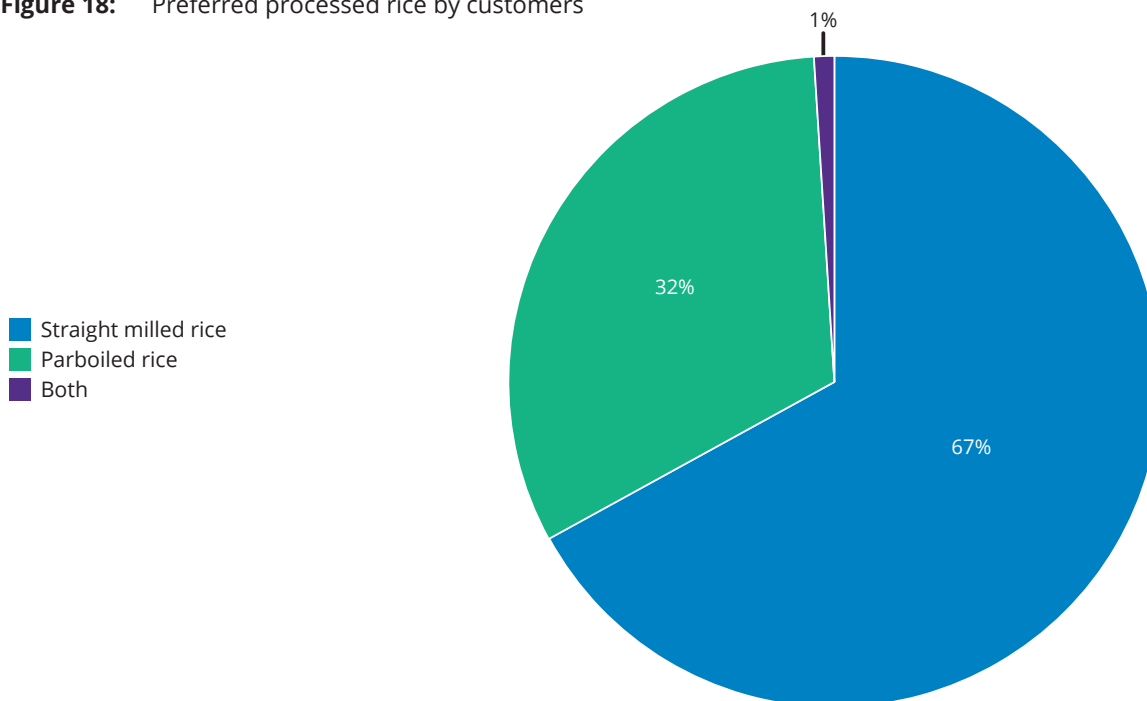


Figure 18 shows consumers' preferences for processed rice in Ghana. Based on the figure, the majority (67%) of the sampled processors reported that about 67% of their consumers prefer straight-milled rice. In comparison, 32% and 1% of their consumers prefer parboiled rice and both, respectively. The information from the survey is necessary for market

segmentation, given that there are different segments of local consumers who can be targeted and tailored to processed rice to meet their preferences. Rice consumers must be sensitized to the nutritional benefits of parboiled rice and promoted especially among children through the school feeding program.

Figure 18: Preferred processed rice by customers



The study further investigates the price differential between parboiled and straight-milled rice and the type that commands a high price in the market (Figure 19). The results show that 50% of the processors agree that there is a price differential between parboiled and straight-milled rice in the market. Comparing rice types, 85% of the sampled processors indicate that straight-milled rice commands a higher price than parboiled rice while 15% of the processors indicate that parboiled rice commands higher prices than straight-milled rice. Figure 20 reports the prices per 100 kg of parboiled and straight-milled rice. Comparatively, the price of straight-

milled (GHS863) rice is relatively higher than that of parboiled (GHS669) rice. The demand for straight-milled rice may account for the high market price. However, the processors of parboiled rice indicate that it reduces the level of breakages when milling compared to straight-milled rice. The survey further revealed that consumption of parboiled rice is relatively high in northern Ghana and among food vendors in southern Ghana. A fairly large section of consumers prefers straight-milled rice relative to parboiled rice despite the nutritional benefits of parboiled rice.

Figure 19: Price differential between parboiled and straight-milled rice

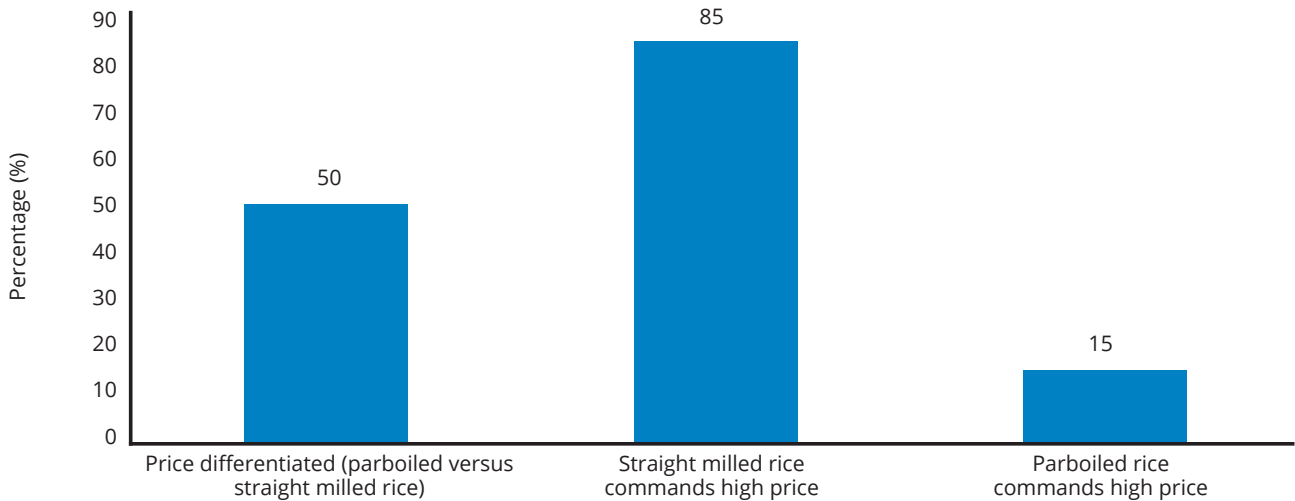
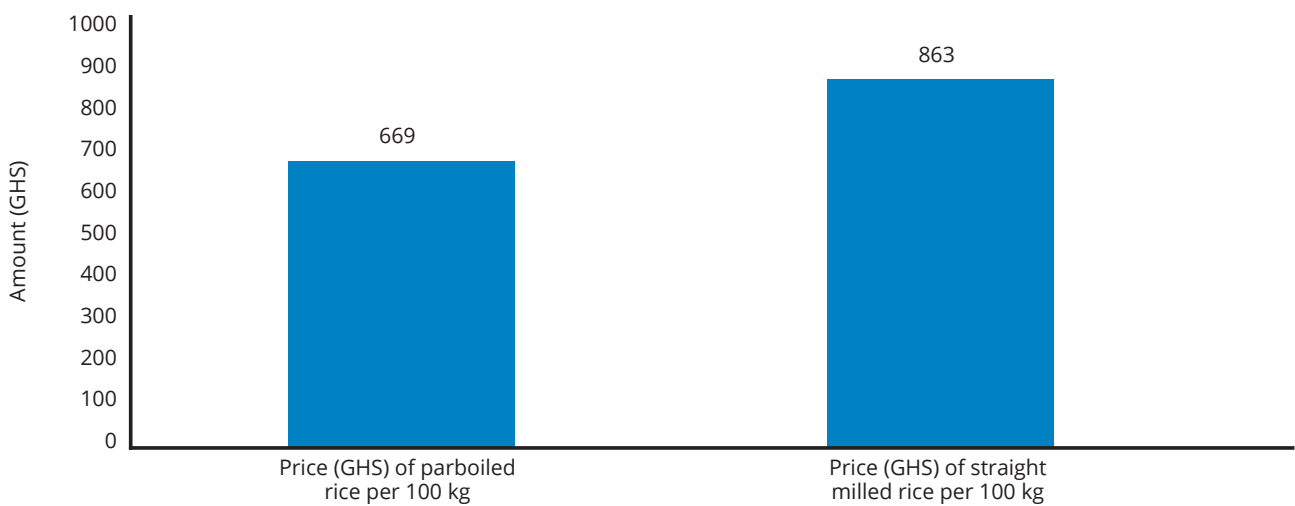


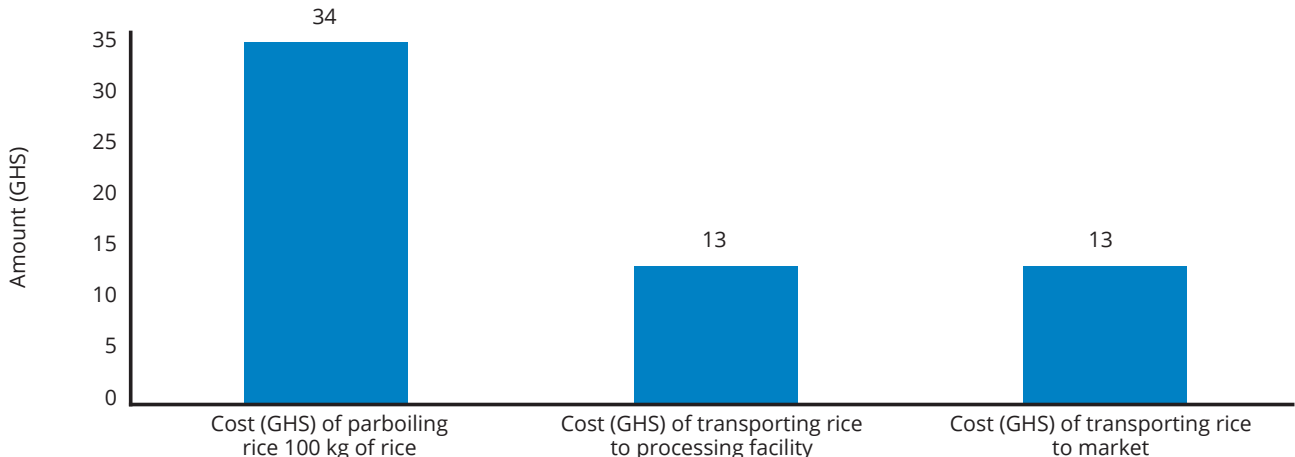
Figure 20: Price of parboiled versus straight-milled rice per 100 kg



Transportation plays a major role in terms of postharvest management and food security. The costs of parboiling and transporting 100 kg of paddy rice to a processing plant are GHS34 and GHS13, respectively (Figure 21). Similarly, the cost of transporting processed rice to the market is GHS13. A relatively high transportation cost is associated with an increase in processed rice market price,

thus making local rice not competitive. According to the processors, the high cost of transportation has primarily been attributed to the high cost of fuel and spare parts. To ensure competitive and affordability of local rice, the local economic environment must be improved in terms of the exchange rate, fuel prices, and interest charges on loans.

Figure 21: Cost of rice parboiling and transportation of processed rice

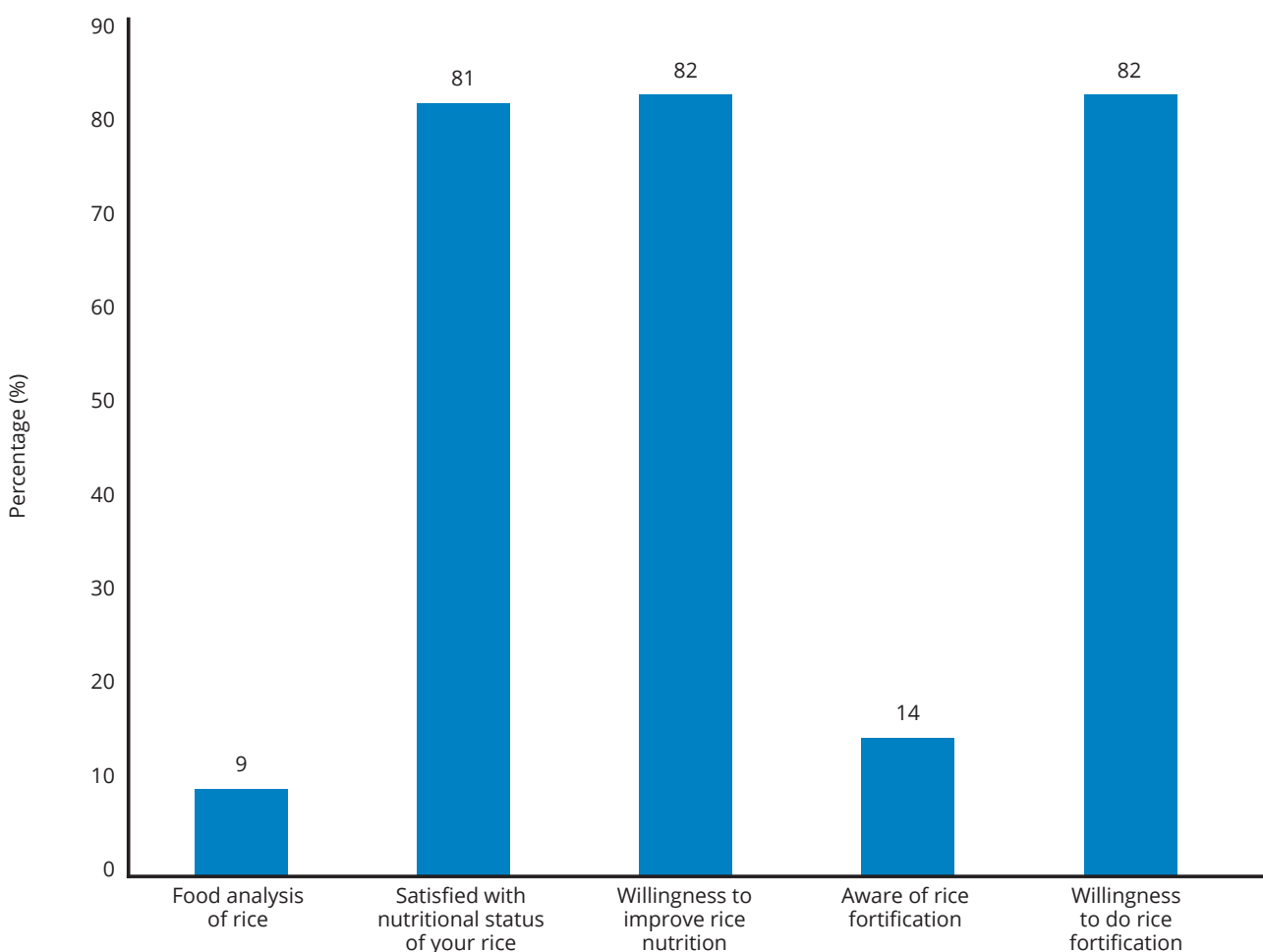


4.4 Processors' willingness to fortify rice

Figure 22 shows the nutritional analysis and local rice fortification among sampled rice processors in Ghana. The study results show that 9% of the sampled processors conduct nutritional/food analysis of processed rice. Out of the 9%, about 81% stated their satisfaction with their processed rice current nutritional value. About 82% of the processors were willing to improve the nutritional value of their rice with micronutrients such as zinc, calcium, iron, manganese, folic acid, etc. However, some processors are unsure of the type of micronutrients to include in rice processing. Concerning rice fortification, the results show that 14% of the sampled rice processors are aware of

rice fortification through the internet, media (radio, television), relatives and friends, books, and training programs. The results further highlight that 82% of the processors are willing to undertake rice fortification if they have the requisite training and support. Reasons for willingness to engage in rice fortification include improved nutrition, an increased market value of processed rice, and increase market demand for local rice. The low awareness of rice fortification serves as an entry point for further engagement and sensitization of local rice processors on the nutritional benefits of local rice fortification. Consensus efforts between private and public institutions are required to boost rice fortification while ensuring available markets for the product. Training local processors is key to successfully implementing rice fortification in Ghana.

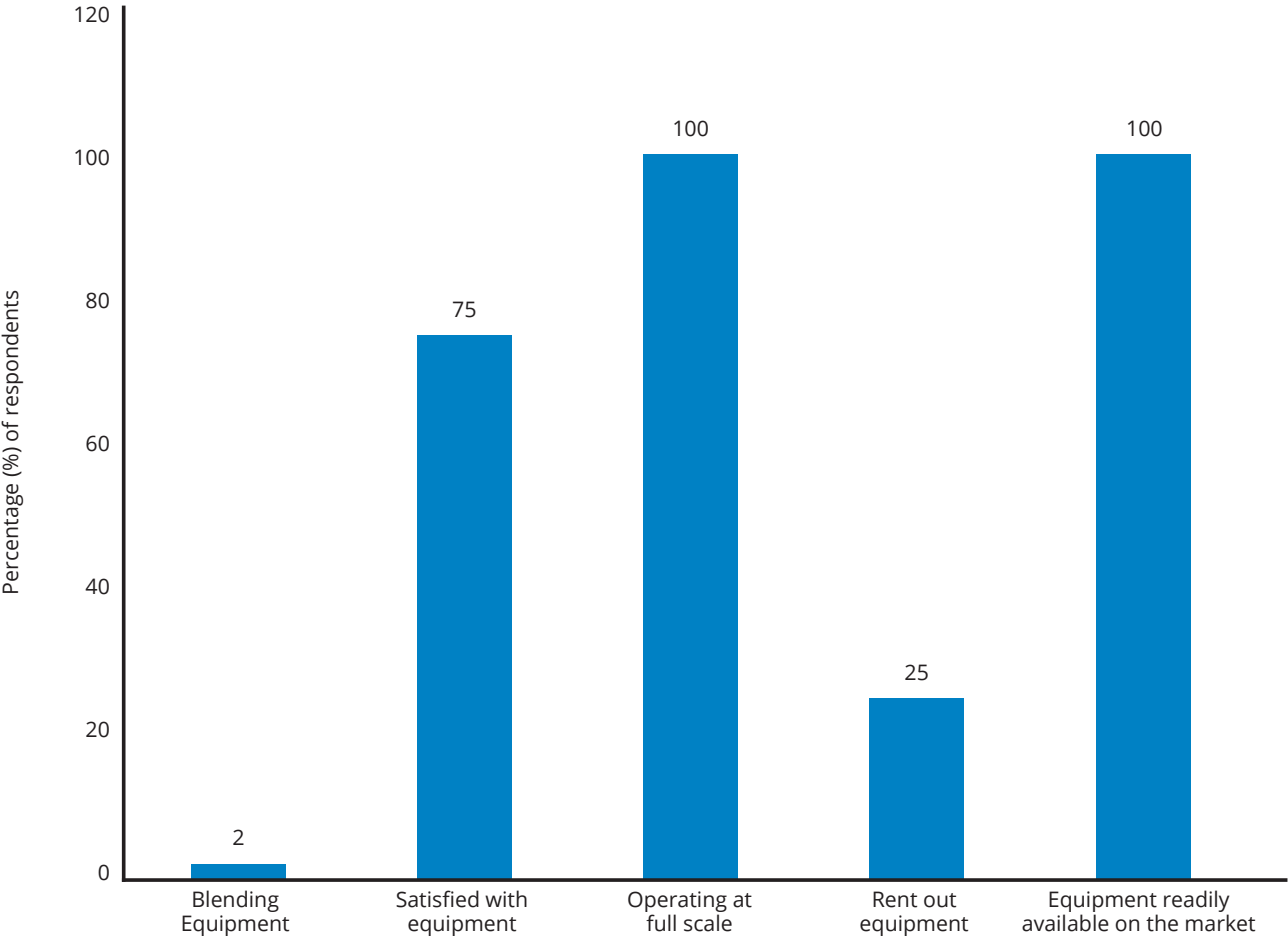
Figure 22: Nutritional analysis and rice fortification



Processors' current sale price of local rice per kilo and their willingness to sell and pay for fortified rice is reported in Figure 23. The current price per kilogram of local rice is GHS10. However, the market price distribution above the mean is higher than that below the mean. The highest current market price for a kilo of locally processed rice is GHS30. The mean willingness to sell a kilogram of fortified rice is GHS16. The price distribution is relatively constant above and below the mean selling value of fortified local rice. The

highest mean willingness to sell a kilogram of fortified rice is GHS75. On average, a processor is willing to make a profit of GHS6 per kilogram of fortified rice. However, the profit can only be sustainable if each sale's return can accommodate part of the cost of fortification. More research is required in this area to ascertain the profitability of local rice fortification. The mean willingness to pay for a kilogram of fortified rice is GHS8.

Figure 24: Rice fortification equipment

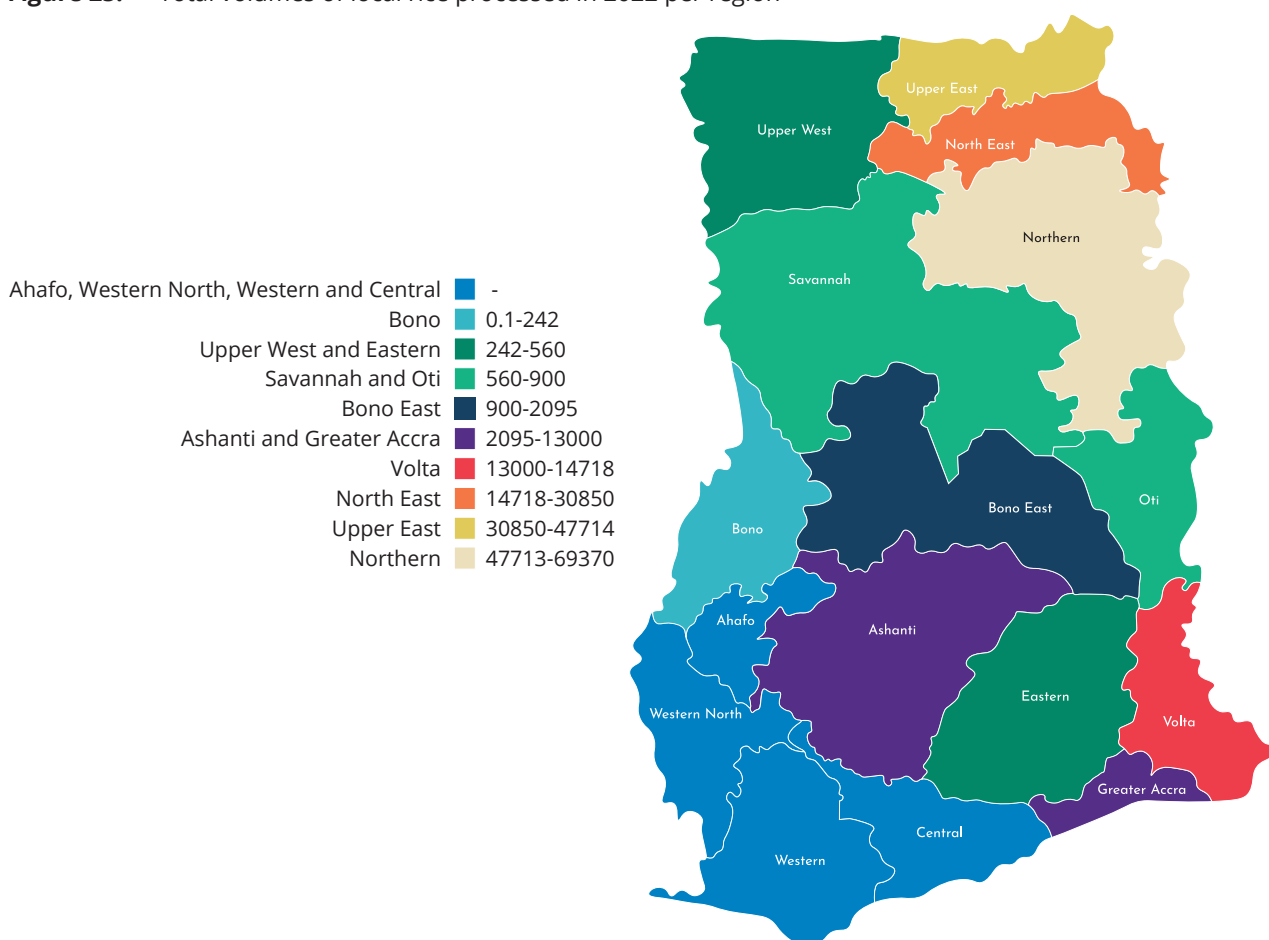


4.5 Quantity of rice processed based on regional disaggregation

The total volume of rice processed in 2022 per region based on the sampled processors interviewed is reported in Figure 25. The spatial location of rice processing concentration is in the Northern Region of Ghana. The total volume of rice processed annually in the Northern Region is between 47,713.1 MT to 69,370 MT. The Upper East Region recorded a total volume of processed rice between 30,850.1 MT to 47,713 MT and followed by North East Region where the total volume of rice processed annually is between 14,718.1 MT to 30,850 MT. The Volta Region followed with an estimated annual volume of rice processed between 13,062.1 MT to 14,718 MT. However, there are some few relatively medium to large firms in the Volta Region who have

not yet started operation as of the time of the survey. Ashanti and Greater Accra regions recorded a total volume of rice processed annually between 2,095.1 MT to 13062 MT while the annual rice processed in the Bono East is between 899.1 MT to 2,095 MT. The processors in Savannah and Oti regions process between 560.1 MT to 899 MT of rice annually followed by processors in Upper West Region that recorded an annual volume of rice processed between 0.1 MT to 242 MT. The regions with high volumes of processed rice also represent the regions of high volumes of rice production. This suggests that the volume of local rice processed annually depends on the volume of production. The findings from the study provides the basis for targeting local rice processors for the rice fortification program.

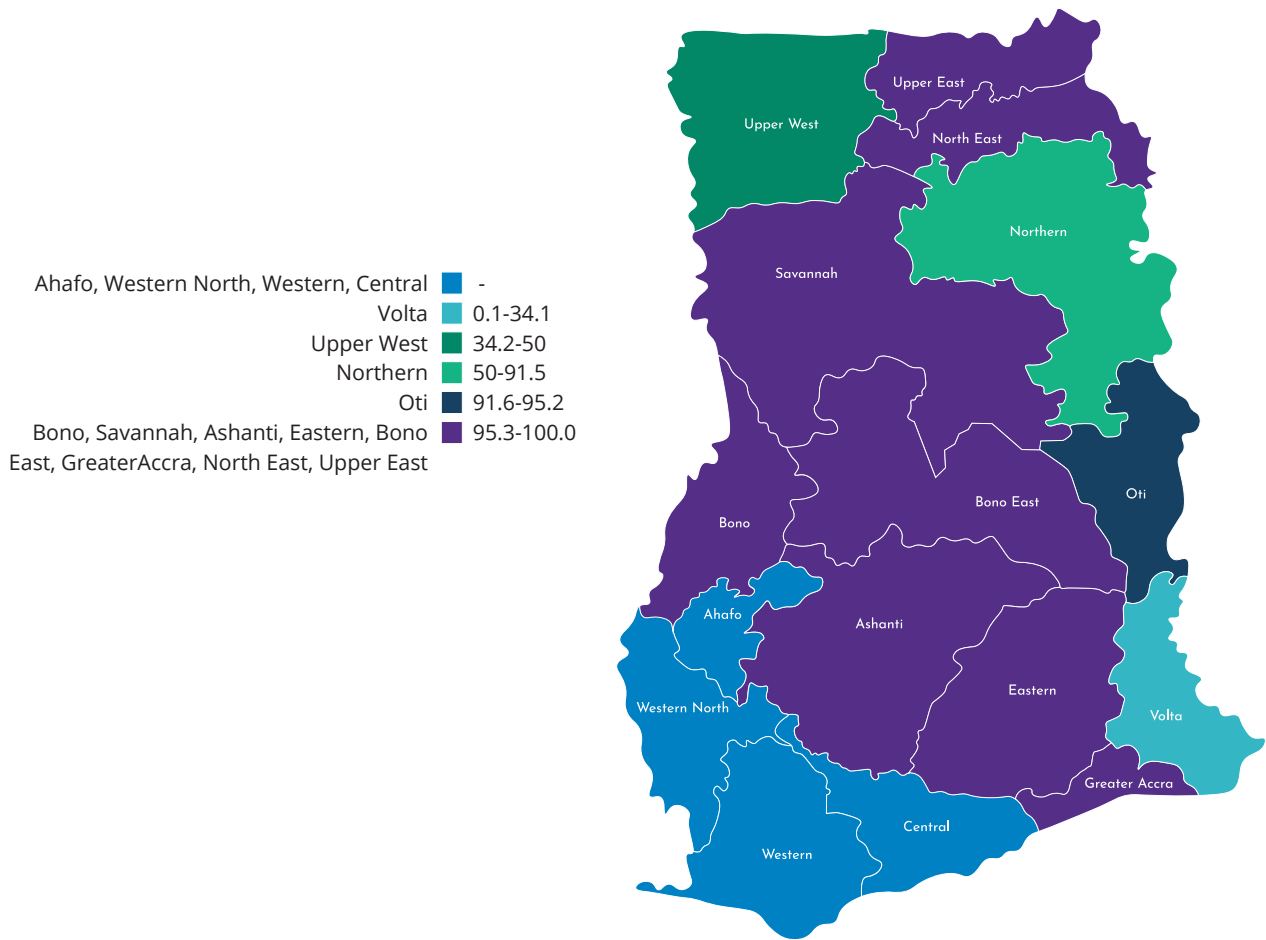
Figure 25: Total volumes of local rice processed in 2022 per region



A more detailed analysis of processors' willingness to participate in rice fortification based on regional disaggregation is presented in Figure 26. The results shows that all the processors in Upper East, North East, Savannah, Bono East, Bono, Ashanti, Eastern, and Greater Accra regions are all willing to participate in rice fortification program. In Oti Region, about 92% to 95% of the processors were willing to engage in rice fortification while about 50% to 92% of the processors in Northern Region are willing to do rice fortification.

About 50% and 34% of the processors in Upper West and Volta region, respectively are willing to fortify their local rice. Non-participant of rice fortification revealed that the local rice is nutritious so there is no need to further add micronutrient to it. The results suggests that more education is required. Any rice fortification program must target regions with high willingness to participate while engaging processors with low numbers of willingness to participate to ensure high participation and impact.

Figure 26: Percentage of processors willing to participate in rice fortification by region



4.6 Strengths and weaknesses of the local rice processing

This section analyzes the strengths and weaknesses of the local rice industry in Ghana. The strengths and opportunities of local rice processing in Ghana, stated by the processors, are as follows:

- Source of income for those engaged in the industry
- Local rice is more nutritious than imported rice
- The abundance of rice paddy
- Employment for the local people and youth
- Existing technologies to increase production capacity
- More land for rice cultivation
- Rice seed is available for cultivation
- Agricultural extension support
- Access to research institutions
- Large water bodies for irrigation farming
- Availability of ready market
- Government support for local rice production
- Increasing demand due to an increase in population.

The weaknesses and threats that exist in the local rice industry include the following:

- High cost of milling machines
- High cost of electricity in operating the machines
- Lack of financial capital and high-interest charges on loans
- Unavailability of spare parts
- Lack of alternate market outlets for local rice
- Lack of quality equipment for rice processing
- High cost of land preparation
- High cost of maintenance
- Unstable electricity supply
- Lack of training in rice handling
- Lack of good farming practices
- Lack of political will to ban rice importation
- High cost of agricultural inputs.



Conclusion

Rice is an essential staple crop in addressing poverty among various actors within the rice value chain and economic growth at the national level. Value addition to locally milled rice such as fortification to enhance nutritional quality is one of the mechanisms of addressing malnutrition especially among women and children. However, there is a limited investment by the government of Ghana in rice fortification despite the enormous benefits. The United Nations World Food Program (WFP) Ghana engaged the Savanna Agricultural Research Institute (SARI) of the Council for Scientific and Industrial Research (CSIR) to conduct a landscape analysis of local rice production in Ghana and its potential for fortification. The study's main objective is to deepen understanding of local rice production in Ghana and the potential for fortification to serve as the basis for establishing partnerships for rice value chain development and fortified rice projects to help improve school meals programs.

The study's major findings show that the rice value chain consists of input dealers, local rice producers, rice importers, local rice processors, aggregators, retailers, and consumers. The primary support services are financial institutions, transportation, and business development services. Northern, Upper East, and Volta regions are Ghana's main local rice-producing regions. Local rice production has been increasing due to several donor-led development programs. However, growth in the sector has not met local demand, which is supplied through imports. The local rice production sector is confronted with challenges such as limited access to modern inputs, extension services, high cost of labour, high cost of farm inputs, lack of farm machinery-ploughs, power tillers, harvesters, and lack of market for local rice. The capacity of rice processors in Ghana varies significantly across firms.

Large-scale mills in Ghana use one-pass milling machines manufactured in Japan or China. In contrast, other mills use Engelberg-type milling machines manufactured in India or Ghana. Processors sell milled rice directly to wholesalers or retailers. The local rice wholesalers consist of two types – itinerant and resident wholesalers. Wholesalers, and retailers serve as the intermediaries between the production and consumption phase of the rice value chain in Ghana. The wholesalers and retailers are predominantly women. In northern Ghana, the wholesalers parboil the paddy, mill, winnow, and sort it before selling. Rice is the second most important staple in Ghana after maize. Most consumers in the urban areas have developed a taste for imported rice over locally produced rice. Consumption of local rice is based on preferences, perceived good nutritional quality, and

relatively low prices. The major challenge with the rice value chain is the lack of financing for value chain activities and standards. High competition between local and imported rice directly impacts the local supply chain through a reduction in income and a long-term impact on poverty.

The local rice processing is male-dominated, they are relatively young and have participated in training on rice processing. The most preferred rice variety processed by processors is AGRA. However, the processors have other preferred varieties they process. Some processors process rice paddy from their production while the majority purchase and mill paddy rice. The mix in variety usually reduces the quality of the processed rice, which negatively affects market value. A relatively small proportion of the processors in northern Ghana engage in rice parboiling, while the majority engage in straight rice milling. The quantities of parboiled rice processed by male processors are twice the volume processed by female processors. Rice processors who engage in parboiled rice purchase from farmers, aggregators, other processors, local parboilers, and farmer associations. Parboiled rice processors sell the processed rice primarily to wholesalers/aggregators. Despite the high nutrient of parboiled rice, straight-milled rice is mainly preferred by most rice consumers relative to the parboiled rice, which is perceived to be low quality and not delicious. Comparatively, the price per kilogram of straight-milled rice is higher than that of parboiled rice, which is predominantly driven by the high demand for straight-milled rice. Most of the processors do not conduct nutrient analysis of the processed rice. The processors' subjectivity of nutritious rice is based on visual inspection, but a relatively large proportion are willing to engage in rice fortification with the needed support and training. The level of awareness of rice fortification among rice processors is relatively low. The main outlets for creating awareness of rice fortification are the internet, media (radio, television), relatives and friends, books, and training programs. Processors' willingness to pay or invest in a kilogram of rice fortification is lower than their willingness to sell a kilogram of fortified rice. The result indicates that processors are profit-oriented and will likely invest in rice fortification if the level of their returns can cover the cost of investment. Despite the high willingness to participate in rice fortification, most processors do not have the equipment for fortification and, therefore, require both technical and financial support to acquire the equipment. Accessing the equipment is not a challenge since they are available on the market, but financial constraints limit the ownership of the equipment. The results suggest that with increased affordability, processors will be willing to engage in rice fortification.

Assessment of the rice industry suggests that the main strengths and opportunities of the sector are the source of income for those engaged in the industry, local rice is more nutritious than imported rice, the abundance of rice paddy, employment for the local people and youth, existing technologies to increase production capacity, more land for rice cultivation, the rice seed is available for cultivation, agricultural extension support, access to research institutions, large water bodies for irrigation farming, availability of ready market, government support for local rice production, and increasing demand due to an increase in population. The main identified weaknesses and threats of the rice sector are the high cost of milling machines, high cost of electricity in operating the machines, lack of financial capital and high-interest charges on loans, unavailability of spare parts, lack of alternate market outlets for local rice, lack of quality equipment for rice processing, high cost of land preparation, high cost of maintenance, unstable electricity supply, lack of training in rice handling, lack of good farming practices, lack of political will to ban rice importation, and high cost of agricultural inputs.

6. Recommendations

Based on the findings of the study, the following recommendations are made:

1. Ghana has made significant gains in terms of rice production volumes. However, the growth in production volume has largely been due to extensification (putting more land under cultivation) rather than intensification. The promotion of intensive cultivation of rice in Ghana must be prioritized and vigorously promoted to ensure a sustainable rice value chain system. In addition, farmers' productivity must be improved through the promotion of good agricultural practices such as superior agroecological practices, improving access to subsidized inputs, extension services, market and weather information for proper planning, as well as fostering partnerships between research and extension.
2. To guarantee a more sustainable value chain system, the rice seed system, which forms an integral component of the rice value chain, must be strengthened. Research institutions responsible for the production of breeder and foundation seeds must be adequately funded by the government to invest in more resilient breeding programs, as well as private seed producers that will satisfy different segments of the rice-producing population. A more robust monitoring system under the PPRSD of MoFA must be created to monitor seed production and ensure that all protocols are strictly adhered to.
3. The sustainability of the rice value chain system is anchored on a sustainable value chain-financing approach which provides an opportunity to de-risk financing which targets various actors, especially smallholder farmers. Existing financing options must be scaled up to include the participation of rural, community, and commercial banks as well as informal financial options that provide financial support to rural farmers.
4. The capacity of all actors in the rice value chain must be built with an emphasis on producers, aggregators and processors. Such training programs must prioritize quality rice production and postharvest management practices, given the high level of losses along the rice value chain. Linking actors to district warehousing projects is worth undertaking to minimize postharvest losses.
5. Rice processing associations must be promoted and strengthened to improve their bargaining position and access to inputs and services (e.g., bulk purchasing of inputs, marketing, and extension) at a relatively lower cost. Such associations must be technically supported and trained on association management to minimize conflict and increase group dynamics and cohesion.
6. A relatively low proportion of processors engage in the processing of parboiled rice due to the high demand for straight-milled rice by consumers. However, parboiled rice is shown to result in fewer breakages after milling thus preserving the quality of the grains. Consumption of parboiled rice is site-specific which requires a market segmentation approach in terms of commercialization efforts. Sensitizing local rice consumers on the nutritional benefits of parboiled rice may serve as an entry-points for investment in parboiled rice processing. Development practitioners must lead in the sensitization efforts through constant engagement with processors both at the lower (community and district) and higher (regional and national) levels.
7. AGRA rice variety is the most consumed local rice in Ghana due to its fragrance. In view of this, we recommend that rice fortification efforts must target AGRA rice. To ensure that the AGRA rice is available at all times, there is the need for investment (supply AGRA seed and modern inputs) in the production of AGRA rice. Other varieties such as Gbewa or Jasmine 85 can also be fortified. The use of multi-stakeholder or innovation platforms can be used to advance the rice fortification process in Ghana.

8. Despite the high proportion of millers in association, there is the need to encourage the rest of the processors to join miller association for effective mobilization, negotiation, and mutual support. The miller association can serve as a point of entry for advocacy on rice fortification.
9. Awareness of rice fortification is low though a relatively high proportion of local rice processors were willing to engage in rice fortification. To ensure that local rice processors buy into the rice fortification agenda, the WFP can lead in organizing a regional and national multi-stakeholder discussion about the prospects and sustainability of rice fortification in Ghana. The WFP can lead in developing a rice fortification protocol with inputs from relevant stakeholders such as the GSFP, Ghana Health Service, District Assemblies, Research Institutions, Ministry of Food and Agriculture, etc. This will require that the scope of the rice fortification protocol must be further defined. The developed protocol can form the basis for organizing training for the local rice processors on rice fortification and the health implications of healthy diets.
10. The successful implementation of local rice fortification and its sustainability is anchored on access to blending equipment. A public-private partnership (PPP) is required to make the equipment available to local processors at an affordable price. The WFP can support the small to medium local processors (especially the youth and women) to acquire the equipment at a subsidized price. However, there is the need to conduct detailed assessment of the milling lines as well as other infrastructure available at the mills based on which recommendations are made on the equipment of the mills.
11. Finally, we recommend that the database of the local rice processors should be updated periodically and validated to reflect current processing capacity for planning purpose.



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List of Acronyms

AGRA	Alliance for a Green Revolution in Africa
ATTP	Agricultural Technology Transfer Project
AVCMP	Agricultural Value Chain Mentorship Project
BDS	Business Development Service
BoG	Bank of Ghana
CSIR	Savanna Agricultural Research Institute
FASDEP	Food and Agriculture Sector Development Policy
FGDs	Focus Group Discussion
FIs	Financial Institutions
GCAP	Commercial Agriculture Project
IRVDP	Inland Rice Valley Development Project
LIPs	Local Implementing Partners
MoFA	Ministry of Food and Agriculture
PFJ	Planting for Food and Jobs
REP	Rural Enterprise Project
RSSP	Rice Sector Support Project
SARI	Savanna Agricultural Research Institute
SHP	Soil Health Project
SRID	Statistics, Research and Information Directorate
SWOT	Strength, Weakness, Opportunities, Threats

Appendix

Figure A1: Processing firms in Northern Ghana



Figure A2: Processing firms in Eastern and Greater Accra Regions of Ghana



Figure A3: Processing firms in Volta and Oti regions of Ghana



Figure A4: Processing firms in Bono East Region of Ghana



Figure A5: Processing firms in Ashanti Region of Ghana



List of respondents

The categories of individuals and groups interviewed include the following:

- Ministry of Food and Agriculture
- Local Implementing Partners (LIPs)
- Local rice producers
- Individual farmers and Farmer based organizations
- Input dealers' association
- Processors and aggregators
- Financial institutions
- Transport operators
- Rural enterprise of Ministry of Food and Agriculture

Contributors

CSIR-Savanna Agricultural Research Institute (CSIR-SARI):

Edward Martey (Lead Researcher, Agricultural and Applied Economist), Abdul-Razak Mohammed (Agribusiness specialist and Focal Person), Alhassan Nuhu Jinbaani (Agricultural Economist), Asante Boadu-Ayebofo (Geographic Information Systems Specialist)

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Nutrition Division

World Food Programme

Via Cesare Giulio Viola, 68/70

00148, Rome, Italy - T +39 06 65131

wfp.org