Food and Agriculture Organization of the United Nations

RICE VALUE CHAIN IN GHANA

Prospective analysis and strategies for sustainable and pro-poor growth

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PROSPECTIVE ANALYSIS AND STRATEGIES FOR SUSTAINABLE AND PRO-POOR GROWTH

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Key messages

- The proposed upgraded scenario for the rice value chain will yield a very positive impact on value added, employment, farmers' income with limited additional Green House Gas emissions.

- Under this scenarios, farmers' income will increase significantly, at the average rate of 9.9 percent per year - moving from USD 528 to USD 1 300 per producer.
- Big processors will experience an average growth of income from USD 260 000 to USD 600 000.
- Employment in the value chain increases at 3.7 percent per year, i.e. an additional 60 000 jobs created by 2030.
- The net carbon balance is estimated at 249 000 tCO_2-e of increased carbon emissions due to the expansion of area under rice production, increased input use, processing and transport linked with increased input use. However, the carbon footprint per ton of paddy is decreasing from 1.4 to 0.7 tCO_2.

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Executive summary

Based on partnership on support to National Rice Development Strategies (NRDS) within Coalition for African Rice Development (CARD), AfricaRice and FAO decided to conduct a series of rice policy reviews for Ghana, Ivory Coast and Mali in 2019. The following study uses the Ex-ante Carbon-balance Value Chain tool (EX-ACT VC), developed in 2016 by FAO, to assess the Ghanaian rice value chain's environmental (in terms of climate mitigation and climate resilience) and socio-economic impact. The tool assesses the value chain for a business as usual scenario in 2020 compared to a defined growth or upgraded scenario for 2030.

Rice is a pertinent crop that is not just a staple in the Ghanaian diet but is also important in terms of income generation for many farmers in Ghana (approx. USD 5/day of work). However, only 40 percent of the rice demand in Ghana is met by domestic production, the remaining of which is met by rice imports. This makes Ghana highly susceptible to market shocks in the rice sector.

With the aim of attaining self-sufficiency in rice and promoting pro-poor, sustainable development in the rice value chain, different policy options have been identified. Promotion of good agricultural practices (GAP), the reduction of crop losses, and an increase in the use of inputs and mechanization are the different strategies considered in this study that would help in realizing this aim.

Through the implementation of these practices, along with the expansion of rice growing areas, the income per day of work per farmer would increase by more than USD 4, reaching approx. USD 9/day of work in the value chain.

The gross production value of the rice value chain would reach USD 856 million, which is an additional USD 511 million in gross production value by 2030. An upgraded rice value chain would also result in an increase in the value added by USD 378 million by 2030, with most of the value added being generated at the production level (USD 258 million). The rice value chain would also experience an increase in employment with more than 60 000 additional jobs created by 2030, with 12 000 jobs opportunities for women and 30 000 for the youth.

In terms of the upgraded value chain's environmental impact, rice would create an overall positive carbon balance and emit 284 852 tCO_2-e in greenhouse gas emissions, primarily because of expansion of areas, additional inputs, and improved agronomic practices. However, as a result of increased yields the carbon footprint of paddy reduces by 50 percent from 1.4 to 0.7 tCO_2-e/ tonne of paddy produced.

The global economic analysis of the economic and environmental benefits of the regional value chain results in a net present value for the growth scenario of USD 397 million after investment, and an internal rate of return of 32 percent when accounting for both public and private investments.

1. Rice production in Ghana: Regional and national policy review and performances

1.1 Overview of recent policies

The structural adjustment program (SAP) developed under the aegis of World Bank (BM) and International Monetary Fund (IMF) in 1990s has been for long the dominant development framework for sub-Saharan African countries, especially in the agriculture sector. This program advocated the withdrawal of public intervention in agricultural markets and in price fixation as an efficient way to promote competition and growth in the sector. However, according to recent evidence, development strategies inspired by this policy framework have been particularly harmful for food crop products (Birner and Resnick, 2010). Such policy withdrawal on food crops during the period of SAP exacerbated the food security status of many countries.

In the early 2000s, the limited success of this strategic shift has led to a change of paradigm in agricultural policies. Several arguments and evidence were developed in favor of active intervention of the public sector for agricultural and food development (Ashley and Maxwell, 2001; World Bank, 2008). First, within the agriculture sector, food crops represent the highest potential to reduce poverty in many countries and regions in Africa. Second, food production contributes directly to food security at household and national levels. Third, the incidence of food insecurity and poverty are the highest in rural areas where food production represents the main source of food and income for the majority of households. Lastly, the 2008 food crisis has raised the importance of developing national food production to minimize the effects of external shocks.

Thus, in 2003, public intervention in food sector has been encouraged at regional level by the formulation of the Comprehensive Africa Agriculture Development Program (CAADP), which aimed at eliminating poverty and food insecurity through the promotion of agriculturally led growth. This new framework has the specificity of being designed by African governments. The program urged each country to allocate at least 10 percent of the national budget to the agriculture sector in order to achieve 6 percent of annual growth in the sector. The CAADP is a shared framework for strategic planning and implementation. Furthermore, it offers an avenue for political, technical and financial support for countries whose plans and strategies are aligned with the principles of CAADP. In Ghana, the ultimate of goals of CAADP is to support strategic planning of agriculture by helping to define a coherent long-term framework to guide the planning and implementation of Food and Agriculture Sector Development Policy (FASDEP II).

To operationalize the CAADP commitment, African Heads of State and Government agreed to prioritize specific commodities, including rice, amongst the list of commodities already agreed to as "Strategic Commodities" in the Abuja Food Security Summit held in 2006 in Abuja, Nigeria. These prioritized strategic commodities are also among key commodities identified under the African Development Bank's agenda for Agricultural Transformation in Africa (ATA) and within the context of its Feed Africa Strategy as those that are necessary to foster agricultural development for achieving transformation.

1.2 Rice policy in Ghana

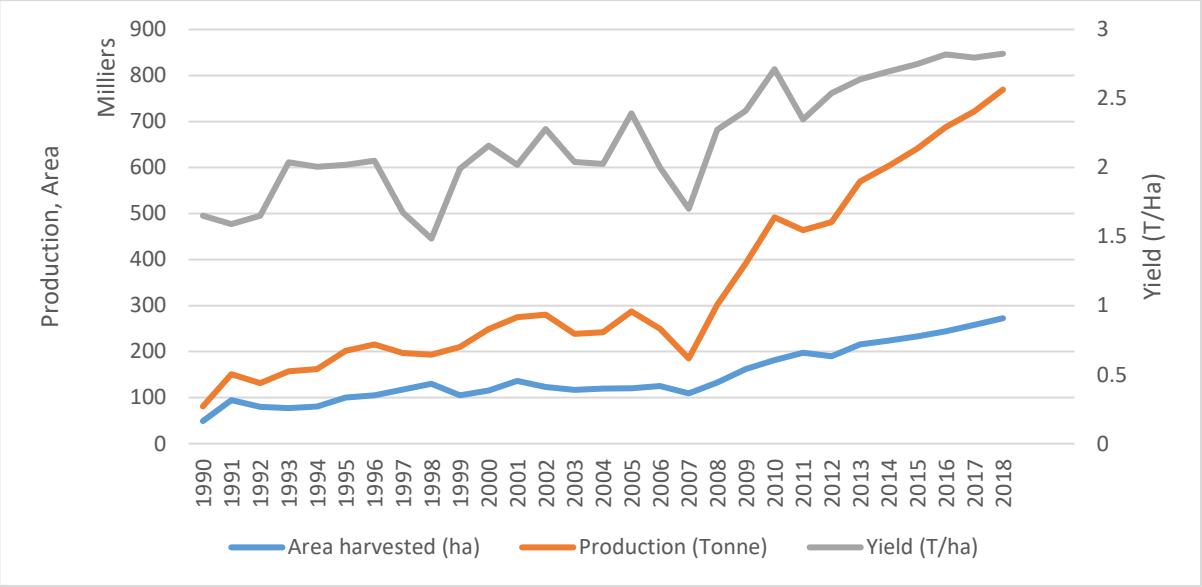
Rice is identified as a priority crop in Ghana and is reflected as such in many of its agricultural policy documents. Like in many African countries, Ghanaian food policy has undergone a significant change since the 2008 crisis. The Coalition for Africa Rice Development (CARD) launched in 2008 aimed to double rice production in Africa. Ghana subscribed to this initiative and formulated the National Rice Development Strategy (NRDS) for the period 2008-2018. The major constraints for the development of rice value chain in Ghana highlighted in the 2009 NRDS include the inadequate access to inputs (seed and fertilizer), inadequate harvesting and post-harvest management technologies, and the weak local rice marketing system. As a result, self-sufficiency rate in rice declined from 38 to 24 percent between 1999 and 2006 in Ghana (MOFA, 2009).

The NRDS addresses these constraints by developing some specific measures such as the promotion of mechanization, increased cultivation of inland valleys and efficient utilization of existing irrigation systems, varietal improvement and increased seed production and utilization (MOFA, 2009). Thus, the strategy developed thematic areas, namely, seed systems, fertilizer marketing and distribution, post-harvest handling and marketing, as well as irrigation & water control investment (MOFA, 2009).

The agenda for transforming Ghana's agriculture (2018-2021) aims to increase productivity of the sector and job creation by promoting sustainable practice and mechanization. The program allocated around USD 1.8 million to crop and livestock development out of which 1.3 million for the two strategic programs, namely - (i) Crops and Livestock Production and Productivity Improvement and (ii) Mechanization, Irrigation and Water Management (MOFA, 2018). Specific challenges noted in the rice sector include problem of competitiveness, milling technology, mechanization along the value chain. These challenges need to be addressed through the value chain approaches that are sustainable, productive and competitiveness-enhancing.

1.3 Pattern of rice production in Ghana and characteristics of producers

Figure 1: Trend of rice production and yield in Ghana between 1990 and 2018



Source: Constructed by the author (FAO, 2020).

As shown in figure 1, production has remained relatively stable between the period 1990 - 2008. The lack of specific food policy support may have contributed to the low performance of the sector during this period. However, from 2008 and 2018, paddy production increased from 301 000 to 733 000 tonnes, corresponding to an average annual production growth of around 9 percent (Figure 1). This growth is due to a steady increase in yield and in areas allocated to rice production. The renewed interest in promoting food production to counteract the negative effect of spike in food price in 2008 has contributed to this growth experienced in the rice sector. Thus, from about 1.7 tonnes/ha in 2008, rice yield increased to about 2.8 tonnes/ha in 2018. In addition, a large area has been devoted to rice production contributing to the significant performance of the sector during the last decade.

1.4 Current and foreseen rice demand and degree of self-sufficiency

Although the growth rate of rice production has been high enough to allow the country to double its rice production, it is inadequate to reduce the country's reliance on rice imports. In fact, during the last decade, rice imports increased at a rate of 14 percent per year on average. In 2019, the local production was able to cover 40 percent of the domestic demand. The level of import is estimated at about 0.7 million of tonnes in 2019 while domestic production reaches 0.47 million tonnes of rice. In the table below, the national demand in 2019 is around 1.2 million tonnes of rice, with an average consumption per capital of 38 kg of rice.

Table 1: Projected trend of rice demand and supply in Ghana

	2019 -20	self suf/import	2030	self-suf/import	Growth 2020-30
rice consumption per cap (kg per year) (1)	38		40		0.5%
Ghana population (million) (2)	30.90		37.7		2.0%
Total rice consumption	1 174 200		1 506 677		2.5%
Rice local production	474 200	40%	1 115 243	74%	8.9%
Rice imports (2)	700 000	60%	391 434	26%	-5.6%

Source: Constructed by authors based on USDA dataset (2020) and FAOSTAT.

This suggests that the country is still at 40 percent of self-sufficiency in rice. Thus, this high reliance on import not only impedes the development of domestic rice production but also represents a threat to national food security. However, rice demand will continue to rise owing to the current population growth (2 percent) and the increase in per capita consumption of rice (0.5 percent per year). Rice is increasingly a main part of the diet in many Ghanaian homes due to its relative convenience in preparation and palatable recipes. Government of Ghana indicate that annual per capita rice consumption is expected to reach 40 kg in coming years.

By assuming that the Government manages to keep a similar production growth trend of 9 percent for the next ten years, the country should reach 74 percent of self-sufficiency by 2030, with rice production multiplied by a factor of 2.3 (134 percent increase) and a significant decrease of rice imports (-5.5 percent per year). The rice sector has the potential to provide substantial income growth and food security for many actors along the chain. Understanding the structure of value chain should provide guidance in identifying adequate strategies to upgrade the value chain for an inclusive and sustainable growth.

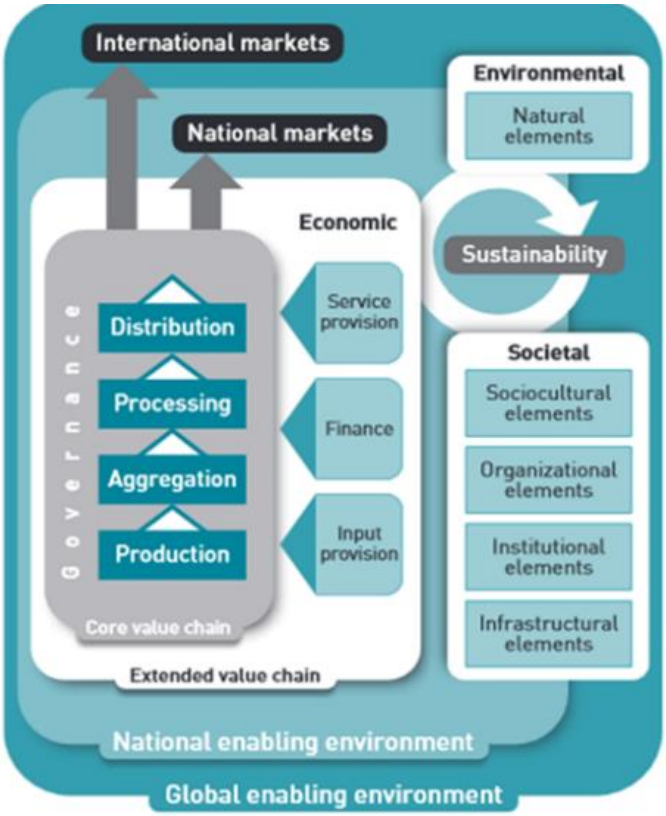
1.5 Characteristics of rice production in Ghana

Upland rain-fed rice, lowland rain-fed rice and irrigated rice are the three main rice production systems in Ghana. The lowland rain-fed system covers 78 percent of the arable area, the irrigated system covers 16 percent while the upland system covers 6 percent. The production system is therefore heavily dependent on rains. Three types of farmers can be broadly defined within the sector. The poor and marginal rice farmers who lack resources to produce a marketable surplus. They represent about 40 percent of all rice farmers. The second group, around 40 percent of rice farmers, are the small and viable scale rice farmers, which have assets to produce for markets but face major constraints such weather risks, market access and poor infrastructure. The third group includes commercial farmers who produce rice as a cash crop and are highly market oriented. These groups use modern technology and most of them are operating under the irrigation system.

2. Methodology and tools used

2.1 Sustainable Food Value Chain Framework

Figure 2: Framework for sustainable food value chain



A sustainable food value chain is defined as the full range of farms, micro-agents, firms and their successive coordinated value-adding activities that produce and transform raw agricultural materials into food products that are sold to final consumers and disposed of after use – all in a manner that is profitable throughout, has broad-based benefits for society, and does not permanently deplete natural resources.

Unlike the related concepts of "filière", "commodity chain" and "supply chain", the sustainable food value chain concept stresses the importance of three elements: (i) a "value chain" is a broadly defined concept and may be applied to any product subsectors (e.g. beef, maize, cocoa or shea), (ii) value chains are dynamic, market-driven systems governed and regulated through vertical coordination; and (iii) sustainability and the value added are explicit and multidimensional performance measures are assessed at an aggregate level (Neven, 2014).

The climate-smart agriculture (CSA) concept, launched by FAO in 2010, encompasses agriculture that targets food security and development goals through sustainable practices (FAO, 2013). CSA has three main objectives: (i) to increase food security while boosting productivity and income generation; (ii) to enhance the resilience of agricultural systems and rural populations to climate change; and (iii) to reduce GHG emissions in agriculture (mitigation). Thus, CSA is neither a new agricultural model, nor a new set of practices, but rather a framework for developing more productive and sustainable food value chains.

This framework involves (i) climate change mitigation and adaptation options through ecosystem management in order to (ii) preserve existing carbon stocks and decrease existing carbon sources, and (iii) improve smallholder livelihoods to reduce their vulnerability to climate change.

The framework for sustainable food value chain acts as a guidance for structuring the analysis of the food chain performance. This framework involves the value chain actors, i.e. those who produce a good or a service, who add value to the product, sell it, transfer it to the next level or export it. In this framework, shown in Figure 4, four core functions of the value chain are identified: (i) production (agriculture, livestock, and fishing), (ii) aggregation, (iii) processing and (iv) distribution (wholesale and retail) at local, national and international levels (Neven, 2014).

This framework enables to identify criteria that can serve as growth engines, to assess the poverty reduction potential of an activity, and to facilitate the adoption of agricultural strategies with appropriate policy measures.

2.2 Empirical method of value chain economic analysis

Value added measures the accumulation of wealth and the contribution of the production process to economic growth. It is defined as the difference between the gross production value (incorporating the value of all factors that contribute to production) and the wealth consumed in the production process (Bockel & Tallec, Commodity Chain Analysis: Financial Analysis. EasyPol module 044, 2005). It is calculated as the difference between the intermediate inputs used (II) and the value of the output in the post-production phase (Y),

$$VA = Y - \pi$$

With Y the value of production and π represents the cost of intermediary input.

Gross income

The gross income or gross profit is defined as the difference between the value added (VA) at each stage of the value chain and the sum of labour costs, interest charges and taxes. Thus, GI refers to the economic gain or loss of the agent, once all production costs are subtracted.

$$GI = VA - labor\ cost - taxes\ and\ interests$$

Number of jobs created

$$Total\ jobs\ generated\ =\ Number\ of\ additional\ man\ days\ divided\ by\ 250\ days$$

2.3 FAO EX-ACT Value Chain tool

The Ex-Ante Carbon Balance Value Chain Tool (EX-ACT VC) is a tool derived from EX-ACT (Ex-Ante Carbon-balance Tool), developed by FAO in 2009. EX-ACT VC is an Agriculture, Forestry and Land Use (AFOLU) model including downstream activities such as trade, processing and transportation. It is built as a framework of 8 Excel modules that provide a co-benefits appraisal of crop-based value chains in developing countries based on income, employment, greenhouse gas (GHGs) emissions and climate resilience.

The EX-ACT VC facilitates designing highly performing, sustainable value chains. The methodology used in the tool incorporates both a quantified socio-economic appraisal of the value chain at the micro and meso level (by agent, by group and for the whole chain), and an environmental carbon-balance appraisal of the value chain, in terms of climate mitigation, adaptation and climate resilience (Bockel, et al., 2019) -

- ✓ The impact on climate mitigation is reflected through quantitative indicators, derived directly from the EX-ACT tool. These indicators are used to obtain and analyse the mitigation impacts in terms of tCO_2-e of the project. The carbon footprint of the product is calculated for the whole value chain and at different needed stage, aiming at analysing the environmental performance of the chain. The equivalent economic return is also determined and could be an important aspect to be considered when attempting, for example, to access to payments for environmental services.
- ✓ Value chain resilience is assessed using simple quantitative but also qualitative indicators. Adaptation indicators measure the reduction of vulnerability of people, livelihoods and ecosystems to CC.
- ✓ Socio-economic impact of the value chain is assessed in terms of value added, income and job generated using a socio-economic appraisal of the value chain.

2.4 Data used and basic scenario options applied

The data used in this study comes from FAOSTAT and current policy documents in Ghana. This information is complemented by field survey data collected by the national consultant for rice in Ghana. This survey was undertaken in the Volta region. This region was selected because it is currently the main rice producing region in Ghana. The sample populations selected hailed from the Dzodze, Akatsi North, Hohoe Municipal and Biokoye districts. In the Avalavi community; two farmers using irrigation systems, two collectors, four processors and one retailer were interviewed.

In the Dakpa community, three lowland farmers were interviewed. In the Hohoe municipality, a focus group discussion for processors was conducted. In addition, one upland farmer and one retailer were interviewed. A large rice processor located in Worawora town was also interviewed in the Biokoye district.

3. Policy options, growth targets and scenarios for rice value development in Ghana

3.1 Key rice policy options

In the last ten years, yields of rice have increased from 1.7 to 2.8 tonnes/ha, resulting in an average annual yield growth of 5.1 percent. In addition, there has been an increase in farm size mostly those working under the rain-fed system. This system presents a lower potential in terms of yield. In order to promote sustainable and inclusive development of rice value chain in Ghana, the following policy options are proposed for the next years.

3.1.1 Promoting Good Agriculture Practices (GAP)

GAP technologies include a whole package or rice practices: Land clearing, tillage, bunding, pre-flooding, puddling, levelling, cultivar choice, certified seeds, nursery sowing, planting method, thinning/gap-filling, fertiliser application (using RiceAdvice), weeding, flooding and drainage (Becker, Johnson , Wopereis , & Sow, 2003). GAP for lowland rice may include labour saving practices such as animal or motorised traction for fine tillage, proper bunding and levelling, and timed weed control using proper herbicide dosages and/or mechanical weeders. Introduction of labour-saving technologies and women-friendly machinery and tools are essential in addressing gender issues. This is especially necessary to respond to the current situations of rising labour scarcity and the increasing agriculture work burden for women due to increased migration of men to urban areas.

3.1.2 Alternate wetting and drying (AWD) as climate smart technology

Alternate wetting and drying (AWD) was originally developed as a water-saving strategy in rice production. With growing water stress, the practice helps rice farmers become more resilient and reduces emissions. AWD is suitable for irrigated rice systems and involves periodic drying of the field by suspending irrigation for several days. Although only marginally used in Ghana, AWD has the potential of expanding to areas all over Africa where paddy rice is grown or being planned (Dinesh, Campbell, Bonilla-Findji, & Richards, 2017).

3.1.3 Increasing the mechanization in rice production and use of modern inputs

Rice production has seen considerable advances in agricultural mechanization in Ghana. The value of small-scale, locally adapted machinery, specifically targeting labour-intensive activities such as land preparation, harvesting and processing cannot be overlooked. The application of agricultural mechanization, along with other farm inputs contributes to crop, labour, and land productivities. Mechanization in the domestic rice production is imperative as far as meeting and sustaining the demand of rice is concerned (Jak Foundation, 2015). The Government of Ghana identified the private sector to be better equipped to look after the day–to–day provision of farm inputs including machinery and associated vital machinery support services. The Ministry's Accelerated Agricultural Mechanization policy provides support by subsidizing 30-50kW tractors and other equipment.

3.1.4 Improving post-harvest management and reducing crop loss

Estimation of post-harvest losses in rice from harvesting to milling was carried out in Ejisu Juabeng District of Ghana in 2011 to provide pertinent information on the losses (Appiah, Guine, & Dartey, 2011). Harvesting losses were higher (2.93 percent) under sickle-harvesting than under the panicle harvesting method (1.39 percent). Threshing losses were also higher (6.14 percent) in the 'bambam' than in the bag beating method (2.45 percent). Cumulated harvesting and threshing losses ranged between 4.07 and 12.05 percent at farmers' fields. Storage and drying losses were 7.02 and 1.66 percent respectively. 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).

3.1.5 Improving the organization and the governance of the sector

To revamp the agricultural sector, GoG introduced a flagship policy called Planting for Food and Jobs (PFJ) in 2017. The main aim of the programme is to address the declining growth of agriculture in Ghana. The policy focused on increasing food production and ensuring food security in the country as well as reducing the food import bills to the barest minimum, especially for rice. The project has five primary pillars – (i) supply of improved seeds to farmers at subsidized prices (50 percent subsidy), (ii) supply of fertilizer at subsidized prices (50 percent subsidy), (iii) free extension services to farmers, (iv) marketing opportunities for produce after harvest, and (v) e-Agriculture (a technological platform to monitor and track activities and progress of farmers through a database system) (MOFA, 2017).

3.1.6 Price support policy

The average price of domestically produced rice is GHS 165.00 per 50 kg bag. Imported rice provides greater variety at more affordable prices than domestically produced varieties. The local rice (parboiled, white and brown) is perceived to have higher nutritional qualities but is less preferred by most consumers due to their perceived poor quality. Nonetheless, the GoG has created demand for the envisaged increase in domestic rice production by linking it to the feeding program of public second cycle institutions nationwide through guaranteed purchases made by the reinvigorated National Food Buffer Stock Company (NAFCO). Furthermore, there is a 20 percent import duty on rice that importers have to pay.

3.2 Production growth and self-sufficiency options

Table 2: Review of growth scenarios and self-sufficiency impact by 2025 and 2030

	Current situation	*self suff by 2025*	*self suff by 2030*	**scenario 2030**
Domestic production of rice	473 949	*1 330 090*	*1 506 677*	1 115 243
Degree of self sufficiency	40.4%	*100%*	*100%*	*74%*
equiv paddy local production	752 300	*2 111 254*	*2 317 965*	1 770 228
annual growth for self sufficiency	-	*23%*	*12%*	*9%*

Source: Constructed by the authors.

Currently, local production can meet only 40 percent of the national demand. Demand for rice should grow at an average rate of 2.5 percent per year. Therefore, domestic production would have to achieve a huge growth of 23 percent per year in order achieve self-sufficiency in rice by 2025. This option is realistically not viable. The second option of reaching rice self-sufficiency by 2030 would require an annual growth rate of 12 percent, which is still out of reach. Therefore, the rice self-sufficiency target is redesigned to achieve at least 74 percent of self-sufficiency by 2030, which is coming from a reduction of rice import by 5.5 percent per year. This should lead to a growth of paddy production from about 752 000 tonnes in 2020 to 1 763 000 tonnes by 2030.

To achieve this objective, the present study developed the following scenarios for the period 2020-2030:

- ✓ Increase in farm size of irrigated rice of 2 percent per year
- ✓ Increase in farm size of lowland and upland rain fed rice of 5 percent per year respectively.
- ✓ Proportion of GAP intensification increases from 30 percent to 60 percent percent of all irrigated land between 2020 and 2030.
- ✓ Owing to improved used of inputs, the average yield grows from 2.9 to 4 tonnes/ha by 2030. Specifically, the average yield increases from 2.6 to 3.8 tonnes/ha for rain-fed lowland rice, from 2.3 to 3.1 tonnes/ha in upland rice, and from 4.8 to 5.8 tonnes/ha in irrigated rice.

- ✓ The reduction of crop loss from 8 to 2 percent, moving from 4 to 1 percent at the production level, and 4 to 1 percent at the processing level.

The environmental and economic impact of these improvements in the value chain will be assessed based on the implementation of these measures.

4. Data used for value chain analysis

The table below summarizes the main data used for rice areas, rice yields and rice producers on the four different rice cropping systems both for 2020 and 2030. Rain-fed rice production mobilizes 221 600 households where the average farm size is estimated at 1 ha/household. In this production system, yield will increase from 2.6 to 3.8 tonnes/ha. Irrigated rice mobilizes 26 400 producers over approx. 40 000 ha with a yield of 4.6 tonnes that increases to 5.9 tonnes by 2030 (Table 2). The average annual growth of rice areas (5.3 percent) combined with the annual yield growth (3.6 percent) generates an annual production growth of 9.1 percent.

Table 3: Main data on rice areas, yields and producers used for the 2020-2030 modelling

	Rainfed lowland rice	Rainfed upland rice	Total Rainfed rice	Irrigated rice	GAP	Total irrigation	All rice system
Current Situation (2020)							
Number of producers	205 732	15 826	221 557	17 615	8 808	26 423	247 980
Proportion of land area %	78.8%	6.1%	84.8%	10.1%	5.1%	15.2%	100%
Land Areas in ha	205 732	15 826	221 557	26 423	13 212	39 635	261 192
Production in tons	534 903	36 399	571 301	110 977	70 021	180 998	752 300
Yield in T/ha	2.6	2.3	2.58	4.2	5.3	4.57	2.88
Land size per producer in ha	1.0	1.0	1.0	1.5	1.5	1.5	1.1
growth assumed 2020-2030							
Annual area expansion rate	**6.0%**	**3.0%**	5.8%	**-5.2%**	6.5%	**2.0%**	5.3%
Additional farming area in ha	162 703	5 443	168 145	-7 312	15 992	8 680	176 825
Annual yield growth rate	4.0%	3.0%		2.0%	2.0%		3.6%
Upgraded scenario 2030							
land in ha	368 434	21 268	389 703	19 111	29 204	48 314	438 017
Production	1 417 969	65 740	1 483 710	97 842	188 676	286 518	1 770 228
Yield	3.8	3.1	3.81	5.1	6.46	5.93	4.04
Number of producers	230 271	14 179	244 450	11 944	18 252	30 197	274 647
Land size per producer (ha)	1.60	1.50	1.59	1.60	1.60	1.60	1.59

Source: Constructed by the authors.

4.1 Land use change

The biggest opportunity for rice land expansion primarily comes from utilizing vast unused rain-fed lowlands in Ghana. Out of the 176 825 ha of new land that will be allocated to rice production, 162 703 ha are grasslands which will be converted in rain-fed lowland rice, 5 443 are grasslands converted in upland rice and 8 680 ha are set aside land converted to irrigated rice.

Table 4: Land use change in rice farming

LUC - NON-FOREST LAND USE CHANGE						
			Fire Use?	Area transformed (ha)		Message
Fill with your description	Initial land use	Final land use		Current	Upgrading	
Add irrigated rice	Set Aside	Flooded Rice	NO	0	8 680	
Add rainfed lowland	Grassland	Flooded Rice	NO	0	162 703	
Add rainfed upland	Grassland	Annual Crop	NO	0	5 443	

Source: Authors, from EX-ACT VC analysis.

4.2 Production practices

Currently, around 33 percent of farmers under irrigated rice areas adopt the system of GAP. In the upgraded scenario, up to 60 percent of total irrigated farm areas will be managed with GAP practices by 2030. This production system is intermittently flooded in-cropping season and non-flooded in preseason. In the current scenario, the straw is burnt. In the upgraded scenario, the straw will no longer be burnt, and the residue will be incorporated long before the cropping season. The production lost will reduce from 4 to 1 percent.

Table 5: Change in production practices

PRODUCTION PRACTICES - FLOODED RICE

	Cultivation period (days)	*Water regime*		Organic amend type	Yield (t/ha/yr)		*Areas concerned (ha)*	
		In cropping season	Before cropping		Current	Upgrading	Current	Upgrading
Rice systems staying as rice system					**Yield (t/ha/yr)**			
Current irrigated areas	150	Irrigated - Continuously flooded	Non flooded preseason >180 days	Straw burnt		4.2	26 423	0
Current areas in SRI	150	Irrigated - Intermittently flooded	Non flooded preseason >180 days	Straw exported		5.3	13 212	0
Current lowland rice	150	Rainfed and deep water	Flooded preseason (>30 days)	Straw burnt		2.6	205 732	0
Irrigated land in 2030	150	Irrigated - Intermittently flooded	Non flooded preseason >180 days	Straw incorporated long (>30d) before cultivation		5.12	0	10 431
Areas in SRI in 2030	150	Irrigated - Intermittently flooded	Non flooded preseason >180 days	Straw exported		6.46	0	29 204
Lowland in 2030	150	Rainfed and deep water	Non flooded preseason >180 days	Straw incorporated long (>30d) before cultivation		3.85	0	205 732
						Total (ha)	**245 366**	**245 366**
				Percentage of production loss	4%	1%		

Source: Authors, from EX-ACT VC analysis.

4.3 Input use

In order to increase productivity, improved seeds must be used. However, with the adoption of improved agronomic practices, the amount of seeds per hectare will reduce from 88 to 82 kg/ha, while the quantity of fertilizer should increase towards the required level. Thus, the urea use will grow from 140 to 183 kg/ha and the NPK from 174 to 226 kg/ha. There will also be an increase in the use of pesticides in the upgraded scenario.

Table 6: Quantity of inputs use

Fertilizer and Pesticides consumption at production level:

Please fill this part both for crop

List of specific fertilizers	Specify NPK parts (%)			Amount introduced and corresponding areas			
				Current		Upgrading	
	N	P	K	Qty (Kg/ha/yr)	Area (ha)	Qty (kg/ha/yr)	Area (ha)
Seeds				88	261 192	82	438 017
Urea	47%			140	261 192	183	438 017
Compost	4%	1.5%	1.2 %	30	261 192	22	438 017
Phosphorus synthetic fertilizer (P2O5)		10%		0	0	0	0
Potassium synthetic fertilizer (K2O)			10%	0	0	0	0
Please enter your specific NPK synthetic fertilizer (N other than urea and not for irrgated rice):							
NPK	15%	15%	15%	174	261 192	226	438 017

Pesticides consumption at production level:

Type of pesticides	Amount introduced and corresponding areas			
	Current		Upgrading	
	Qty (kg/ha/yr)	Area (ha)	Qty (kg/ha/yr)	Area (ha)
Herbicides (kg of active ingredient per year)	5	261 192	8	438 017
Insecticides (kg of active ingredient per year)	1	261 192	1	438 017
Fungicides (kg of active ingredient per year)	1	261 192	1	438 017

Source: Authors, from EX-ACT VC analysis.

5. Micro-economic data used - economic analysis

5.1 Input –output matrix and prices

Rice farming currently requires 92 man-days per hectare. In the upgraded scenario, the ambition is to improve labour productivity through the adoption of mechanization. This should reduce labour demand in rice farming. In addition, structural transformation of the sector will lead to a reduction of the proportion of family labour in rice farming from 68 to 50 percent (see tables below)[1].

Table 7: Input cost in rice production under current situation and upgraded situation

ECONOMIC ANALYSIS - PRODUCTION LEVEL - INPUT & OUTPUT BUDGET							
	CURRENT SITUATION AGRICULTURAL PRODUCTION				UPGRADED SITUATION AGRICULTURAL PRODUCTION		
Consumable							
	Quantity (kg/ha/yr)	Unit	Price per unit in GHS	Annual production cost GHS/ha/yr	Quantity (kg/ha/yr)	Price per unit in GHS	Annual production cost GHS/ha/yr
Fertilizer			GHS			GHS	
Seeds	**88.5**	kg	4	376	**82.2**	4	350
Urea	**139.7**	kg	1	196	**183.3**	1	257
Compost	**30.3**	kg	1	15	**22.1**	1	11
NPK	**173.7**	kg	2	260	**226.1**	2	339
Pesticides							
Herbicides	**4.9**	kg of active ingredient per year	100	491	**7.8**	100	777
Insecticides	**0.6**		40	23	**1.0**	40	40
Fungicides	**0.6**		150	86	**1.0**	150	150

Source: Authors, from EX-ACT VC analysis.

[1] The exchange rate used in this study is 1 USD=5.65 GHC. The analysis does not take into account the inflation rate and considers the same price during the period of study.

Table 8: Labour cost in rice production under current situation and upgraded situation

Labor cost								
Crop production (in man-days/ha)			Salary in GHS per man-day	Cost GHS/ha/yr			Salary in GHS per man-day	Cost GHS/ha/yr
% of family labour	68 %	*Women, men, youth dominant*			50 %	*Women, men, youth dominant*		
Land preparation-tillage	3	men	50	49	3	men	50	63
Seeding- input procurement	7	women	10	23	4	women	10	20
Weeding - treatment	6	women	30	59	15	women	30	218
Manure- compost delivery	2	men	15	10	4	men	15	30
Harvesting, transport	20	men	35	228	9	men	35	149
Threshing	19	women			9	women		
Drying& winnowing	5	youth	15	24	6	youth	15	41
scaring- cating	30	youth	10	98	30	youth	10	150
Total man-days spent by men	25				15			
Total man-days spent by women	32				27			
Total man-days spent by youth	35				35			
Total man-days per ha	**92**				**77**			
Total cost per ha per year				**1 937**				**2 593**

Source: Authors, from EX-ACT VC analysis.

5.2 Prices and margins in the value chain

With an average price of paddy rice estimated at USD 345 / tonne, rice producers gain an average margin of USD 210 /ton in the current situation. In the upgraded scenario, the average production cost will reduce from USD 130 to 120 /tonne. Considering the price of paddy rice is slightly higher (USD 354) in 2030, this will result in an increase in the margins of USD 24 /tonne.

Table 7: Set of average prices observed / projected in rice value chain

GhC/ ton	2019-2020		2030	
	Gh cedi	USD	Gh Cedi	USD
Paddy farmers price	1 950	345	2 000	354
Paddy collectors selling price	2 250	398	2 300	407
Rice rural-processor selling price	3 200	566	3 450	611
Paddy big processor purchase price	2 050	363	2 200	389
Rice big processor Price	3 650	646	3 800	673
Import rice price	4 000	708	4 200	743

Source: Constructed by the authors.

However, the margin for irrigated rice farmers is higher than that of rain fed farmers. In irrigated rice, the margins will increase from USD 231 to USD 249 /tonne while in the case of the rain-fed producers the margin will increase from USD 203 to USD 231/tonnes between 2020 and 2030. This represents a global growth of 12 percent in the household income per tonne of production. During the ten years, the processors will also experience a global growth of 1.6 percent in the income per tonne of rice processed. As for the wholesalers and retailers, the profit will remain nearly constant between 2020 and 2030, at USD 86 and USD 83 /tonne respectively.

Table 9: Costs and margins per tonne of production

Activities	Costs (USD)		Price (USD)		Margin(USD)		Balance	Growth rate (%)
Year	**2020**	**2030**	**2020**	**2030**	**2020**	**2030**		
Production (rain fed)	92	86	345	354	203	231	28	14
Production (Irrigated)	114	105	345	354	231	249	18	8
Production (Total)	130	120	345	354	210	234	24	12
Processing	434	421	708		56	57	1	1.6
Wholesale	727	727	796		86	87	1	1
Retail	805	805	885		83	76	-7	-8

Source: Authors' own calculation.

6. Ex-Ante appraisal results of the rice value chain in Ghana

6.1 Socio-economic and environmental impact of rain-fed rice production

6.1.1 Socio-economic performances of rain-fed production

Rain-fed rice production mobilizes 221 600 households where the average farm size is estimated at 1 ha/household. In this production system, yield will increase from 2.5 to 3.3 tonnes/ha, resulting in an increase in production from 548 332 to 1 468 000 tonnes between the current and upgraded scenario (Table 9).

Table 10: Production and yield of rain fed rice

PROJECT	Rice value chain in Ghana		Current VC	Up. VC
COUNTRY	Ghana	**Production (tonne)**	548 449	1 468 872
REGION	0	**Yield (t/ ha/ yr)**	2.58	3.81
BUDGET	$0.00	**Hectares**	221 557	389 703
DURATION	20	**Households**		244 450

Source: Authors, from EX-ACT VC analysis.

This represents an average annual growth rate of 10.3 percent. The value added per tonne will increase by USD 28, moving from USD 203 to USD 231. This will result in an income increase from USD 443 to USD 1 220 per rain fed rice producer, presenting an average annual growth of 10.6 percent.

Table 11: Economic performance of rain fed rice producers

PRODUCER	Current VC	Upgraded VC	Balance
Nb of employment-eq	73 557	109 117	35 560 jobs
Gross production value	**189 288**	**519 955**	330 667 000 USD
Value Added (VA)	**111 429**	**339 092**	227 663 000 USD
Gross Income (GI)	**98 194**	**298 225**	200 031 000 USD
VA / tonne of product	**203**	**231**	28 USD
Gross income / HH	**443**	**1 220**	777 USD

Source: Authors, from EX-ACT VC analysis.

6.1.2 Environmental performances of rain-fed rice production

In terms of climate mitigation, rain-fed rice production currently emits 853 800 tonnes of CO_2-e per year. With the expansion of areas, additional inputs, improved agronomic practices, the GHG emissions will increase to 1 139 000 tCO_2-e, resulting in almost 285 000 tCO_2-e of additional emissions. However, the carbon footprint per tonne of paddy would reduce from 1.4 to 0.7 tCO_2-e/ tonne of paddy (-50 percent).

Table 12: Environmental impact of rain fed rice producers

Climate Mitigation dimension of the whole value chain	Current	Upgrading	Balance
GHG impact (tCO_2-e per year)	853 831	1 138 684	
GHG impact (tCO_2-e per year per hectare) - Production level only	2	3	1
Carbon footprint of production (tCO_2-e per tonne of product)	1	1	- 1
Annual tCO_2-e [emitted (+) / reduced or avoided (-)]		**284 852**	
Annual tCO_2-e from renewable energy		0	
Equivalent project cost per tonne of CO_{2-e} reduced or avoided (in US$ on		0	
Equivalent value of mitigation impact per year 30 US$ /tCO2-e/year	30	0	
Equivalent value of mitigation impact per year per ha (tCO_2-e per year p		- 18	

Source: Authors, from EX-ACT VC analysis.

6.2 Socio-economic and environmental impact of irrigated rice production

6.2.1 Socio-economic performances of irrigated rice system

Irrigated rice farms represent only 15 percent of total rice farms in Ghana. From 39 600 ha in 2020, irrigated rice farms will increase by 5 percent annually to reach 48 300 ha in 2030. The average farm size under the irrigation system will remain constant at 1.5 ha/household. An improvement in the yield from 4.1 to 6.5 tonnes/hectare will contribute to an increase in the production under the irrigated system from 173 758 to 283 653 tonnes, representing an average growth of 5 percent per year.

Table 13: Production and yield of irrigated rice

PROJECT	Rice value chain in Ghana		Current VC	Up. VC
COUNTRY	Ghana	Production (tonne)	173 758	283 653
REGION	0	Yield (t/ ha/ yr)	4.57	5.93
BUDGET	$0.00	Hectares	39 635	48 314
DURATION	20	Households		30 197

Source: Authors, from EX-ACT VC analysis.

The evaluation of the economic performance of the value chain indicate that the value added in irrigation system that is currently estimated at USD 40 million will experience an average growth of 5.8 percent per year to reach USD 70 million by 2030. The value added per tonne will increase from USD 231 to USD 249. As a result, the income per irrigated rice producers will increase from USD 1 344 to USD 2 130 between 2020 and 2030, representing an average annual growth of 4.7 percent.

Table 14: Economic performance of rice producers under irrigation system

PRODUCER	Current VC	Upgraded VC	Balance
Nb of employment-eq	16 012	16 427	415 jobs
Gross production value	**59 970**	**100 408**	40 438 000 USD
Value Added (VA)	**40 176**	**70 708**	30 533 000 USD
Gross Income (GI)	**35 518**	**64 316**	28 799 000 USD
VA / tonne of product	**231**	**249**	18 USD
Gross income / HH	**1 344**	**2 130**	786 USD

Source: Authors, from EX-ACT VC analysis.

6.2.2 Environmental performances of irrigated rice system

The environmental evaluation of the impact of upgrading the value chain in irrigated system shows a slight reduction of GHG emission from 213 000 to 208 000 tCO_2-e. This represents a net GHG reduction of 5 146 tCO_2-e per year. This means that, under irrigated rice production system, the carbon footprint will reduce from 4.2 tCO_2-e to 3.9 tCO_2-e per hectare of farm size between the current and the upgraded scenario. The performance of carbon footprint per ton of paddy is much better since it decreases from 1.1 to 0.7 tCO_2-e/ tonne of paddy (-42 percent).

Table 15: Environmental impact of rice producers under irrigation system

Climate Mitigation dimension of the whole value chain	Current	Upgrading	Balance
GHG impact (tCO_2-e per year)	213 169	208 023	
GHG impact (tCO_2-e per year per hectare) - Production level only	4	4	0
Carbon footprint of production (tCO_2-e per tonne of product)	1	1	0
Annual tCO_2-e [emitted (+) / reduced or avoided (-)]		**- 5 146**	
Annual tCO_2-e from renewable energy		0	
Equivalent project cost per tonne of CO_{2-e} reduced or avoided (in US$ on		0	
Equivalent value of mitigation impact per year 30 US$ /tCO2-e/year	30	154 382	
Equivalent value of mitigation impact per year per ha (tCO_2-e per year p		7	

Source: Authors, from EX-ACT VC analysis.

6.3 Socio-economic and environmental impact of the global rice value chain in Ghana

Currently, the total production of paddy in Ghana is roughly 722 200 tonnes. In the prospective analysis to 2030, paddy production will grow at an average rate of 9.3 percent annually to reach over 1.75 million tonnes. With this growth rate, 74 percent of self-sufficiency will be achieved by 2030. This will be achieved through the expansion of farmland allocated to rice production and an increase in yield from 2.9 to 4.0 tonne/ha.

Table 16: Average production and yield of rice in Ghana

PROJECT	Rice value chain in Ghana		Current VC	Up. VC
COUNTRY	Ghana	Production (tonne)	722 208	1 752 238
REGION	0	Yield (t/ ha/ yr)	2.88	4.04
BUDGET	$0.00	Hectares	261 192	438 017
DURATION	20	Households		274 647

Source: Authors, from EX-ACT VC analysis.

6.3.1 Socio-economic impact of rice value chain upgrading

Table 16 presents the results of the socio-economic impact of the value chain in the current situation and for the upgraded scenario. The findings show that, at the production level, the value added will grow at the average annual rate of 10.1 percent, resulting in the increase of the total value added in rice production from USD 152 million to USD 410 million.

Farmers' performances: The income of farmers will also experience a growth of 9.6 percent per year. Thus, with an average farm size of 1.1 ha, the current income is estimated at USD 520 per household. The upgraded scenario will yield an average income of USD 1 303 per producer by 2030, with the farm area per producer increasing to 1.6 ha.

Table 17: Results of the socio-economic analysis of the rice value chain

SOCIO-ECONOMIC PERFORMANCES OF THE VALUE CHAINS			
PRODUCER	**Current VC**	**Upgraded VC**	**Balance**
Nb of employment-eq	96 119	135 785	39 667 jobs
Gross production value	**249 258**	**620 261**	371 004 000 USD
Value Added (VA)	**151 605**	**409 699**	258 094 000 USD
Gross Income (GI)	**128 993**	**357 757**	228 764 000 USD
VA / tonne of product	**210**	**234**	24 USD
Gross income / HH	**520**	**1 303**	782 USD
COLLECTORS MICRO PROCESSORS			
Nb of operator-eq	**419**	**757**	
Nb of employment-eq	**21 517**	**46 014**	24 496 jobs
Gross production value	**16 307**	**59 157**	42 850 000 USD
Value Added (VA)	**15 730**	**49 316**	33 586 000 USD
Gross income	**6 135**	**42 529**	36 394 000 USD
VA / tonne of product	**22**	**28**	6 USD
Gross income / operator	**14 631**	**56 207**	41 576 USD
PROCESSOR			
Nb of operator-eq	9	19	
Nb of employment-eq	12 905	28 753	15 847 Jobs
Gross processed production value (GPPV)	**20 531**	**48 911**	28 379 000 USD
Value added	**10 988**	**30 415**	19 426 000 USD
Gross income	**3 673**	**13 250**	9 577 000 USD
VA / tonne of product	**56**	**57**	1 USD
Gross income / operator	**410 114**	**698 524**	288 410 USD

Source: Authors, from EX-ACT VC analysis.

Collectors' performances: an estimated 419 collectors and small processors collect paddy rice from farmers. They process 55 percent of the paddy rice collected (900 tons processed per operator) and sell the remaining 45 percent to large processors. The results of the analysis indicate that the value added of these operators will increase from about USD 15.7 million to USD 59.1 million between 2020 and 2030, representing an average annual growth of 12.5 percent. This will lead to an increase in income of collectors and small processors from USD 14 000 to USD 56 000, representing an average annual growth rate of 14 percent. By 2030, the activity should further develop, with over 750 of such operators in Ghana processing up to 1 100 tons of paddy per operator.

Large-scale processors: As for large-scale processors, they are currently 7-9 processors processing 14 000 tonnes per year. This processing capacity is expected to grow to 20 000 tonnes by 2030. In addition, the number of large processing units should increase from 8 to 19 units in order to meet the increased need for processing capacity due to the increase in the level of production. This will result in an increase from USD 11 million to USD 30 million of the total valued added of large processors. The value added per tonne of paddy processed will stay constant at around USD 56 - 57. In the current situation, the income per large processor is about USD 410 114. In the upgraded scenario, the average income may increase up to USD 698 000, with an upscaling of processed volumes per year.

Table 18: Results downstream the value chain

WHOLESALERS			
Nb of operator eq	282	622	
Nb of employment-eq	3 381	8 456	5 075 jobs
Gross production value	**37 398**	**93 543**	56 145 000 USD
Value added	**36 551**	**91 672**	55 122 000 USD
Gross income	**35 803**	**89 801**	53 999 000 USD
VA / tonne of product	**86**	**87**	0 USD
Gross income / operator	**127 080**	**144 425**	17 345 USD
RETAILERS			
Nb of operator	2 113	3 523	
Nb of employment-eq	0	0	0 Jobs
Gross production value	**37 398**	**93 543**	56 145 000 USD
Value added	**35 154**	**80 447**	45 293 000 USD
Gross income	**34 967**	**80 135**	45 168 000 USD
VA / tonne of product	**83**	**76**	- 7 USD
Gross income / operator	**16 549**	**22 743**	6 195 USD
AGGREGATED SOCIO-ECONOMIC PERFORMANCES	**Current**	**Upgrading**	**Balance**
VALUE ADDED	**234 298**	**612 233**	377 934 000 USD
GROSS PRODUCTION VALUE	**344 586**	**856 258**	511 672 000 USD
TOTAL JOB GENERATED	**112 405**	**172 994**	60 589 Jobs created

Source: Authors, from EX-ACT VC analysis

Source: Authors, from EX-ACT VC analysis.

Wholesalers – retailers: For the sellers of milled rice (wholesalers and retailers), the value added will grow at an average annual rate of 9.6 and 8.6 percent respectively. This will also result in a change in the income. Income of wholesalers will increase from USD 127 000 to USD 144 000 between 2020 and 2030, which represents an average growth of 1.3 percent. However, the retailer will experience a high growth rate of income estimated at 3.2 percent, which will result in a change in income from USD 16 549 to USD 22 743 per retailer.

Concerning the impact of value development on employment, the production level will experience the most mechanization. The mechanization increases the labour productivity and therefore, reduces the quantity of labour required per hectare. However, employment in rice production will still increase from around 96 000 to 136 000 jobs as a result of area expansion, which represents about 40 000 additional employments. Furthermore, jobs will also increase in the other segments of the value chain, especially at the processing level. Currently, the number of employments is about 21 500 in the small processors and 12 500 in the large processors. The upgrading scenario will lead to an increase in employment of 24 500 in the segments of collectors and small processing and 15 000 in the segment of large processing.

The global socio-economic results of the value chain indicate that the total value added that is currently estimated at USD 234 million will grow at the annual average rate of 11.58 percent, reaching USD 612 million by 2030. In addition, the total jobs in the sector will increase by 4.4 percent resulting in 60 600 additional jobs created by 2030.

6.3.2 Social footprint of the value chain

The social footprint highlights the performances of the value chain in terms of labour intensity, labour productivity, labour return per day, pro-poor valued added per tonne reaching low-income households, and gender and youth involvement in the value chain which links with potential of employment creation for both.

Most of the value added in the rice value chain is found to be generated at the production level, reaching the poorest in the value chain and making rice a pro-poor value chain. Moreover, the current income generated per day of work in the rice value chain (USD 5.39) is far above the poverty line (the poverty headcount ratio is USD 1.90/day in Ghana (Macrotrends, 2020)), making rice a value chain that can uplift those suffering from poverty. The rice value chain ensures an income per day that is currently 3 times over the poverty rate. By 2030, the enhanced value chain will increase this average income per day to 5 times the poverty rate.

Table 19: Social footprint of rice value chain

Days of labour per ton of paddy	39	25	working days/ T
Days of labour per ton of rice	**61**	**39**	**working days/ T**
Pro-poor Value added per ton of paddy	210	234	USD/ Ton
Income generated per day of work (prod)	5.39	9.47	USD/ working day
	production	processing	
Gender : part of labour covered by women	35%	18%	
Youth: part of labour provided by youth	38%	45%	

Source: Authors, from EX-ACT VC analysis.

In terms of the current labour distribution between women and youth, the additional 60 600 jobs created by 2030 should generate equivalent employment opportunities for 12 000 women and 30 000 youth.

6.3.3 Environmental impact of rice value chain upgrading

6.3.3.1 Mitigation impact of the value chain

The current rice value chain in Ghana emits about 1 067 000 tCO_2-e of greenhouse gas emissions per year. In the upgraded scenario, wide area expansion and adoption of GAP will result in an increase of GHG emissions per year to 1 347 616 tCO_2-e, which represents 279 615 tCO_2e of additional emissions. At the production level, this corresponds to an increase of GHG emission from 2.3 tCO_2e to 2.8 tCO_2-e per hectare and therefore does not warrant for the use of a carbon based, Payment of Environmental Services (PES) as a potential policy option. However, the carbon footprint of paddy generated decreases from 1.4 to 0.7 tCO_2-e/ tonne of paddy.

Table 20: Environmental impact results of the rice value chain

Climate Mitigation dimension of the whole value chain	Current	Upgrading	Balance
GHG impact (tCO_2-e per year)	1 067 000	1 346 616	
GHG impact (tCO_2-e per year per hectare) - Production level only	2	3	0
Carbon footprint of production (tCO_2-e per tonne of product)	1	1	- 1
Annual tCO_2-e [emitted (+) / reduced or avoided (-)]		**279 616**	
Annual tCO_2-e from renewable energy		0	
Equivalent project cost per tonne of CO_{2-e} reduced or avoided (in US$ on		0	
Equivalent value of mitigation impact per year 30 US$ /tCO2-e/year	30	0	
Equivalent value of mitigation impact per year per ha (tCO_2-e per year p		- 15	

Source: Authors, from EX-ACT VC analysis.

The carbon footprint of the whole value chain, inclusive of processing and transport, is currently up to 1.55 tCO_2-e per ton of paddy. This should reduce to 0.86 tCO_2-e per tonne of paddy by 2030 due to reduced waste and increased yields. This would be below Egypt's carbon footprint for paddy rice of around 1.90 tCO_2eq / tonne of paddy rice (Awny Farag, Radwan, & Abdrabbo, 2013) and below that of Mali's rice value chain, which is dominated by irrigated rice, with 6.9 tCO_2-e/ tonne of paddy in the current situation (Bockel & Ouedraogo, 2020).

Table 21: Carbon footprint of the different value chain levels

Carbon footprint at the different levels of the va	tCO_2-e per tonne of product			Balance
	Current VC	Upgraded VC		
PRODUCTION	1.35	0.70	-	0.66
PROCESSING	0.15	0.12	-	0.03
TRANSPORT	0.04	0.04		-
TOTAL	1.55	0.86	-	0.69

Source: Authors, from EX-ACT VC analysis.

6.3.3.2 Climate resilience impact of the value chain

The climate resilience of the value chain is evaluated by quantitative and qualitative assessment methods. Quantitative results indicate that 231 000 ha in the value chain are managed under climate-resilient practices with soil carbon increasing in 198 093 ha of rice farmland due to GAP. In addition, 274 647 ha will become more resilient to climate shocks. The qualitative assessment shows the resilience index of the value chain as medium. Most components of the resilience index are medium (buffer capacity of watershed, food security, household self-organization and learning capacity) while buffer capacity of crop production is considered high.

Table 22: Resilience dimension of the value chain

System resilience dimensions	Upgraded VC	
Hectares of land managed under climate-resilient practices	231 988	ha
Hectares with improved tree and vegetal coverage (land slide, flood resilien	0	ha
Hectares with increased soil carbon (drought and erosion resilience)	198 093	ha
Number of HH having become more climate resilient	274 647	HH

Resilience index of the system		Upgraded VC	
Buffer capacity of watershed and landscape and project area	90	Medium	Buffer capacit
Buffer capacity of crop production	100	High	buffer capacit
Buffer capacity of households in relation to food security	90	Medium	Buffer capacit
Self-organisation of households	90	Medium	Self-organisatio
Learning capacity of households	90	Medium	Learning capa
Climate resilience generated by upgrading the value chain		**Medium**	

Source: Authors, from EX-ACT VC analysis.

7. Incremental private - public investments and input-energy to be mobilized

7.1 Additional public investment and subsidies

Table 23: Investment public costs for 2020-2030

Investment Public cost		USD/ unit	Area / units		total cost (USD)
new irrigated area		4000	8 680	ha	34 719 069
additional Ha with applied GAP		200	178 695	ha	35 738 946
Additional farmers trained on GAP	50%	150	137 323	farmers	20 598 450
support to Expanded low land rice area	of farmers	0	162 703	ha	-
support to Expanded upland rice area		0	5 443	ha	-
					91 056 465

Source: Authors, from EX-ACT VC analysis.

The target of farmers trained and supported on GAP (137 000 farmers) is equivalent to less than 10 percent of the target GAP supported farmers in Medium Term Expenditure Framework (MTEF) for Agriculture MTEF 2019 by 2022 (MFA, 2019).

The proposed upgraded scenario requires a pre-estimate of USD 91 million in public investment on the installation of new irrigated areas and promotion of GAP practices on an additional 178 695 ha. This should be added to the current subsidy applied on fertilizers used in the rice value chain, which is estimated for the next five years to be around USD 322 million of public cost. This amount represents USD 64 million per year or 70 percent of currently allocated funds for subsidies per year in the MTEF for agriculture (MFA, 2019).

Table 24: Subsidy allocations

Subsidy to producers			Subsidy /ha/year	area	nb of years		
Subsidy on fertilizer	**USD**	50%	147.3	438 017	5	322 564 239	USD
PES on CO_2 reduction	**USD**	0	USD/ tCO_2		TCO_2 reduced/ year	-	USD

Source: Authors, from EX-ACT VC analysis.

7.2 Incremental private investments required

Private sector investments for farmers, small and big processing operators is estimated to be around USD 132 million for the next 5 years. It would need appropriate credit facilities, reduced import tax and an eventual subsidy for farmers' equipment.

Table 25: Private investments 2020-2025

Private investment	nb of equipt units per operator	mill / equipt cost USD	other inv cost USD	nb operators	total
Tractors-tricycles for producers	20% of farmers	3 000	200	37 197	119 030 400
New equipt for add small processor (1)	3	8 850	26 500	337	11 912 950
New equipt for add big processor (2)	4	35 400	79 000	10	1 145 421
					132 088 771

Source: Authors, from EX-ACT VC analysis.

It could be funded with the support of the Brazilian Facility Fund (USD 66 million) or Indian Exim Bank (USD 150 million), both of which can support the new MTFE Programme (2019-2022) of the Ghana Ministry of Food and Agriculture (MFA, 2019).

7.3 Additional input requirement

In reference to the current situation, upgrading the value chain will require an increase in input use. Thus, the additional seeds needed is about 12 900 tonnes per year. The urea and NPK demand will also increase by 43 781 and 53 663 tonnes respectively. In total, the cost of the additional input demand is estimated at USD 52 million/year. The increase in input demand represents an opportunity for input sellers in the sector, while farmers would need credit support to facilitate their access to inputs.

Table 26: Additional inputs and costs in the value chain (annual costs)

Additional input needed	Quantity (kg)	Cost (USD)
Urea (kg)	43 781 004	10 848 390
NPK (15-15-15) (kg/ha)	53 663 185	14 246 863
Compost (kg)	1 735 953	153 624
Seed (kg)	12 912 648	9 713 053
Herbicide (litres) selective	37 101	1 477 471
Nonselective herbicide (L)	2 121 744	6 196 243
Insecticide (litres)	287 604	2 036 132
Fungicide (litre)	287 604	7 635 495
Total additional cost		**52 307 272**

Source: Authors' own calculation.

7.4 Public cost – benefit balance on Ghana public budget

Currently the rice sector is subjected to a series of taxes that are considered as fund providers for the public sector and even funds allocated by the Government for support to the rice sector.

When accounting for a rice import tax of 20 percent, the total taxes levied on rice are higher than its subsidies in 2020. By 2030 with a significant reduction in rice import, the public balance becomes negative even if subsidies on inputs are accounted for.

Table 27: Public cost – benefit balance

	2020	2030
OUT	In 000 USD	In 000 USD
Subsidies per year	64 513	64 513
Public investment per year	18 211	18 211
IN Tax per year		
rice import tax 20%	99 115	58 195
Tax on processors	1 458	4 340
Tax on wholesalers	150	374
Tax on retailers	187	312
Balance	**18 185**	**-19 502**

Source: Authors, own calculation.

7.5 Impact of rice import reduction on Ghana trade balance

Government plans in 2019 are to reduce rice imports by 50 percent (MOAF 2019). Currently, Ghana imports USD 331 million worth of rice annually. Reducing rice imports from the current 700 000 tonnes to 370 000 tonnes by 2030 will effectively reduce annual food imports down to 50 percent and reduce rice import costs by USD 170-200 million.

7.6 Economic return of rice value chain public investments

A rough economic analysis of the return on the rice value chain for public and private combined investments, using the incremental value added, finds the net present value (NPV) of the upgraded value chain to be USD 397 million and an internal rate of return (IRR) to be 32 percent.

Table 28: Economic analysis of investment return

Years	1	2	3	4
Total public investment	30 352	30 352	30 352	
Total subsidies 20 years	64 513	64 513	64 513	64 513
Private invest	44 030	44 030	44 030	
Incremental Value added		37 793	56 690	113 380
	- 138 895	- 57 072	- 38 175	48 867
NPV	**USD 396 960**			
IRR	**32%**			

Source: Authors, from EX-ACT VC analysis.

8. Conclusion

The value chain approach provides a promising way of achieving sustainable development in the food sector in developing countries. Based on the EX- Ante Carbon Balance Value Chain tool (EX-ACT VC), this study conducted a prospective analysis for the rice sector in Ghana. The objective of the study was to identify strategies that can potentially increase rice production, competitiveness and contribution to food security and poverty reduction.

Analysing the data gathered from secondary sources and field surveys conducted in various districts in Ghana, results indicate that the adoption of Good Agricultural Practices (GAP), the improvement of crop management, access to input and mechanisation are important to increase the self-sufficiency rate by 2030.

Through an expansion strategy that would involve increasing the area cultivated for rice, instituting GAP and other improved production methods, the upgraded rice value chain would:

- increase the value added by USD 378 million by 2030, with most of the value added being generated at the producer level (USD 258 million),
- reduce the carbon footprint of paddy from 1.4 to 0.7 tCO_2-e/ tonne of paddy produced,
- increase employment - with approx. 60 600 additional jobs created by 2030, including equivalent employment opportunities for 12 000 women and 30 000 youth, and
- generate an increase in income received by more than USD 4 per day of work, which is 5 times above the current poverty rate in Ghana.

The proposed upgraded scenario requires a pre-estimate of USD 86 million in public investment on the installation of new irrigated areas and promotion of GAP practices. The current subsidy applied on fertilizers used in the rice value chain is estimated for the next five years to be around USD 141 million in incremental public cost.

At the macro level, the growth scenario would effectively create a 2 percent growth in GDP. It should also decrease rice imports from the current 700 000 tonnes to 370 000 tonnes by 2030 down to 50 percent and reduce rice import costs by USD 170-200 million. Implementing such a strategy will have a significant impact on not just the livelihoods of those working in the rice sector in Ghana, but also the rest of the population in Ghana by enhancing the food security and self-sufficiency of the country.

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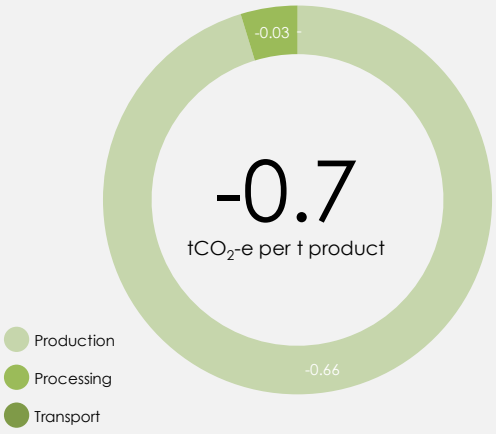
Appendix

CARBON FOOTPRINT

Carbon footprint balance



Summary

	Current	Upgraded
Production	1.35	0.70
Processing	0.15	0.12
Transport	0.04	0.04

FOOD LOSS & WASTE

Food loss and waste balance

Summary loss and waste

	Current	Upgraded
Production	30092.0 t	17699.4 t
Processing	13070.2 t	10677.1 t
Wholesalers	0.0 t	0.0 t
Retailers	0.0 t	0.0 t
Transport	0.0 t	0.0 t

Efficiency improvement on transformation

	Current	Upgraded
Processing	250425.5 t	613725.7 t

SYSTEM RESILIENCE

Summary

	Upgraded value chain
Land under climate-resilient practices	231,988
Improved tree and vegetal coverage	-
Increased soil carbon	198,093
More resilient households	274,647

EX-ANTE CARBON-BALANCE TOOL for Value Chain [EX-ACT VC]

The EX-Ante Carbon-balance Tool for Value chain (EX-ACT VC) is an appraisal system developed by FAO providing estimates of the impact of agriculture and forestry development projects, programs and policies on the carbon-balance, value added, jobs created, and income generated. The tool helps project designers estimate and prioritize project activities with high benefits in terms of economic and climate change mitigation, and it helps decision-makers to decide on the right course to mitigate climate change in agriculture and forestry and to enhance environmental services and economic benefits.

This report is part of a series of studies, presenting the appraisals of rice value chain for different countries using the EX-ACT Tool for Value Chain, which provides the potential climate change mitigation and economic impacts of investment projects in the Agriculture sector.

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