This document is an extract from:
Data collection survey on rice related programs/projects in the CARD member countries (with Study on the local rice competitiveness in 15 selected countries) : Final Report. -- Japan International Cooperation Agency : NTC International Co., Ltd. : RECS International Inc., 2021. 8, Annex A.

Competitiveness Analysis of Local Rice to Imported Rice
Sierra Leone

1. Objectives and outline of the analysis

The program of CARD2, launched in 2019, aims to increase rice production in Sub-Saharan Africa from 28 million tons to 56 million tons by 2030. The competitiveness of local rice against imported rice would be an important aspect to look into to achieve this aim. Given this context, a study comparing the competitiveness of local and imported rice for 15 countries[1]. was implemented by Japan International Cooperation Agency (JICA) from February to August 2021.

With relentless efforts in rice sector development, the competitiveness of the locally produced rice against imported rice has been recently improving in Sub-Saharan African countries. However, the pace of development in local rice is not sufficient due to the rapid expansion in demand. In addition, local rice often faces competition from imported rice. The main objective of this survey was to analyze the competitiveness of major local rice varieties against imported rice. DRC (domestic resource cost) approach was applied to quantitatively analyze the competitiveness, and sensitivity analysis to discuss the achievable approach to improve it. The competitiveness analysis should be updated as more information becomes available, since the situation on the rice sector in Sub-Saharan Africa is constantly changing and the information in the current survey was very limited.

2. Local rice and imported rice

2.1. Comparison of local rice and imported rice

Rice is the main staple food of the vast majority of Sierra Leoneans; eaten on a daily basis by almost every household in the country (Conteh *et al.*, 2012), and consumption is one of the highest in Africa (161 kg/capita/year in 2018, FAOSTAT). Rice cultivation is widely practiced, and 94% of agricultural households grow either upland or lowland rice (Graham *et al.*, 2020). The demand has been increasing notably after 2010 but not the production (Fig. 1). The self-sufficiency rate was more than 75% for some years, but it has decreased after 2010 and then presently around 65%.

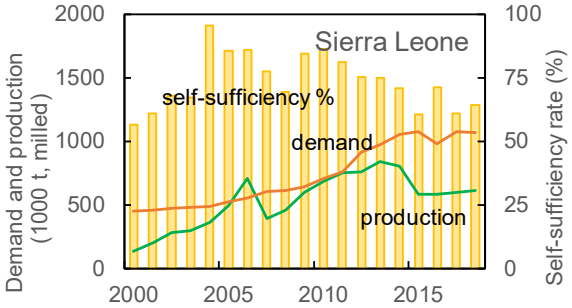


Fig. 1. Rice supply in Sierra Leone.
Source: Made by JICA Survey Team based on data from FAOSTAT, browsed in June, 2021.

Most of the domestic production is consumed by farmers. Only about 10-15% of domestic production is marketed through the traditional value chain, and only a small proportion reaches Freetown, the capital city (Graham *et al.*, 2020). Rice quality in the traditional value chain is generally poor with over 35% of broken grain. The modern value chain involves a mix of both smallholder and large-scale producers who market through institutional buyers, and the quality of the rice is similar to imported rice (Graham *et al.*, 2020). The imported rice is consumed mainly in Freetown, and only a small portion is consumed in the rural areas when stock of the domestic rice is low (July and August).

Parboiling is widely practiced and parboiled rice constituted a substantial proportion of local rice in the market, particularly in the North (NRDS, 2009). The price of local rice is generally higher than the price of comparable grades

[1] Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Ghana, Guinea, Kenya, Liberia, Madagascar, Mozambique, Niger, Nigeria, Senegal, Sierra Leone, Togo.

of imported rice, by about 15-20% (NRDS, 2009).

2.2 Consumers' preference

The consumer preference survey was carried out in June-July 2021. The number of respondents to the web-based questionnaire survey was 28 in total. The people purchase the local and imported rice almost equally according to the survey results. The important factors when choosing rice are taste, swelling capacity, aroma, and cleanliness. The imported rice is evaluated better than the local rice in price, taste, aroma, and cleanliness. Regarding the nutritional value and safeness, the local rice is evaluated better than the imported rice. The results of the consumer survey show that the local rice is constantly supplied but negatively evaluated in quality and price factors. The competitiveness of the local rice would be increased by introduction of suitable variety, improvement of quality, and improvement of productivity (increase cost efficiency).

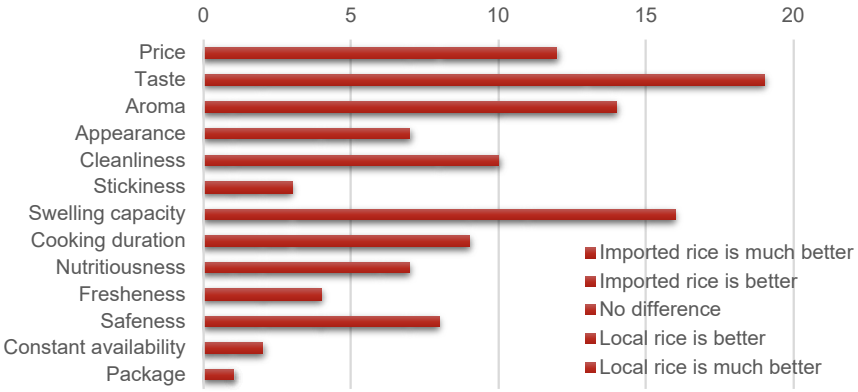


Fig. 2. Important factors when choosing rice and comparison between imported and local rice.

2.3 Major brands/varieties

(1) Local rice

Because of a long history of rice culture, farmers maintain various indigenous varieties with different traits. Despite their low yielding capacities, they have some advantages including their adaptability to local conditions (Ngaujah and Spencer, 2010).

Table 1 shows improved/semi-improved varieties in Sierra Leone, and some of their information. According to the baseline survey for sustainable rice production project of JICA (2018) and report of Spencer and Fornah (2014), major improved varieties grown are Pa Kiamp (ROK 24), NERICA L-19, Buttercup and other ROK series. The Sierra Leone Agricultural Research Institute (SLARI) tried to disseminate improved varieties including ROK series and NERICA. Table 2 shows the group of varieties grown by the CARE[2] farmers in Bombali District.

[2] CARE Rice value chain development project.

Table 1. Improved/semi-improves rice varieties grown in various regions of Sierra Leone [a].

Cultivar	Region [b]	Agro-ecology [c]	Cultivated years	Growth duration [d] (month)	Plant height (cm)
Buttercup [e]	N	IVS	10	3.5	110-130
CP4	S	IVS, Boli	30	6-9	-
Indochina	N	Rv, Boli	30	6	150-200
Kori-Korie	N	Upland, IVS, Boli	2	4	60
LAC 23	E, S	Upland	40-50	4-5	120-150
Nerica L-19	N, E, S, W	IVS	3-5	4	80-120
Pa Kiamp [f]	N, E, S, W	Upland, IVS, Boli, MS, Rv	10	4-5	110-150
CCA [g]	N	IVS	-	3.5	80
ROK 3	N, E, S	Upland, IVS, Boli, MS	30	4.5-5	100-120
ROK 5	N, S	IVS, MS, Upland	30	4-5	130-150
ROK 10 [h]	N, E, S	MS, IVS, Boli, Rv	30	5-6	130-150
ROK 14 [i]	W	IVS	30	4	120
Sinoa	N	IVS	50?	3.5	-
Yeffin	N	IVS	2	3.5	120-140

Source: JICA, 2014.
a) Most information collected during the training on TP-R for MAFFS staff by SRDP/JICA (2014).
b) N: Northern, E: Eastern, S: Southern, W: Western.
c) IVS: inland valley swamp, Boli: Boliland, Rv: riverine grassland, and MS: Mangrove swamp.
d) Growth duration of photoperiod-sensitive cultivars vary with planting season.
e) Synonym: Patele.
f) Locally called as Rizis in the east.
g) 'Chen-Chu-ai'. Synonym: Patheden.
h) Synonym: Tonsor Kayrain and Gbasnin in the north.
i) Formaly called as Mange 2.

Table 2. Groups of varieties covered in the CARE survey (%).

Variety group	Upland	IVS [a]	Boliland [b]
Local indigenous variety	33	58	17
ROK series	13	20	21
NERICA	2	3	1
Pa Kiamp	50	9	61
Other improved	2	10	0

Source: Modified by JICA Survey Team based on Spencer and Fornah, 2014.
a) IVS: Inland valley swamp
b) Boliland is a kind of huge pool in lowland formed only in rainy season

In Sierra Leone, all the rice cultivation is under rain-fed condition (Fig. 3). The majority is cultivated under upland condition which occupies about 78% of rice growing area (total area = 1,516,701 ha in 2015, Graham *et al*., 2015). The rest is under lowland. The lowland ecology includes inland valley swamp (IVS), Boliland, mangrove swamp and riverine. The ratio of the area under the condition of upland, IVS, Boliland, riverine, and mangrove swamp are 77.5%, 15.5%, 3.5%, 1.7% and 1.8%, respectively. Boliland is a kind of huge pool in lowland formed only in rainy season. Where Boliland is formed becomes a meadow in dry season. In IVS cultivation, the water comes from one or combination of two among three types of sources, i.e. (1) spring water, (2) seepage water from forest, and (3) inflow from upstream (JICA, 2018).

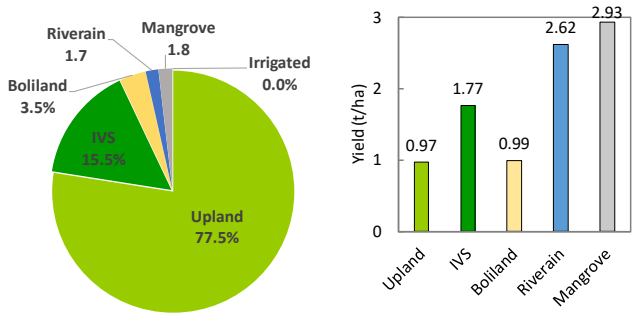


Fig. 3. Percentage of rice ecologies and their average yield.
Source: Made by survey team based on the study of Graham *et al*., 2020. The figure of yield (right) was made according to the data in Table 3.

Fig. 3 and Table 3 show the harvested area and production in different districts, and average yield of each rice ecology. The average yield is generally low

in upland and Boliland, while relatively high in riverine and mangrove swamp.

Table 3. Rice area and production quantity in each district.

District	Upland Rice		IVS Rice		Boliland Rice		Riverain Rice		Mangrove Rice		Total	
	Area (ha)	Prod (t, paddy)	Area (ha)	Prod (t, paddy)	Area (ha)	Prod (Mt) Paddy	Area (ha)	Prod (t, paddy)	Area (ha)	Prod (t, paddy)	Area (ha)	Prod (t, paddy)
Bo	78,311	70,871	7,286	13,901	1,098	1,270	4,834	12,061	0	0	91,529	98,103
Bombali	54,654	44,598	16,659	26,388	4,850	3,989	4,212	11,859	0	0	80,375	86,834
Bonthe	7,384	7,923	9,048	15,020	1,421	1,449	4,240	11,908	3,221	10,178	25,314	46,478
Kailahun	73,989	82,646	21,836	37,645	0	0	4,309	11,524	0	0	100,134	131,815
Kambia	32,124	29,008	20,406	45,036	4,671	4,297	3,499	8,956	872	2,486	61,572	89,783
Kenema	96,557	90,570	15,959	26,731	0	0	3,554	9,168	0	0	116,070	126,469
Koinadugu	48,183	51,074	19,148	52,121	3,542	3,797	2,640	8,762	0	0	73,513	115,754
Kono	56,743	59,921	19,422	29,366	0	0	2,168	5,507	0	0	78,333	94,794
Moyamba	68,585	64,401	7,874	13,386	2,330	2,796	3,987	11,164	1,724	4,931	84,500	96,678
Port Loko	53,448	45,645	22,779	33,576	4,742	5,121	4,753	9,506	3,247	9,221	88,969	103,069
Pujehun	31,218	33,122	8,816	12,395	1,261	1,319	3,048	7,803	1,023	2,949	45,366	57,588
Tonkolili	58,954	62,786	20,799	29,930	3,570	3,213	3,028	8,197	0	0	86,351	104,126
Western Area	2,365	2,247	543	992	180	184	1,373	3,165	287	679	4,748	7,267
National	**662,515**	**644,812**	**190,575**	**336,487**	**27,665**	**27,435**	**45,645**	**119,580**	**10,374**	**30,444**	**936,774**	**1,158,758**
Average yield (t/ha)		***0.97***		***1.77***		***0.99***		***2.62***		***2.93***		***1.24***

Source: Modified by JICA Survey Team based on Graham *et al*., 2020.

Figure 4 shows the distribution of rice production. Rice has been produced in all over the country, however, the main producing districts are Kailahum, Kenema, Bo, Port Loko and Tonkolili districts (Table 3).

Figure 5 shows the cropping system of upland rice and lowland rice according to the survey of 180 farmers in Bombali district. For upland rice, seeds are sown in mid-June, and rice is harvested in October to November. For lowland rice, seedlings are transplanted in July, and rice is harvested at the end of November to December. The average plot area for upland and lowland rice were 0.99 ha and 0.66 ha, respectively.

Figure 6 shows the choice of cropping season in IVS (inland valley swamp) with different rice genotypes for single and double cropping.

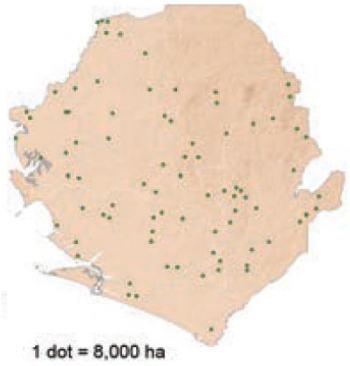


Fig. 4. Distribution of rice producing area.
Source: GRiSP, 2013.

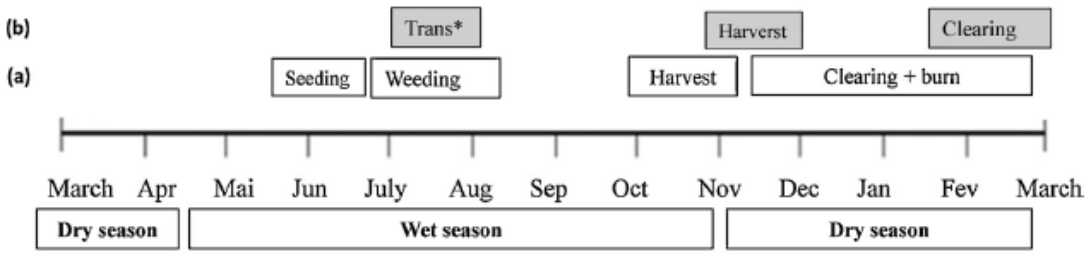


Fig. 5. Cropping pattern by (a) direct sowing (upland rice) and (b) transplanting methods (lowland rice) in Bombali district (* Transplanting).
Source: Modified by JICA Survey Team based on Chenoune *et al*., 2016.

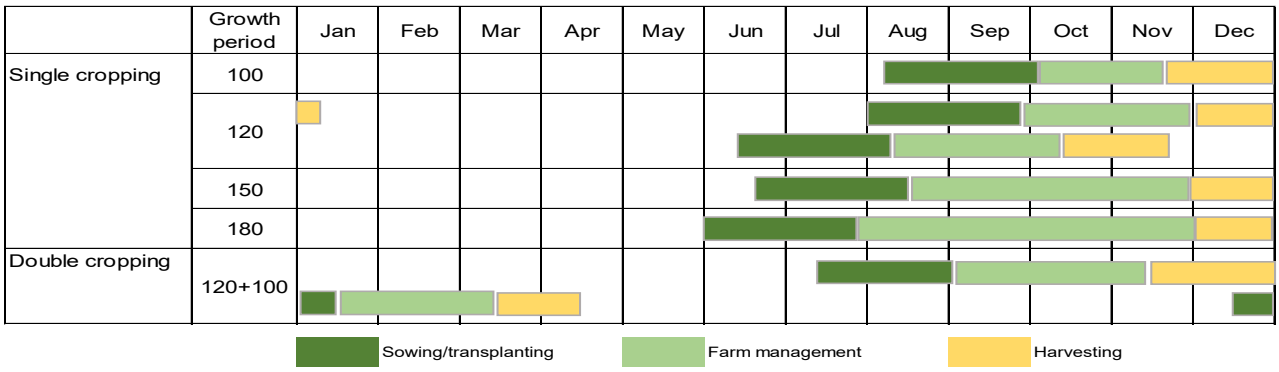


Fig. 6. Choice of cropping season in inland valley swamp.
Source: JICA, 2014.

(2) Imported rice

According to the data set of International Trade Center, the largest exporter to Sierra Leone was China in 2019 with the share of 36% (Table 4). In recent years, the major exporting countries to Sierra Leone have been changing notably. The import from China has increased by 85% from 2018. Pakistan and Thailand used to be the main exporter to Sierra Leone, however, the imports from Pakistan and Thailand decreased by 62% and 87%, respectively. The price of rice from China and Brazil, which are the first and second exporters, are lower than that from Pakistan and Thailand.

Table 4. Information about imported rice (Total quantity, value, average tariff%, etc. of rice 1006 in 2019).

	Quantity imported (t)	Share in quantity (%)	Value imported (1,000 USD)	Unit value (USD/t)	Growth in imported quantity between 2015-2019 (%, p.a.)	Growth in imported value between 2018-2019 (%, p.a.)	Average tariff (estimated) applied by Sierra Leone (%)
Total	**330,874**		**108,590**	**328**	**6**	**4**	
China	122,626	35.6	38,624	315	1699	85	13.5
Brazil	79,596	21.0	22,853	287	16	0	13.5
India	47,376	16.4	17,841	377	2	-1	13.5
Uruguay	35,909	10.1	11,008	307	-8	-20	13.5
Pakistan	18,889	6.5	7,037	373	-25	-62	13.5
United States of America	4,037	4.4	4,732	1,172	35	280	13.5
Paraguay	17,874	4.1	4,463	250	55	62	13.5
Thailand	1,233	0.7	780	633	-52	-87	13.5
Myanmar	2,150	0.5	549	255		89	13.5
Burkina Faso	230	0.4	398	1,730	-31		13.5

Source: ITC (International Trade Center), https://www.trademap.org/Country_SelProductCountry, browsed on April 20, 2021

2.4 Marketing

(1) Market structure

Figure 7 shows the two typical channels for local rice distribution. Figure 7a shows the traditional market channels which is by far the most important for local rice in the country, accounting about 95% of the marketable surplus of local rice (Spencer and Fornah, 2014). The produce for this channel can be raw milled rice or parboiled, usually containing impurities, such as sand, “black-black”, and bran, with over 35% of broken grains. Figure 7b shows the emerging rice value chain which accounts for 5-10% of local rice in the country. The channel is through institutional buyers and delivers rice of same quality as imported rice (no impurities and less than 25% of broken grains) to meet

the standards established by P4P[3] (Spencer and Fornah, 2014).

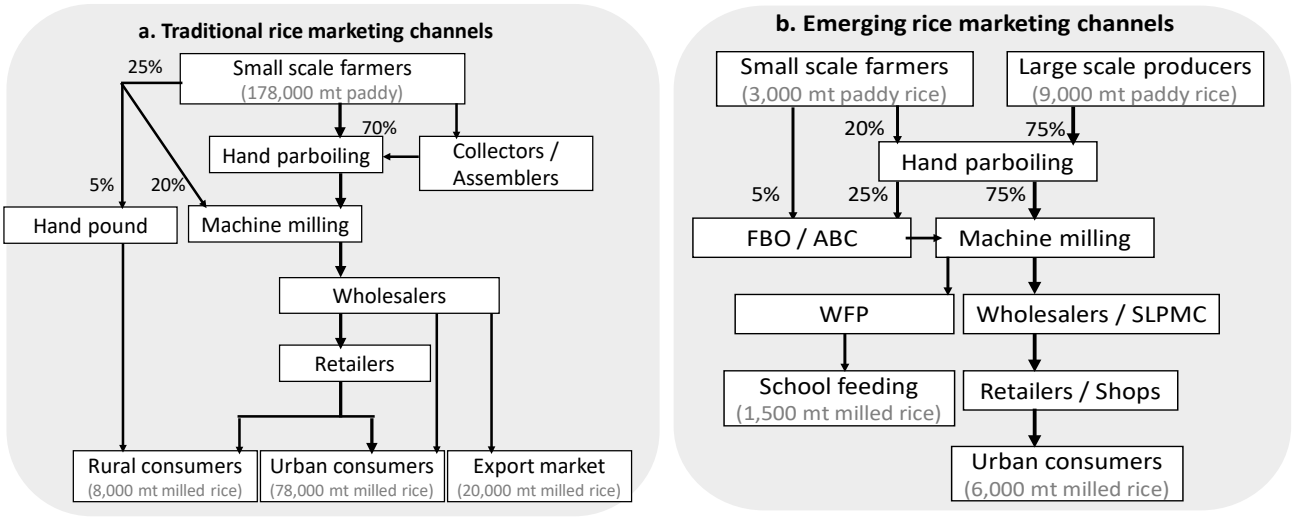


Fig. 7. Market channels for marketed surplus of local rice in Sierra Leone: Traditional rice marketing channels (a) and emerging rice marketing channels (b).
Source: Made by JICA Survey Team based on Spencer and Fornah, 2014.
FBO: Farmer Based Association, ABC: Agricultural Business Center, Distribution % indicated in the figures are the estimation)

Figure 8 shows the market channel for imported rice. The marketing system for imported rice is much simpler than that for local rice. Until 1980's, government agencies, such as the Rice Department, the Rice Corporation and the Sierra Leone Produce Marketing Board (SLPMB), and then the private sector now has the dominant role in the marketing of imported rice (Spencer *et al.*, 2014). The figure indicates that about 80% of imported rice are consumed by urban consumers.

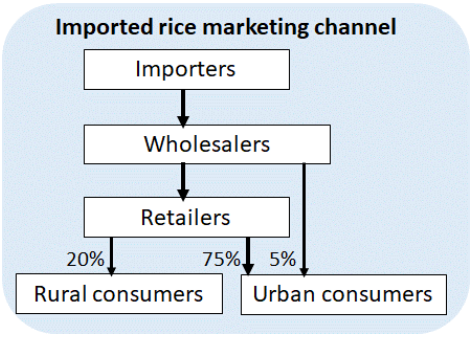


Fig. 8. Market channel for imported rice.
Source: Made by JICA Survey Team based on Spencer *et al.*, 2014.
Distribution % indicated in the figure are the estimation.

(2) Market path of local rice and imported rice

The most important seaport is at Freetown (Capital), and the largest amount of the imported rice is transported within Western area (50%), followed by Bombali district (20%) and Kenema district (15%) (Table 5). Rice is also imported from neighboring countries through land borders (CARD training, 2021). The market paths of local rice and imported rice which are made based on those information and, additionally, the inception report prepared by the Sierra Leonean Ministry staff participated in the CARD training (2021) are shown in Fig. 9.

[3] P4P: World Food Purchase for Progress program

Table 5. Estimated proportion of imported rice received by Districts.

	Proportion (%)
Western area	50
Bombali District	20
Kenema District	15
Bo District	10
Kono District	10
Others	5

Source: Spencer and Fornah, 2014 (The table was made based on their data by JICA Survey Team)

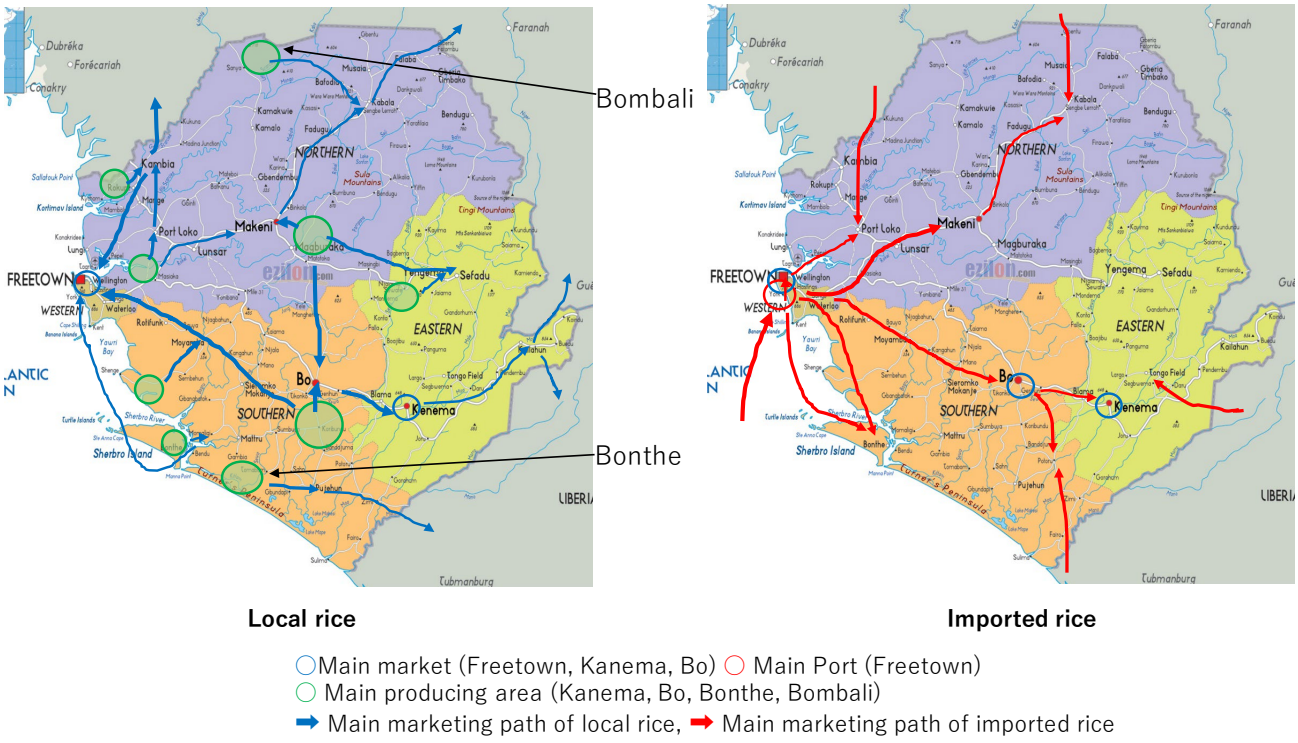
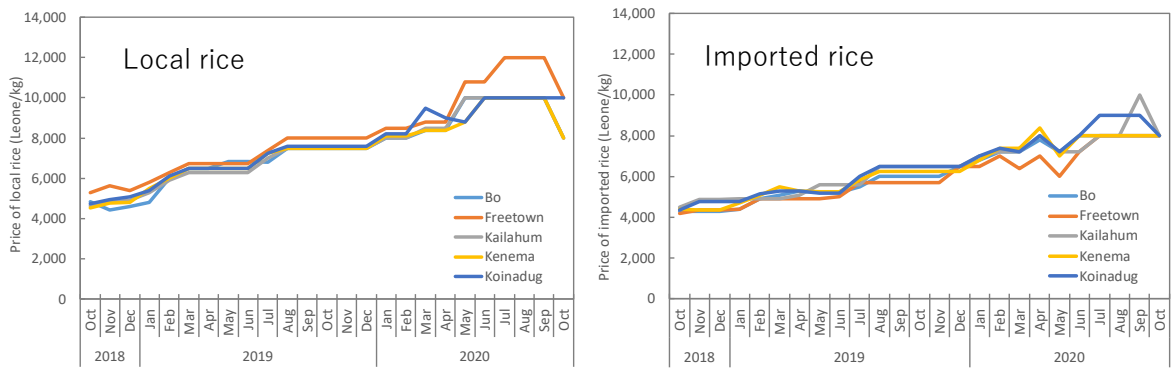


Fig. 9. Marketing path of local rice and imported rice
Source: Made by JICA Survey Team based on the CARD training, 2021.

2.5 Price comparison in the market

Figure 10 shows the retail price of local rice and imported rice in different towns/markets of last two years. In Sierra Leone, the price of local rice is higher than that of imported rice in all the towns according to the data of GIEWS FPMA Tool of FAO (wholesale price was not available). Most of the time, both local rice and imported rice had similar price among the towns, but from May, 2020, price of local rice became higher in Freetown than other towns. There is a possibility that this tendency was due to the COVID-19 which restricted the movement of people and commodities.



Average price (Leone/kg, milled) in last two years

	Bo	Freetown	Kailahum	Kenema	Koinadug
Average	7,458	8,201	7,450	7,447	7,650
SD	1,725	2,066	1,701	1,620	1,707

	Bo	Freetown	Kailahum	Kenema	Koinadug
Average	6,210	5,963	6,447	6,334	6,523
SD	1,332	1,248	1,364	1,309	1,437

Fig. 10. Price of local rice and imported rice in different towns.
Source: GIEWS FPMA Tool, FPMA Tool (fao.org).

A survey of Conteh *et al*. (2012) also indicated that the retail price of local rice was more expensive (1,868,872 Le/t) than the imported rice (1,507,895,616 Le/t) in 2012 (Table 6), which could affect the promotion of local rice production although the imported quantity was small but enough to feed the urban population in the country (Conteh *et al.*, 2012).

Table 7 comparing the price of milled rice and parboiled rice in some districts. The price was the highest at Bombali district with both milled rice and parboiled rice. The tendency in price difference between these two types of rice varied with districts.

Table 6. Retail price of local rice and imported rice (2012).

Statistics	Local Rice Production (Mt)	Retail Price of Local Rice (Le)	Rice Imported (Mt)	Retail Price of Imported Rice (Le)
Mean	762731.7	1,868,872	138.5951	1507895.616
Maximum	1,570,094	3,165,021	193.146	2715749.76
Minimum	310,620	867129.2	96.4	724320.99

Source: Conteh *et al.*, 2012
Note: Production quantity and imported quantity are average of 10 years. Prices are in Le/t.

Table 7. Selling price (Leone/kg) in Bombali, Kambia and Port Loko (2018).

Type of rice	Bombali	Kambia	Port Loko	Mean
Milled	4,580	3,775	4,152	4,169
Parboiled	5,172	3,939	3,969	4,360

Source: JICA, 2018.

3. Competitiveness analysis

3.1 Production cost of local rice for DRC ratio analysis

For DRC analysis to evaluate the competitiveness of the local rice, totally ten cases of production conditions/ecologies were compared. They were;

Case I a: Mangrove rice / manual (NGB Districts[4])

Case I b: Boliland rice / partially mechanized (NGB Districts)

Case II a: Bombali District: Boliland, IVS, upland

Case II b: Tonkolili District: Boliland, IVS, upland

Case II c: Kambia District: Mangrove, Boliland

IVS (inland swamp valley) and Boliland are the unique names for rice ecologies in Sierra Leone. Boliland is a kind of huge pool in lowland formed only in rainy season. Table 8 and 9 show the production costs of these cases for the

[4] NGB Districts: Kambia, Port Loko, Bombali, Tonkolili, and Western area.

DRC analysis. Case I is from the survey study in 2014 of Spencer and Fornah (2014) in NGB districts (Kambia, Port Loko, Bombali, Tonkolili districts and Western area) which are important rice growing areas. Case II is based on the survey in 2008 for different conditions in different districts. Values in production cost of Case II and marketing costs are shown in USD since it was the common currency used in the original survey report, and then the total value is converted to Leone by market exchange rate of the year.

Table 8. Production cost for Case I (Leone/ha) (2014).

	Case I a	Case I b
	Mangrove rice - manual	Boliland rice – partially mechanized
Paddy yield (t/ha)	1.56	0.86
Input		
Family labor (Leone/ha) [a]	67,933	15,649
Cost		
Hired labor	983,970	321,039
Seed	146,433	148,054
Fertilizer	149,096	68,347
Pesticide	34,162	10,777
Sack	77,033	74,460
Land rent	148,312	13,019
Mechanical cultivation	882	301,157
Capital interest [b]	82,837	73,747
Total production cost (Leone/ha)	**1,690,657**	**1,026,248**
Total production cost (Leone/kg milled rice) [c]	**1,748**	**1,925**

Source: Modified by JICA Survey based on Team Spencer and Fornah, 2014. Surveyed year was 2014. Original figures in USD were converted to Leone using the exchange rate in 2014, 4,524 Leone/USD (FAOSTAT).
a) Assuming the labor wage = 3,500 Leone/day (JICA, 2014).
b) Capital interest was estimated for the expenses on material inputs and 40% of labor inputs by applying 10% of annual interest rate.
c) Conversion rate from paddy grain to milled rice is 0.62 (Spencer and Fornah, 2014).

Table 9. Production cost for Case II (USD/t, paddy) (2008).

	Case II a			Case II b			Case II c	
	Bombali District			Tonkolili District			Kambia District	
	Boliland	IVS [a]	Upland	Boliland	IVS	Upland	Mangrove	Boliland
Yield (t/ha)	0.71	0.83	0.66	1.18	1.54	0.66	1.32	1.58
Land clearing	1.43	0.00	31.38	2.30	21.35	42.50	1.47	0.00
Land preparation (Machine)	43.02	13.78	5.84	72.51	0.00	0.00	0.00	40.51
Land preparation (Manual)	33.77	103.84	66.39	9.31	119.14	81.62	100.59	137.47
Crop establishment (Seed, Fert, Chem)	36.85	33.18	30.75	67.20	28.48	48.93	45.70	88.88
Crop care (Weeding, bird scare)	11.22	2.64	28.35	8.44	24.60	38.07	0.00	0.00
Harvest, port-harvest	39.50	49.00	51.01	18.40	41.86	59.30	46.16	32.14
Fixed cost (Land rent, family lab.)	39.97	59.32	95.85	54.92	129.15	188.07	41.78	61.26
Capital interest [b]	7.06	9.54	8.91	8.17	10.27	12.05	10.44	15.67
Total production cost (USD/t, paddy)	**212.82**	**271.30**	**318.48**	**241.25**	**374.85**	**470.54**	**246.14**	**375.93**
Total prod cost (Leone/kg, milled) [c]	**1,026**	**1,308**	**1,536**	**1,163**	**1,808**	**2,269**	**1,187**	**1,813**
Total prod cost (Leone/ha)	**451,805**	**673,278**	**628,479**	**851,164**	**1,726,044**	**928,569**	**971,465**	**1,775,980**

Source: Modified by JICA Survey Team based on Spencer and Fornah, 2014. Surveyed year was 2008.
a) IVS: Inland valley swamp
b) Capital interest was estimated for the expenses on material inputs and 40% of labor inputs by applying 10% of annual interest rate.
c) Conversion rate from paddy grain to milled rice is 0.62 (Spencer and Fornah, 2014). The exchange rate in 2008 was 2,990 Leone/USD (FAOSTAT).

3.2 Marketing cost for DRC ratio analysis

Post-harvest cost for local rice

Table 10 shows the post-harvest cost for local rice which consists of milling cost, transporting cost and wholesale market margin.

Table 10. Market cost for local rice (for Case I and II) (USD/t, paddy) (2014).

	Mangrove rice - manual	Boliland rice – partially mechanized
Paddy milling cost	41.50	41.50
Transport: production zone to Freetown	19.30	20.50
Wholesalers market margin (32%) [a]	121.19	120.81
Total cost (USD/t, paddy)	**181.99**	**182.81**
Total cost (Leone/kg, milled rice) [b]	**1,328**	**1,334**

Source: Modified by JICA Survey Team Spencer and Fornah, 2014.
a) Estimated as 32% of the buying price from the producers.
b) Conversion rate from paddy grain to milled rice is 0.62 (Spencer and Fornah, 2014)
The exchange rate in 2014 was 4,524 Leone/USD (FAOSTAT).

Distribution cost of imported rice

Table 11 and 12 show the market cost for imported rice from the port in Freetown to the wholesale market in Freetown, for the DRC analysis of Case I, and Case II, respectively.

Table 11. Market cost for imported rice (for Case I) (USD/t, milled rice, 2014).

	Cost (USD/t)
Sales tax (3.0%) [a]	14.73
SLPA [b] sales tax	3.93
Importers margin (14.86%) [a]	72.96
Total cost (USD/t, milled rice)	**91.62**
Total cost (Leone/kg, milled rice) [c]	**414**

Source: Modified by JICA Survey Team based on Spencer and Fornah, 2014.
a) Estimated as 3.0% and 14.86% of CIF price of 25% broken rice from Pakistan (491 USD/t).
b) Sierra Leone Ports Authority Tax
c) The exchange rate in 2014 was 4,524 Leone/USD (FAOSTAT)

Table 12. Market cost for imported rice (for Case II) (USD/t, milled rice, 2009).

	Cost (USD/t)
Landing cost (12%) [a]	57.60
Importers margin (10%) [a]	48.00
Total cost (USD/t, milled rice)	**105.60**
Total cost (Leone/kg, milled rice) [b]	**342**

Source: Modified by JICA Survey Team based on Spencer *et al.*, 2014.
a) Estimated as 12% and 10% of CIF price of 25% broken rice from Pakistan (480 USD/t).
b) The exchange rate in 2009 was 3,236 Leone/USD (FAOSTAT).

3.3 Competitiveness analysis by DRC ratio

(1) DRC ratio Analysis

In this survey, we use DRC (domestic resource cost) ratio as an indicator for the competitiveness of local rice. This measures the comparative advantage of local rice production at the capital's wholesale market, where local rice and imported rice are sold side by side (Kikuchi *et al.,* 2016). The DRC ratio is the cost-benefit ratio between the cost of domestic resources used to produce one unit of rice and the net foreign exchange that can be earned by exporting one unit of rice. We use 'tradable-good component ratio' and 'domestic-resource component ratio' of each cost needed for production and marketing of rice. Domestic rice production has a comparative advantage if DRC ratio < 1.0. Regarding the exchange rate of the currency, due to the lack of precise information on the shadow price, the market exchange rate was used to calculate the prices according to the corresponding year for conversion of foreign currency into local currency. The tradable-good component ratio refers to Kikuchi *et al.* (2016).

Table 13 shows the results of the DRC analysis. The data source of production costs, marketing costs for local rice and marketing cost for imported rice are shown in Table 8 - 12. As shown in these tables, cost information are from different sources and from different years. In Sierra Leone, all the rice cultivation is under rain-fed condition (Fig. 3, Graham *et al.*, 2020). In the DRC analysis, competitiveness of local rice produced under IVS cultivation, Boliland cultivation and in mangrove swamp are analyzed. The detailed calculation results of the DRC ratio are shown in the attached table (after the reference list).

For imported rice price for the analysis, the CIF prices indicated in the study of Spencer and Fornah (2014) (price in 2014) and Spencer *et al.* (2014) (price in 2009) were used to evaluate Case I and Case II, respectively. They were both CIF price of 25% broken rice. The imported rice for Case II analysis was from Pakistan but that for Case I the country was not mentioned in the report of Spencer and Fornah (2014). Most of the imported rice to Sierra Leone is broken rice, and had share of 97% of all imported rice in 2014 (ITC).

In general, DRC ratios of Case I were lower than those of Case II, however, none of the cases had DRC ratio lower than 1.0 (Table 13). Among the cultivation ecologies, rice produced in mangrove swamp obtain higher competitiveness than Boliland in Case I. The total production cost of mangrove cultivation was higher with more labor, fertilizer usage and land rent than that of Boliland, but the higher yield made the DRC ratio lower for mangrove swamp cultivation.

Within the Case II, the competitiveness tended to be higher in the order of mangrove swamp > Boliland > IVS, upland. In Case II a and II b, Boliland had higher cost for land preparation (mechanized) but less manual work for land preparation and cleaning than others, which made its DRC ratio lower than IVS and upland cultivation. In Case II c, mangrove cultivation had lower DRC than Boliland but the area of mangrove cultivation is only 1.5% of the total rice cultivation area in the district (Kambia District) (Table 3).

According to those results it could be said that Pa Kiamp and ROK series in mangrove swamp have higher competitiveness than other combinations of variety and condition. They are the major varieties cultivated in mangrove swamp (Spencer and Fornah, 2014). The rice in upland cultivation whose major variety is also Pa Kiamp was not found to be competitive with imported rice under this condition, mainly due to its low yield. Upland rice covers 77.5% of total rice area in the country (Fig. 3).

We have to note that, in all cases, import tariffs are not included in the calculation in this analysis since the DRC ratio analysis in principle is to evaluate the competitiveness of local rice without government intervention. Therefore, including tariffs would improve the competitiveness of local rice in all cases.

Table 13. Result of DRC analysis.

Case	Area / Production ecology		Yield (t/ha)	DRC ratio
I a	Mangrove rice / manual		1.56	1.22
I b	Boliland rice / partially mechanized		0.86	1.41
II a	Bombali District	Boliland	0.71	1.40
		IVS *	0.83	1.58
		Upland *	0.66	1.74
II b	Tonkolili District	Boliland	1.18	1.64
		IVS *	1.54	1.92
		Upland *	0.66	2.34
II c	Kambia District	Mangrove	1.32	1.49
		Boliland	1.58	2.27

Note: Cases with * mark were the subject of sensitivity analysis.

(2) Sensitivity analysis

Although rice grown in mangrove swamp has relatively higher competitiveness, it occupies only 1.8% of the country's rice field. Upland field covers the largest area (77.5%) and IVS has the second largest area (15.5%) (Fig. 3). Therefore, the sensitivity analysis was conducted for those two rice ecologies (with * mark in Table 13). Table 14 shows the possible approaches to lower their DRC ratio and increase the competitiveness.

Bombali District

Case II a, IVS: The yield of this case (0.83 t/ha) in Bombali District was lower than that of IVS in Tonkolili District (1.54 t/ha). The main difference was the cost which the farmers spend for crop management, such as weeding and bird scaring. Since the weeding practice before the rice plant establishment and bird scaring after heading stage are important to maintain the yield, they need to adopt these practices. This possibly will contribute to higher the yield and lower the DRC ratio (Table 14).

Case II a, Upland: As same approach for IVS above, if the farmers practice better crop management with weeding and bird scaring, there is a possibility that they can improve the yield up to 1.3 t/ha and lower the DRC ratio.

Tokolili District

Case II b, IVS: In Tokolili District, farmers with IVS farming system, were not using any machinery for plow nor harrow (Spencer and Farnah, 2014) and required high input with labor work for land preparation. If they can introduce plowing machinery and reduce the labor costs, and then increase the yield to 2.0 t/ha from 1.54 t/ha (30%), the competitiveness would increase to DRC ration of 1.44.

Case II b, Upland: The yield of upland cultivation was very low with 0.66 t/ha which was lower than the average yield of upland rice in Sierra Leone (0.97 t/ha, Fig. 3). If crop management practices can be improved with higher efficiency, without spending additional input, and increase yield to 1.3 t/ha, the DRC ratio would be decreased to 1.43.

In Sierra Leone rice farmers who use fertilizer is limited, and the application rate (quantity) is also very low. Chemical fertilizers are used by about 15% of Boliland farmers, and a third of rice farmers using mangrove swamp (Spencer and Farnah, 2014). Farmers in upland often practice slash-and-burn shifting cultivation and rarely use fertilizers. Therefore, it is not easy to introduce the fertilizer application to the upland farmers because it is not

customary.

Table 14. Result of sensitivity analyses for DRC ratio.

	Possible approach to increase the competitiveness	Effect (change of DRC ratio)
Case II a, IVS	Practice proper crop management (weeding, bird scaring) with same level as IVS in Tonkolili District, and increase yield up to 1.5 t/ha from 0.83 t/ha.	1.58 → 1.20
Case II a, Upland	Practice proper crop management (weeding, bird scaring) with same level as upland cultivation in Tonkolili District, and increase yield up to 1.3 t/ha from 0.66 t/ha.	1.74 → 1.18
Case II b, IVS	Introduce usage of the machinery for plow and reduce labor work, and increase yield up to 2.0 t/ha from 1.54 t/ha.	1.92 → 1.44
Case II b, Upland	Increase yield up to 1.3 t/ha from 0.66 t/ha.	2.34 → 1.43

4. Related policy

4.1 Policy measure to stimulate consumption of local rice

In 2009, the Government launched National Sustainable Agriculture Development Programme 2010-2030 (NSADP) to make agriculture the engine for socio-economic growth and development through commercial agriculture and the Smallholder Commercialization Programme (SCP) is identified as the priority to deliver this goal (Sierra Leone's CAADP, 2009). SCP consists of six components: (1) Smallholder commercialization: production intensification, diversification, value addition, and marketing; (2) small scale irrigation development; (3) Market access expansion through feeder road rehabilitation; (4) Smallholder access to rural financial services; (5) Strengthening social protection, food security, productive social safety nets; and (6) SCP Planning, coordination, monitoring and evaluation (Ministry of Agriculture, Forestry and Food Security, 2010).

Currently, the tariff of 15 % on imported rice is waived (Graham *et al.*, 2020). The Government has removed both import tariffs and services tax for imported rice under the Finance Act of 2021 to ensure that the prices of rice would go down (The Calabash newspaper, 2021).

4.2 Quality standards and status of the application

In Government Agricultural Development Policy, the one of implementation strategies in marketing is subjecting all exportable commodities to grading and certification to maintain acceptable quality standards (NRDS, 2009).

Kamara *et al.* (2015) evaluated the quality of rice grains available in the local markets based on criteria adapted from the Philippines Rice Grading Standards for milled rice grains. This survey was co-authored by an officer of the Ministry of Agriculture, Forestry and Fisheries, it seems there is no national quality standard for rice.

Spencer *et al*. (2014) reported that the modern rice value chain emerged with production from small as well as large scale producers who market rice through institutional buyers such as the WFP's P4P program and the Sierra Leone Produce Marketing Company, or large scale producers who process and market their produce as well as produce by neighboring farmers. The system delivers rice of the same quality as imported rice to consumers (no impurities and less than 25% broken grains) because quality standards have been established (P4P) or rice is milled in the more modern rice mills in Agribusiness Centers or the Farmer Based Associations of the Rural and Private Sector Development Project.

5. Main issues and suggestions

In Sierra Leone, rice is the main staple food and the consumption is one of the highest in Africa (161 kg/capita/year). The self-sufficiency rate is relatively high (about 65%), and only 10-15% of locally produced rice is distributed through market. Irrigated rice production is not recognized, and 100% is the rain-fed production with the unique systems such as IVS and Boliland.

According to the consumers' survey, statistical data of market price and some references, the local rice have higher price than imported rice in the market and retail shops. Consumers' survey indicated that quality of local rice is not satisfactory despite the high price. Therefore, it is necessary to develop market channel effectively and improve the post-harvest technology. Regarding rice production, the results of DRC ratio analysis suggested that the competitiveness of local rice would be improved if farmers can increase the yield by applying appropriate crop management method with some more important labor work, such as weeding and bird-scaring. In general, the degree of competitiveness tended to be higher in the order of mangrove swamp > Boliland > IVS, upland. Upland rice which covers 77.5% of total rice area had lowest competitiveness against imported rice according to the analysis.

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Attached Table: Calculation and result of DRC ratio analysis

		LOCAL PRODUCTION											IMPORT			DRC CALCULATION		
		Paddy yield	Production cost Total	Total	Production		Irrigation cost		Marketing cost Farm-gate to market		Total		Border price (CIF price of 2,221 Leone/kg) [a]	Marketing cost Border to market		Total cost		DRC ratio
					Tradable	Domestic	Tradable	Domestic	Tradable	Domestic	Tradable	Domestic		Tradable	Domestic	Tradable	Domestic	
	Production conditions										$\Sigma a_i P_i SER$ (①)	$\Sigma b_j P_j$ (②)	$P_w SER$ (③)	$\Sigma_k c_k P_k SER$ (④)	$\Sigma_m d_m P_m$ (⑤)	A = ①-④	B = ②-⑤	B / (③-A)
		t/ha	Leone/ha		Leone/kg of milled rice													
Case I a	**Mangrove rice -manual**	1.56	1,690,657	1747.99	202.52	1545.47			138	1,190	341	2,735	2,221	91	324	249.77	2411.70	**1.22**
Case I b	**Boliland rice –partially mechanized**	0.86	1,026,248	1924.70	639.64	1285.06			143	1,191	782	2,476	2,221	91	324	691.70	2152.43	**1.41**

			LOCAL PRODUCTION											IMPORT			DRC CALCULATION		
			Paddy yield	Production cost Total	Total	Production		Irrigation cost [a]		Marketing cost Farm-gate to market		Total		Border price (CIF price of 1,553 Leone/kg) [b]	Marketing cost Border to market		Total cost		DRC ratio
						Tradable	Domestic	Tradable	Domestic	Tradable	Domestic	Tradable	Domestic		Tradable	Domestic	Tradable	Domestic	
	District	Production conditions										$\Sigma a_i P_i SER$ (①)	$\Sigma b_j P_j$ (②)	$P_w SER$ (③)	$\Sigma_k c_k P_k SER$ (④)	$\Sigma_m d_m P_m$ (⑤)	A = ①-④	B = ②-⑤	B / (③-A)
			t/ha	Leone/ha		Leone/kg of milled rice													
Case II a	**Bombali District**	**Boliland**	0.71	451,805	1,026	289	737			143	1,191	432	1,929	1,553	43	299	389.00	1629.56	**1.40**
		IVS	0.83	673,278	1,308	170	1,139			143	1,191	313	2,330	1,553	43	299	269.97	2030.58	**1.58**
		Upland	0.66	628,479	1,536	132	1,404			143	1,191	275	2,595	1,553	43	299	232.46	2295.61	**1.74**
Case II b	**Tonkolili District**	**Boliland**	1.18	851,164	1,163	505	658			143	1,191	648	1,849	1,553	43	299	605.44	1550.19	**1.64**
		IVS	1.54	1,726,044	1,808	103	1,705			143	1,191	246	2,896	1,553	43	299	203.13	2596.83	**1.92**
		Upland	0.66	928,569	2,269	177	2,092			143	1,191	320	3,283	1,553	43	299	277.10	2984.34	**2.34**
Case II c	**Kambia District**	**Mangrove**	1.32	971,465	1,187	165	1,022			143	1,191	308	2,213	1,553	43	299	265.41	1913.82	**1.49**
		Boliland	1.58	1,775,980	1,813	468	1,345			143	1,191	611	2,536	1,553	43	299	568.11	2237.05	**2.27**

a) CIF price of 25% broken rice in 2014 from Spencer and Fornah (2014) was used for the analysis (the exporting country was not mentioned in the report of Spencer and Fornah).

b) CIF price of 25% broken rice from Pakistan in 2009 from Spencer *et al.* (2014) was used for analysis.