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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
Kenya

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 follows maize and wheat among Kenya's staple food. Traditionally, rice is eaten in Mwea and the coastal area with Arabic and Islamic influence (Promar consulting, 2016). The demand of rice has been increasing drastically in recent years, and rice production in the country cannot fulfil the demand. The self-sufficiency rate of rice still stays low. It was 11% in 2018 (Fig. 1).

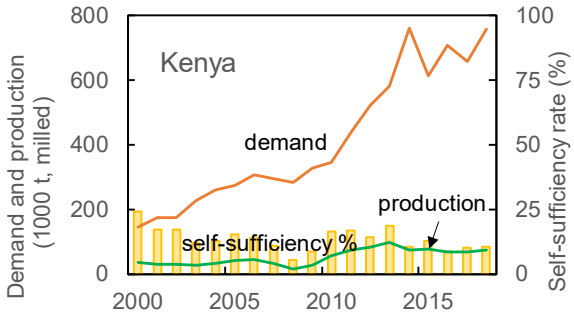

Fig. 1. Rice supply in Kenya.
Source: Made by JICA Survey Team based on data from FAOSTAT, browsed in June, 2021.

About 70 to 80% of rice is produced in the large-scale irrigation schemes (Mwea, West Kano, Ahero, Bunyala, etc.), under the management of NIA[2]. Main rice producing areas are Mwea area near Mt. Kenya, and the area around Lake Victoria. The former produces about 60%, the later produces about 30% of the national production, and about 10% is produced near Tana river in the east (Kakuta, ARDEC No. 58).

The Mwea Irrigation Scheme, which is the largest scheme, produce Pishori rice which is Basmati rice with good aroma. Pishori rice is the most popular brand, and sold with relatively high price. Compared to local rice, imported rice, especially from Pakistan, is comparatively cheap. It is reported that imported rice sells as low as at 80 Ksh/kg, while, Mwea Pichori rice is sold at 130 Ksh/kg in the market, which is giving a problem in sales of Pishori rice

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

(Kenya News Agency, 2021).

2.2 Consumers' preference

A consumer preference survey was carried out in June-July 2021, and the result is shown in Fig. 2. The number of respondents to the web-based questionnaire survey was 74 in total. In Kenya, both local rice and imported rice widely distributed. People prefer local rice in general, and about a half of the respondents usually consume local "Pishori" rice. The important factors when choosing rice are taste, aroma, price, appearance, and cleanliness. The local rice is evaluated better in taste and aroma. The price of the local rice is not always higher than the imported rice. Regarding the appearance and cleanliness, the imported rice is evaluated better than the local rice. The results of the consumer survey show that the local rice is positively evaluated in quality factors, and the competitiveness of the local rice would be increased by improvement of post-harvest handling.

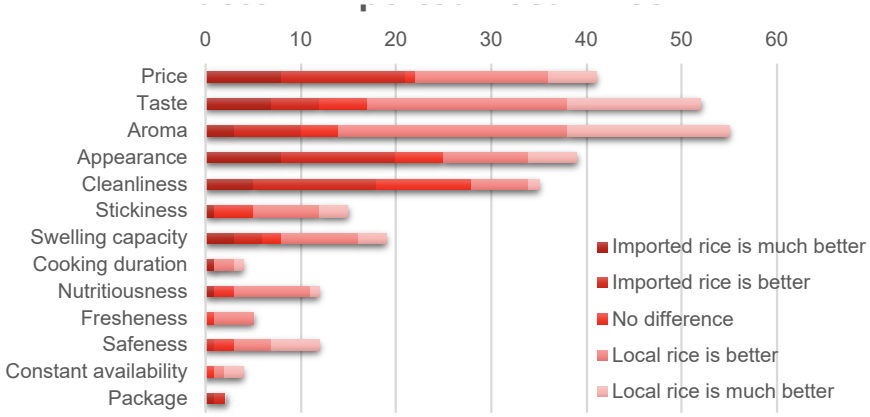

Fig. 2. Important factors when choosing rice and comparison between imported and local rice.

2.3 Major brands/varieties

(1) Local rice

Table 1 shows major varieties under irrigated, rain-fed lowland and rain-fed upland rice ecology.

Pishori rice which is mainly produced in Mwea irrigation scheme is the dominant brand by far in Kenya. Pishori rice is grown in the area of about 80% of Mwea irrigation scheme, and its variety name is Basmati 370. Farmers in Mwea irrigation scheme grow BW196 mainly for self-consumption in the field where the condition is not very suitable (i.e. not leveled well) or during off season. BW196 has higher productivity than Basmati 370 but Basmati 370 has higher marketability with preferred aroma. In other large-scale irrigation schemes, such as Ahero irrigation scheme and Buyara irrigation scheme, IR 2793-80-1 is the dominant variety. Basmati 370 is a short-duration (130 days) variety. IR 2793-80-1 is a medium-long duration (145 days) variety (Ndiiri *et al.*, 2017).

Table 1. List of cultivated varieties under different rice ecologies.

Rice ecology	Cultivated varieties
Irrigated lowland	**Basmati 370** (Nibam 11)
	IR 2793-80-1 (Nibam 108)
	Basmati 217 (Nibam 10)
	ITA 310 (Nibam 110)
	BW 196 (Nibam 109)
	Jasmin 85
	Arize 6444 Gold (hybrid)
	Ariz Tej Gold (hybrid)
	IR-05N221 (Kombosa)
Rain-fed lowland	Arize 6444 Gold (hybrid)
	Ariz Tej Gold (hybrid)
	NERICA 1
Rain-fed upland	NERICA 4
	NERICA 10
	NERICA 11
	Dourado Precoce

Source: Atera, *et al.*, (2018), Cheserek, *et al.* (2012), Farm LINK Kenya (2018), IRRI News, Ndiiri, *et al.* (2017), Rahab, *et al.* (2019), Roadmap for Rice Seed Development, Kenya 2016-2026.

Table 2 shows the rice varieties preferred by farmers in different irrigation schemes, and percentage of farmers purchasing seeds (not self-producing). IR 2783-80-1 was preferred by most of the farmers in Ahero and Bunyala irrigation scheme. Farmers in irrigation schemes usually buy seeds from NIA.

Table 2. Farmers-preferred rice variety.

Irrigation scheme	Variety	Preferred %	Purchased %
Ahero	IR 2793-80-1	81.3	55.0
	Basmati 370	16.3	35.0
	ITA 310	1.3	2.5
West Kano	IR 2739-80-1	35.0	62.5
	Basmati 370	42.5	27.5
	ITA 310	20.0	2.5
Bunyala	IR 2739-80-1	87.5	87.5
	Basmati 370	12.5	5.0
	ITA 310	0	1.3

Source: Modified by JICA Survey Team based on Cheserek *et al*., 2012.

In Kenya rice is mostly cultivated under irrigated condition which occupies about 95% of rice growing area (Fig. 3) (total area = 18,384 ha in 2013). Most of the irrigated area is under the large irrigation schemes managed by NIA. Small quantities of rice are produced along river valleys especially in smallholder irrigation schemes include Kore, Alungo, Nyachoda, Wanjare, Anyiko and Gem-Rae in Western Kenya, and Kipini, Malindi, Shimoni and Venga at the coastal region (Atera *et al*., 2018). Average yield of each rice ecology is also shown in Fig. 3.

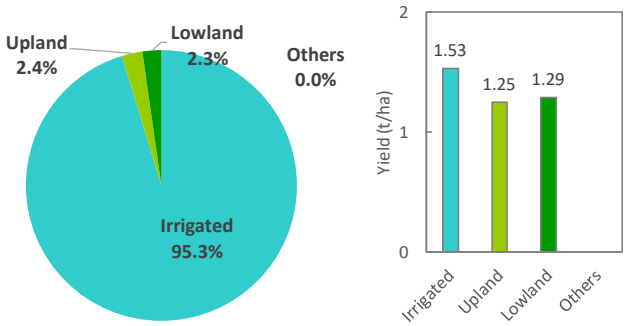

Fig. 3. Percentage of rice ecologies and their average yield.
Source: Made by JICA Survey Team based on Diagne, *et al*. (2013).

Table 3 shows the rice production in major NIA irrigation schemes. The Mwea irrigation scheme produces about 77% of rice produced under irrigation schemes in 2015. The rice production in Mwea irrigation scheme has been increasing, and currently it is 113,000 t (National Irrigation Authority, browsed on April 2, 2021). The Mwea irrigation scheme covers an area of 9,000 ha, with a potential for 4,000 ha expansion (Emongór *et al*., 2009; Ndiiri *et al.,* 2017). Most of rice produced by farmers in irrigation schemes is for sale (Cheserek *et al*., 2012). In some limited portion of the field or during off-season, farmers produce high-yielding variety, such as BW 196, for self-consumption.

Table 3. Rice production (t) in major irrigation schemes in Kenya.

Scheme	2013	2014	2015
Mwea	64,672	70,416	91,624
Ahero	8,326	7,405	7,942
West Kano	5,165	4,345	4,660
Bunyala	4,278	4,289	4,600
South west Kano	8,262	9,574	10,268
Total	**90,703**	**96,029**	**119,094**

Source: Atera, *et al*. (2018), Kenya Bureau of Statistics (2016).

Figure 4 shows the current cropping season and proposed double cropping system. According to the report of Samejima *et al*. (2020) which examined various cropping time for Basmati 370 in Mwea, planting in March and June is not recommended due to cold stress in a highland. Since sowing between October and February is a possible alternative, double cropping by adding a cultivation from January/February to the current cultivation can be an alternative way to increase the productivity per area (Samejima *et al*., 2020).

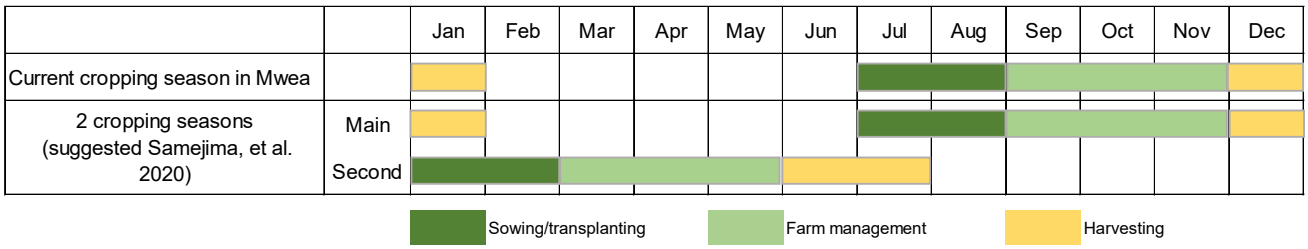

Fig. 4. Rice cropping season: Current cropping season and suggested cropping season with two cultivations a year.

Source: Made by JICA Survey Team based on Samejima *et al.,* 2020.

(2) Imported rice

Table 4 shows the quantity and values of imported rice. The imported rice was mainly from Pakistan, followed by Thailand and Korea. Rice from Pakistan has share of 64%, and is known as "Pakistani" (Long grain IRRI 6). Unit value of rice from Pakistan (387 USD/t) is reported much lower than rice from Thailand (432 USD/t) and Korea (474 USD/t). According to Table 4, the tariff of 35.5% was applied equally to all countries except EAC (East African Community) member countries, e.g. Tanzania.

Table 4. Information about imported rice (Total quantity of milled rice, husked rice, broken rice, etc. in 2019).

	Quantity imported (t)	Share in quantity (%)	Value imported (1000 USD)	Unit value (USD/t)	Growth in imported quantity between 2015-2019 (%, p.a.)	Average tariff (estimated) applied by Kenya (%)
Total	**608,136**		**245,283**	**403**	**8**	
Pakistan	406,804	64.1	157,305	387	-3	35.5
Thailand	151,432	26.7	65,454	432	76	35.5
Korea	20,000	3.9	9,479	474	741	35.5
India	12,508	2.5	6,186	495	30	35.5
China	9,357	1.6	3,877	414	202	35.5
Myanmar	5,150	0.8	1,842	358		35.5
Tanzania	2,006	0.3	659	329	-5	0
Viet Nam	574	0.1	279	486	-50	35.5
Cambodia	150	0.0	68	453	17	35.5
Italy	43	0.0	47	1093	26	35.5

Source: ITC: International Trade Center, Trade Map - List of supplying markets for the product imported by Kenya in 2019, browsed March 23, 2021.

Table 5 shows the prices at Mombasa with different ratio of broken rice from Pakistan. The Pakistani rice with 15% of broken rice is most preferred by importers of Kenya (HAS Rice, 2021).

Table 5. CNF price of "Pakistani" rice with different ratio of broken rice.

Broken rice %	CNF price at Mombasa (USD/t)
5	510
10	506
15	503
25	495

Source: HAS Rice, 2021.

2.4 Marketing

(1) Market structure

Figure 5 shows the simplified rice value chain of local rice. Paddy rice from small, medium and large-scale farmers is collected by paddy collectors or taken directly by farmers to the mills. The milled rice is distributed by traders or

in some few cases sold directly to markets or consumers by millers (Ndirangu and Oyange, 2019). For rice milling and processing, there are various rice mills spread across the country with varying capacities between 1 and 3.5 t/hr. Majority of these mills are located within the Mwea irrigation scheme (Morara and Mecheo, 2020).

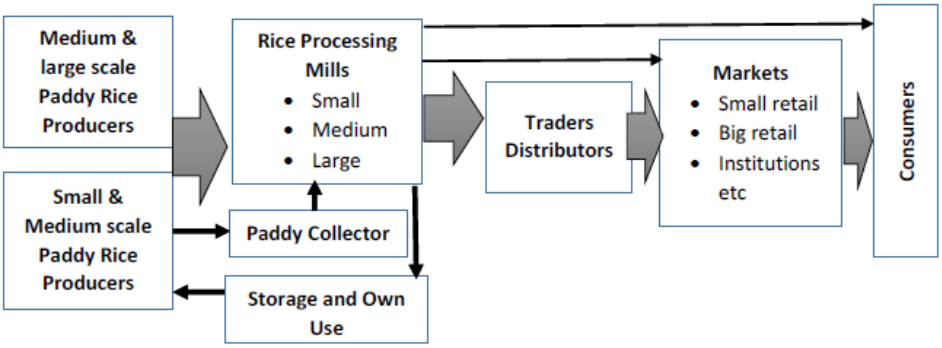

Fig. 5. Simplified rice value chain for Kenya.

Source: Ndirangu and Oyange, 2019.

(2) Market path of local rice and imported rice

Main markets, port, and producing areas are indicated in Fig. 6. Kenya's biggest seaport is Mombasa (484 km from Nairobi). Five most populated cities are Nairobi, Mombasa, Kisumu, Nakuru and Eldoret. Mwea irrigation scheme (Kirinyaga County) and Ahero irrigation scheme (Kisumu County) are the largest rice producing schemes.

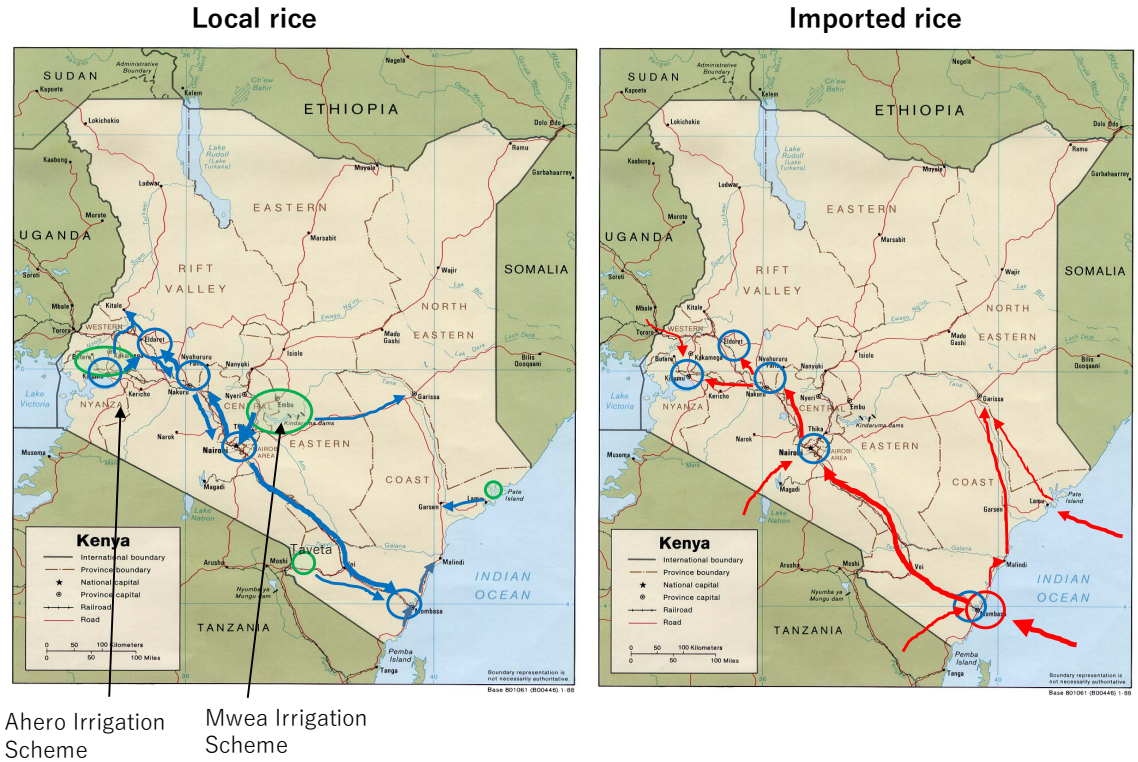

Fig. 6. Main marketing path of local rice and imported rice.

Source: The flows were drawn by JICA Survey Team.

2.5 Price comparison in the market

Price comparison between local rice and imported rice at wholesale market or retail shops are not easy without on-site survey. The followings describe some information about price of local rice.

The home page of RATIN (Regional Agricultural Trade Intelligence Network) provides updated market price, and the price on March 26, 2021 is shown in Table 6. It is price as of "rice" (not defined local or imported). The retail price is about 7-9 % higher than wholesale price in both Mombasa and Nairobi.

Table 6. Rice price in Mombasa and Nairobi (Ksh/kg) on March 26, 2021.

	Mombasa	Nairobi
Wholesale	110	140
Retail	130	150

Source: Modified by JICA Survey Team based on GIEWS FPMA Tool, FPMA Tool (fao.org).

According to an example of the report of Ndirangu and Oyange (2019), through the supply chain 76% of the farm-gate price was added, and 58 Ksh/kg of milled rice became 102 Ksh/kg at the end of supply chain (Fig. 7).

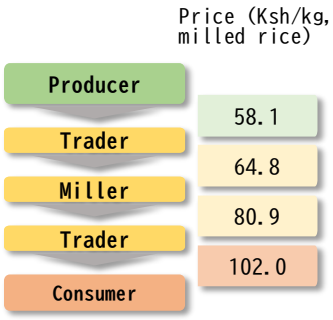

Fig. 7. Price change through the supply chain.
Source: Made by JICA Survey Team based on the information in Ndirangu and Oyange, 2019.

According to the Betta Grains home page (browsed on March 18, 2021), retail price of Kenya Pishori is presently 168,000 Ksh/t and its wholesale price is 158,000 Ksh/t. Sindano (or called Biriyani rice), an imported non-aromatic rice which is popular among the budget conscious households, has retail price of 104,000 Ksh/t and wholesale price of 98,000 Ksh/t. Super Basmati Parboil, an imported rice from Pakistan is 150,000 Ksh/t at retails and 144,000 Ksh/t at wholesale. Pishori rice has the highest price at both retails and wholesale market.

3. Competitiveness analysis

3.1 Production cost of local rice for DRC ratio analysis

For DRC ratio analysis to evaluate the competitiveness of the local rice, seven cases of production conditions were compared. They were;

Case I: Large-scale irrigation (Mwea irrigation scheme)

Case II: SRI farm in Mwea irrigation scheme

Case III: FP farm in Mwea irrigation scheme

Case IV: Large-scale irrigation (Ahero irrigation scheme)

Case V: Rain-fed farm in out-growers area of Ahero scheme

Case VI: Small-scale irrigation (Awach scheme)

Case VII: Small-scale irrigation (Gem-Rae scheme)

Case I is based on Handbook on paddy rice production in Mwea (2021) (Table 7). Case II and III are from the survey reports of Ndiiri *et al.* (2013) which compared different cultivation methods, i.e. SRI (system of rice intensification) method and FP (conventional farmers' practice) (Table 8). They were from 40 famers survey. All information of Case I – III were about Mwea irrigation scheme. The rice variety was Basmati 370 in all these three cases.

Production costs of Case IV – VII are based on Yamane *et al.* (2019) which reported the results of survey in

2011/2012 season (Table 9). Case IV is in the Ahero irrigation scheme, one of the largest NIA schemes after Mwea, Case V is in out-growers area (Masune) of Ahero irrigation scheme, without irrigation infrastructure in the area. Some farmers make ditches for themselves and draw water from the primary canal, but mostly rain-fed. Case VI and VII are the farmers in the small-scale irrigation (< 300 ha) in Awach and Gem-Rae. The schemes of Case VI and VII are managed by farmers' association, not by NIA.

Total cost which is the sum of production cost and irrigation development cost was much higher in Mwea than in other irrigated areas. The total cost per area was between 320,000 and 340,000 Ksh/ha in Mwea irrigation scheme (Case I-III), while, 140,000 and 190,000 Ksh/ha in Case IV, VI and VII. Case V without any irrigation development cost had about 100,000 Ksh/ha. However, because the yield in Mwea irrigation scheme was higher (5.3- 7.1 t/ha), the total cost per kg of milled rice was about the same level under irrigation. Actually the total cost in Case VII (Gem-Rae) had the highest cost per milled rice (104 Ksh/kg of milled rice), due to the low yield (2.2 t/ha).

In Mwea case, Case I requires high inputs of fertilizer and agro-chemicals. Case II with SRI[3] farming method can save some input cost, such as seed, fertilizer and herbicide with appropriate crop management, and resulted in lower total cost. When the proportion of each item was estimated, the irrigation development cost accounts for 50% of the total cost (Table 7).

[3] System of rice intensification.

Table 7. Production costs (recommended) (Ksh/ha) in Mwea irrigation scheme (Case I).

Items	Case I Large scale irrigation (Mwea irrigation scheme) Var: Basmati 370 (Nibam 11) Yield (t/ha): 6.20 Unit value (Ksh)	Unit	Qty/ha	Cost (Ksh/ha)	%
Production cost					
Labor	316	man-day	239.6	75,829	22.3
Certified seeds	115	kg	37.1	4,261	1.3
Manure	600	Ox cart	9.9	5,928	1.7
Rotovation	3,500	acre	2.5	8,645	2.5
Levelling	1,000	No. of times	4.9	4,940	1.5
Fungicides for the nursery	150	package (150 mL)	2.5	371	0.1
Insecticides for the nursery	150	package (150 mL)	2.5	371	0.1
Basal fertilizer	3,500	50 kg (1 bag)	2.5	8,645	2.5
Basal MOP	2,800	bag	2.5	6,916	2.0
Insecticide	250	package (250 mL)	2.5	618	0.2
Fungicides	250	package (250 mL)	2.5	618	0.2
Weeding: Herbicide application	1,000	L	2.5	2,470	0.7
Follar application	500	L	1.2	618	0.2
1st top dressing with SA	2,100	bag	4.9	10,374	3.1
2nd top dressing with SA	2,100	bag	2.5	5,187	1.5
Harvesting (combine harvester)	6,000	acre	2.5	14,820	4.4
Gunny bags	50	No.	61.8	3,088	0.9
Transport	180	bag	61.8	11,115	3.3
Capital interest [a]				7,979	2.4
Total production cost (Ksh/ha)				**172,790**	
Total production cost (Ksh/kg, milled rice) [b]				**42.88**	
Irrigation development [c]					
Construction				83,352	24.6
O & M				83,352	24.6
Total irrigation development (Ksh/ha)				**166,704**	
Total irrigation development (Ksh/kg, milled rice)				**41.37**	
Total cost (Ksh/ha)				**339,495**	
Total cost (Ksh/kg, milled rice)				**84.24**	

Source: Handbook on paddy rice production in Mwea (2021)
a) Capital interest was estimated for the expenses on material inputs and 40% of labor inputs by applying 10% of annual interest rate.
b) Conversion rate from paddy grain to milled rice of 0.65 (Kikuchi, *et al*., 2016) was adopted.
c) Irrigation development cost: The unit cost of hard ware part was calculated as [Mwea project cost in 1968 (3,925,000 USD) from Kikuchi *et al.* (2020) x 0.72 (the ratio of hard ware cost/total project cost from Inocencio *et al.*, 2007) /total area (3,192 ha)]. And then it was converted to the year of production cost data by GDP deflator, and multiplied by 0.01, assuming the interest rate is 10%. This is applied to both annual construction cost and O & M cost.

Table 8. Production costs (Ksh/ha) under SRI and FP in Mwea irrigation scheme (Case II and III). The surveyed result of 2011/2012 season.

	Case II	Case III
	SRI [a]	FP [a]
Yied (t/ha)	7.1	5.3
Production cost		
Seed	790	5,545
Labor [b]	38,285	40,088
Land preparation	11,406	11,609
Fertilizer	18,303	24,075
Insecticide	1,010	1,625
Herbicide	432	1,230
Manure	3,038	0
Transport	6,513	5,145
Land rent	98,800	98,800
Other costs [c]	4,318	3,357
Capital interest [d]	4,321	5,187
Total production cost (Ksh/ha)	**187,217**	**196,661**
Total production cost (Ksh/kg, milled rice) [e]	**40.57**	**57.09**
Irrigation development [f]		
Construction	68,762	68,762
Operation and maintenance	68,762	68,762
Total lirrigation development (Ksh/ha)	**137,524**	**137,524**
Total lirrigation development (Ksh/kg, milled rice)	**29.80**	**39.92**
Total cost (Ksh/ha)	**324,741**	**334,186**
Total cost (Ksh/kg, milled rice)	**70.37**	**97.01**

Source: Modified by JICA Survey Team based on Ndiiri *et al*., 2013.
a) SRI: system of rice intensification, FP: farmer practices
b) Labor costs include nursery and land preparation weeding, harvesting, packaging and transporting from the farm to the store.
c) Other cost is assumed such as sacks, farm tools, etc.
d) Capital interest was estimated for the expenses on material inputs and 40% of labor inputs by applying 10% of annual interest rate.
e) Conversion rate from paddy grain to milled rice is assumed as 0.65 (Kikuchi *et al.*, 2016)
f) Irrigation development cost: The unit cost of hard ware part was calculated as [Mwea project cost in 1968 (3,925,000 USD) from Kikuchi *et al.* (2020) x 0.72 (the ratio of hard ware cost/total project cost from Inocencio *et al.*, 2007) /total area (3,192 ha)]. And then it was converted to the year of production cost data by GDP deflator, and multiplied by 0.01, assuming the interest rate is 10%. This is applied to both annual construction cost and O & M cost.

Table 9. Production costs (Ksh/ha) in Ahero irrigation scheme, out-growers, and in small irrigation schemes (Case IV - VII). The surveyed result of 2011/2012 season.

	Case IV	Case V	Case VI	Case VII
	Ahero irrigation scheme	Farmers in outgrowing area of Ahero scheme (Masune)	Awach	Gem-Rae
	Large-scale Irrigated scheme (NIB)	Rain-fed	Small-scale irrigation	Small-scale irrigation
Management	NIB		Farmers' Association	Farmers' Association
Area	877 ha	250 ha	200 ha	120 ha
No. of farmers	560 farmers	400 farmers	400 farmers	500 farmers
Main variety	IR [a]	IR, BR	IR, Basmati	IR, ITA
Average yield (t/ha)	**4.25**	**3.71**	**2.72**	**2.20**
Production cost				
Land rent	2,057	2,712	4,378	2,723
Labor [b]	66,362	89,346	74,909	78,791
Seed	2,590	4,436	2,240	3,173
Water management fee	3,588	49	431	145
Chemicals	2,026	434	500	1,305
Herbicide	72	32	13	50
Fertilizer	9,781	4,254	2,298	3,098
Manure	336	356	195	111
Compost	32	190	0	9
Sack	2,020	1,850	1,350	1,100
Capital interest [c]	4,340	4,729	3,656	4,036
Total production cost (Ksh/ha)	**93,205**	**108,387**	**89,970**	**94,541**
Total production cost (Ksh/kg, milled rice) [d]	**33.75**	**44.99**	**50.85**	**66.11**
Irrigation development [e]				
Construction	48,074		26,906	26,906
O & M	48,074		26,906	26,906
Total production cost (Ksh/ha)	**96,148**		**53,812**	**53,812**
Total production cost (Ksh/kg milled rice)	**34.82**		**30.42**	**37.63**
Total (Ksh/ha)	**189,352**	**108,387**	**143,782**	**148,353**
Total (Ksh/kg, milled rice)	**68.57**	**44.99**	**81.27**	**103.74**

Source: Modified by JICA Survey Team based on Yamane *et al*., 2019.
a) The main variety in Ahero irrigation schem is IR 2973-80-1.
b) Assumed the total labor cost is twice as much as hired cost. Therfore, the original cost for hired labor was doubled.
c) Capital interest was estimated for the expenses on material inputs and 40% of labor inputs by applying 10% of annual interest rate.
d) Conversion rate from paddy grain to milled rice is assumed as 0.65 (Kikuchi *et al.*, 2016)
e) Irrigation development cost: Case IV (Large-scale irrigation scheme): The unit hardware cost of 'success' projects in sub-Saharan region (3,552 USD/ha in 2000 price) from Inocencio *et al*., (2007) was converted to the year of production cost data by GDP deflator, and multiplied by 0.01, assuming the interest rate is 10%. This is applied to both annual construction cost and O & M cost. Case VI, VII (Small-scale irrigation scheme): The unit hard ware cost of small irrigation schemes were calculated with the conversion from [the average price in 2000, of small-scale irrigation projects in Uganda (Fujiie *et al*., 2011) x 0.725 (the ratio of hard ware cost/total project cost (Inocencio *et al.*, 2007))], and multiplied by 0.01, assuming the interest rate is 10%. This is applied to both annual construction cost and O & M cost of Case VI and VII.

3.2 Marketing cost for DRC ratio analysis

Table 10 and Table 11 show the marketing costs of local rice and imported rice. Table 10 is the cost from farm gate to Nairobi and milling cost. Table 11 is the cost from Mombasa port to Nairobi wholesale market (about 440 km away from each other).

Table 10. Post-harvest cost for local rice (2010).

Item	Cost (Ksh/t, paddy)
Unloading	246.3
Loading	205.0
Drying	281.3
Milling	2,000.0
Storage fee	143.8
Watchmen	67.5
Licensing fee	15.0
Electricity	3.8
Transport to mill	750.0
Transport to Nairobi	2,875.0
Total (Ksh/t, paddy)	**6,587.5**
Total (Ksh/kg, milled) [a]	**10.13**

Source: Modified by JICA Survey Team based on Gitau *et al*., 2011, FAO, 2012.
a) Conversion rate from paddy grain to milled rice of 0.65 was adopted (Kikuchi *et al.*, 2016)

Table 11. marketing cost for import rice (2010).

Item	Cost (Ksh/t, milled)
KPA [a] handling charges	2,240
KARI [b] (1% C&F)	395
Min. of Health (0.2% C&F)	79
Transport to warehouse	240
Storage and handling charges	120
Fumigation charges	120
Transport to Nairobi	2,640
Total cost (Ksh/t, milled)	**5,834**
Total cost (Ksh/kg, milled)	**5.83**

Source: Modified by JICA Survey Team based on Gitau *et al*., 2011.
a) KPA: Kenya Port Authority
b) KARI: Kenya Agricultural Research Institute whose present name is Kenya Agriculture and Livestock Research Organization

3.3 Competitiveness analysis by DRC ratio

(1) Results of 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 12 shows the results of the DRC analysis. It also shows the DRC ratio without irrigation construction cost and O&M cost. The data source of production costs, irrigation costs, marketing costs for local rice and marketing cost for imported rice are shown in Table 7 - Table 11. As shown in these tables, cost information are from different sources and from different years. The main variety for Case I, II and III (Mwea irrigation scheme) is Basmati 370, and that of Case IV and V (Ahero irrigation scheme) is IR 2973-81-1. Farmers in Case VI and VII (Awach and Gem-Rae irrigation scheme) are producing Basmati 370, IR 2973-81-1 and ITA series. The imported rice is mainly from Pakistan (64% share in 2019) and from Thailand (27%) (Table 3), and its marketing cost and CIF price of rice from Pakistan were used for the analysis. The detailed calculation results of the DRC ratio are shown in the attached table (after the reference list).

When calculated including costs of construction and management of irrigation infrastructure, all the DRC ratio, even under small-scale irrigation scheme (Case VI, VII) were higher than 2.0 (Table 12). This high DRC ratio under the small-scale irrigation scheme is due to the relatively low yield (2.2-2.7 t/ha). Case I under Mwea irrigation scheme had very high DRC ratio (8.31) although the yield was high (6.2 t/ha). According to the Handbook which is the source of the production cost information, it is recommended to practice quite intensive usage of agro-inputs. The harvest is operated by the combine harvester. Since these inputs and machinery are mainly imported ones, this agricultural practice adopted in Mwea makes the DRC ratio higher by lowering the domestic resource component ratio in its rice production costs. The import ratio of, for example, NPK fertilizer is about 100% (World data atlas). The agricultural

machinery depends on import which has been growing rapidly in last 10 years by 34 % (World data atlas).

When calculated excluding costs of construction and management of irrigation infrastructure, all the DRC ratios become lower than 2.0 (Table 12). The ratio under the Ahero irrigation scheme (Case IV) becomes lower than 1.0. This means that irrigated rice cultivation by large-scale irrigation scheme which is the majority among all the rice cultivation ecologies is competitive when the cost of irrigation development is treated as a sunk cost. This can suggest that, in Kenya, if the existing large-scale irrigation scheme can be managed well for longer time, instead of starting the new construction of irrigation facility, the local rice, such as Basmati 370 and IR 2973-81-1, have reasonable competitiveness against the imported rice. The IR variety of IR 2973-81-1 in Ahero irrigation scheme had higher competitiveness than Basmati 370 in Mwea irrigation scheme, according to the information obtained.

If double cropping becomes possible, the competitiveness of local rice production could be increased. Double cropping has been examined by some projects (Fig. 4). Although the cold temperature in high plateau can be the limiting factor in Mwea and Ahero irrigation schemes, DRC ratio with double cropping is estimated with Case IV (Ahero irrigation scheme) as the DRC ratio is lower than Case I and III (Mwea). The elevation of Mwea and Ahero scheme are about the same with 1,100-1,200 and 1,133 m, respectively. When it is assumed that the yield in the second season is equivalent with the same level of farm inputs, the DRC ratio of Case IV changes to 1.60 from 2.70 by adopting half the cost of irrigation development for the calculation. This indicates the advantage of double cropping in increasing the competitiveness.

In case of rain-fed condition in Ahero scheme out-growers' area, local rice (IR 2973-81-1) had relatively high competitiveness with DRC ratio of 1.28. They had moderately high yield (3.71 t/ha), probably because of the appropriate farm management with proper inputs influenced by the scheme.

The DRC ratios under small irrigation scheme of Awach and Gem-Rae (Case VI and VII) were similar or higher than those of Ahero scheme (Case IV and V). One of the main reasons is relatively low yield in Awach and Gem-Rae which is possibly due to lack of proper weeding practice, low usage of certified seeds, and inappropriate fertilizer usage (Yamane *et al*., 2019).

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 12. Result of DRC analysis.

Case	Production condition/area	Yield (t/ha)	DRC ratio (DRC without irrigation cost [a])
I	Large-scale irrigation (Mwea irrigation scheme)	6.20	8.31 (1.33)
II	SRI farm in Mwea irrigation scheme	7.10	2.86 (1.18)
III	FP farm in Mwea irrigation scheme	5.30	6.40 (1.80)
IV	Large-scale irrigation (Ahero irrigation scheme)	4.25	2.70 (0.96)
V	Rain-fed farm in out-growers area of Ahero scheme	3.71	1.28
VI	Small-scale irrigation (Awach)	2.72	2.56 (1.44)
VII	Small-scale irrigation (Gem-Rae)	2.20	3.55 (1.90)

a) Irrigation infrastructure cost is the sum of construction cost and O&M cost (10% of the infrastructure unit cost). The detail information is shown in the foot note of Table 8 and 9.

(2) Sensitivity analysis

Sensitivity analysis was conducted for Case I, III, VI, and VII without irrigation infrastructure costs. Table 13 shows the possible approaches to lower its DRC ratio and increase the competitiveness.

Case I: A Handbook on paddy rice production in Mwea irrigation scheme recommends intensive application of fungicide, insecticide and herbicide. If quantities of these agro-chemical application is reduced by practicing IPM (integrated pest management), and labor intensity can be reduced to the Case III level, the DRC ratio could be reduced to 0.97 and increase the competitiveness of locally produced Basmati 370.

Case III: Basically, if SRI cultivation method is adopted as Case II, the DRC ratio would be improved. Specifically, as shown in Table 13, reducing agro-chemicals to SRI level, and increase the yield by 20% by applying the intensive management as SRI method, the DRC ratio could be reduced to 1.36. In this sensitivity analysis the labor cost is also reduced as the spraying agro-chemicals was reduced.

Case VI and VII: By increasing yield to 3.7 t/ha which is the same level as Case V, the DRC ratio become lower and close to 1.0. As mentioned above, appropriate weeding, purchasing certified seeds, proper fertilizer application, and lower the labor intensity could improve the productivity.

Table 13. Result of sensitivity analyses for DRC ratio.

	Possible approach to increase the competitiveness	Effect (change of DRC ratio)
Case I	Reduce application quantity of agro-chemicals by 40% by applying IPM system, and reduce labor intensity by 40% (to the level of Case III).	1.33 → 0.97
Case III	(1) Reduce insecticide application to SRI practice level. (2) Reduce herbicide application to SRI practice level. (3) Increase yield from 5.3 to 6.4 t/ha by 20%.	1.80 → 1.36
Case VI	Increase yield from 2.72 to 3.7 t/ha (same level as Case V)	1.44 → 1.06
Case VII	Increase yield from 2.20 to 3.7 t/ha (same level as Case V)	1.90 → 1.12

4. Related policy

4.1 Policy measure to stimulate consumption of local rice

The government has prioritized rice production in “Big Four” food security agenda, and more resources are expected to be directed towards farmer support programs (The Executive Office of the President, 2021). The programmes and projects for rice sector had implemented in the Second Medium Term Plan (MTP II) and will be planned in the third Medium Term Plan (Table 14) (MTP III) (Government of the Republic of Kenya, 2018).

Table 14. Implemented programmes in MTP II 2013-2017 and planned programmes M TP III 2018-2022.

Programmes in MTP II 2013-2017
Accelerated Agricultural Inputs Access Programme: ・purchased A total of 70 MT of seed and five rice mills to promote small scale farmers production. ・150 extension officers were trained and entrepreneur' training sessions for farmer's groups were held. ・Tractors, combine harvesters, reapers and threshers were distributed to rice farmers' organizations. Kenya Cereal Enhancement Programme: ・The scheme was operated in partnership with Equity Bank and agro-dealers under PPP arrangement. ・A total of 23,622 farmers accessed agricultural inputs through the e-voucher. Strategic Food Reserve Trust Fund: ・To facilitate the stocking of critical foodstuffs such as rice and others.
Programmes in MTP III 2018-2022
Agricultural Mechanization Programme: ・Involving strengthening adoption of agricultural mechanization by supporting counties to provide affordable agricultural mechanization services to small scale farmers. ・600 tractors and 3,000 walking tractors will be sourced and sold at subsidized rates to SMEs. ・Development of Agricultural Development Corporation (ADC) farms will be retailed including increasing land for crop production in ADC; distribution of tractor implements and other machinery. Food and Nutrition Security: ・To focus on new and innovative initiatives by supporting enhanced large scale production, smallholder productivity, agro-processing, and reduction in food prices. ・Increased production through expansion of production areas enhanced access to quality inputs (seed and fertilizer), irrigation, mechanization, and post-harvest management. ・Developing nutrition sensitive indicators for use in agriculture.

In 2020, the Kenya National Trading Corporation announced a program to support producer prices by increasing the prevailing price of rough rice from Ksh 45/kg ($0.19/lb) to Ksh 85/kg ($0.37/lb), and rough rice will be milled and supplied to local schools and colleges at a discounted price (USDA, 2021).

Since 2015, Kenya has been allowed to reduce its rice tariff from non-East African Community countries because of limited local production. The current common external tariff on rice that is charged by all East African Community (EAC) countries, except Kenya, is 75 % ad-valorem or $345 per MT (whichever is higher). Rice exports to Kenya from outside EAC are charged a 35 % ad valorem tariff, or $200 per MT (whichever is higher), and that from other EAC countries enter duty-free (USDA, 2021).

4.2 Quality standards and status of the application

East African Standards are established by the East African Standards Committee, and the Partner States shall adopt the East African Standard as a national standard (East African Community, 2011). On the other hand, Kenya Bureau of Standards published specifications for rice as below; brown rice (KS EAS 765: 2013), milled rice (KS EAS 128:2017), variety blend milled rice (KS 2086:2009), Kenya Pishori milled rice (KS 2087:2009). In case of blended rice with more than two varieties, the listed varieties must account for at least 25% of the total amount. There have been cases of a malpractice of blending rice of inferior quality with a limited proportion of Kenya Pishori and selling it as Pure Kenya Pishori. The Kenya Pishori, specification indicates that the varieties shall be NIBAM 10, NIBAM 11, and domestically produced in Kenya. The name "NIBAM" is the registered name for Basmati varieties in Kenya.

The Table 15 compares rice grading requirements of EAS (left) and Kenya (right) specification. The requirement of EAS has stricter limits in broken rate. Specification for Kenya brown rice and milled rice are not available for free

on website. East African standards and Kenya standards are shown the rule of labeling that each package shall be legibly and indelibly marked with the grading and others.

Table 15. Comparison of rice standard requirements between EAS and Kenya specification.

East African Standard -milled rice (EAS 128:2011)					Kenya Varieties blend milled rice — Specification (DKS 2086: 2020)					
Characteristics	Maximum limits			Test method	Grading factor	Grade requirement/limits				Test method EAS 901
	Grade 1	Grade 2	Grade 3			Premium	Grade 1	Grade 2	Grade 3	
Moisture contents, %	13	13	13	EAS 82/ ISO 712	Moisture content %, m/m, max.	14				Clause 5
Broken, %	5	7	15	ISO 605	Broken %, m/m, max.	5	15	25	35	Clause 4
Heat damaged rice, %	1	1.5	2							
Damaged rice, %	1.5	2	3		Damaged grains %, m/m, max	1	2 1.5	3 2	4 3	Clause 4
Chalky %	2	4	10		Chalky/green immature grains %, m/m, max.	1	3	5	10	Clause 4
immature grains, %	1	1.5	2							
Red or red streaked, %	2	6	12		Red or red streaked %, m/m, max.	2	2	6	12	Clause 4
Organic matter, %	0.1	0.2	0.5							
Inorganic matter, %	0.1	0.1	0.1		Inorganic matter % m/m	0.1				Clause 4
Paddy grains, %	0.3	0.3	0.3		Paddy (grains per 1 000), by count, (or % m/m), max.	3 (0.03)	0.3			Clause 4
Live weevils/kg	Nil	Nil	Nil							
Filth, %	0.1	0.1	0.1		Filth%m/m	0.1				
Other contrasting varieties, %	1	2	3							
					Foreign and extraneous matter, %, m/m, max.	Nil	Nil 0.2	0.5 0.3	0.75 0.6	Clause 4
Total Aflatoxin (AFB1+AFB2+AFG1 +AFG2)), ppb	10			ISO 16050						
Aflatoxin B1 only, ppb	5									
Fumonisin ppm	2									

Source: Made by JICA Survey Team based on East African Community, 2011 and Kenya Bureau of Standards, 2020.

In terms of price, rice retail prices reflect demand and supply trends and vary between rice types (aromatic or nonaromatic) (USDA, 2019). The price is low in the harvest season from December to March and is high during the lean season from July to October (JICA, 2011). Kenyans prefer aromatic rice varieties and aromatic rice fetching a higher price (USDA, 2019). Kakuta (2018) also reported that Pishori rice (aromatic) is sold with more than 50% higher price than general Indica rice and imported rice. However, the reflected price by grading based on specification is not founded in any documents.

Although the standards have been set, there are still challenges for each stakeholder involved in their adaptation.

5. Main issues and suggestions

In Kenya, demand of rice has been drastically increasing in recent years, and now rice is one of the most important staple foods after maize and wheat. About 70 to 80% of rice is produced in the large-scale irrigation schemes, but the self-sufficiency rate is still low and only 11%. The local rice is evaluated well with reasonable price (not always more expensive than the imported rice) and good quality, according to our consumers' survey. The most popular brand is 'Kenya Pishori' which is one of the high standard rice brands, and mainly produced in Mwea irrigation scheme.

Results of DRC ratio analysis suggested that the irrigated rice cultivation, which accounts for 95% of local rice production in Kenya, does not have a comparative advantage to imported rice when the irrigation development cost was included in the analysis, both under large-scale irrigation scheme and small-scale irrigation scheme. When the

cost of irrigation infrastructure is treated as a sunk cost or when double cropping is considered, the local rice become a competitive level, especially under SRI farming system. This is to indicate that options to increase the competitiveness are to maintain the existing large-scale irrigation scheme instead of starting the new construction of irrigation facility, to establish the double cropping system of rice, and to disseminate the SRI farming method. To minimize agro-chemical application rate by introducing IPM was also suggested to increase the competitiveness.

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Attached Table: Calculation and results of DRC ratio analysis

With irrigation infrastructure cost

		LOCAL PRODUCTION											IMPORT			DRC CALCULATION		
			Production cost				Irrigation cost		Marketing cost		Total		Border price	Marketing cost		Total cost		DRC ratio
		Paddy yield	Total	Total	Production				Farm-gate to market					Border to market				
			(/ha)	(/kg mille	Tradable	Domestic	Tradable	Domestic	Tradable	Domestic	Tradable	Domestic	(CIF price of 39.47 Ksh/kg) [a]	Tradable	Domestic	Tradable	Domestic	
Area	Production conditions										$Sa_i P_i SER$ (①)	$Sb_j P_j$ (②)	$P_w SER$ (③)	$S_k c_k P_k SER$ (④)	$S_m d_m P_m$ (⑤)	$A = ① - ④$	$B = ② - ⑤$	$B / (③ - A)$
		t/ha	Ksh/ha	Ksh/kg of milled rice														
Mwea Irrigation scheme	Case I: Large-scale irrigation (Mwea irrigation scheme)	6.20	172,790	42.88	14.11	28.76	16.55	24.82	3.68	6.45	34.34	60.04	39.47	1.58	4.25	32.76	55.79	**8.31**
	Case II: SRI farm in Mwea irrigation scheme	7.10	187,217	40.57	6.54	34.03	11.92	17.88	3.68	6.45	22.14	58.36	39.47	1.58	4.25	20.56	54.11	**2.86**
	Case III: FP farm in Mwea irrigation scheme	5.30	196,661	57.09	9.94	47.14	15.97	23.95	3.68	6.45	29.59	77.55	39.47	1.58	4.25	28.01	73.30	**6.40**
Western Kenya near Lake Victoria	Case IV: Large-scale irrigation (Ahero irrigation scheme)	4.25	93,205	33.75	3.77	29.98	13.93	20.89	3.68	6.45	21.38	57.32	39.47	1.58	4.25	19.80	53.07	**2.70**
	Case V: Rain-fed farm in out-growers area of Ahero scheı	3.71	108,387	44.99	2.05	42.94	0.00	0.00	3.68	6.45	5.73	49.39	39.47	1.58	4.25	4.14	45.14	**1.28**
	Case: VI: Small-scale irrigation (Awach)	2.72	89,970	50.85	1.76	49.09	6.08	24.33	3.68	6.45	11.53	79.87	39.47	1.58	4.25	9.95	75.63	**2.56**
	Case: VII: Small-scale irrigation (Gem-Rae)	2.20	94,541	66.11	2.91	63.20	7.53	30.10	3.68	6.45	14.12	99.76	39.47	1.58	4.25	12.54	95.51	**3.55**

Without irrigation infrastructure cost

		LOCAL PRODUCTION											IMPORT			DRC CALCULATION		
			Production cost				Irrigation cost		Marketing cost		Total		Border price	Marketing cost		Total cost		DRC ratio
		Paddy yield	Total	Total	Production				Farm-gate to market					Border to market				
			(/ha)	(/kg mille	Tradable	Domestic	Tradable	Domestic	Tradable	Domestic	Tradable	Domestic	(CIF price of 39.47 Ksh/kg) [a]	Tradable	Domestic	Tradable	Domestic	
Area	Production conditions										$Sa_i P_i SER$ (①)	$Sb_j P_j$ (②)	$P_w SER$ (③)	$S_k c_k P_k SER$ (④)	$S_m d_m P_m$ (⑤)	$A = ① - ④$	$B = ② - ⑤$	$B / (③ - A)$
		t/ha	Ksh/ha	Ksh/kg of milled rice														
Mwea Irrigation scheme	Case I: Large-scale irrigation (Mwea irrigation scheme)	6.20	172,790	42.88	14.11	28.76			3.68	6.45	17.79	35.22	39.47	1.58	4.25	16.21	30.97	**1.33**
	Case II: SRI farm in Mwea irrigation scheme	7.10	187,217	40.57	6.54	34.03			3.68	6.45	10.22	40.48	39.47	1.58	4.25	8.64	36.23	**1.18**
	Case III: FP farm in Mwea irrigation scheme	5.30	196,661	57.09	9.94	47.14			3.68	6.45	13.63	53.60	39.47	1.58	4.25	12.04	49.35	**1.80**
Western Kenya near Lake Victoria	Case IV: Large-scale irrigation (Ahero irrigation scheme)	4.25	93,205	33.75	3.77	29.98			3.68	6.45	7.46	36.43	39.47	1.58	4.25	5.87	32.18	**0.96**
	Case V: Rain-fed farm in out-growers area of Ahero scheı	3.71	108,387	44.99	2.05	42.94			3.68	6.45	5.73	49.39	39.47	1.58	4.25	4.14	45.14	**1.28**
	Case: VI: Small-scale irrigation (Awach)	2.72	89,970	50.85	1.76	49.09			3.68	6.45	5.45	55.54	39.47	1.58	4.25	3.86	51.29	**1.44**
	Case: VII: Small-scale irrigation (Gem-Rae)	2.20	94,541	66.11	2.91	63.20			3.68	6.45	6.59	69.65	39.47	1.58	4.25	5.01	65.40	**1.90**

a) CIF price of imported rice from Pakistan (387 USD/t in 2019) (ITC, Trade Map - List of supplying markets for the product imported by Kenya in 2019, browsed March 23, 2021). The exchange rate used to convert is the market exchange rate (101.99 Ksh/USD) in 2019.