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
Mozambique

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 cultivation has been practiced in Mozambique for more than 500 years. Approximately 90% of the rice production is produced by subsistence smallholder farmers with the field size of less than 0.5 ha (Popat *et al.*, 2017).

After 2000 the rice demand drastically increased, by more than 5 times, but not the production quantity (Fig. 1). The production increased between 2007 and 2011, but decreased significantly afterwards, to the level below the potential (Popat *et al.*, 2017). The self-sufficiency rate is as low as 10-16% after 2015, and rice food balance is depending on the imported rice by a large extent.

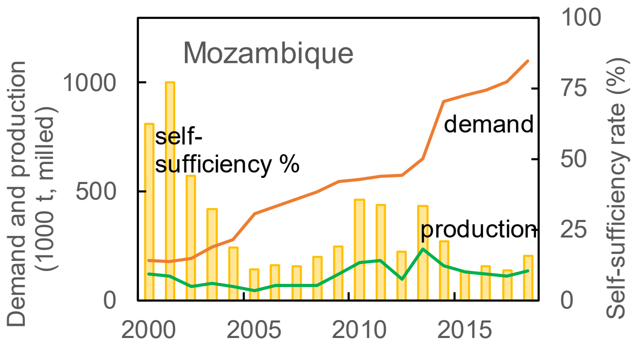


Fig. 1. Rice supply in Mozambique
Source: Made by JICA Survey Team based on data from FAOSTAT, browsed in June, 2021.

2.2 Consumers' preference

Consumers in Mozambique give a high priority to aroma among rice characteristics. The disadvantages of local rice in the market include low availability in some time of the year, poor cleanness and higher price than imported rice in some cases (JICA, 2019). The milling rate of local rice is very low, i.e. about 50%, with 30% of broken grain, which is one of the issues in domestically produced rice (JICA, 2014 a).

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

2.3 Major brands/varieties

(1) Local rice

Mozambique has a great diversity of local genotypes of rice, mostly concentrated in the provinces of Zambezia, Sofala and Nampula. Although breeders of research institutes have been trying to introduce some high-yielding varieties, such as ITAC4 and R64, farmers generally tend to prefer more of grain quality and aroma than productivity since most of the rice is consumed by farmers (JICA, 2014 a; Abade *et al.*, 2016). According to the survey of JICA (2010) in Nante area in Zambezia Province, farmers grow Chupa, Mocuba, ITA312, C4-63, Nene and Limpopo. Among these varieties, Chupa with favorable aroma is most popular, and was produced by 40% of farmers. The JICA project[2] has recommended ITA312, Limpopo and Macassane as early-maturing high-yielding varieties, and Chupa and Mocuba as late-maturing (relatively low-yielding) varieties. Table 1 shows some information of Chupa and Mocuba. The national average yield is very low (0.47 t/ha), however, Kajisa and Payongayong (2013) reported the top 25% of rain-fed farmers' average yield is 2.5 t/ha.

Table 1. Information of major local rice varieties.

Local varieties	Main producing area [a]	Production condition	Yield (t/ha)	Growing period (days)
Chupa	Zambezia	Irrigated	4.1 [b] 3.0-3.5 [a] 4.7 [c]	110 [d]
Mocuba	Zambezia	Irrigated	4.2 [b] 5.4 [c]	103 [d]
Total production and average yield (2019) [e]			0.47	

a) JICA, 2010.
b) JICA, 2019. The yield in the field trial.
c) JICA, 2019. In case seeds were sown in January.
d) Abade *et al*., 2016. The yield was obtained at the Muirrua Research Station, Alto Ligoule District.
e) FAOSTAT (browsed on March 22, 2021)

According to Diagne *et al.* (2013), irrigated rice area and rain-fed lowland rice area occupied about the same at 40% (Fig. 2) (total area = 182,820 ha). However, some other surveys reported that most of the rice production (about 90%) is classified under rain-fed lowland ecology in Mozambique (Kajisa and Payongayong, 2013, NRDP, 2016). Several irrigation systems have been abandoned or damaged without rehabilitation, and only 10% of the total irrigated area is currently used for rice cultivation (NRDP, 2016; IRRI, 2021).

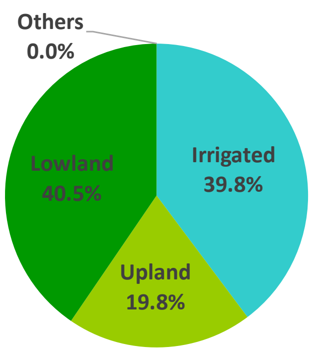


Fig. 2. Area percentage of rice ecologies.
Source: Made by JICA Survey Team based on the study of Diagne, *et al.* (2013).

Rice production in Mozambique is concentrated in 6 geographic areas and confined to the clusters namely: Maputo, Gaza, Sofala, Zambezia, Nampula and Cabo Delgado (Fig. 3). Table 2 shows the harvested area in ratio by each production zone. Zambezia covers about 50% of total rice area in the country.

[2] The project for improvement of techniques for increasing rice cultivation productivity in Nante area, Zambezia province.

Table 2. Rice production zone and area%.

Production zone	Harvested area %
Zambezia	48.8
Sofala	17.7
Nampula	14.0
Cabodel	7.3
Gaza	6.2
Maputo	3.1
Niassa	1.6
Inhambane	1.0
Manica	0.2
Tele	0.1

Source: FAO, http://www.fao.org/3/Y4347E/y4347e17.htm#bm43 (browsed on April 23, 2021 and modified by JICA Survey Team).

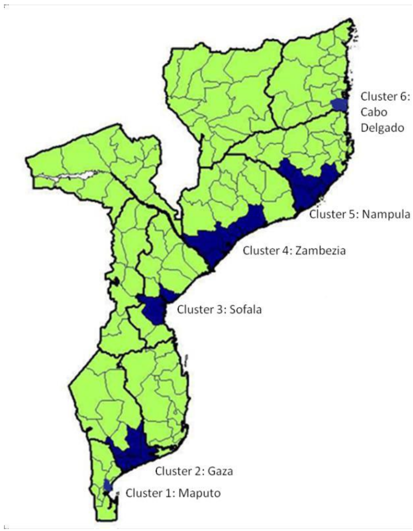


Fig. 3. Six rice producing clusters.
Source: NRDP, 2016.

Figure 4 shows the major planting and harvesting time in Mozambique. According to the survey of JICA in Nante area, varieties such as Chupa and C4-63 were planted in January for major cultivation season. For the second season, planting ITA 312, with shorter growing period, in May-October has been tried by some farmers (JICA, 2010).

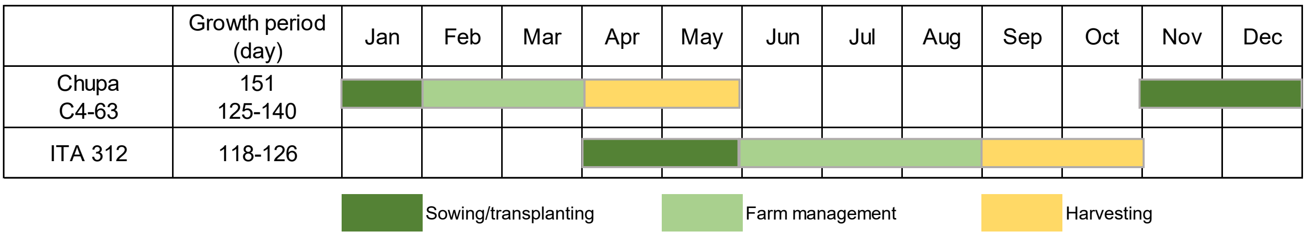


Fig. 4. Rice cropping season: Current cropping season (Chupa, C4-63) and cropping season under trial (ITA 312) in Nante area.
Source: Made by JICA Survey Team with information based on JICA, 2010.

(2) Imported rice

According to the data set of International Trade Center, the two largest exporters to Mozambique were Thailand and Pakistan in 2019 with the share of 42% and 34%, respectively (Table 3). However, imported quantity from Thailand has been decreasing together with rice from China and UAE. The imports from Pakistan, Myanmar and USA increased recently.

Table 3. Information about imported rice (Total quantity, value, average tariff%, etc. of rice 1006 in 2019).

	Quantity imported (t)	Share (%)	Value imported (1000 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 Mozambique (%)
Total	**405,158**		**240,370**	**593**	**7**	**9**	
Thailand	168,883	41.8	100,417	595	-2	-25	7.4
Pakistan	136,668	33.8	81,202	594	18	177	7.4
Viet Nam	40,444	10.0	24,048	595	40	-5	7.4
China	18,707	4.6	11,123	595	178	-37	7.4
Myanmar	13,300	3.3	7,908	595		2430	7.4
Singapore	12,107	3.0	7,199	595	127	79	7.4
India	7,745	1.7	4,079	527	-10	97	7.4
United Arab Emirates	3,689	0.9	2,199	596	-24	-55	7.4
United States of America	1,414	0.3	841	595	-77	3062	7.4
Hong Kong, China	543	0.1	323	595	78	76	7.4

Source: ITC (International Trade Center), https://www.trademap.org/Country_SelProductCountry, browsed on April 23, 2021

According to the market survey of JICA project in Chokwe irrigation scheme, most popular imported rice in the area were Mariana, Familia, Coral, Xirico and Dona Ana. Table 4 shows their original country and selling price in the Chokwe town.

Table 4. Price of imported rice in Chokwe.

Rice name	Original country	Price (Mt/kg)
Mariana	Thailand	21
Familia	Pakistan	19
Coral	Pakistan	21
Xirico	Thailand	21
Dona Ana	Thailand	34

Source: JICA, 2014 a.

2.4 Marketing

(1) Market structure

According to the food balance provided by the MIC (BA, 2011/2012) about 53% of the rice consumed is imported. In Mozambique, there are several large-scale milling companies involved in the production (Multi-stakeholder action plan, 2012; FAO-MAFAP, 2014). Data from the FAO-MAFAP (2014) indicate that Mozambique has around 791,400 small rice farmers and of these 102,178 sell their produce. Figure 5 shows the rice value chain in Mozambique. The explanation of some actors are as follows;

Input providers: The use of inputs such as improved seeds and fertilizers in rice production is still very low. The Ministry of Agriculture has been distributing improved rice seeds and fertilizers to smallholders, and the input stores are present in the main cities and towns of some districts.

Small producers: These are almost entirely subsistence producers. Small producers who produce a surplus usually sell their husked rice to processing factories or traders in the local market as well as husked rice directly to other families.

Merchants: Most traders who play a very important role in Mozambique are informal. Due to the poor quality of access roads, small informal traders are able to reach places close to the producer by bicycle. Formal traders buy most grains from informal ones, and buy small quantities from producers who bring their product to the village.

Wholesalers: Wholesalers are located in the villages. They generally buy processed products in processing factories, and, in some cases, buy grains from informal traders or from producers who bring their product to the village.

Processors: Both small village mills and industrial mills play an important role. The existing small mills do not always purchase paddy grains but provide husking services where producers or traders pay for the service.

Retailers: The marketing margin is very high in Mozambique (about 35 % in the central region). This makes the price of local rice to the consumer higher when compared to the price of imported rice and the price in the international market.

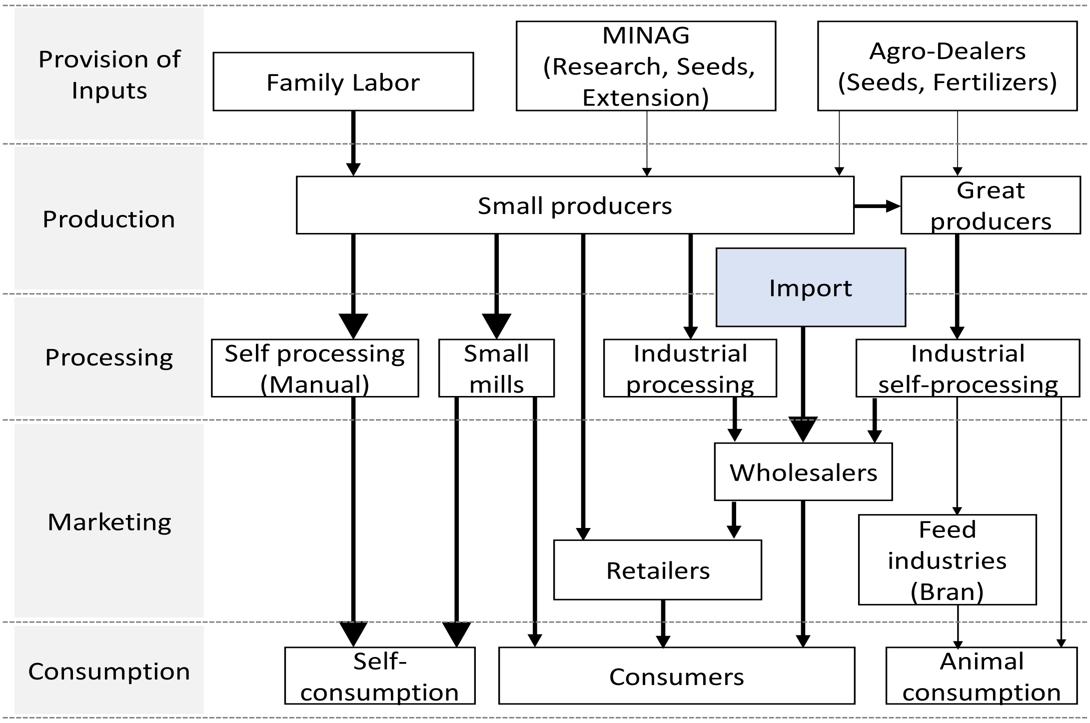


Fig. 5. Rice value chain in Mozambique.

(Made by JICA Survey Team based on FAO-MAFAP, 2014)

(2) Market path of local rice and imported rice

Figure 6 shows the market path of local rice and imported rice. Mozambique's important seaports are at Maputo, Beira and Nacala. The port in Maputo is the largest followed by that in Beira. The port in Beira has the advantage because it is close to Quilimane. The most important markets are in Maputo, Beira, Quilimane and Nampla.

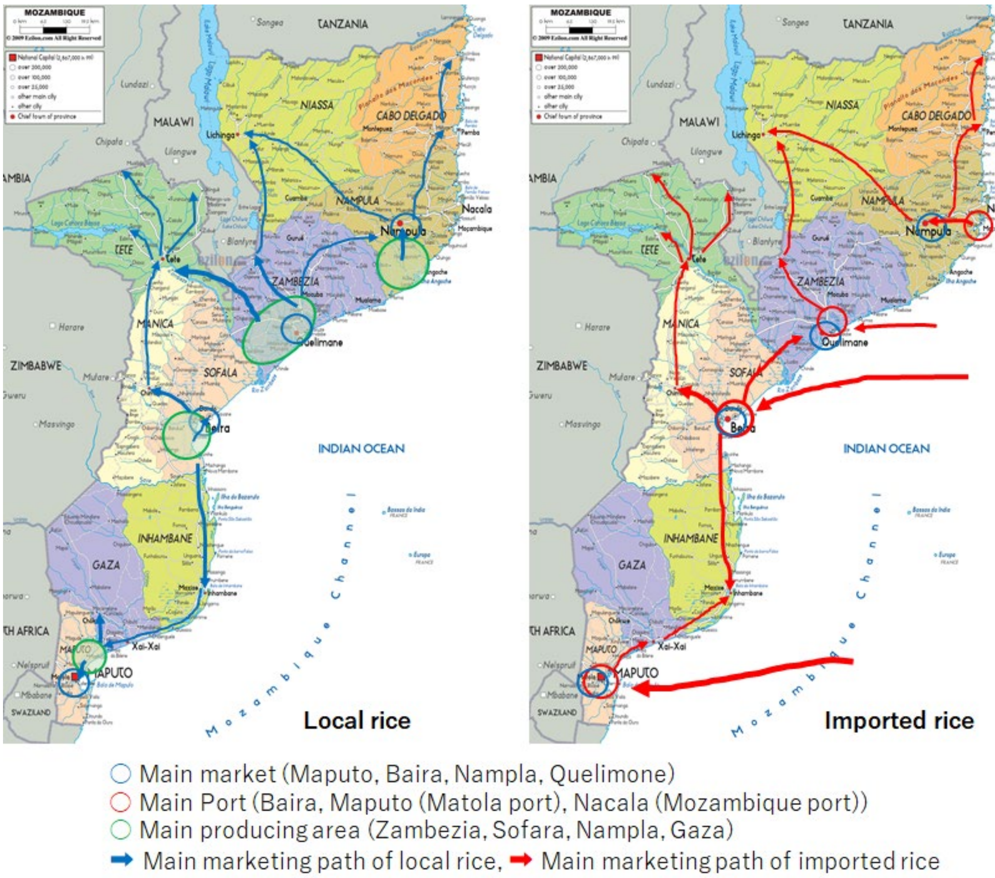
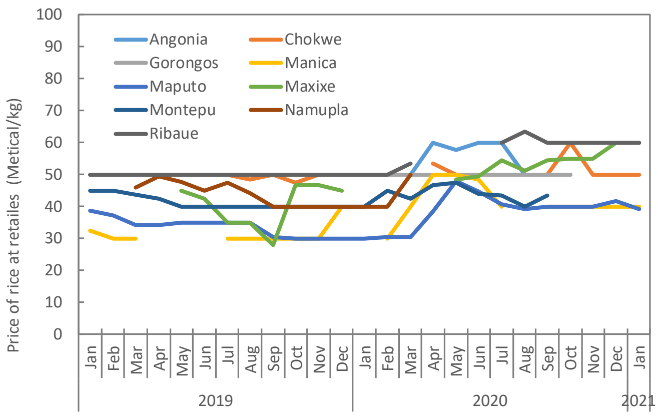


Fig. 6. Marketing path of local rice and imported rice.

2.5 Price comparison in the market

Information to compare prices of local rice and imported rice is very limited. The followings are some information about the local rice price in the country.

Figure 7 shows the retail price of rice of last two years in different town (assumed it is an average price of all kinds of rice). The retail prices were lower in large cities, such as Maputo and Nampula, and higher in the other remote towns such as Angonia, Chókwe, Gorongos and Ribaue. Information comparing price of local rice and imported rice could not be obtained.



Average rice price in retail shops of different towns (Metical/kg)

	Angonia	Chokwe	Gorongos	Manica	Maputo	Maxixe	Montepu	Namupla	Ribaue
Average	51.72	50.39	50.00	36.71	36.27	47.74	42.33	46.43	53.48
SD	3.75	2.26	0.00	7.06	5.00	8.92	2.53	10.03	4.98

Fig. 7. Rice price at retailers in different town.
Source: GIEWS FPMA Tool, FPMA Tool (fao.org) (the figure was made by JICA Survey Team)

Between 2008 and 2011, the local paddy price increased in parallel with international rice price, however, from 2011 onwards, international prices have gradually decreased. Although the transmission between international and domestic farm-gate price is slow, farmers faced substantial price disincentives (Kajisa, 2014; Papot *et al.*, 2017). This may have reflected to the production reduction after 2011 (Fig. 1).

3. Competitiveness analysis

3.1 Production cost of local rice for DRC ratio analysis

For DRC analysis to evaluated the competitiveness of the local rice, two cases of production conditions were compared. They were;

Case I: Nante irrigation scheme

Case II: Chokwe irrigation scheme

Both are under large-scale irrigation scheme. Rice area under rain-fed cultivation is larger than irrigated area (Fig. 2). However, the production cost for rain-fed cultivation was not available.

Table 5 shows the production cost of rice farmer under irrigation in Nante area in Zambezia Province, surveyed in 2008/2009 season. This Case I is an example of average farmer in Nante irrigation scheme. The varieties produced in Nante irrigation scheme were Chupa, C4-63, ITA-312 and Nene (JICA, 2009; JICA, 2010). About 65% of farmers in the area sell their rice, and the benefit has been an important income for farmers (JICA, 2010). According to this survey, neither purchased seeds nor fertilizer were used. According to Kajisa and Payongayong (2013), only 25% of farmers use fertilizer, 5.2% use pesticides, 11% use animal traction and 25% use some machinery on small-scale farms (an average of 1.3 ha). However, for the economic analysis, the cost for seeds was estimated referring the reports of JICA, 2009, and Kajisa, 2014.

Table 6 shows the production cost of farmers in Chokwe irrigation scheme in Gaza Province, surveyed in 2008/2009 season. This information is based on a farmer's interview with full use of improved technology. The farmer was using the machinery service for land preparation, applying fertilizer and herbicide, and obtaining high yield of 5.0 t/ha. This is quite high standard comparing to the national average (0.47 t/ha, Table 1, FAOSTA). The fertilizer application rate was high with the total amount of 200 kg urea/ha (basal and top dressing). The variety used was ITA-312, and the farm size was 5 ha.

Table 5. Rice production cost under irrigation in Nante irrigation scheme in Zambezia Province for Case I of DRC analysis (Mt/ha) (2008/2009).

Items		Cost (Mt/ha)
Production cost		
Field preparation	Machinery service	2,350
Nursery preparation	Hired labor	900
Seed [a]	100kg/ha	520
Transplanting	Hired labor	1,600
Bird scaring	Family member [e]	3,600
Weeding	Family member [e]	3,150
Harvesting, drying, threshing (manual)	Hired labor	850
Sack	16 Mt x 70 sacks	1,050
Transport	From Nante to Maganda da Costa	2,500
Capital interest [b]		561
Total production cost (Mt/ha)		**17,081**
Total production cost (Mt/kg, milled) [c]		**9.76**
Irrigation development [d]		
Construction		13,885
O&M		13,885
Total irrigation cost(Mt/ha)		**27,771**
Total irrigation cost(Mt/kg,milled)		**15.87**
Total cost (Mt/ha)		**44,852**
Total cost (Mt/kg, milled)		**25.63**
Yield (t/ha)		**3.50**

Source: Modified by JICA Survey Team based on JICA, 2009 and JICA, 2010 ().
a) JICA, 2009. and Kajisa, 2014 were referred to estimate seed amount and price.
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 0.50 (JICA, 2014 a).
d) Irrigation development cost: 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.
e) Family labor is added as labor cost using the survey in JICA, 2009.

Table 6. Rice production cost under irrigation in Chokwe irrigation scheme in Gaza Province for Case II of DRC analysis (Mt/ha) (2008/2009).

Items		Cost (Mt/ha)
Production cost		
Field preparation	Machinery service	4,800
Sowing	Family labor (1day, 4 members) [e]	240
Seed [a]	100kg/ha	520
Fertilizer	Urea 100 kg/ha	2,400
Fertilizer application	Family labor (1day, 4 members) [e]	240
Herbicide	Propanil 5L, MCPA 2L	2,125
Herbicide application	Family labor (3 days, 4 members) [e]	720
Top dressing fertilizer	Urea 100 kg/ha	2,400
Top dressing application	Family labor (1day, 4 members) [e]	240
Bird scaring	Hired labor (60 man-date)	3,600
Harvesting, drying, threshing	Machinery service	2,000
Sack	16 Mt x 72 sacks	1,150
Transport		1,000
Capital interest [b]		1,061
Total production cost (Mt/ha)		**22,496**
Total production cost (Mt/kg, milled) [c]		**8.93**
Irrigation development [d]		
Construction		13,885
Water fee for irrigation facilities		13,885
Total irrigation cost(Mt/ha)		**27,771**
Total irrigation cost(Mt/kg,milled)		**11.02**
Total cost (Mt/ha)		**50,267**
Total cost (Mt/kg, milled)		**19.95**
Yield (t/ha)		**5.04**

Source: JICA, 2009 (modified by JICA Survey Team).
a) JICA, 2009. and Kajisa, 2014 were referred to estimate seed amount and price.
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 0.50 (JICA, 2014 a).
d) Irrigation development cost: 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.
e) Family labor is added as labor cost using the survey in JICA, 2009.

Table 7 shows the examples of farmers in Chokwe irrigation scheme with different level of cultivation technology. It indicates how sowing methods and technology levels affect the variable cost (production cost), yield and benefit. The "improved" technology includes appropriate application of fertilizer, optimum amount of seeds (reduced amount), and application of agro-chemicals. (JICA, 2014). These examples were of farmers using ITA 312, which was the most popular variety that time in the Chokwe irrigation scheme. Net benefit of transplanting with traditional technology was negative (-6.86 Mt/ha) because the labor cost for transplanting, weeding and manual harvesting were high. In all sowing methods, improving the technology let the net benefit increase. The highest yield of 5.3 t/ha was obtained with improved technology and line sowing. This high yield was equivalent to the farmer in Case II (Table 6).

Table 7. Variable cost and benefit under different cultivation methods (2014).

Sowing method	Technology level	Variable cost (1000 Mt/ha)	Yield (t/ha)	Gross benefit (1000 Mt/ha)	Net benefit (1000 Mt/ha)
Transplanting	Traditional	28.11	2.50	21.25	-6.86
	Improved	34.40	7.90	67.14	32.74
Broadcasting	Traditional	16.22	2.64	22.44	6.22
	Improved	19.49	4.60	39.10	19.61
Line sowing	Traditional	n.a.	n.a.	n.a.	n.a.
	Improved	22.89	5.34	45.36	22.47

Source: JICA, 2014 a (Only partly excerpted and modified by JICA Survey Team).

3.2 Marketing cost for DRC ratio analysis

Post-harvest cost for local rice and marketing cost for imported rice are shown in Table 8 and 9. Table 8 shows the information based on the survey conducted in Chokwe irrigation scheme (JICA, 2014 a). According to this survey, the actual milling yield was approximately 50%, and this values was used for converting the cost from paddy grain to milled rice base in the analysis. The marketing cost for imported rice is shown in Table 9. Generally, in Mozambique, access costs are quite large both from farm gate to the market and from the border to the market. However, the access costs faced by farmers are typically higher than the access costs faced by the importers (Popat *et al.*, 2017).

Table 8. Post-harvest cost for local rice.

	Cost (Mt/kg, milled)
Milling	9.60
Cleaning (separating the broken grains, etc.)	4.00
Packaging (sack and labor)	2.80
Transport	0.90
Selling cost (labor)	6.00
Total cost (Mt/kg, milled rice)	**23.30**

Source: JICA, 2014 a

Table 9. Marketing cost for imported rice.

	Cost (Mt/kg, milled)
Transport cost from Meira port to Quelimone (500 km)	0.45
Document cost	1.30
Handling charge	1.20
Dealer's margin (10%)	2.09
Total cost (Mt/kg, milled rice)	**5.04**

Source: FAO-MAFAP, 2014

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 10 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 5, 6, 8 and 9 above. As shown in these tables, cost information are from different sources in different years. The detailed calculation results of the DRC ratio are shown in the attached table (after the reference list).

Case I is an example of average farmer in Nante irrigation scheme where the major varieties produced were Chupa, C4-63, ITA-312 and Nene (JICA, 2009; JICA, 2010). The analysis for Case II is based on information of an advanced farmer with full use of improved technology in Chokwe irrigation scheme where the high yield of 5.0 t/ha was reported. The cultivated variety was ITA-312 (JICA, 2009; JICA, 2010). The imported rice is mainly from Thailand (42% share in 2019) and from Pakistan (34%) (Table 3, ITC), and the CIF price of rice from Thailand (595 USD/t) was used for the analysis.

Since the information sources of production costs and rice yields are not the result of on-farm survey with several farmers, there is a possibility that the yield is set higher than the average of rice producers in the area (3.5 and 5.0 t/ha). Therefore, the DRC ratio was analyzed also with the assumption that they produce the average yield of Sub-Saharan Africa (SSA) region under irrigated cultivation (2.2 t/ha, Diagne *et al.*, 2013). These cases are indicated as Case I-2.2 and Case II-2.2.

The DRC ratio of both Case I-3.5 and Case II-5.0 were lower than 1.0 with a competitiveness against imported rice from Thailand even with the construction cost of irrigation infrastructure (Table 10). The DRC ratios at both sites, when calculating with the yield of 2.2 t/ha, were higher than 1.0 with the construction costs but lower than 1.0 when those costs are excluded. These results indicate that rice cultivation at both sites is competitive with imported rice, even when calculated using average yield of irrigated rice in SSA region, as long as the irrigation infrastructure cost was treated as a sunk cost.

One of the issues which needs to be considered is the conversion rate of paddy grains to milled rice. In Mozambique it is reported as 0.5 (JICA, 2014 a) which is lower than a typical rate of SSA region (Kikuchi *et al.,* 2016). Commercial mills properly adjusted and working with "good" quality paddy can yield 67% milled rice (FAO, 1998). This means post-harvest loss in Mozambique rice value chain is quite high.

In Nante irrigation scheme, double cropping per year has been tried with rice varieties of short growing period, such as ITA 312 (Fig. 4). Therefore, DRC ratio with double cropping cultivation was calculated with Case I-2.2, in order to find the effect on the competitiveness. 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 I-2.2 changes to 0.99 from 1.58, by adopting half the cost of irrigation infrastructure for the calculation. This indicates a significant advantage of double cropping in making the local rice competitive.

The result of DRC analysis would be similar even if the local rice is compared to the rice from Pakistan, since the CIF price of rice from Pakistan was 594 USD/t, almost the same as that from Thailand (2019 price, ITC, 2021).

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 10. Result of DRC analysis.

Case	Production condition	Yield (t/ha)	DRC ratio (DRC without irrigation cost [a])
I -3.5	Nante irrigation scheme	3.5	0.90 (0.44)
II -5.0	Chokwe irrigation scheme	5.0	0.68 (0.36)
I -2.2	Nante irrigation scheme	2.2	1.58 (0.59)
II -2.2	Chokwe irrigation scheme	2.2	2.20 (0.68)

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 Table 5 and 6 (the production cost table).

(2) Sensitivity analysis

Sensitivity analysis was conducted for Case I-2.2 and Case II-2.2, in case of including the construction costs. Table 11 shows the possible approaches to lower its DRC ratio and increase the competitiveness.

Case I-2.2: If quality of paddy grains is improved by proper drying method, and milling technology is appropriately practiced in order to raise the conversion rate of paddy grains to milled rice from 0.5 to 0,65, the DRC ratio can be lowered from 1.58 to 0.99. Another option to lower the DRC ratio is to apply fertilizer of half the amount of Case II (100 kg/ha of urea), and higher the yield to 3.0 t/ha. The latter is rather achievable because the yield in farmers' interview was already 3.5 t/ha (without fertilizer application). The improvement of post-harvest technology needs to involve extension of appropriate way to dry paddy and adjusting the technology of milling. In case if both approaches are applied, the DRC ratio decreases to 0.72. These results suggest that the local rice, such as Chupa, has comparative advantage to imported rice as far as the milling rate is improved to 0.65.

Case II-2.2: The first option to lower the DRC ratio was same as in Case I-2.2. The level of DRC decrease by this approach indicates that improving post-harvest technology affects the competitiveness by quite large degree (from 2.20 to 1.18). The second point is to increase yield. Since the production method of Case II employs intensive management with proper fertilizer and agro-chemical application, to achieve 3.5 t/ha is not impossible. Actually according to the original survey (JICA, 2009; JICA, 2010) the advanced farmer had 5.0 t/ha.

Table 11. Result of sensitivity analyses for DRC ratio

	Possible approach to increase the competitiveness	Effect (change of DRC ratio)
Case I-2.2	(1) Improve the post-harvest technology to raise milling conversion rate from 0.5 to 0.65.	1.58→ 0.99
	(2) Apply basal fertilizer of half the amount of Case II (50 kg/ha of urea), and raise yield up to 3.0 t/ha from 2.2 t/ha.	1.58 → 1.10
	Combination of (1) + (2) above.	1.58→ 0.72
Case II-2.2	Improve the post-harvest technology to raise milling conversion rate from 0.5 to 0.65.	2.20 → 1.18
	Raise yield up to 3.5 t/ha from 2.2 t/ha.	2.20→ 1.02

4. Related policy

4.1 Policy measures to stimulate consumption of local rice

The consumption of rice in Mozambique is rising and much of this demand is now coming from the urban markets that want medium length varieties with good quality. The total rice market is estimated to be 550,000 tons with 350,000 tons being imported from Asia (NRDS, 2009) at 7.5 % tariff rate (WTO, 2021).

The National Rice Development Programme 2016-2027 (Programa Nacional para o Desenvolvimento do Arroz, NRDP 2016- 2027)) aims to increase local rice production and reduce rice imports through sustainable intensification of the use of appropriate technologies and processes in Mozambique. To achieve the goals, the NRDP proposes the following strategies (NRDP, 2016):

- Make fertilizers available to small producers at subsidized prices through vouchers.
- Facilitate the supply of fertilizers (5,249 ton in 2016; 6,823 ton in 2017; 8,870 ton in 2018 and 11,531 ton in 2019).
- Exempt fertilizer imports customs duties from 2.5% to 0%.
- Introduce a pilot program on a brand of locally produced rice through campaigns to publicize the selected varieties.
- Mobilize about 720 million Mt (Meticais) for financing rice producers
- Increase budget allocation for breeder seed production and seed fund (CEPAGRI, FDA).

The National Investment Plan for the Agrarian Sector (PNISA) is aimed at agricultural investment in the public-private sector and food crop program which focuses on facilitating access of producers to inputs to increase productivity. The budget for rice production accounts for about 60% of the total, indicating that the policy has been focused on (Ministry of Agriculture, 2014).

Moreover, input supply and subsidization in Mozambique tend to be externally driven. In 2009/10, the government of Mozambique launched a two-year fertilizer subsidy program, funded by EU, and implemented in partnership with FAO and IFDC and reached 10,000 rice farmers and extension program for a further five years was implemented (2013-2018) (African Centre of Biodiversity, 2019). SUSTENTA (2016-2021) is currently a subsidy program funded by WB and FNDS, and the package of agricultural inputs such as seed, fertilizer and pesticide is prepared (African Centre of Biodiversity, 2019). The SUSTENA program was first launched in 10 districts in the provinces of Nampula and Zambezia, and now is in its second phase to cover the whole country in 2020 (CGTN Africa, 2020).

4.2 Quality standards and status of the application

There is no standard for quality and hygiene of local rice set by the government (JICA, 2009). According to JICA survey for the trading company (Inácaio de Sousa), they handle 4 types of rice,' Extra' (5% broken), 'Current', 'Fine crack' and 'Coarse crack', in descending order of price (JICA, 2009). The farm-gate price of paddy grain is usually decided by consultation between the government, irrigation cooperatives, farmer representatives, the trading company and milling companies. The selling price of rice milled by this company is determined based on the farm-gate price, Type of the rice, the broken grain ratio, and the water content, etc.

The grades and standards system in Mozambique is yet to become an important tool for both domestic production and consumption (NRDS, 2009). Therefore, NRDS I proposed to establish stable quality standards to enhance the competitiveness of local rice.

5. Main issues and suggestions

In Mozambique, rice cultivation has been practiced for more than 500 years. Approximately 90% of the rice production is produced by subsistence smallholder farmers. The demand for rice has drastically increased in last 20 years, but not the production. The self-sufficiency rate is as low as 16%. Local rice has challenges with low availability in some time of the year, poor cleanness, poor quality and relatively higher price. The milling rate from paddy grain to white rice is recognized very low (50%). There are several large-scale milling companies involved in the production, and it seems that rice business is now developing rapidly.

DRC ratio analysis was conducted for irrigated cultivation in Nante and Chokwe irrigation scheme. Rain-fed cultivation could not be analyzed due to the lack of information. Adopting information from literature reviews, both irrigated cultivation had comparative advantage to imported rice, mainly due to the high yield (3.5-5.0 t/ha). When the yield was set at the level of SSA average under irrigation (2.2 t/ha), the DRC ratio exceeded 1.0 but the level of non-competitiveness was not serious. It was concluded that rice cultivation at both sites is competitive with imported rice, even when calculated using average yield of irrigated rice in SSA region, as long as the irrigation infrastructure cost was treated as a sunk cost. It was also found that it is possible to secure the competitiveness of local rice by implementing the double cropping even when the irrigation construction cost is included for the DRC ratio calculation. The result of sensitivity analysis suggested that improving milling rate from 0.5 to 0.65 can raise the competitiveness of local rice significantly.

References

Abade, H., J.M. Bokosi, A.M. Mwangwela, T.R. Mzengeza, and A.J. Abdala. 2016. Characterization and evaluation of twenty rice (*Oryza sativa* L.) genotypes under irrigated ecosystems in Malawi and Mozambique. African J. Agr. Res. Vol.11: 1559-1568.

African Centre of Biodiversity. 2019. Input subsidies in Mozambique: The future of peasant farmers and seed systems.

CGTN Africa. 2020. Mozambican president launches program to boost agriculture. https://africa.cgtn.com/2020/07/30/mozambican-president-launches-program-to-boost-agriculture/, browsed in June 14, 2021.

Diagne, A., E. Amovin-Assagba, K. Futakuchi, and M.C.S. Woperisis. 2013. Estimation of cultivated area, number of farming households and yield for major rice-growing environments in Africa. *In* Realizing Africa's rice promise. Africa Rice Center, p35-45.

FAO-MAFAP. 2014. Análise de incentivos e desincentivos de preço para o arroz em Moçambique.

FAO. http://www.fao.org/3/Y4347E/y4347e17.htm#bm43, browsed on March 5, 2021.

FAOSTAT. http://www.fao.org/faostat/en/#data/FBS, browsed on June 8, 2021.

GIEWS FPMA Tool, FAO. https://fpma.apps.fao.org/giews/food-prices/tool/public/, browsed on March 17, 2021.

Inocencio, A., M. Kikuchi, M. Tonosaki, A. Maruyama, D. Merry, H. Sally, and I. de Jong. 2007. Costs and performance of irrigation projects: A comparison of sub-Saharan Africa and other developing regions. IWMI Research Report 109. International Water Management Institute, Colombo, Sri Lanka.

IRRI. 2021. IRRI in Mozambique. www.irri.org/where-we-work/countries/mozambique, browsed on April 21, 2021.

JICA. 2009. Regional Development and Economic Promotion (Rice Promotion) Program Cooperation Preparatory

Survey of Republic of Mozambique Regional (モザンビーク共和国地方開発・経済振興(稲作振興)プログラム協力準備調査最終報告書) *In Japanese*.

JICA. 2010. Detailed planning survey for the project for improvement of techniques for increasing rice cultivation productivity in Nante area, Zambezia District. *In Japanese.*

JICA. 2014 a. Project for rice productivity improvement in Chokwe irrigation scheme. Final report. *In Japanese.*

JICA. 2014 b. Terminal evaluation. The project for improvement of techniques for increasing rice cultivation productivity in Nante area, Zambezia Province. *Reported in Japanese with English summary.*

JICA. 2019. Project for improvement of rice production in Zambezia province. Progress report of second period. *In Japanese.*

JICA. 2015. Pre-evaluation report for Project for improvement of rice production in Zambezia Province (ProAPA). *In Japanese.*

Kajisa, K. 2014. Constrains on rice sector development in Mozambique. JICA-Research Institute Working Paper No. 86.

Kajisa, K., and E. Payongayong. 2013. Extensification and intensification process of rainfed lowland rice farming in Mozambique. *In* The coalition for Africa rice development (CARD): Progress in 2008-2013. JICA Research Institute. P 121-144.

NRDS of Mozambique. 2009. National Rice Development Strategy Mozambique, Ministry of Agriculture.

Ministry of Agriculture. 2014. National Agriculture Investment Plan 2014–2018 (Comprehensive Africa Agriculture Development Programme).

Multi-stakeholder action plan. 2012. Stimulating private-sector agribusiness investment in Mozambique. https://pdf.usaid.gov/pdf_docs/PA00JZ7F.pdf

NRDP 2016-2027. 2016. Programa Nacional para o desenvolvimento do Arros. Misisterio da Agricultura e Segurança Alimentar, Publica de Moçambique.

Popat, M., E. Tostão, F. Fontes, and O.C. Vilanculos. 2017. Monitoring price incentives for rice in Mozambique. CEEPPAG technical note No.03.

WTO. 2021. Tariff data base. http://tariffdata.wto.org/ReportersAndProducts.aspx, browsed in June 14, 2021.

Attached Table: Calculation and result of DRC analysis

With irrigation infrastructure cost

		LOCAL PRODUCTION											IMPORT			DRC CALCULATION		
			Production cost				Irrigation cost		Marketing cost		Total		Border price	Marketing cost		Total cost		
		Paddy yield	Total	Total	Production				Farm-gate to market					Border to market				DRC ratio
			(/ha)	(/kg milled rice	Tradable	Domestic	Tradable	Domestic	Tradable	Domestic	Tradable	Domestic	(CIF price of 37.22 Mt/kg) [a]	Tradable	Domestic	Tradable	Domestic	
Case (yield)	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	Mt/ha	Mt/kg of milled rice														
Case I - 3.5	**Nante irrigation scheme**	3.50	17,081	9.76	2.24	7.52	6.35	9.52	2.25	11.65	10.84	28.69	37.22	0.25	4.79	10.59	23.90	**0.90**
Case II - 5.04	**Chokwe irrigation scheme**	5.04	22,496	8.93	4.65	4.28	4.41	6.61	2.25	11.65	11.30	22.54	37.22	0.25	4.79	11.06	17.75	**0.68**
		t/ha	Mt/ha	Mt/kg of milled rice														
Case I - 2.2	**Nante irrigation scheme**	**2.20**	17,081	15.53	3.57	11.96	10.10	15.15	2.25	11.65	15.92	38.76	37.22	0.25	4.79	15.67	33.97	**1.58**
Case II - 2.2	**Chokwe irrigation scheme**	**2.20**	22,496	20.45	10.64	9.81	10.10	15.15	2.25	11.65	22.99	36.61	37.22	0.25	4.79	22.74	31.82	**2.20**

Without irrigation infrastructure cost

		LOCAL PRODUCTION											IMPORT			DRC CALCULATION		
			Production cost				Irrigation cost		Marketing cost		Total		Border price	Marketing cost		Total cost		
		Paddy yield	Total	Total	Production				Farm-gate to market					Border to market				DRC ratio
			(/ha)	(/kg milled rice	Tradable	Domestic	Tradable	Domestic	Tradable	Domestic	Tradable	Domestic	(CIF price of 37.22 Mt/kg) [a]	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	Mt/ha	Mt/kg of milled rice														
Case I - 3.5	**Nante irrigation scheme**	3.50	17,081	9.76	2.24	7.52			2.25	11.65	4.49	19.17	37.22	0.25	4.79	4.25	14.38	**0.44**
Case II - 5.04	**Chokwe irrigation scheme**	5.04	22,496	8.93	4.65	4.28			2.25	11.65	6.90	15.93	37.22	0.25	4.79	6.65	11.14	**0.36**
		t/ha	Mt/ha	Mt/kg of milled rice														
Case I - 2.2	**Nante irrigation scheme**	2.20	17,081	15.53	3.57	11.96			2.25	11.65	5.82	23.61	37.22	0.25	4.79	5.57	18.82	**0.59**
Case II - 2.2	**Chokwe irrigation scheme**	2.20	22,496	20.45	10.64	9.81			2.25	11.65	12.89	21.46	37.22	0.25	4.79	12.65	16.67	**0.68**

a) CIF price of Thai rice in 2019 is 595 USD/t (International Trade Center, browsed on April 23). Exchange rate in 2019 was 62.55 Mt/USD.