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The competitiveness of domestic rice production in East Africa: A domestic resource cost approach in Uganda

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Abstract

The rapid increase of rice imports in sub-Saharan Africa under the unstable situation in the world rice market during the 2000s has made it an important policy target for the countries in the region to increase self-sufficiency in rice in order to enhance food security. Whether domestic rice production can be competitive with imported rice is a serious question in East African countries that lie close, just across the Arabian Sea, to major rice exporting countries in South Asia. This study investigates the international competitiveness of domestic rice production in Uganda in terms of the domestic resource cost ratio. The results show that rainfed rice cultivation, which accounts for 95 % of domestic rice production, does not have a comparative advantage with respect to rice imported from Pakistan, the largest supplier of imported rice to Uganda. However, the degree of non-competitiveness is not serious, and a high possibility exists for Uganda's rainfed rice cultivation to become internationally competitive by improving yield levels by applying more modern inputs and enhancing labour productivity. Irrigated rice cultivation, though very limited in area, is competitive even under the present input-output structure when the cost of irrigation infrastructure is treated as a sunk cost. If the cost of installing irrigation infrastructure and its operation and maintenance is taken into account, the types of irrigation development that are economically feasible are not large-scale irrigation projects, but are small- and micro-scale projects for lowland rice cultivation and rain-water harvesting for upland rice cultivation.

Keywords: modern input, irrigation infrastructure, labour productivity, rainfed cultivation, rate of protection, yield

1 Introduction

Rice is an important staple food in sub-Saharan Africa (SSA), and among the major food items, demand for it has increased the fastest. The increasing urbanisation and per-capita income in the region will further increase rice consumption in the near future (Seck *et al.*, 2013). To meet this rising demand, both domestic production and rice imports have been increasing with the latter outpacing the former. Imported rice accounts for nearly 40 % of the total rice consumed in SSA, absorbing as much as one-third of the rice traded in the world rice market (Seck *et al.*, 2010). This situation has made reducing dependence on imported rice and increasing domestic rice production an overriding concern in SSA (Pearson *et al.*, 1981; Diagana *et al.*, 1999; Lançon *et al.*, 2004; Balasubramanian *et al.*, 2007). The world rice crisis in 2007–2008 has added further impe-

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tus to resolving this issue for enhancing food security (Moseley *et al.*, 2010; Oyejide *et al.*, 2012; Seck *et al.*, 2013).

Whether SSA countries can increase their self-sufficiency in rice critically hinges on the competitiveness of domestic rice production *vis-à-vis* imported rice. Depending on whether domestic production has a comparative advantage over imported rice, rice policies can sharply differ. The literature on this topic, though limited, shows that the major rice growing countries in West Africa, which have relatively long histories of rice cultivation, used to have no comparative advantage in rice production (with the possible exception of Mali) until the mid-1990s (Pearson *et al.*, 1981; Lançon & Erenstein, 2002), and since then, have been enjoying increasing comparative advantages in various rice production ecosystems, such as irrigated, rainfed-lowland, and upland (Lançon & Erenstein, 2002; AfricaRice *et al.*, 2011; Diallo *et al.*, 2012). The literature is particularly limited regarding East Africa, where rice is not a traditional staple food and rice cultivation has a shorter history than in West Africa. However, demand for rice in East Africa has been increasing rapidly for the last two decades, and those countries face the same problems as in West Africa (EUCORD, 2012).

This study examines the actual and potential comparative advantages of domestic rice production in Uganda. As in other countries in East Africa, rice is not a traditional dietary staple for the average Ugandan, but the total rice consumption in the country began to increase significantly in the 1990s, and by 2011, had reached a level more than 10 times that of the 1980s (FAO, 2014). Both domestic production and imports increased rapidly, but the rate of increase between 1990 and 2010 was much faster for imported rice (20 %/year) (FAO, 2014) than for domestic rice (10 %/year) (Kikuchi *et al.*, 2014). The Ugandan government established a national rice development strategy in 2008 (MAAIF, 2009), with a stated objective to increase domestic rice production and reduce rice imports. Earlier, in 2005, under the East African Community Customs Union Protocol, the Common External Tariff for rice was set at a high level of 75 %, primarily at the Ugandan government's request (Vitale *et al.*, 2013). These facts suggest that government policy makers are concerned that rice production in Uganda is not competitive against imported rice. By estimating the domestic resource cost (DRC) of rice production, we examine whether such concerns are substantiated, and, if so, how weak the competitiveness is.

2 Materials and methods

2.1 Domestic resource cost ratio

According to Chenery (1961), a country has a comparative advantage in producing rice if the social opportunity cost of producing one unit of rice in that country is lower than the international price of one unit of rice. Using the concept of net social profitability (NSP) in a cost-benefit analysis, his definition can be explained as follows (Kikuchi *et al.*, 2002). The social benefit of producing one unit of rice is evaluated using the shadow price. Because the shadow price of a tradable good, such as rice, is its international price, the social benefit of producing rice in a country is simply the amount of foreign exchange that can be earned when the country exports one unit of rice. On the other hand, the social opportunity cost of rice produced in a country is the value of the domestic resources and tradable inputs that are used for producing one unit of rice, evaluated at their shadow prices. If the social benefit of rice is larger than its social opportunity cost or, equivalently, if the NSP, defined as the difference between the social benefit and the social opportunity cost, is positive, it is said that rice has a comparative advantage.

Classifying production inputs into two groups, tradable inputs and non-tradable domestic resources, the NSP is expressed as follows:

$$\begin{aligned} NSP &= B - C \\ &= P_w\, SER - \left(\sum_i a_i\, P_i\, SER + \sum_j b_j\, P_j \right) \\ &= \left(P_w - \sum_i a_i\, P_i \right) SER - \sum_j b_j\, P_j\,, \end{aligned} \tag{1}$$

where NSP = the net social profitability of producing one unit of rice, B = the social benefit of producing one unit of rice, C = the social opportunity cost required to produce one unit of rice, P_w = the international price of rice in foreign currency, SER = the shadow exchange rate, a_i = the input coefficient of i-th tradable input to produce rice, P_i = the shadow price of i-th tradable input in foreign currency, b_j = the input coefficient of j-th domestic resource to produce rice, and P_j = the shadow price of j-th domestic resource. Domestic rice production has a comparative advantage when

$$B > C, \text{ or } P_w\, SER > \left(\sum_i a_i\, P_i\, SER + \sum_j b_j\, P_j \right).$$

Now, define a *SER* such that $NSP = 0$. Denoting the *SER* satisfying this condition as SER^*, we obtain from Eq. (1),

$$SER^* = \frac{\sum_j b_j P_j}{P_w - \sum_i a_i P_i} \quad (2)$$

The SER^* is called the domestic resource cost (*DRC*) (Bruno, 1972). From Eq. (1) and Eq. (2), it is clear that if $SER > SER^*$ and $NSP > 0$, rice production has a comparative advantage. It is more convenient to employ the domestic resource cost ratio (*DRCR*) by dividing the *DRC* by the *SER* as

$$DRCR = \frac{\sum_j b_j P_j}{(P_w - \sum_i a_i P_i)\ SER} \quad (3)$$

Domestic rice production has a comparative advantage if $DRCR < 1$. Note that the *DRCR* is the cost-benefit ratio between the cost of the domestic resources used for producing one unit of rice and the net foreign exchange that can be earned by exporting one unit of rice (Balassa & Schydlowsky, 1968). Although this is a static measure of the comparative advantage in a partial equilibrium framework (Tower, 1992; Masters & Winter-Nelson, 1995; Cai *et al.*, 2009), it provides a basic measure of the comparative advantage and international competitiveness for initial examinations (Siggel, 2006).

In this study, we measure the comparative advantage of domestic rice production at the Kampala wholesale market, where both domestic and imported rice are sold side by side. Accounting for the marketing costs of transporting imported rice from the national border to the wholesale market, Eq. (3) is revised as follows:

$$DRCR = \frac{\sum_j b_j P_j - \sum_m d_m P_m}{(P_w - \sum_i a_i P_i + \sum_k c_k P_k)\ SER} \quad (4)$$

where c_k = the input coefficient of *k*-th tradable input to transport imported rice from the border to the wholesale market, P_k = the shadow price of *k*-th tradable input in foreign currency, d_m = the input coefficient of *m*-th domestic resource to transport imported rice from the border to the wholesale market, and P_m = the shadow price of *m*-th domestic resource. Accordingly, a_i and b_j are re-defined as input coefficients, including the marketing services to transport rice from the farm-gate to the wholesale market. We estimate the *DRCR* for rice production in Uganda using Eq. (4).

2.2 Data

The *DRCR* analysis requires a large variety of data. The bulk of data used in this study is obtained from a nation-wide market survey that we conducted from March to October in 2012 with rice traders, rice retailers, small shop owners, supermarkets, rice mills, transporters, agricultural suppliers, and rice importers. The details of this survey are reported in Kikuchi *et al.* (2013). Aside from this data set, further data are obtained from various specified sources.

2.2.1 Import price of rice

Among the data necessary to estimate the *DRCR*, the most basic, yet difficult to obtain, is P_w in Eq. (4), *i.e.*, the international price of rice; in a country where many grades/brands of rice are produced and imported, it is not easy to determine which grade/brand of local rice is to be compared with which grade/brand of imported rice of equal quality in order to evaluate the competitiveness of domestic rice production.

To identify which grade of rice imported from which country is the real competitor of domestically produced rice, we first observe the trends of rice imports and the structure of rice demand in Uganda. Figure 1 shows rice import, export, and net import from 1990 to 2013. Rice imports were practically non-existent in the early 1990s, but they began increasing sharply from the mid-1990s, a trend that accelerated from the mid-2000s onward. Exports of rice began in the mid-2000s and increased sharply as if to compensate for the acceleration in imports. As a result, net rice imports were relatively constant in the last decade. It should be noted that these trends occurred under tariff systems that impose duties on rice imports. Since 2005, when the Common External Tariff under the East African Community (EAC) Customs Union Protocol was launched, an import tariff of 75 % has been levied on rice imported from outside the EAC. Before 2005, the tariff rate on rice for non-EAC member countries was 15 %. The tariff rate for the EAC member countries has been 6 % since before 2005 (Stahl, 2005; Vitale *et al.*, 2013). Figure 2 shows the countries from which Uganda imported rice between 2002 and 2013. Pakistan, Vietnam, and Tanzania have been the three principal countries from which Uganda imports rice, although there have been ups and downs among the three countries. Vietnam was the top exporter in the early 2000s and Tanzania, an EAC member country, emerged as an important exporting country in the mid-2000s. The most dramatic case is Pakistan, which became the top exporter after the tariff rate was raised in 2005 and it increased its share of total Ugandan rice imports to 90 % in recent years.

Kikuchi *et al.* (2015b) presented the structure of rice demand in Uganda in 2011–2012 by grade/brand (Table 1). The rice market has a simple structure. For the

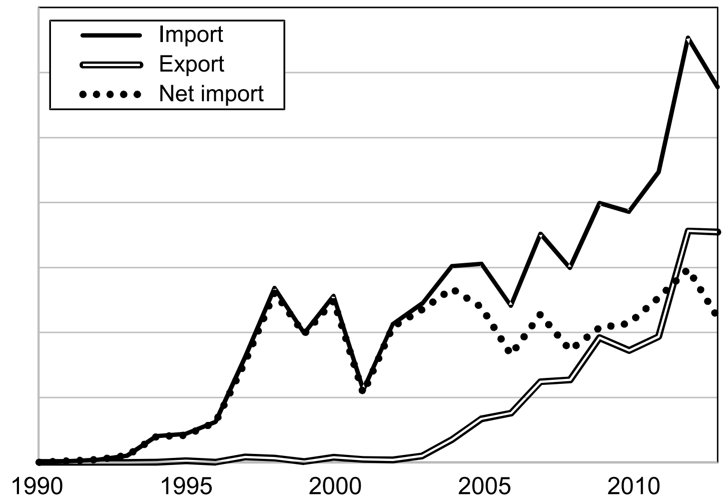

Fig. 1: *Import, export and net import of rice in Uganda 1990–2013 as reported in FAOSTAT/COMTRADE*

Source: FAO (2014), UN (2014)

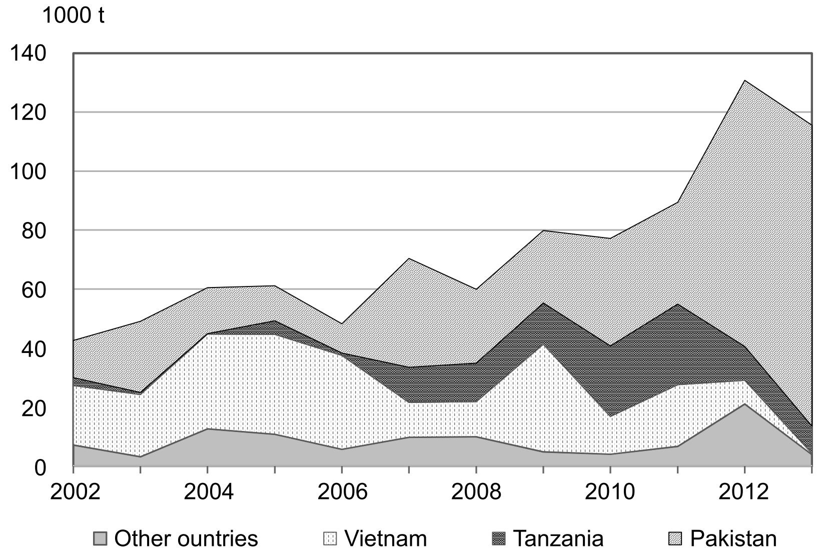

Fig. 2: *Quantity of rice import in Uganda, by exporting country, 2002–2013*

Source: UN (2014)

market as a whole, domestic rice accounts for 69 % of all rice sold to consumers. The rice that is sold loose in ordinary public markets accounts for 94 %, leaving little room for the high quality packaged expensive rice that is mostly sold in supermarkets. Domestic rice that is sold loose, all of which is produced by smallholders, accounts for 66 % of total rice consumption and imported rice that is sold loose next to the domestic rice accounts for 28 % of the total. In this main segment of the market where rice is sold loose, there are essentially only three brands of domestic rice. Although Ugandan rice farmers grow more than 40 rice varieties (Haneishi *et al.*, 2013a), when the rice comes to the market, it is sold as one of three brands. Similarly, there are essentially only three brands of imported rice in this market segment, with the country of origin designating the brand name. Together, these six brands are grouped into two categories by price; Supa and non-Supa. Supa, also referred to as 'Super', is a lowland variety that is most popular among Ugandan consumers for its slightly aromatic properties, hence commanding significantly higher prices than Kaiso, another lowland variety group, or Upland, which is a mixture of upland varieties, including NERICA (New Rice for Africa). 'Pakistan' and 'Vietnam' are imported by large importers, whereas 'Tanzania', popularly referred to as 'Supa TZ', is imported by Ugandan rice wholesalers who travel to Tanzania for procurement. These popular imported rice brands are priced to compete with the locally produced Supa. 'Pakistan', which accounted for 52 % of all imported rice consumed in Uganda in 2011–2012, is the lowest among the grades of rice imported from Pakistan. Multiple importers import this grade of rice from multiple Pakistani exporters, but, when it is sold in the public markets of Kampala, its price is highly uniform across those markets (Kikuchi *et al.*, 2015b).

These observations lead us to choose 'Pakistan' as the imported brand for the study's comparison with domestically produced Ugandan rice. The Kampala CIF (Cost, Insurance, and Freight) price of 'Pakistan' is estimated by adjusting its Kampala wholesale market price by the marketing costs incurred between the wholesale market and importers' warehouses and by the import tariff and other taxes incurred in the process of importation. It should be noted that the importers' warehouse, which is located close to the Kampala customhouse which all import formalities go through, is the point of import or the *de fact* national border. As explained earlier, an import tariff of 75 % has been levied on rice imported from Pakistan because it is outside the EAC. Although rice, as a staple food item, is exempted from the value-added tax, a withholding tax of 6 % is levied on the CIF value plus the import duty. These taxes make the nominal rate of protection for the rice imported from Pakistan as high as 85.5 %. The deduction of the taxes and marketing costs from the Kampala wholesale price shown in Table 1 restores the Kampala CIF price as of 2012. Since we choose the wholesale market in Kampala as the point for the comparison of imported to domestic rice prices, the Kampala CIF price is further adjusted back to the wholesale market to account for the costs incurred between the importers' warehouse and the Kampala wholesale market. Marketing cost data are obtained from Kikuchi *et al.* (2015a) and our market survey.

2.2.2 *Shadow prices*

Other data necessary to estimate Eq. (4) are the shadow prices of tradable goods and domestic resources used in the production and post-harvest marketing of domestic rice and the foreign exchange rates. Shadow prices represent the social opportunity costs of these goods and resources when the relevant markets, international and domestic, are malfunctioning due to government interventions, monopolistic elements, information asymmetry, or underdevelopment of markets causing the market prices to diverge from their social opportunity costs. Indeed, the crop markets in SSA have been notoriously distorted by government interventions (Jayne & Jones, 1997; Oyejide *et al.*, 2012).

The rice market in Uganda, however, is a rare exception. Rice is a staple crop that has been newly added to the Ugandan diet only since about 1990, and the markets related to domestic rice production and post-harvest rice marketing chains have been functioning well without any government intervention, except for import controls through tariffs levied at the border. All agricultural inputs, such as fertilisers, agro-chemicals and farm tools, are imported without any import duty or withholding tax. No government interventions, such as input subsidies or import restrictions, have existed in the input markets related to rice production or the post-harvest marketing process. Kikuchi *et al.* (2015a) find for the national rice market in Uganda that, when all marketing costs, including capital interests and risk premiums, are accounted for by using the market prices, few surpluses are left for rice traders involved along the post-harvest rice market chains from the farm-gate to the Kampala retail market. These results lead us to use the market prices as the shadow prices for tradable goods used in domestic rice production.

Moreover, rice production in Uganda has been increasing as a cash crop, not a subsistence crop, produced by smallholders who add rice to their traditional cropping systems for increasing income (Haneishi *et al.*, 2013b). Other studies on rice production in Uganda (Kijima *et al.*, 2006, 2008, 2011; Haneishi *et al.*, 2013a,c) do not find any overt imperfections in the workings of related markets of domestic resources, such as labour and land. As the first approximation, therefore, we adopt the market prices of domestic resources as their shadow prices. Similarly, the floating exchange rate system is so well established and stable in Uganda that there is no legitimate reason for not taking the official exchange rate as the shadow exchange rate. The market prices of tradable goods and domestic resources used in the production and post-harvest marketing of domestic rice are obtained from Kikuchi *et al.* (2015a) and our market survey. The actual exchange rates, which are US Dollar (US$) 1.00 = Ugandan Shillings (USh) 2,500 and Tanzanian Shilling (TSh) 1.00 = USh 1.60, both the averages over 2011–2012, are obtained from World Bank (2014).

Table 1: *Quantity and price of rice sold to consumers by mode of sale, country of origin, and brand, 2011–2012, Uganda*

Mode of sale / Country of origin / Brand	*Quantity* † (1000 t)	(%)	*Price* ‡ (USh/kg of milled rice) *Retail*	*Wholesale*
Sold loose	159	(94)		
Domestic rice	112	(66)		
Upland	29	(17)	3,060 A	2,872 A
Kaiso	33	(20)	3,121 A	2,836 A
Supa	50	(29)	3,651 B	3,330 B
Imported rice	47	(28)		
’Pakistan’	27	(16)	3,604 B	3,264 B
’Tanzania’ (Supa TZ)	12	(7)	3,556 B	3,127 B
’Vietnam’	7	(4)	3,433 B	3,239 B
Others §	1	(0)	na	na
Sold in package	10	(6)		
Domestic rice	5	(3)	4,770 C	na
Imported rice	5	(3)	7,331 D	na
Total	169	(100)		

Source: Kikuchi *et al.* (2015b)

† Rice sold to consumers in the country for the one year period of 2011–2012.

‡ The retail and wholesale prices in the Kampala market during March-April of 2012. For rice sold loose (sold exclusively in ordinary public markets and small grocery stores), mean price by brand. For rice sold in package (mostly sold in supermarkets), weighted average price for over all brands, for which data are available, using the quantity sold as weight. For each market level, prices followed by the same alphabet are statistically not distinguishable.

§ Kenya and Democratic Republic of the Congo.

Another parameter necessary to estimate Eq. (4) is related to the dichotomizing of inputs into tradable goods or domestic resources. This dichotomy, though conceptually clear, has practical problems for the estimation, particularly for countries such as Uganda where, as landlocked countries, the costs of transportation are substantial for any goods, which are handled by many traders before reaching final buyers. The non-tradable components of the market price of tradable goods used in rice production, such as fertilisers, must be removed and counted as domestic resources. Similarly, the tradable components in the market price of services used in the post-harvest rice marketing chains, such as rice milling, must be separated out and counted as tradable goods. The share of tradable-goods components in the market price of each input used in the production and marketing of domestic rice is obtained from our market survey.

2.2.3 Domestic rice production

The last parameters required for the DRCR are the input coefficients in rice production. Rice is grown in many parts of Uganda in various ecologies/ecosystems. The 2008–2009 Agricultural Census reported that rice was grown in 51 of the 80 districts in the country (UBOS, 2010) and in seven of Uganda’s nine agro-ecological zones (Haneishi *et al.*, 2013c). Balasubramanian *et al.* (2007) observe that the rice growing ecologies/ecosystems in Uganda comprise rainfed lowlands (53 %), rainfed uplands (45 %), and irrigated lowlands (2 %), and their observation is confirmed by Haneishi *et al.* (2013c). The potential, as well as actual performance, of rice production varies across these growing ecologies/ecosystems and among farmers with different levels of technology.

For this study, we select the following four existing rice growing ecologies/technology levels, using data from previous studies that report the cost structure of rice production based on field surveys of actual rice farmers (the data sources are in parenthesis): (I) rainfed lowlands with no modern inputs in the eastern and northern regions (Haneishi *et al.*, 2013a), (II) rainfed uplands with no modern inputs in the western and northern regions (Haneishi *et al.*, 2013a), (III) rainfed uplands with low levels of modern inputs in the central, western, and northern regions (Kijima *et al.*, 2008; Miyamoto *et al.*, 2012; Haneishi *et al.*, 2013b), and (IV) irrigated lowlands with low levels of modern inputs in the Doho Irrigation System, which is one of the few irrigation systems in Uganda (Watanabe, 2009).

In addition to the abovementioned four cases, we use the following four cases to examine possible means of increasing rice productivity through irrigation infrastructure, accounting for investment and operation and maintenance (O&M) costs: (V) irrigated lowlands with large-scale irrigation (Inocencio *et al.*, 2007; Fujiie *et al.*, 2011), (VI) irrigated lowlands with small-scale irrigation (Fujiie *et al.*, 2011), (VII) irrigated lowlands with micro-scale irrigation (Fujiie *et al.*, 2011; our market survey), and (VIII) irrigated uplands with rainwater harvesting (Fox *et al.*, 2005; Fujiie *et al.*, 2011). Of these four cases, the 'large-scale irrigation' and the 'rainwater harvesting' are counter-factual in the sense that the irrigation cost data are not specific to Uganda. With respect to 'small-scale' and 'micro-scale' irrigations, the cost data are based on projects actually implemented in Uganda by JICA (Japan International Cooperation Agency) (Fujiie *et al.*, 2011) or by farmers with assistance from JICA volunteers (our market survey). The cost structure of rice production for Cases V through VII is assumed the same as the irrigated lowland ecosystem with low modern inputs (Case IV), except that the improvement in irrigation infrastructure increases the level of fertiliser inputs by 10 times. The cost structure of Case VIII is assumed the same as Case III with fertiliser inputs increased by two times. The resulting rice yield from the increase in fertiliser inputs is estimated by applying the nitrogen-yield response function reported by Miyamoto *et al.* (2012), assuming that the fertiliser inputs are represented by urea. All prices used in this study are in 2012 prices. When prices from earlier years are used, the prices are deflated to 2012 prices by applying the GDP implicit deflator for domestic prices (World Bank, 2014) and the IMF world trade price index for international prices (IMF, 2013).

3 Results and Discussion

3.1 *Border price of imported rice*

The estimation results of the border price of imported rice are shown in Table 2. For 'Pakistan', the most popular brand of imported rice, the Kampala CIF price is estimated from the selling price at the Kampala wholesale market. By subtracting from the wholesale price the marketing costs that wholesalers must incur to transport one unit of 'Pakistan' from importers' warehouses in Kampala to the wholesale market, the wholesalers' acquisition price at the importers' place is estimated to be USh 3,044/kg. Leaving out the import duty (75 %) and withholding tax (6 %) from this acquisition price results in the Kampala CIF price estimated at USh 1,641/kg (US$ 597/t). Summing the necessary marketing costs up to the wholesale market with this CIF price, the Kampala wholesale market price is USh 1,797/kg without import duty and withholding tax.

It is worth noting that the Karachi FOB (Free on Board) price of this 'Pakistan', estimated at US$ 271/t when the costs of transportation from Karachi to Kampala via Mombasa, insurance, customs clearance, and importers' handling charges and margins are accounted for, is lower than the price of US$ 379/t for 'Pakistan IRRI 25 % broken' as of January 2012 (FAO, 2012). These observations suggest that the quality/grade of 'Pakistan' that is sold in public markets in Uganda is lower (or equivalently, the rate of broken rice inclusion is higher) than 'Pakistan IRRI 25 % broken'.

Table 2 also presents the price of 'Supa TZ' imported from Tanzania, which is estimated by adding all of the marketing costs incurred in the transportation of the rice to Kampala to the procurement price in Tanzania. The Kampala wholesale market price of 'Supa TZ' is estimated to be USh 1,809/kg for the land route through Mutukula. Another main route is the Lake Victoria through Port Bell, which estimates at USh 1,831/kg for the same price (Kikuchi *et al.*, 2013). These prices are only slightly higher than the border price of 'Pakistan' at the Kampala wholesale market (USh 1,797/kg), which this study uses as the international price of rice.

3.2 *Costs of domestic rice production*

The actual cost structures of rice production of the four rice growing ecosystems/technology are presented in Table 3. Case I is rainfed lowland rice cultivation with no modern input application, practiced in Soroti and its adjacent districts in East and North, while Case II is rainfed upland rice cultivation with no modern input application, found in West, Central, and upland areas of

Table 2: *Estimation of border prices of imported rice from Pakistan and Tanzania, March–April 2012* *

	USh/kg of milled rice	*Remarks*
'Pakistan' †		
Kampala wholesale market selling price	3,264	From Table 1
Wholesalers' return	76	2.5 %
Capital interest	67	i = 0.27/year (2.2%/1.1mo for acquisition price + costs)
Traders' time (labour)	17	
Store, storage	22	
Loading & off-loading	18	
Transport cost	20	7 km by truck
Price at importers' place	3,044	Importers'-warehouse-gate price
Import duty × withholding tax	1,403	Withholding tax (6 %) is levied after the import duty (75 %) is levied.
Border price	1,641	Kampala CIF is estimated at US$ 0.597/kg, assuming importers' handling charge + margin = 10 % and US$ 1 = USh 2500.
Transport cost	20	7 km by truck
Loading & off-loading	18	
Store, storage	22	
Traders' time (labour)	17	Traders' & their workers' work time
Capital interest	38	i = 0.27/year (2.2%/1.1mo for acquisition price + costs)
Wholesalers' return	41	2.5%
Price at the Kampala wholesale market	1,797	
'Supa Tanzania' ‡		Transported on land through Mutukula.
Rice-mill price in Tanzania (TSh/kg)	850	Price in rice growing areas along the Southern coast of Lake Victoria.
Taxes (TSh/kg)	85	10 %
Sack, stitching, weighing (TSh/kg)	9	
Transport within Tanzania (TSh/kg)	44	Truck: Sengerema-Mutukula (400 km)
Loading & off-loading (TSh/kg)	10	TSh 500/sack/loading
Border price (TSh/kg)	998	
Converted to USh/kg	1,596	TSh 1.00 = USh 1.60
Transport within Uganda	61	Truck: Mutukula-Kampala (250 km)
Loading & off-loading	17	
Store, storage	20	
Trip for procurement	19	Trip, boarding, visa (50,000 TSh/entrance)
Traders' time (labour)	17	Traders' & their workers' work time.
Capital interest	39	i = 0.27/year (2.2%/1.1mo for acquisition price + costs)
Wholesalers' return	40	2.5%
Price at the Kampala wholesale market	1,809	

* Data on marketing costs are from Kikuchi *et al.* (2015a) and our market survey.

† The most popular brand of imported rice in Uganda, the border price of which is estimated as follows: 1) adjust back the price of the Kampala wholesale market (Table 1) to the importers' warehouse-gate price by subtracting the marketing costs incurred between the importers' warehouse-gate and the market, 2) subtract the import duty and the withholding tax from the importers' warehouse-gate price to reach the Kampala CIF price, and 3) bring the Kampala CIF price, by adding the necessary marketing costs, back to the Kampala wholesale market where the imported rice competes with domestic rice.

‡ The second most popular brand of imported rice in Uganda, the border price of which is estimated by adding the marketing costs incurred between the producing areas in Tanzania and the border and between the border and the Kampala wholesale market to the procurement price at the rice producing areas in Tanzania.

Table 3: *The yields and production inputs per ha of domestic rice production by rice-growing ecology, level of modern inputs, and type of irrigation development, 2012*[a]

Case		*I*			*II*			*III*			*IV*	
Growing ecology		*Rainfed lowland*			*Rainfed upland*			*Rainfed upland*			*Irrigated lowland*	
Modern inputs		None			None			Low			Low	
Major growing region		East, North			West, North, Central			West, North, Central			Doho System (East)	
Yield (paddy t/ha)		1.8			1.6			2.7			3.7	
	Qty	USh 000/ha	%	Qty	USh 000/ha	%	Qty	USh 000/ha	%	Qty	USh 000/ha	%
Production inputs:												
Seeds (kg/ha)[b]	96	156	10	89	127	8	110	157	7	100	143	7
Fertilisers (kg/ha)[c]	0	0	0	0	0	0	24	62	3	11	30	1
Chemicals (liter/ha)[d]	0	0	0	0	0	0	5	73	3	2	21	1
Sack (no.)[e]	18	18	1	16	16	1	27	27	1	37	37	2
Farm tools[f]		13	1		13	1		13	1		13	1
Labour (md/ha)[g]	328	1,148	72	333	1,166	74	464	1,624	72	463	1,621	75
Land[h]		200	13		200	13		200	9		200	9
Transport[i]		27	2		24	2		46	2		56	3
Capital interest[j]		29	2		29	2		50	2		45	2
Total		1,591	100		1,575	100		2,252	100		2,164	100
Source of data		Haneishi *et al.* (2013a)			Haneishi *et al.* (2013a)			Haneishi *et al.* (2013b) Miyamoto *et al.* (2012) Kijima *et al.* (2008)			Watanabe (2009) Nakano & Otsuka. (2011)	

Case		*V*			*VI*			*VII*			*VIII*	
Growing ecology		*Irrigated lowland*			*Irrigated lowand*			*Irrigated lowland*			*Irrigated upland*	
Type of irrigation		Large-scale[k]			Small-scale[l]			Micro-scale[m]			Rainwater-harvesting[n]	
Modern inputs		High			High			High			High	
Yield (paddy t/ha)		5.5			5.5			5.5			4.0	
	Qty	USh 000/ha	%	Qty	USh 000/ha	%	Qty	USh 000/ha	%	Qty	USh 000/ha	%
Production inputs:												
Seeds (kg/ha)[b]	100	143	2	100	143	4	100	143	5	100	143	6
Fertilisers (kg/ha)[c]	100	260	4	100	260	7	100	260	8	50	130	5
Chemicals (liter/ha)[d]	2	21	0	2	21	1	2	21	1	5	73	3
Sack (no.)[e]	55	55	1	55	55	2	55	55	2	35	35	1
Farm tools[f]		13	0		13	0		13	0		13	0
Labour (md/ha)[g]	463	1,621	22	463	1,621	45	463	1,621	53	464	1,621	63
Land[h]		200	3		200	6		200	6		200	8
Transport[i]		83	1		83	2		83	3		53	2
Capital interest[j]		60	1		60	2		60	2		54	2
Irrigation development:												
Construction[o]		2,432	33		564	16		312	10		124	5
O & M[p]		2,432	33		564	16		312	10		124	5
Total		7,319	100		3,583	100		3,078	100		2,568	100
Source of data		Fujiie *et al.* (2011) Inocencio *et al.* (2007)			Fujiie *et al.* (2011)			Fujiie *et al.* (2011) This study			Fujiie *et al.* (2011) Fox *et al.* (2005)	

[a] Values are all in 2012 prices. Price data are from our market survey unless otherwise noted. [b] Seeds are valued at the paddy price.
[c] Price of fertilisers = USh 130,000 / 50 kg. [d] Price of chemicals = USh 14,000 / liter. [e] Price of sack = USh 1000/sack.
[f] Includes farm tools, instruments and draft animals, valued by depreciation or at market rental rates (Haneishi *et al.*, 2013b).
[g] For all cases, valued at the wage rate of USh 3,500/day, which is the average of USh 5,500 for ordinary labour works (6 hours/day) and USh 1,500 for bird watching work (12 hours/day) (Haneishi *et al.*, 2013b).
[h] Valued at the leasehold rent reported by Haneishi *et al.* (2013b) for all cases.
[i] Assumes harvested paddy is hauled for 1 km from field to farm-gate by bicycle at the cost of USh 1700/100 kg paddy sack based on the transportation rate function reported by Kikuchi *et al.* (2015a).
[j] Capital interest is estimated for the expenses on fertilisers, chemicals, sacks and 40 % of labour input (the average share of hired labour from Haneishi *et al.* (2013a) by applying the interest rate of 6.1 % per 3 months (27%/year) (Kikuchi *et al.*, 2015a).
[k] Large-scale irrigation: irrigation construction projects with benefited area of 300 ha or more. Investment data are for 26 large-scale irrigation projects implemented in sub-Saharan Africa.
[l] Small-scale irrigation: irrigation construction projects with benefited area between 7 and 20 ha. Data are for four JICA-supported projects in Uganda.
[m] Micro-scale irrigation: irrigation construction projects with benefited area less than 1 ha. Data are for five JICA-supported projects in Uganda and one project implemented by a farmer with assistance from JICA volunteers.
[n] Installing a simple rainwater-harvesting facility. Data are for Kenyan farmers.
[o] Average investment cost per ha in 2011 prices is annualized by using an interest rate of 10 % (international donor agencies' lending interest rate). For large-scale irrigation, if only 13 'success' projects, which attained the internal rate of return to the project investment of 10 % or higher, are selected, the irrigation development cost is reduced to USh 1,193,000/ha for construction and O&M. For details, see Inocencio *et al.* (2007).
[p] Operation and maintenance costs of irrigation systems/facilities, assumed to be 10 % of investment cost.

North. Note that no application of modern agricultural inputs, such as fertilisers and agro-chemicals, results in low yields. Case III represents slightly advanced rainfed rice cultivation practiced in West, North, and Central, in which some modern inputs are applied for improved variety (NERICA 4), resulting in a relatively higher yield of 2.7 t/ha. Though advanced in comparison to Cases I and II, the intensities of modern inputs in Case III are still low. For example, fertiliser is used at a level of 24 kg (about one-half bag of urea or other fertilisers) per ha. Case IV is the irrigated lowland rice cultivation practiced in the Doho Irrigation Scheme in East. Thanks to irrigation, the yield there is as high as 3.7 kg/ha, but the intensities of modern inputs are lower than in Case III. Cases III and IV thus represent advanced rice cultivation in the Ugandan context, but both cases still have opportunities to increase rice yields by increasing the application levels of modern inputs.

Case IV shows the clear advantage of irrigated lowland cultivation in terms of yield per ha. A straightforward deduction from this fact is that the installation of irrigation infrastructure would help to increase the competitiveness of local rice production against imported rice. The lower panel of Table 3 shows the four cost structures for possible higher productivity with some improved irrigation infrastructure and higher levels of modern inputs. Note that, although rice yields are significantly higher than without or low modern inputs, the increase in total costs, including the investments and O&M costs of irrigation facilities, is also significant. Moreover, the higher levels of modern inputs and the installation of irrigation infrastructure necessitate increased tradable goods. As shown in Table 4, the tradable-good components are higher for modern inputs, such as fertilisers and chemicals, and for large-scale irrigation development.

3.3 Marketing costs

Domestic rice produced by farmers in rice growing areas in Uganda goes, through the post-harvest marketing chains, to the wholesale market in Kampala. Generally, paddy rice produced by farmers is brought to rice mills in nearby towns by farmers, village-level rice traders, rice mills or district-level rice brokers, and then milled rice is sold to Kampala wholesalers who come to the rice mills for procurement. The marketing costs involved in these marketing chains, enumerated by Kikuchi *et al.* (2015a), are summarized in Table 5, together with the share of tradable-good components of these costs obtained by this study. Table 5 also shows the tradable and non-tradable costs of the marketing costs that are necessary to transport imported rice from the national border to the Kampala wholesale market.

3.4 Domestic resource cost ratio

The estimated domestic resource cost ratios (DRCR) are summarized in Table 6. Of the four cases of actual rice cultivation (the top panel of Table 6), the DRCR is greater than unity for the three rainfed cultivation cases, and less than unity for the irrigated lowland cultivation case. Domestic rice production of rainfed rice cultivation, which accounts for more than 95 % of the total rice growing area, has no comparative advantage over the rice imported from Pakistan. However, the proximity to unity of the DRCRs in these growing ecologies also indicates that the extent of non-competitiveness is not excessive. Indeed, a sensitivity analysis reveals that an increase in the yield by 300 kg/ha from 1.8 t/ha to 2.1 t/ha decreases the DRCR to unity for Case I, rainfed lowland cultivation with no modern inputs (Table 7). For Case II, an increase of 500 kg/ha brings the DRCR to unity. These results imply that slight improvements in rainfed rice cultivation could make domestic production competitive with ‘Pakistan’.

Sensitivity analyses applied to Case III reveal possible ways to increase the productivity of rainfed rice cultivation to improve its international competitiveness (Table 7). One option is to increase the application of modern inputs, particularly fertilisers. NERICA 4, an improved upland variety widely adopted by smallholders in Uganda, is highly responsive to nitrogen (Miyamoto *et al.*, 2012). Doubling the nitrogen application from 11 kg/ha to 22 kg/ha would be expected to increase the yield from 2.7 t/ha to 3.2 t/ha. With this level of yield, *ceteris paribus*, the DRCR improves to 0.99 (Case III-i in Table 7). Another option for increasing productivity would be to lessen the heavy labour intensity that is characteristic of rice cultivation in Uganda, rainfed upland rice cultivation in particular (Kijima *et al.*, 2008; Miyamoto *et al.*, 2012; Haneishi *et al.*, 2013a). A reduction of the labour intensity by 30 %, *ceteris paribus*, would lower the DRCR to 0.91 (Case III-ii). If both of these changes were to occur simultaneously, competitiveness would be further strengthened (Case III-iii). Another vulnerability of heavy labour intensity is that the competitiveness of rice cultivation is easily undermined when the wage rate in the rural labour market rises. The Ugandan economy has been experiencing steady growth since the early 1990s (World Bank, 2014). If the wage rate in the rural labour market were to increase by 30 % with the present cost structure, rainfed cultivation would experience a strong comparative

Table 4: *Percentage share of tradable-good component of inputs used in domestic rice production and irrigation development* *

Rice production:	*Tradable-good component* (%)	*Irrigation development*:	*Tradable-good component* (%)
Seeds †	0	Large: Construction	60
Fertilisers	75	O&M	20
Chemicals	75	Small: Construction	20
Sack	75	O&M	20
Farm tools	75	Micro: Construction	0
Labour	0	O&M	0
Land	0	Rain-water harvesting	
Transport	55	Construction	50
Capital interest	0	O&M	0

* For rice production inputs, data are from our market survey, and for irrigation development, from Fujiie *et al.* (2011) and Fox *et al.* (2005).

† Treated as a domestic resource, because the seed supply in the country is severely constrained (MAAIF, 2009) while rice farmers secure seed themselves out of their produce (Goto *et al.*, 2013).

Table 5: *The shares of tradable-goods in marketing costs, post-harvest marketing costs for domestic rice from the farm-gate to the Kampala wholesale market, and marketing costs between the national border to the Kampala wholesale market*

		Marketing costs from farm-gate to Kampala wholesale market † (USh/kg of milled rice)			*Marketing costs from the border to Kampala wholesale market* ‡ (USh/kg of milled rice)		
	Tradable-good component * (%)	*Total*	*Tradable goods* $a_i P_i$ §	*Domestic resources* $b_j P_j$ §	*Total*	*Tradable goods* $c_k P_k$ §	*Domestic resources* $d_m P_m$ §
Transport	55	127	70	57	20	11	9
Loading & off-loading	0	49	0	49	18	0	18
Village collector	0	20	0	20			
Rice milling	20	150	30	120			
Trip for procurement	30	4	1	3			
Sack	75	20	15	5			
Stitching sack	0	2	0	2			
Weighing sack	0	3	0	3			
Tax / duty / charge	0	13	0	13			
Store / storage	0	33	0	33	22	0	22
Traders' time	0	61	0	61	17	0	17
Capital interest	0	181	0	181	38	0	38
Risk premiums / insurance	0	147	0	147	41	0	41
Total		810	116	694	156	11	145

* The share of tradable goods in each cost item, data on which are from our market survey.

† Post-harvest marketing costs incurred between the farm-gate to the Kampala wholesale market. Data are from Kikuchi *et al.* (2015a). It is assumed that these costs are common to all the cases in Table 3.

‡ Marketing costs incurred to transport imported rice from importers' warehouse on the national border to the Kampala wholesale market, from Table 2.

§ Terms in Eq. (4).

Table 6: *Domestic resource cost ratio, by growing ecology, level of modern inputs, and type of irrigation development, 2012, Uganda* *

Growing ecology / level of modern inputs / region of production or type of irrigation construction	*Paddy yield* (t/ha)	*Costs of rice production* †					*Total costs* ‡		*DRCR* (P_w = USh 1,797/ kg)
		Total	*Production*		*Irrigation*				
			Tradable	Domestic	Tradable	Domestic	Tradable $A =$	Domestic $B =$	
			$\sum a_i P_i$	$\sum b_j P_j$	$\sum a_i P_i$	$\sum b_j P_j$	$(\sum_i a_i P_i - \sum_k c_k P_k)$	$(\sum_j b_j P_j - \sum_m d_m P_m)$	$B/(P_w - A)$
Actual production conditions:									
I. Rainfed lowland with no modern inputs (East and North)	1.8	1337	20	1317			125	1866	1.12
II. Rainfed upland with no modern inputs (West, North and Central)	1.6	1492	21	1471			126	2019	1.21
III. Rainfed upland with low modern inputs (West, North and Central)	2.7	1283	75	1208			180	1757	1.09
IV. Irrigated lowland with low modern inputs (Doho in East)	3.7	900	31	868			137	1417	0.85
With irrigation development:									
V. Lowland with high modern inputs (large-scale irrigation) §	5.5	2047	73	613	544 *267*	816 *400*	723 *445*	1979 *1563*	1.84 *1.16*
VI. Lowland with high modern inputs (small-scale irrigation)	5.5	1002	73	613	63	252	242	1415	0.91
VII. Lowland with high modern inputs (micro-scale irrigation)	5.5	861	73	613		174	178	1337	0.83
VIII. Upland with medium level modern inputs (rainwater-harvesting)	4.0	992	74	824	24	71	203	1444	0.91

* Domestic resource cost ratio is estimated at the Kampala wholesale market using Eq. (4). Symbols shown in the fourth row of the table headings correspond to the terms of Eq. (4).

† Computed from Tables 3 and 4; the production coefficients in value term ($q P_i$'s and $b_j P_j$'s) in Eq. (4) are computed by dividing each production input (USh/ha) in Table 3 by respective rice yield in kg of milled rice/ha converted from paddy rice using the conversion rate of 0.65, while applying respective tradable-good ratio in Table 4. For example for Case I, the total input cost of USh 1,591/ha in Table 3 is converted to the total cost of USh 1,337 (= 20 + 1,317) per kg of milled rice in this table.

‡ The total costs are obtained by adding the post-harvest marketing costs (Table 5) to, and subtracting the marketing costs to transport imported rice between the border and the Kampala wholesale market (Table 5) from, the production costs.

§ Shown in italics is DRCR estimated by assuming the irrigation development costs of 'success' projects defined in the footnote o) of Table 3.

disadvantage (Case III-iv), and even if an increase in fertiliser application concurrently were to occur, the disadvantage would not be eliminated (Case III-v). To maintain competitiveness under a rising wage rate, it would be essential to reduce the labour intensity of rice cultivation (Case III-vi).

In the case of irrigated lowland rice cultivation (Case IV in Table 6), under the present conditions, rice production is highly competitive. Even if the yield were 2.9 t/ha instead of 3.7 t/ha, with the present input structure, rice production would still be competitive (Table 7). This production ecology is also robust against a hike in the wage rate; an increase in the wage rate by as much as 30 % maintains rice cultivation as competitive. All this shows the effectiveness of irrigation infrastructure for enhancing the productivity of rice cultivation, as demonstrated by the Green Revolution in Asia during the last third of the 20th century (Otsuka & Kalirajan, 2006). However, it bears repeating that the DRCR estimation for Case IV treats the construction cost of irrigation infrastructure as a sunk cost.

It is no doubt true in Uganda, as in developing countries in Asia, that irrigation is the best means for attaining a higher, and stable, rice yield. However, not all types of irrigation development are economically viable when the construction costs of irrigation infrastructure are taken into account. The lower half of Table 6 presents the results of the DRCR estimation of irrigated

Table 7: *Sensitivity analyses for the domestic resource cost ratio*

Case / Change in conditions	
Case I. Rainfed lowland with no modern inputs	
Paddy yield that makes DRCR=1 (t/ha)	2.1
Case II. Rainfed upland with no modern inputs	
Paddy yield that makes DRCR=1 (t/ha)	2.1
Case III. Rainfed upland with low level of modern inputs	
DRCR Original estimate	1.09
i) DRCR when Fertiliser input increase by 100 % (with yield=3.2 paddy t/ha *)	0.99
ii) DRCR for Labour intensity decrease by 30 % (with the same yield)	0.91
iii) DRCR for Case i + Case ii	0.84
iv) DRCR when Wage-rate increase by 30 % (with the same yield)	1.26
v) DRCR for Case i + Case iv	1.14
vi) DRCR for Case i + Case ii + Case iv	0.94
Case IV. Irrigated lowland with low level of modern inputs	
Yield that makes DRCR=1 (paddy t/ha)	2.9
DRCR when wage-rate increased by 30 % (with the same yield)	0.98

* This increase of 0.5 t over 2.7 t is estimated by assuming: 1) the fertiliser used is urea and the quantity applied is increased from 24 kg/ha to 48 kg/ha, and 2) the marginal yield response to nitrogen input is 46 kg/kg of N/ha (Miyamoto *et al.*, 2012).

rice production for four different types of irrigation development, taking into account the costs of construction and O&M of the irrigation infrastructure. If the level of the investment cost were as high as that of large-scale irrigation projects implemented in SSA during the last three decades of the 20th century, domestic rice production would not be competitive with imported rice, even if the newly constructed irrigation system could yield as much as 5.5 t/ha per crop with complete double cropping per year (Case V). As revealed by Inocencio *et al.* (2007), such a high level of performance has rarely been reached by major irrigation projects in developing countries. Even if the construction cost data are taken only from the successful irrigation projects that achieved an internal rate of return of 10 % or higher (Inocencio *et al.*, 2007), it is estimated that the development of large-scale irrigation schemes hardly makes domestic irrigated rice production competitive (Case V; the DRCR value in italics in Table 6). This means that even if large-scale projects were well planned, well designed, well implemented with reasonably low cost avoiding unnecessary, lavish structures and facilities, and attaining high levels of performance in operation (Fujiie *et al.*, 2011), the probability is still low that such projects would be economically viable. However, small- and micro-scale irrigation construction projects in lowland ecology (Cases VI and VII) and a rainwater harvesting system in upland ecology (Case VIII) could be much more economically viable methods of irrigation development, in which the competitiveness of domestic rice production *vis-à-vis* imported rice could be enhanced.

At present, domestic rice production is heavily protected by a tariff barrier; the nominal rate of protection is 85.5 % and the effective rate of protection is approximately 200 % for rainfed rice cultivation with low levels of modern inputs. As domestic rice production is an infant industry in Uganda, its protection by means of an import tariff can be justified until such time that the productivity of the industry increases so that domestic rice would be competitive with imported rice. However, a high level of protection as high as the present one is not necessary for local rice producers. The sensitivity test for Case II in Table 7 suggests that a nominal protection rate of about 35 % would make rainfed upland rice cultivation with no modern inputs sufficiently competitive with imported rice.

It is a difficult task, however, to ascertain an appropriate level of protection, because it depends on the productivity level of domestic rice production, which in turn depends not only on improvements in quantitative productivity but also on the quality of the output. It is necessary to increase the quantitative productivity of domestic rice production, but at the same time, it is equally, or even more, important to improve the quality of domestic rice. Similar to many other countries in SSA (Lançon *et al.*, 2004; Becker & Yoboué, 2009; Moseley *et al.*, 2010; Futakuchi *et al.*, 2013), the quality of Ugandan domestic rice is poor mostly because of low quality rice milling. In particular, domestic rice is inferior to 'Pakistan' in terms of its cleanliness, and the demand for 'Pakistan' would have increased because of its superior cleanliness regardless of Ugandan consumers' preference for aromatic Supa. By improving the quality of the milling and thus improving the cleanliness of domestic rice, competitiveness could improve. Because of lack of data, however, this study cannot address the extent to which improvements in rice quality could increase competitiveness.

4 Conclusions

This study investigated the international competitiveness of domestic rice production by estimating the domestic resource cost ratio. The results show that the actual rainfed rice cultivation, which accounts for 95 % of domestic rice production at present, does not have a comparative advantage with respect to the rice imported from Pakistan. However, the extent of non-competitiveness is not great, and rainfed rice cultivation can become internationally competitive by improving the yield levels through increasing modern inputs and enhancing labour productivity. Irrigated rice cultivation, though very limited in acreage, is competitive even under the present input-output structure when the cost of developing irrigation infrastructure is treated as a sunk cost. However, if we consider irrigated rice cultivation with newly constructed irrigation infrastructure, it is necessary to take the construction and O&M costs of the infrastructure into account. Our analysis reveals that the most suitable types of irrigation development to pursue in Uganda, as in sub-Saharan countries in general, are small- and micro-scale projects for lowland rice cultivation, and rain-water harvesting for upland rice cultivation.

To increase the competitiveness of domestic rice production, it is imperative to enhance its physical productivity. However, it is also important to improve the quality of domestic rice by improving the quality of rice milling. In particular, improved cleanliness of domestic rice could increase its competitiveness against rice imported from Pakistan, though the extent to which these improvements in rice quality could actually increase competitiveness is a question left for future studies.

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