Which Local Rice To Satisfy The Urban Consumers In Benin In Order To Ensure Rice Self-Sufficiency?

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Abstract:

This study was initiated to identify the local rice varieties which can be promoted to satisfy the most the urban consumers' requirements in Benin. Vikrey's method of second price experimental auction was combined with "Endow-and-upgrade" method to collect data. The results show that the competitiveness of local rice vis-à-vis the most preferred imported rice is low. The most competitive local rice were the non-parboiled IR841, Gambiaca, and Nerica L20. Based on these results, the improved variety "IR841" and the local variety "Gambiaca" are the rice varieties to promote. However, the processing technology and the post-harvest activities need to be improved.

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1 Introduction

In Benin in the 1990s, rice was considered as food for celebrations. But today, it is becoming increasingly important in the diet of Beninese people (MAEP, 2010). According to FAOSTAT (2014), each consumer in Benin was consuming on average 16 kg of rice per year in 1990, but in 2011, each was already consuming on average 53.2 kg per year. In other respects, rice ranks third in cereal production in Benin after maize and sorghum. However, many people in Benin prefer consuming imported rice (Adégbola and Singbo 2005; Mhlanga 2010; Naseem et al. 2013), even during the harvest period when local rice is abundantly available (Kinkpé 2012).

Rice production in Benin—estimated to be about 207,000 tons in 2013—does not yet meet the national demand (estimated at over 500,000 t in 2011; FAOSTAT 2014). Accordingly, the rice import dependency is in average high (about 75%) in this country (FAS/USDA, 2016). Moreover, the quality of the local rice offered is not really appreciated by consumers. Studies have shown that the major factors determining the preference of rice consumers in Benin are grain size, percentage of broken rice, grain color, cooking time, taste and rice price (Mhlanga 2010; Naseem et al. 2013). According to Kinkpé (2012) and Kinkpé et al. (2016), Benin people prefer white rice, long grains, perfumed (aromatic) varieties, without foreign matters and at low price. Although these studies revealed preferred rice characteristics of consumers, they did not show consumer interest in local rice varieties which could partially or completely meet the preferences of Beninese consumers and especially the urban consumers. Moreover, sensory attributes have not been properly taken into account through sensory evaluations. Therefore, it is still topical to ask *which local rice variety do we need to satisfy Benin urban consumers.* This paper intends to contribute to the answer of this problem by analyzing: (1) the quality-competitiveness of local rice vis-à-vis the imported rice in terms of price premium in the most important urban area of Benin, (2) the potential demand for local rice in Benin.

2 Data and methodology

2.1 Urban market sampling

Two urban markets were selected in Benin. Three criteria were used to make these choices. First, the markets need to be in the biggest cities. Secondly, the market must be exposed to imported rice. Thirdly, the markets must be supplied with rice by the rice development hub of Glazoué, one of the most important. Combining these three criteria, the markets of Dantokpa (Cotonou) and Ouando (Porto-Novo) were selected (fig. 1).

2.2 Rice products sampling

The analysis of the domestic rice competitiveness and potential demand vis-à-vis the imported rice requires a representative sampling of rice types. To select the rice types, a deepened literature review and a market survey were done. For each market, different rice types were selected. First, a "standard" rice was selected. The standard rice was a traditionally produced in the hub of Glazoué, commonly available on the market and known as mediocre quality. Secondly, at least two local rice known as improved quality rice produced in the hub were selected (Agbobli et al. 2007). The quality improvement was judged based on the intrinsic characteristics of the variety, the parboiling and the milling technology (Ndindeng et al. 2015, Demont et al, 2012). Finally, the most preferred imported rice available on the market was selected (Houssou et al. 2014). The table1 presents all details on the auctioned rice types.

2.3 Framed the field experiment

This research was carried out using experimental auction methods because they allow observing consumers' purchase behavior first-hand under controlled conditions (Demont et al., 2013a,

Demont et al., 2013b, De Groote et al., 2011, Le Gall-Ely, 2009; Lusk and Shogren, 2007). The research was based on Lancaster (1966)'s consumer theory for which a good is demanded for its characteristics (attributes) because they provide the usefulness to consumers.

In order to measure effectively the competitiveness of the local rice types vis-à-vis the imported rice (Demont and Ndour, 2015), the data collection was based on Vikrey's second price auction (Vickrey 1961, Demont and Ndour, 2015) through the "endow-and-upgrade" method (Lusk and Shogren 2007). The basic experimental design of Demont et al (2013a) was used.

In each selected urban market, 10 experimental sessions were organized during 5 days: two sessions per day (one in the morning and the second in the afternoon). For each experiment session, 10-15 consumers were recruited randomly as participants. They were men and women of 19 to 65 years old age. The experiment was carried out in a suitable conference hall allowing experimental disposition. The disposition of the hall enabled each participant to discuss confidentially with the data collection agent. The standard rice and all alternative rice types were disposed in dishes with different colors on the table in front of each participant to allow them to really examine them.

At the beginning of each session, an animator explained the objective of the experiment in both French and Fongbé (local language). He explained the process to the participants and made sure that all of them understood it. During this introduction, the animator present the standard rice type to the participants and inform them on its price. After all explanations, a trial auction was done on biscuits of a brand well-known by consumers (Demont et al. 2013a; Shogren et al. 1994) to be sure that each participant understand very well the process.

Each session comprised four chronological rounds with the process explained above. First, an individual auction was run after the participants examined the uncooked rice types (pre-sensory round). Secondly, another individual auction was run after the participants tasted the cooked rice (post sensory round). This second round enable measuring the taste premium. Thirdly, as Demont et al. (2013b), the collective auction was run to experience the Word-of-Mouth (WOM) on individual behavior. Finally, an individual auction (post collective round) was run again to capture the effect of WOM on the individual Willingness to Pay (WTP) (Akoa Etoa et al., 2016). Finally to complete the finds of Demont et al. (2013a), we introduced an experiment of demand measurement. In fact, participants were asked to allocate a hypothetical budget of US$ 20 to buy different auctioned rice types (standard and alternative rice types) they prefer on the price (WTP+ standard rice price) they proposed during the last round. This innovation allowed to measure the potential market share for all auctioned rice types. Using this market shares and the stated rice consumption data, the potential demand for each auctioned rice type was calculated.

After all, a short survey was done to collect data on rice demand and household characteristics. Finally, the participants were asked to select the top-five most important attributes they consider in purchasing rice among a pre-defined attributes list including cleanness, whiteness, head rice recovery, slenderness, unstickiness, taste, aroma, softness, swelling capacity, grain size, and duration of cooking (Naseem et al., 2013 and Fiamohe et al., 2014).

2.4 Analyzing the factors determining the quality competitiveness and the potential demand

According to Lancaster (1966), a good is demanded because of the usefulness it gives. But this usefulness is determined by its attributes. It is therefore unthinkable to study the demand of a good without considering its characteristics. Lancaster (1966) guided this research.

In the experiment, the bids proposed by the consumers in each round represented their WTP to upgrade a kilogram of the "standard" rice to a kilogram of alternative rice. The bids were measured before and after exposing consumers to two treatments: tasting and collective induction.

Let P_j be the price of the standard rice and WTP_{ijpr} be the price premium paid by the ith consumer ($i = 1, …, n$) on the jth Benin urban market ($j = 1, …, 5$) for the pth product upgrade ($p = 0$ for

imported rice, $p = 1, \ldots, k$ for local rice) in the rth bidding round ($r = 1$ before tasting, $r = 2$ after tasting, $r = 3$ after collective induction). Some local rice were specific to each Benin urban market. Therefore, we standardized the bids in order to pool data in a single dataset. We first divided the bids by the price of the standard rice in each market to cancel out price differences between the two urban markets. The revealed price premium for each upgraded local rice relative to imported rice was used as indicator of quality-competitiveness of the local rice vis-à-vis the imported rice. Following Oparinde et al. (in press), we then calculated the revealed price premium to upgrade each local rice p relative to imported rice, π_{ijp} as follows:

$$\pi_{ijp} = \frac{WTP_{ijp3} - WTP_{ij03}}{P_j} \qquad (1)$$

It has been demonstrated that sensory experience and WOM communication can influence WTP for a product and its competitor (Arndt 1967; Allsop, Bassett, and Hoskins 2007; Demont et al. 2013b). To capture these impacts on final WTP for each local rice and the imported rice, the treatment effects were calculated as the difference between standardized post and pre-treatment bids:

$$\tau_{ijp} = \frac{WTP_{ijp2} - WTP_{ijp1}}{P_j}, \text{ and } \tau_{ij0} = \frac{WTP_{ij02} - WTP_{ij01}}{P_j} \quad (2)$$

$$\omega_{ijp} = \frac{WTP_{ijp3} - WTP_{ijp2}}{P_j}, \text{ and } \omega_{ij0} = \frac{WTP_{ij03} - WTP_{ij02}}{P_j} \quad (3)$$

where τ_{ijp} and τ_{ij0} are respectively the "taste premiums" paid by consumer i in market j for upgrading standard to a local rice p and the imported rice after tasting; ω_{ijp} and ω_{ij0} are respectively the "WOM premiums" paid by consumer i in market j for upgrading standard to a local rice p and the imported after WOM communication.

As far as the potential demand is concerned, it was calculated for each local rice as follows:

$$q_{ijp} = Q_{ij}\rho_{ijp} = \frac{F_{ij}D_{ij}}{N_{ij}}\rho_{ijp} \quad (4)$$

where Q_{ij} is the total annual per-capita consumption of rice by consumer i in market j; ρ_{ijp} is the budget share allocated to local rice product p by consumer i in market j; F_{ij} is the annual rice consumption frequency in the household of consumer i in market j; D_{ij} is the rice quantity demanded per frequency; and N_{ij} is the household size (number of members).

Stating their potential demand, consumers take a two-stage decision. They first decide to buy or not the local rice p and if yes, they decide the quantity to buy. Accordingly, the potential demand can be modeled as two-stage decision (Cragg, 1971 and Haines et al., 1988).

Let b_{ij} be the propensity to buy a local rice, and q_{ijp} the potential demand of a local rice p by the consumer i in market j. The factor determining the quality-competitiveness of local rice p, relative to imported rice, π_{ijp}, the propensity of buying local rice p, b_{ijp}, and the potential demand for local rice p, q_{ijp}, can be determined by regressing these variables to the following set of covariates:

$$\pi_{ijp} = \alpha + \boldsymbol{\beta}'_{ij}\mathbf{T}_{ij} + \boldsymbol{\delta}'_j\mathbf{D}_j + \boldsymbol{\gamma}'_{ij}\mathbf{X}_{ij} + \boldsymbol{\theta}'_{ij}\mathbf{Z}_{ij} + \varepsilon_{ij} \quad (5)$$

$$b_{ijp} = \alpha + \boldsymbol{\beta}'_{ij}\mathbf{T}_{ij} + \boldsymbol{\delta}'_j\mathbf{D}_j + \boldsymbol{\gamma}'_{ij}\mathbf{X}_{ij} + \boldsymbol{\theta}'_{ij}\mathbf{Z}_{ij} + \varepsilon_{ij} \quad (6)$$

$$q_{ijp} = \alpha + \boldsymbol{\beta}'_{ij}\mathbf{T}_{ij} + \boldsymbol{\delta}'_j\mathbf{D}_j + \boldsymbol{\gamma}'_{ij}\mathbf{X}_{ij} + \boldsymbol{\theta}'_{ij}\mathbf{Z}_{ij} + \varepsilon_{ij} \quad (7)$$

In these equation the different specifications are as follows: $\mathbf{T}_{ij}$ is a vector of treatment (tasting and WOM) expressed in equations 2 and 3; $\mathbf{D}_j$ is a vector of distances between market j and the sea port of Cotonou relative to the rice development hubs of Glazoué; $\mathbf{X}_{ij}$ is a vector of the most important rice attributes for consumer i in market j (dummies which equal to one when the attribute is featured in the top-five of desired attributes); $\mathbf{Z}_{ij}$ is a vector of socio-demographic characteristics of

consumer i in market j; α is a constant parameter to be estimated, $\boldsymbol{\beta}_{ij}$, $\boldsymbol{\delta}_j$, $\boldsymbol{\gamma}_{ij}$, and $\boldsymbol{\theta}_{ij}$ are parameter vectors to be estimated, and ε_{ij} is a stochastic error term. Equation (5) was estimated using ordinary least squares with the correction of eventual heteroskedasticity. Equation (6) was estimated using a probit model and equation (7) was estimated using a truncated regression (Cragg, 1971).

3 Results

3.1 Consumers' characteristics, preferred rice attributes and WTP for alternative rice

At total, the sample includes 284 consumers in Dantokpa market (134) in Cotonou and Ouando market (150) in Porto-Novo (table 2). The results of mean comparison test of Student suggest that apart from the household size and the formal education, the characteristics of sampled rice shoppers varied with the market (table 2). The yearly income per capita was higher in Porto-Novo than Cotonou. The proportion of male participating in Cotonou was higher than the one of Porto-Novo. This result could be due to the fact that Porto-Novo is a historically traditional city while Cotonou is the more important cosmopolitan city in Benin. So in Porto-Novo the culture which suggests that the female are responsible of the activities linked to the food preparation is more respected.

Apart from the unstickiness, the proportion of most important rice attributes for Benin urban consumers varied with the city (table 3). For the consumers in Porto-Novo, the cleanness, whiteness, head rice recovery, slenderness, aroma and softness are more important than for consumers in Cotonou. For the consumers in Cotonou, taste and swelling capacity are more important than for consumers in Porto-Novo.

No matter the market and the round, the imported rice received the highest WTP from consumers (table 4). In Cotonou, Delice (IR841 variety, NP, IM), Saveur (IR841 variety, GEM, IM) and Unlabeled 2 (Nerica L20 variety, NP) received relatively good bids from consumers. As far as Porto-Novo is concerned, both Delice (IR841 variety, NP, IM) and Unlabeled 3 (Gambiaca variety, NP) received good bids.

3.2 Willingness to buy local rice, price premium, potential market share and potential demand

The willingness to buy local rice differed with the rice type (table 5). In Cotonou, Nerica 2 variety (NP, NIM); IR841 variety (NP, IM, L) and Nerica L20 variety (NP, NIM) were the most important rice type consumers were willing to buy while in Porto-Novo, IR841 variety (NP, IM, L) and Gambiaca variety (NP, NIM) were the most important local rice type consumers were willing to buy. So, in the two most important city of Benin, the IR841 variety (NP, IM, L) was the one of the most important local rice consumers were willing to buy.

In terms of price premiums to upgrade local rice relative to the imported rice, they significantly varied with the rice type, no matter the market (table 5). All the price premiums to upgrade local rice relative to the imported rice were negative suggesting that the imported rice is more competitive to the Benin urban consumers than the local rice. In Cotonou, Nerica L20 variety (NP, NIM), IR841 variety (NP, IM, L) and IR841 variety (GEM, IM, L) received the highest price premiums relative to the imported rice. The potential demand for local rice followed the same trend. In Porto-Novo, IR841 variety (NP, IM, L) and Gambiaca variety (NP, NIM) received the highest price premiums relative to the imported rice. However, the IR841 variety (NP, IM, L) was the most demanded. The demand of Nerica 1 variety (NP, NIM) slightly exceeded the one of Gambiaca variety (NP, NIM). This can be explained by the low price of the Nerica 1 variety (NP, NIM) which was the standard rice.

3.3 Factors determining the quality-competitiveness of Benin local rice vis-à-vis the imported rice

The table 7 presents the factors determining the consumers' revealed price premium to upgrade local rice relative to the imported rice and the potential demand for local rice in Benin. The Word-of-Mouth (WOM) premiums for both local rice and imported rice and the taste premium for imported had positive and significant effect on the revealed price premium to upgrade local rice relative to imported rice. These results suggest that the price premium to upgrade local rice relative to imported rice increased with the WOM communication and the tasting no matter the origin of the rice. So Benin urban consumers do not consider the local rice and the imported rice (Gino brand) as competitor. For them each of these rice is suitable for a kind of event. Generally, they use Gino (very expensive) for punctual celebrations such as Christmas while they use the relatively cheap rice for daily consumption. The revealed price premium decreased with the household size, the formal education, the distance to port relative to the hub. As far as the rice type is concerned, all alternative local rice types presented significant and positive effect. The Gambiaca variety (NP, NIM) and the IR841 variety (NP, IM, L) presented the highest effect. These rice types were the most competitive vis-à-vis the most preferred imported rice in Benin urban markets. The consumers who take into account the whiteness and the swelling capacity in the top-five attributes to purchase rice decreased their price premium for local rice. This suggests that Benin urban consumers are not yet satisfied about the swelling capacity and the whiteness of the locally produced rice. Male consumers accorded relatively high price premium to upgrade local rice relative to imported rice.

The factors which significantly affected the Benin urban consumers' potential demand for local rice were the WOM communication, the tasting, the household income, the household size, the distance to port relative to the Glazoué hub, the rice type, the head rice recovery and the slenderness of the grains. The potential demand for local rice increased with both the WOM and the taste premium for local rice while the willingness to buy local rice decreased with the taste premium for imported rice. When the yearly income increase, both the willingness to buy and the demand of local rice decrease. These results suggest that in Benin urban area, the local rice was more demanded by the consumers with moderate income level. The household size negatively affected the local rice demand suggesting that the large household in Benin urban area demanded less local rice, certainly due to the swelling capacity. When the distance to port relative to the hub increases, the willingness to buy local rice increases suggesting that if the distance to the rice development hub decreases relatively to the distance to port, the consumers will have high propensity to consume local rice. However the potential demand for the local rice decreases when the distance to port relative to the hub increases. This confusion of the direction of the influence of the distance could be due to the closeness between Porto-Novo and Cotonou. All local rice types have positive influence on both the willingness to buy and the potential demand of local rice.

In terms of partial effect, IR841 variety (NP, IM, L), Gambiaca variety (NP, NIM) and the Nerica 1 or 2 variety (NP, NIM) are respectively the local rice types that the consumers were mostly willing to buy and demanded. The consumers who require the head rice recovery and the grains' slenderness increased their willingness to buy and their potential demand for these rice types.

4 Discussion

In terms of price premium relative to the imported rice, alternative local rice were not competitive vis-à-vis the imported rice. This result is consistent with Naseem et al. (2013) who show that Benin people prefer imported rice.

The results of the present paper show that Benin urban consumer prefer white rice, with entire and slender grains and good swelling capacity. They are consistent with Kinkpé et al. (2016) who show that Benin people prefer rice that is white, aromatic, long-grain, without foreign matters and at a low price. Identifying the varieties which are competitive the most with imported rice and which

can mostly satisfied the urban consumers, the present paper complements the work of Kinkpé et al. (2016) who did not take into account the variety and the post-culinary characteristics of rice.

In the West African sub-region, Fiamohe et al. (2014) found that whiteness is the most important characteristic in the preference of urban consumers in Togo. This result tallies with that of the present paper. However, with regard to the variety, the present paper complements Fiamohe et al. (2014). Demont et al. (2013a) found that Senegalese consumers are willing to pay for local rice if it is of good quality. Therefore, they suggest investing in post-harvest activities to improve the quality of rice. The results of the present paper tally with those of Demont et al. (2013a).

Demont (2013), from the data of 19 African markets including Benin, reached the conclusion that the only way to make local rice competitive vis-à-vis the imported rice is to add value to it. This would involve investments to improve the intrinsic and extrinsic attributes of local rice. Thus, more effort should be made to make the identified variety, competitive vis-à-vis the most preferred imported rice in Benin.

The yearly income does not have significant effect on the quality competitiveness of local rice relative to the imported rice in terms of price premium and the willingness to buy local rice. These results tally with Demont et al. (2013a; 2013b) and Akoa Etoa et al. (2016). However, contrary to the findings of these authors, the present paper shows that rich consumers significantly consume less local rice relative to the imported rice.

5 Conclusion

This paper intends to analyze: (1) the competitiveness of local rice vis-à-vis the imported rice in the most important urban area of Benin and (2) the potential demand for local rice in Benin urban area. From the experiments, we deduce that the IR841 variety, non-parboiled, milled with improved technology and Labelled and the Gambiaca variety, non-parboiled and simply milled with the usual miller are simultaneously the most competitive vis-à-vis the imported rice, the rice types that consumers mostly are willing to buy and the most demanded by the consumers. The whiteness, the head rice recovery, the slenderness and a good swelling capacity are the requirements of the consumers. Working on these attributes in these two varieties, they could more satisfied Benin urban consumers.

From the results, one can conclude that the improved variety "IR841" and the local variety "Gambiaca" are those which could more satisfied the urban consumers' requirements. The processing technologies should be improved to get white, entire and slender grains. The post-harvest activities should be rigorously carried out to get rice with good swelling capacity.

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Tables

Table 1. List of rice types on two Benin urban markets

Urban market	Standard rice and price	Alternative rice
Dantokpa Market (Cotonou)	Unlabeled standard 1 (Nerica 2, NP) Price = 0.74 US$/kg	Delice (IR841 variety, NP, IM) Saveur (IR841 variety, GEM, IM) Unlabeled 1 (IR841 variety, TP) Unlabeled 2 (Nerica L20 variety, NP) Gino (imported rice, NP)
Ouando Market (Porto-Novo)	Unlabeled standard 2 (Nerica 1, NP) Price = 0.58 US$/kg	Delice (IR841 variety, NP, IM) Unlabeled 3 (Gambiaca variety, NP) Gino (imported rice, NP)

Note. NP = non-parboiled; TP = parboiled using the traditional parboiling technology; IM = improved milling technology; GEM = parboiled using the improved GEM ("Grain quality enhancer, Energy-efficient and durable Material") parboiling technology.

Table 2. Descriptive statistics of rice shoppers' socio-demographic characteristics on Benin most important urban markets

Variable	Unit/description	Dantokpa, Cotonou		Ouando, Porto-Novo		t of Student
		Mean	SD	Mean	SD	
Income per capita	US$	553	452	867	3709	2.2**
Household size	Individuals	6.34	7.68	5.93	4.41	-1.4
Age	Years	30.9	8.17	33.2	11.0	4.0***
Male	1 = male; 0 = female	0.35	0.48	0.27	0.45	-3.4***
Formal education	1 = yes; 0 = no	0.66	0.48	0.63	0.48	-0.8
Distance from the port	km	3.20	0.00	37.5	0.00	3.6E+16***
Distance from the hub	km	242	0.00	279	0.00	7.6E+14***
Number of participants		134		150		

, * Denotes respectively statistical significance at the 5% level and 1% level.

Table 3. Descriptive statistics of consumers' preferred rice attributes on Benin most important urban markets

Variable	Unit/description	Dantokpa, Cotonou		Ouando, Porto-Novo		t of Student
		Mean	SD	Mean	SD	
Cleanness[a]	1 = yes; 0 = no	0.34	0.47	0.38	0.49	1.9*
Whiteness	1 = yes; 0 = no	0.65	0.48	0.80	0.40	7.5***
Head rice recovery	1 = yes; 0 = no	0.15	0.36	0.23	0.42	4.4***
Slenderness	1 = yes; 0 = no	0.39	0.49	0.54	0.50	6.3***
Unstickiness	1 = yes; 0 = no	0.29	0.46	0.31	0.46	0.7
Taste	1 = yes; 0 = no	0.75	0.43	0.63	0.49	-5.7***
Aroma	1 = yes; 0 = no	0.36	0.48	0.49	0.50	5.4***
Softness	1 = yes; 0 = no	0.13	0.34	0.33	0.47	9.6***
Swelling capacity	1 = yes; 0 = no	0.39	0.49	0.00	0.00	-23.9***
Other attributes[b]	1 = yes; 0 = no	0.07	0.25	0.37	0.49	16.11***
Number of participants		134		150		

[a] Absence of foreign matter

[b] These attributes include long grain size and low cooking duration.

*, *** Denotes respectively statistical significance at the 10% level and 1% level.

Table 4. Descriptive statistics of rice shoppers' willingness to pay to upgrade standard to alternative rice types on two Benin urban markets

Urban market, standard rice and price	Alternative rice upgrade	Pre-sensory WTP (US$/kg)		Post-sensory WTP (US$/kg)		Post-collective WTP (US$/kg)	
		Mean	SD	Mean	SD	Mean	SD
Dantokpa Market (Cotonou) Standard = Nerica 2 Price = 0.74 US$/kg	Delice (IR841 variety, NP, IM)	0.09	0.10	0.08	0.12	0.09	0.11
	Saveur (IR841 variety, GEM, IM)	0.12	0.13	0.08	0.14	0.07	0.10
	Unlabeled 1 (IR841 variety, TP)	0.07	0.11	0.03	0.07	0.04	0.10
	Unlabeled 2 (Nerica L20 variety, NP)	0.13	0.14	0.10	0.14	0.09	0.11
	Gino (imported rice, NP)	0.35	0.26	0.31	0.26	0.32	0.24
Ouando Market (Porto-Novo) Standard = Nerica 1 Price = 0.58 US$/kg	Delice (IR841 variety, NP, IM)	0.13	0.11	0.11	0.11	0.15	0.11
	Unlabeled 3 (Gambiaca variety, NP)	0.13	0.12	0.12	0.12	0.14	0.10
	Gino (imported rice, NP)	0.34	0.29	0.37	0.32	0.45	0.28

Note. WTP = willingness to pay, NP = non-parboiled; TP = parboiled using the traditional parboiling technology; IM = improved milling technology; GEM = parboiled using the improved GEM ("Grain quality enhancer, Energy-efficient and durable Material") parboiling technology.

Table 5. Descriptive statistics of Consumers' willingness to buy local rice and consumers' revealed price premium for upgraded local rice relative to imported rice

Rice type	Willingness to buy local rice (%)				Revealed price premium (%)[a]			
	Dantokpa, Cotonou		Ouando, Porto-Novo		Dantokpa, Cotonou		Ouando, Porto-Novo	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Nerica 1 or 2 variety (NP, NIM)[b]	75.4	43.2	64.4	48.0	-46.2	34.4	-58.5	49.9
IR841 variety (NP, IM, L)[b]	59.4	49.3	82.6	38.1	-34.0	37.6	-32.6	47.7
Gambiaca variety (NP, NIM)[b]	_	_	73.0	44.6	_	_	-35.1	48.4
Nerica L20 variety (NP, NIM)[b]	49.3	50.2	_	_	-33.5	37.4	_	_
IR841 variety (GEM, IM, L)[b]	29.9	45.9	_	_	-37.4	37.3	_	_
IR841 variety (TP, NIM)[b]	12.7	33.4	_	_	-42.2	39.0	_	_
Number of participant	134		150		134		150	
ANOVA F of Fisher	40.4***		6.40***		2.90**		12.9***	

[a] Revealed price premium for domestic rice relative to imported rice obtained in the third (post-collective) bidding round = (average WTP for local upgrades – WTP for imported upgrade)/price of benchmark rice.
[b] : GEM denotes GEM parboiling technologies, IM denotes improved milling technologies, L denotes labeled, NIM denotes non improved milling technologies, NP denotes non parboiled, TP denotes traditional parboiling technologies
, * Denotes respectively statistical significance at the 5% level and 1% level.

Table 6. Descriptive statistics of Potential demand for local rice in most important Benin urban markets

Rice type	Dantokpa, Cotonou		Ouando, Porto-Novo	
	Mean	SD	Mean	SD
Nerica 1 or 2 variety (NP, NIM)[a]	15.0	18.2	7.37	13.39
IR841 variety (NP, IM, L)[a]	7.71	10.6	9.40	10.75
Gambiaca variety (NP, NIM)[a]	_	_	7.20	8.91
Nerica L20 variety (NP, NIM)[a]	5.70	10.6	_	_
IR841 variety (GEM, IM, L)[a]	2.87	7.51	_	_
IR841 variety (TP, NIM)[a]	0.89	3.45	_	_
Number of participant	134		150	
ANOVA F of Fisher	31.4***		1.78	

[a] : GEM denotes GEM parboiling technologies, IM denotes improved milling technologies, L denotes labeled, NIM denotes non improved milling technologies, NP denotes non parboiled, TP denotes traditional parboiling technologies
*** Denotes statistical significance at the 1% level

Table 7. Factors determining consumers' revealed price premium to upgrade local rice relative to imported rice, and potential demand for local rice on most important Benin urban markets

Variable	Revealed price premium	Potential demand			
		First hurdle: willingness to buy local rice		Second hurdle: potential demand for local rice	
	Coefficient	Coefficient	Partial effect	Coefficient	Partial effect
WOM premium local rice	0.254 (0.102) **	0.458 (0.293)	0.152	3.356 (1.989)*	1.774*
WOM premium imported rice	0.368 (0.047) ***	0.008 (0.133)	0.003	-0.346 (0.981)	-0.183
Taste premium local rice	0.102 (0.088)	0.225 (0.297)	0.075	3.967 (1.911)*	2.097**
Taste premium imported rice	0.194 (0.075)**	-0.368 (0.188)*	-0.122**	-0.452 (1.519)	-0.239
Income per capita (1000 US$)	0.000 (0.000)	-0.018 (0.000)**	-0.006**	-0.112 (0.046)**	-0.059**
Household size	-0.015 (0.004)***	0.007 (0.008)	0.002	-0.204 (0.051)***	-0.108***
Age	-0.002 (0.003)	-0.008 (0.006)	-0.003	-0.021 (0.042)	-0.011
Male	0.132 (0.004)**	-0.062 (0.119)	-0.020	1.006 (0.849)	0.532
Formal education	-0.101(0.055)*	-0.081 (0.118)	-0.027	0.619 (0.833)	0.327
Distance to port/distance to hub	-1.560 (0.472)***	2.128 (1.171)*	0.708*	-20.369 (9.589)**	-10.769**
Nerica 1 or 2 variety (NP, NIM)[a]	-0.071 (0.035)**	1.612 (0.167)***	0.536***	11.473 (1.259)***	6.066***
IR841 variety (NP, IM, L)[a]	0.115 (0.036)***	1.661 (0.173)***	0.552***	9.040 (0.921)***	4.779***
Gambiaca variety (NP, NIM)[a]	0.129 (0.037)***	1.623 (0.193)***	0.540***	9.107 (1.237)***	4.815***
Nerica L20 variety (NP, NIM)[a]	0.095 (0.036)***	1.168 (0.177)***	0.388***	4.843 (0.967)***	2.560***
IR841 variety (GEM, IM, L)[a]	0.060 (0.036)*	0.640 (0.177)***	0.213***	2.058 (0.746)***	1.088***
Cleanness	–0.007 (0.053)	-0.124 (0.117)	-0.041	-1.072 (0.805)	-0.567
Whiteness	–0.104 (0.047)**	0.073(0.111)	0.024	-0. 400 (0.894)	-0.212
Head rice recovery	0.015 (0.051)	0.227 (0.130)*	0.076*	1.778 (1.065)*	0.940*
Slenderness	-0.001 (0.045)	0.324 (0.116)***	0.108*	0.351 (0.736)	0.185
Unstickiness	-0.007 (0.050)	0.092 (0.121)	0.031	-0.446 (0.854)	-0.236
Taste	0.000 (0.052)	0.135 (0.128)	0.045	-1.044 (0.970)	-0.552
Aroma	0.021 (0.047)	-0.113 (0.114)	-0.037	-1.040 (0.799)	-0.550
Softness	–0.009 (0.052)	0.069 (0.131)	0.023	0.673 (1.120)	0.356
Swelling capacity	–0.127 (0.064)**	0.059 (0.134)	0.020	0.427 (0.904)	0.226
Other attributes	–0.089 (0.059)	-0.193 (0.154)	-0.064	-1.405 (1.055)	-0.743
Constant	–0.125 (0.127)	-1.201 (0.334)***	_	3.933 (2.307)*	_
Number of observations	1116	1112		1112	
R^2	0.314	–		–	
Sigma (error variance)	–	11.086 (0.603)***			

Note. Standard errors are represented between brackets.

[a] : GEM denotes GEM parboiling technologies, IM denotes improved milling technologies, L denotes labeled, NIM denotes non improved milling technologies, NP denotes non parboiled, TP denotes traditional parboiling technologies

*, **, *** Denotes respectively statistical significance at the 10% level, 5% level and 1% level.
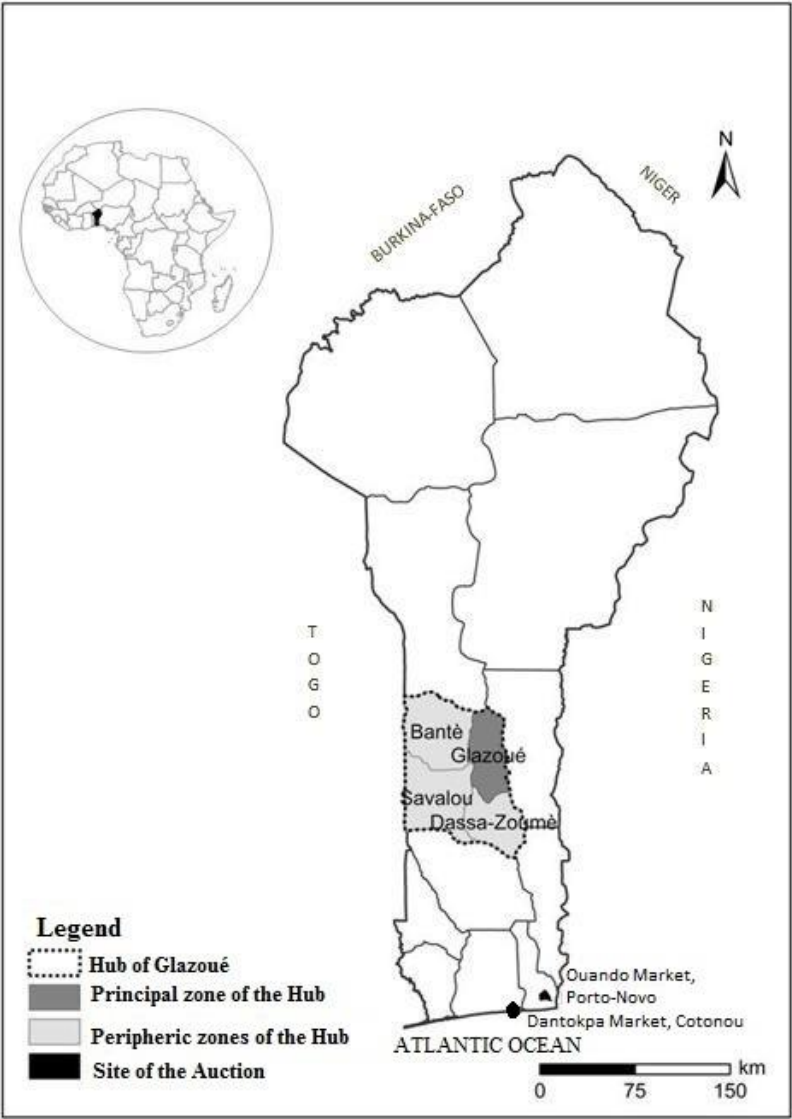
Figure

Fig.1. *Rice sector development hub of Glazoué and sample of urban markets in Benin Republic*