Consumer valuation of an improved rice parboiling technology: Experimental evidence from Cameroon

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Abstract

African countries have become increasingly dependent on rice imports, with concomitant risks for food security. Local rice often has had difficulties competing quality-wise with imported rice in urban markets. Parboiling can enhance the quality of local rice, but traditional methods often yield poor grain quality. Local rice was parboiled through an improved parboiling technology and consumers' willingness to pay for the end product was assessed through experimental auctions on the Yaoundé market. We found that, relative to traditionally parboiled rice, consumers were 14% more likely to purchase rice parboiled through the improved technology, and those who perceived the improved product as being imported (two thirds of the auction participants) paid 5% price premiums for it, while they discounted traditionally parboiled rice by 2%. This suggests that the major value of the improved parboiling technology lies in its ability to successfully dedifferentiate local from imported rice.

Key words: Central Africa; double-hurdle model; value chain upgrading; experimental auction; improved parboiling technology

1. Introduction

Since the 2008 food crisis, several African countries have recognised that agricultural growth is a precondition to broader growth (Aker *et al*. 2011). However, their food self-sufficiency programmes typically focus solely on production, with a disregard for the other changes along the value chain that need to complement such measures (Demont 2013). Cameroon's National Rice Development Strategy (NRDS) is no exception (GoC 2009). As a response to the food crisis, the government has taken actions to boost rice production in the country. These include, among others, (i) restructuring state corporations involved in rice production (SEMRY, UNVDA); (ii) promoting private rice-production firms to produce upland rice, like in Ebolowa, Nanga-Eboko, Akono, Tonga and Makenene; and (iii) strengthening the R&D research capacities of the Institute of Agricultural Research for Development (IRAD). As a result, paddy production has increased by 23% annually, i.e. from 68 000 tons in 2007 to 194 000 tons in 2013 (CountrySTAT Cameroon 2014). However, these impressive growth rates have not yet closed the gap between production and consumption, which has increased at a similar rate of 17% since 2000 (Rutsaert *et al*. 2013). As a result, the rice import bill is steadily growing and this has serious consequences for food security and the political stability of the country, as recorded during the 2008 food crisis (Moseley *et al*. 2010; Seck *et al*. 2010).

Rice production in Cameroon began in the 1930s. Between 1970 and 1990, government policies were geared toward the development of irrigated rice ecologies that were considered relatively more productive than the other ecologies. These policies led to the creation of three state corporations: SEMRY[1] in the northern region, UNVDA[2] in the north-western region, and SODERIM[3] in the western region. These corporations ensured the development of the Cameroonian rice sector and enabled the country to attain rice self-sufficiency and to export rice to other countries in the region. These corporations were mainly involved in the development of rice farms, water management, provision of farm input credits, advisory services, and the purchase, processing and marketing of rice. Following the economic crisis in the 1980s, Cameroon witnessed a decline in rice production owing to the discontinuation of state subsidies to state corporations involved in rice production and the soaring prices of basic farm equipment and inputs. This has transformed Cameroon from being a rice exporter to a rice importer.

The potential of Cameroon to produce enough rice for both local consumption and export is huge. The country has an abundance of forested land, but this potential has not been realised due to other constraints along the value chain, with one of the most important being poor post-harvest management practices. Locally produced rice is typically low-grade (high proportion of broken grains), contains a mix of varieties and is characterised by a high degree of foreign matter (stones, insects, weed seeds, etc.). This is symptomatic of the larger region (Seck *et al*. 2010). Cameroon's NRDS focuses mainly on supply-increasing investments and, although it explicitly recognises that investments in processing are necessary, the planned investments are targeted primarily at increasing processing capacity, such as husking machines, and do not encompass quality upgrading. Moreover, less than 1% of the planned budget is devoted to value chain upgrading (Demont 2013). Due to long-time exposure to rice imports, consumers in urban markets are now used to the superior quality (and associated image) of imported rice and have developed preferences for it. As a result, local rice producers have to compete quality-wise if they ever want to conquer urban markets.

The challenge of achieving quality-based competitiveness of local rice is not unique to Cameroon.

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[1] Société d'Expansion et de Modernisation de la Riziculture de Yagoua.
[2] Upper Noun Valley Development Authority.
[3] Société de Développement de la Riziculture dans la plaine de Mbo.

Demont (2013) identifies at least six other coastal countries (Benin, Côte d'Ivoire, Ghana, Nigeria, Senegal and Togo) with similar problems related to their rice market. He proposes that, for these countries, the first step to improving quality-based competitiveness of local rice is *quality dedifferentiation*, i.e. in the absence of strong consumer attachment to domestic rice, the best short- and medium-term option these countries face is to first quality dedifferentiate local from imported rice by adding value to local rice products, so that they blend into the set of competing imported rice brands. It is expected that this intermediate stage of quality dedifferentiation will enable farmers to participate in broader (urban) markets (Barrett 2008).

Parboiling provides a promising avenue for increasing the quality of local rice. Rice parboiling is a common practice in some sub-Saharan African countries like Cameroon, Nigeria, Ghana and Benin (Demont *et al*. 2012). The parboiled rice is mainly for domestic consumption, as in Benin (Fofana *et al*. 2011), or for export and domestic consumption in the case of Cameroon. The main reason for parboiling rice is to reduce grain breakage during milling, although it also has been shown that the nutritional quality of parboiled rice is superior to non-parboiled rice (Rao & Juliano 1970).

Recently, an improved parboiling technology was developed in Cameroon which enables further reducing the quality gap between local and imported rice (Ndindeng *et al*. 2014). However, it remains to be seen how consumers value this quality upgrade relative to other technologies. Therefore, this paper demonstrates how experimental methodologies based on auctions can be used to address this question. Experimental auctions have not been used widely in the African context, although they are useful tools for assessing empirically whether consumers are willing to pay price premiums for upgraded quality attributes that are not yet available on the market (e.g. De Groote *et al*. 2011; Morawetz *et al*. 2011; Demont & Ndour 2015). Because real products and real money are exchanged in experimental auctions, participants have increased incentives to reveal the true value they place on the attributes under research.[4] The results of these experiments may help investors, researchers and policy makers understand how the quality-based competitiveness of local rice can be improved in import-biased markets, such as the Yaoundé market in Cameroon.

The paper proceeds as follows. After this introduction, we briefly describe the improved parboiling technology in section 2. Section 3 provides the design of a set of framed field experiments, followed by an econometric approach in order to analyse the effectiveness of the improved technology in improving the quality-based competitiveness of local rice. Section 4 analyses the data and discusses the results, and section 5 concludes.

2. An improved parboiling technology

Traditional parboiling does not consistently lead to superior rice quality because processors are often poorly aware of the basic technicalities of parboiling, despite its simplicity (Diop *et al*. 1997). In traditional parboiling, the paddy is neither pre-cleaned nor washed before soaking. This usually results in a high level of impurities in the end product (milled rice). Soaking temperature is typically higher than 90°C and steaming time up to 60 minutes. These intense parboiling conditions typically turn the colour of the end product dark, with the development of a rancid flavour in storage. With the traditional vessel (drum), the samples at the bottom receive more steam over a longer period than the samples at the top. The difference in the degree of parboiling of samples from different locations within the same steaming vessel results in high grain breakage during milling and non-uniformity in the colour of traditionally parboiled milled rice.

The Institute of Agricultural Research for Development (IRAD) in Cameroon recently developed an improved parboiling technology code-named GEM (grain quality-enhancer, energy-efficient and

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[4] See Lusk and Shogren (2007) for an extensive review of the methodology.

durable material), which combines the use of a uniform steam parboiling system and an improved parboiling stove (Ndindeng *et al*. 2014). The paddy is first pre-cleaned by winnowing (throwing the mixture into the air) and washing to get rid of impurities and immature and poorly filled grains. This action alone significantly reduces the level of impurities and also reduces the broken fractions, as immature and poorly filled grains generally break during milling. Milder parboiling conditions (soaking temperature of 80°C and steaming time of 25 minutes) and more uniform distribution of the steam within the parboiling vessel both significantly reduce breakage during milling and result in a lighter, more uniform colour of the end product, which mimics high-grade imported rice in physical characteristics. Compared to traditionally parboiled rice, the improved product has a higher swelling capacity, a typical characteristic of imported rice that is highly valued by consumers (Demont *et al*. 2012). The improved product also has superior sensory quality, as it tends to have a less sour aftertaste than traditionally parboiled rice.

3. Data and methodology

3.1 Framed field experiments

We conducted a series of framed field experiments[5] based on experimental auctions in one of the two major urban consumption zones, i.e. Yaoundé, the political capital of Cameroon, which is remote from the rice-production zones. We use a similar procedure as described in Demont *et al*. (2012; 2013a; 2013b) and reviewed by Demont and Ndour (2015), with the exception of three methodological innovations. The detailed, step-by-step procedure can be found in the appendix, but here we will review the main features. The experiments were carried out in April 2012 and lasted four days, during which eight experimental auction sessions were conducted, one in the morning and one in the afternoon. The market segment targeted in our consumer experiment was female rice shoppers, as women are the major decision makers in households' rice purchases in Cameroon, as well as in other rice-consuming West-African countries (Demont *et al*. 2012). The experiments took place in the amphitheatre of IRAD Nkolbisson, which is five kilometres from Mokolo market, the most important and largest market in the town. All types of consumers visit it and all types of rice can be found there. For each session, 15 women were randomly selected and recruited on the spot.

The auctions were based on the "endow-and-upgrade" method, according to which each participant was endowed with a fixed "benchmark" rice and was presented three times with the option to upgrade it to an alternative rice type. We purposely selected the benchmark and three alternative rice types so that they would be different only in a bundle of post-harvest processing quality attributes that are relevant to rice value chain upgrading. On the Cameroonian rice market, the following rice types commonly can be found: imported non-parboiled homogenised rice, local non-parboiled non-homogenised rice and local traditionally parboiled rice. In order to focus purely on quality attributes generated through upgraded post-harvest processing, we kept the varietal component constant by using a single rice variety, viz. *Tox 3145,* processed into four different end products: (i) non-parboiled broken (NPB) rice (benchmark) priced at 350 FCFA/kg (€0.53/kg); (ii) non-parboiled homogenous (NPH) rice; (iii) "traditionally parboiled" (TRAD) rice, i.e. rice parboiled through the traditional technology; and (iv) rice parboiled through the improved technology (GEM). The benchmark (NPB) had a high percentage of broken grains and its quality was inferior to the three alternatives in the auction. The NPH rice was non-parboiled high-grade *Tox 3145* rice with about 95% head grain yield (5% of broken rice) and 1% of impurities thanks to cleaning and grading. As the parboiled rice types (TRAD and GEM) had lower percentages of broken grains, which is the main reason for the use of this processing technology (Rao & Juliano 1970), these products were not further cleaned and graded. The TRAD rice was *Tox 3145* rice parboiled by local parboilers in Ndop in the Northwest region of Cameroon, using the traditional parboiling technology (Ndindeng *et al*. 2014). The milled rice

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[5] See Harrison and List (2004) for a classification of experiments in empirical economics literature.

produced through the latter technology was darker, not homogenous and had impurity levels of up to 4%. The "GEM rice" was *Tox 3145* rice parboiled at IRAD using the GEM parboiling technology (Ndindeng *et al*. 2014). The improved parboiled rice had better physical (high head grain yield, low level of cracked and burnt grains, high whiteness value) and sensory (high swelling ratio, non-sour taste) quality than parboiled rice produced using the traditional method. Head grain yield was 95% and impurity levels were smaller than 0.02%. Hence, the difference between NPB (benchmark) and NPH was grain quality (purity and homogeneity), the difference between NPH and TRAD was the parboiling processing, and the difference between TRAD and GEM was the added value of the improved parboiling technology.

In order to simulate a market setting, we presented the four rice types in four plain white bags on a presentation table in the front part of the closed amphitheatre. The rice types were also presented on the participants' tables in four dishes, each one containing one kilogram of uncooked rice of each type. During the experiment, participants could examine the visual (purity and homogeneity) and sensory (taste and aroma) quality attributes of the uncooked rice types (taste is typically tested by biting the uncooked grains).

We chose the Vickrey (1961) second-price auction mechanism, whereby participants submit sealed bids on a product in a group context and the highest bidder buys the product at the second price. In combination with the endow-and-upgrade method, this implies that the bids represent the price premiums bidders are willing to pay in order to upgrade the benchmark rice to an alternative rice type. The winner exchanges his/her benchmark for the upgrade and all losing bidders retain their benchmark. The second-price auction is incentive compatible, because bidders cannot be made better off by misrepresenting their actual value, i.e. their weakly dominant strategy (i.e. a strategy that yields at least as good an outcome as any other) is to bid their real value for the good (Lusk & Shogren 2007). This auction mechanism has proven to be successful for assessing consumers' willingness to pay (WTP) for rice quality attributes in the African context (Demont & Ndour 2015). The experiment was conducted verbally in the languages French and *Pidjin*.

We conducted three bidding rounds separated by two within-subject treatments, viz. (i) a sensory test, aimed at assessing the impact of post-cooking quality attributes on WTP, and (ii) a collective induction treatment (CIT) aimed at assessing the impact of social cognition, or so-called word-of-mouth (WOM) communication, on WTP (Demont *et al*. 2013b). During the sensory test, each participant was presented with four dishes containing cooked samples of the four rice types and was asked to taste the rice types and rinse her mouth between each tasting. This allowed the participants to experience the sensory quality attributes (aroma, taste, texture and stickiness) and observe the swelling capacity of the cooked rice types. During the CIT, the participants were requested to gather around a table and attempt to achieve a consensus on their collective WTP (CWTP) to upgrade the benchmark rice to each alternative rice type. The CIT has been successfully used as a mechanism to elicit WOM exchange between participants on the valuation of rice quality, as it provides incentives for participants to reveal knowledge, information and opinion leadership about the value of the products under research (Demont *et al*. 2013b). We improved the CIT on the basis of Demont *et al*. (2013b) by splitting the 15 participants into three competing groups of five, making the CIT binding and subjecting it to the same Vickrey auction mechanism. Hence, the complete bidding sequence involved five steps to which all participants were exposed, i.e. (i) first individual bidding round, (ii) first treatment (sensory test), (iii) second individual bidding round, (iv) collective bidding round that serves as a second treatment (CIT), and (v) third individual bidding round. We did not vary the sequence of the treatments (to control for sequence dependency), as we wanted the participants to use all information, including sensory, during group discussion.

At the end of the four bidding rounds, i.e. three individual and one collective, we randomly selected one upgrade and one round as binding. Hence, depending on the selected round, there was either one

winner or a group of five winners. Finally, we administered a two-page questionnaire to collect sociodemographic data. We split the questionnaire into two parts, viz. one with general questions administered before and during the auctions, and one with rice-related questions administered after the auctions in order to avoid revealing too much about the rice types' identity and the objectives of the study (Corrigan & Rousu 2008).

3.2 Methodology for analysing the determinants of WTP

Haines *et al*. (1988) argue that food consumption decisions should be modelled as a two-stage process. Participants first decide whether they are willing to upgrade their endowed kilogram of rice or not and, if yes, they decide next how much they are willing to add for the new product. The double-hurdle model introduced by Cragg (1971) correctly represents this two-stage decision process.

Let *WTU$_{ijpr}$* be the variable representing the willingness to upgrade an endowed kilogram of rice as a dichotomous 'adoption' variable (willing to upgrade or not) and let *WTP$_{ijpr}$* be the amount spent on the upgrade by the *i*th consumer (*i* = 1, …, 15) in the *j*th session (*j* = 1, …, 8) for the *p*th rice type (*p* = NPH, TRAD, GEM) in the *r*th bidding round (*r* = pre-tasting, post-tasting, post-CIT):

$$WTU_{ijpr} = \boldsymbol{\alpha}'\mathbf{x}_{ijpr} + u_{ij} + v_{ijpr} \tag{1}$$

$$WTP_{ijpr} = \boldsymbol{\alpha}'\mathbf{x}_{ijpr} + u_{ij} + v_{ijpr} \tag{2}$$

where $\mathbf{x}_{ijpr}$ is a vector of independent variables including two product dummy variables identifying the three alternative rice types (NPH and GEM; TRAD is set as the reference), two dummy variables for the bidding round (pre-tasting and post-CIT; the post-tasting round is set as the reference), a dummy variable for the time of the day, and a vector of socio-demographic variables $\mathbf{x}_v$ (*v* = 1, …, *s* = 23), $\boldsymbol{\alpha}$ is a conformable vector of coefficients, *u$_{ij}$* is an individual-specific disturbance for participant *i* in session *j*, and *v$_{ijpr}$* is the overall error term.

Following Cragg (1971), *WTP$_{ijpr}$* is the consumers' bid to upgrade the mediocre-quality benchmark rice to any of the three alternatives. The first hurdle (WTU) is the consumer's decision of whether or not to upgrade. The probability of the respondent choosing not to bid a positive amount in order to upgrade (*WTP$_{ijpr}$* = 0) is expressed by:

$$Prob(WTP_{ijpr} = 0) = \Phi(-\boldsymbol{\alpha}'_1\mathbf{x}_{ijpr}) \tag{3}$$

where Φ is the standard normal density function. The second hurdle determines the effect of independent variables on *WTP$_{ijpr}$*, given *WTU$_{ijpr}$* = 1 and *WTP$_{ijpr}$* > 0. The distribution of *WTP$_{ijpr}$* conditional on being positive is truncated at zero and assumed normal, with mean $\boldsymbol{\alpha}'_2\mathbf{x}_{ijpr}$ and variance σ^2. The second hurdle is formulated as:

$$\tag{4}$$
$$f(WTP_{ijpr}|WTP_{ijpr} > 0) = \frac{(1/\sigma)\Phi[(WTP_{ijpr}-\boldsymbol{\alpha}'_2\mathbf{x}_{ijpr})/\sigma]}{\Phi(\boldsymbol{\alpha}'_2\mathbf{x}_{ijpr}/\sigma)}$$

where Φ is the standard normal density function and $\boldsymbol{\alpha}_2$ is a vector of coefficients.

4. Results and discussion

4.1 Descriptive statistics

A total of 120 female shoppers participated in the field experiments. Table 1 reports some key summary statistics of the socio-demographic characteristics of the sample. Two ethnic groups dominated, i.e. *Bamiléké* (41%) and *Béti* (35%). Shoppers were on average 34 years old and 37% of them had attained tertiary education, i.e. a higher rate than the average of 13% recorded for Yaoundé's female population (INS 2003). More than a quarter (28%) of the participants were active in small trade, 21% were students, 15% were employed, 10% were servants and 3% were housewives. Household sizes averaged 5.0 persons, which is consistent with the Yaoundé average of 4.7 (INS 2003). The average monthly household earnings were almost 120 000 FCFA (€183), or 25 000 FCFA (€38) per capita, which is substantially smaller than the average of 55 000 FCFA (€84) for Yaoundé (INS 2003) and the urban average of 54 000 FCFA (€83) for the country (INS 2011). Only 8% of the households had a paid cooking housemaid and 4% owned a motorbike, but almost half (45%) of them owned a house, 34% owned land and 15% a car. A little over one-third (36%) presented themselves as household head, which is higher than the average share of female-headed households of 24% for Yaoundé (INS 2003). Close to three-quarters of the women (73%) were members of a formal group, in most cases (49%) a credit-savings association ("tontine"). Hence, our sample of the target population of "female shoppers between 19 and 65 years old" is more educated, poorer and more in charge of their households than the average female urban dweller in Yaoundé. Most women who visit the Mokolo market for shopping purposes come from the city centre of Yaoundé, where women tend to be more educated than in the surrounding semi-urban and rural outskirts. Moreover, the women who do their own shopping on weekdays (our experiment took four days, three of which were weekdays) tend to work in less time-demanding jobs that are usually in the low to medium salary scale. Women with lower opportunity costs of time are more likely to accept the invitation to participate in a two-hour experiment and this may explain the higher share of household heads, as 77% of the latter were single.

The average time spent on lunch preparation, including going to the market, preparation and actual cooking, was almost three hours each day (168 minutes). On a weekly basis, households usually purchased on average about five kilograms of rice and had three to four rice meals, resulting in an annual consumption of 50 kilograms per capita. Women were highly (84%) involved in household decision making on rice purchases, which justifies our focus on women.

Table 1: Summary statistics of socio-demographic variables in the experimental sample

Variable	Definition	Mean (Std. dev.)
Bamiléké	1 = belongs to ethnic group *Bamiléké*; 0 = otherwise	0.41 (0.49)
Béti	1 = belongs to ethnic group *Beti*; 0 = otherwise	0.35 (0.48)
Bassa	1 = belongs to ethnic group *Bassa*; 0 = otherwise	0.10 (0.30)
Age	Age in years	34 (9)
Tertiary education	1 = has had tertiary education; 0 = otherwise	0.37 (0.48)
Trader	1 = active in trading; 0 = otherwise	0.28 (0.45)
Student	1 = studying at university; 0 = otherwise	0.21 (0.41)
Servant	1 = is a servant; 0 = otherwise	0.10 (0.30)
Housewife	1 = is a housewife; 0 = otherwise	0.03 (0.18)
Employed	1 = is employed; 0 = otherwise	0.15 (0.36)
Group membership	1 = member of a formal group; 0 = otherwise	0.73 (0.45)
Tontine	1 = member of a savings/credit association; 0 = otherwise	0.49 (0.50)
Household head	1 = presents herself as head of household; 0 = otherwise	0.36 (0.48)
Household income	Monthly household income in 1 000 FCFA[a]	119 (246)
Household size	Number of individuals in household	5.0 (2.5)
House	1 = household owns a house; 0 = otherwise	0.45 (0.50)
Car	1 = household owns a car; 0 = otherwise	0.15 (0.36)
Motorbike	1 = household owns a motorbike; 0 = otherwise	0.04 (0.20)
Land	1 = household owns land; 0 = otherwise	0.34 (0.47)
Cooking housemaid	1 = household has a paid cooking housemaid; 0 = otherwise	0.08 (0.28)
Lunch preparation time	Total time (minutes) spent on preparing lunch (going to the market, preparation and cooking)	168 (66)
Purchase frequency	Number of rice purchases per week	2.1 (1.8)
Purchase quantity	Quantity of rice purchased per week (kg)	4.7 (4.2)
Consumption frequency	Number of rice meals per week	3.4 (3.9)
Per capita consumption	Annual quantity of rice consumed per capita (kg)	50 (44)
Involvement	1 = is involved in rice purchase decision-making in household; 0 = otherwise	0.84 (0.37)
Hungry	1 = is currently hungry; 0 = otherwise	0.73 (0.44)
Awareness	1 = is aware of local rice; 0 = otherwise	0.87 (0.33)
GEM_imp	1 = recognises GEM as imported rice; 0 = otherwise	0.68 (0.47)
Prefers fragrant	1 = prefers fragrant rice; 0 = otherwise	0.51 (0.50)
Prefers local	1 = prefers local rice; 0 = otherwise	0.36 (0.48)
Prefers parboiled	1 = prefers parboiled rice; 0 = otherwise	0.24 (0.43)
Quality sensitive	1 = judges quality to be more important than price; 0 = otherwise	0.89 (0.31)
Sample size		120

Note: Standard deviation is in parenthesis
[a] fixed exchange rate is €1 = 655.957 FCFA
Source: own calculations

Yaoundé women are very sensitive to rice quality; 89% of them judged quality to be more important than price. Although 87% of the participants were aware of the existence of local rice, due to quality issues only one third (36%) preferred it to imported rice. Due to Cameroon's long history of rice imports, Yaoundé women have been highly exposed to high-quality imported fragrant rice, which was preferred by half (51%) of the participants. However, when asked which rice type(s) were imported, only in 4% of cases all rice types were correctly identified as being local (Figure 1). Due to the inferior quality produced by traditional parboiling technologies, only a quarter (24 percent) had a preference for traditionally parboiled rice (Table 1) and only in 16 percent of the cases perceived it as being "imported" (Figure 1). The GEM rice type, in contrast, was perceived as being "imported" by more than two thirds of the population (Table 1 and Figure 1).

Table 1This suggests that the GEM technology successfully dedifferentiates local parboiled rice from imported rice. Therefore, in order to assess the impact of perceived dedifferentiation on WTP, in the remainder of the analysis we will include a dummy variable "GEM_imp" equalling one in case the participant had (erroneously) identified the GEM rice as being imported and zero otherwise (Table 1).
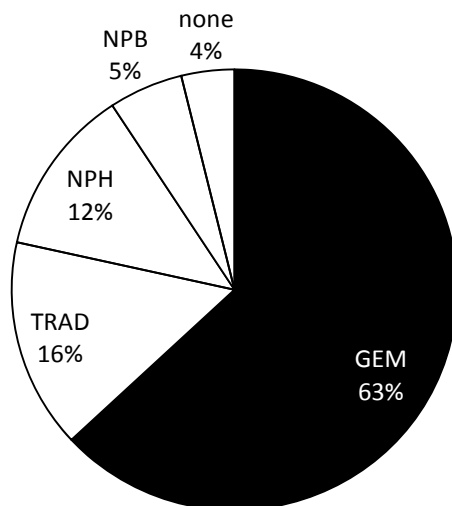

Figure 1: Perceived quality dedifferentiation of alternative rice types (proportion of cases in which the products were perceived as being "imported")
Note: NPB = non-parboiled broken rice; NPH = non-parboiled homogenous rice; TRAD = traditionally parboiled rice; GEM = rice parboiled through the improved technology
Source: own calculation

4.2 Determinants of WTP

Table 2 displays the mean bids for the rice types in Yaoundé over three individual bidding rounds separated by the sensory test and the CIT. Due to the use of the endow-and-upgrade method, bids have to be interpreted as differences in WTP between the benchmark rice (priced at 350 FCFA/kg or €0.53/kg at the time of the experiment) and the upgrades. Due to the mass of non-positive bids, we report the mean of the positive bids in addition to the mean of all bids. Average individual positive bids ranged from 54 to 139 FCFA/kg (€0.08 to 0.21/kg), depending on the product and the bidding round. GEM rice fetched the highest bids, followed by TRAD and NPH rice, suggesting positive price premiums for rice quality upgrading through parboiling. Willingness to upgrade (WTU, proportion of participants willing to upgrade) and bids on GEM and TRAD rice seemed to decline after the sensory test, however, while the opposite seemed to hold for the NPH rice. However, these changes need to be analysed more rigorously through econometrics (double-hurdle model).

The determinants of WTP identified through the double-hurdle model are presented in Table 3. The first three data columns show the effect of rice characteristics and consumer demographics on the probability that the consumer will upgrade the benchmark rice to enhanced-quality rice, while the determinants of WTP are presented in the last three columns. Overall, we found little influence of socio-demographic variables on WTU and WTP, which is consistent with the literature (Lusk & Shogren 2007). Since treatments and perceptions may be product specific, we added several interaction terms.

Table 2: Descriptive statistics of consumers' willingness to upgrade (WTU) and willingness to pay (WTP) to upgrade non-parboiled broken rice to alternative rice types

	Rice type	Pre-tasting	Post-tasting	Post-CIT
WTU (%)	Non-parboiled homogenous (NPH)	79	79	77
	Traditionally parboiled (TRAD)	84	70	70
	GEM parboiled	95	87	84
Mean of positive WTP bids (FCFA)	Non-parboiled homogenous (NPH)	54 (48)	62 (46)	66 (48)
	Traditionally parboiled (TRAD)	108 (89)	100 (84)	100 (66)
	GEM parboiled	137 (95)	132 (98)	139 (64)
Mean of all WTP bids[a] (FCFA)	Non-parboiled homogenous (NPH)	43	49	51
	Traditionally parboiled (TRAD)	91	70	70
	GEM parboiled	130	114	117

Note: WTU was recorded as a dichotomous 'adoption' variable (willing to upgrade or not) and the percentages represent the proportion of participants who were willing to upgrade. The retail price of the benchmark rice was about 350 FCFA/kg (€0.53/kg) in April 2012 at a fixed exchange rate of €1 = 655.957 FCFA; Standard deviation is in parenthesis
[a] We set the non-positive bids to zero
Source: own calculations

Five major observations can be made with important implications for value chain upgrading. First, consumers are 12 to 14% more likely to upgrade to GEM and NPH rice than to TRAD rice. This suggests that post-harvest quality upgrading, whether it be improved parboiling or purification and homogenisation, is important in the struggle to make local rice competitive with imported rice in urban markets in Cameroon. Secondly, the GEM product is not significantly affected by tasting, while the TRAD product lost 12% of its market share after tasting, to the benefit of NPH rice. This is consistent with claims in the literature that traditional parboiling technologies often yield inferior post-cooking quality attributes (Diop *et al*. 1997; Behrens *et al*. 2007; Ituen & Ukpakha 2011). Thirdly, employed women or group members are more likely to pay for rice quality than traders, students, servants or housewives. The latter may be due to increased opportunity costs for time (for cleaning, sorting and purifying rice with mediocre grain quality) due to urbanisation (Reardon 1993). Fourthly, households with higher per capita consumption levels are also more likely to pay for quality. Since per capita consumption of rice in Cameroon has been increasing at an impressive annual rate of 17% since 2000 – the highest growth rate recorded in Central Africa (Rutsaert *et al*. 2013) – this has important implications for value chain upgrading.

Finally, the strongest and most important result for marketing research is our finding that the likelihood to upgrade from the benchmark to the GEM parboiled rice can be explained mainly by the fact that shoppers confounded the GEM product with imported rice. While the product dummy for NPH featured a significantly negative coefficient, the coefficient for the GEM dummy was not significant. Instead, its significance was transferred to the interaction term with the GEM_imp variable, implying that the GEM technology adds value to locally parboiled rice precisely because, as perceived by consumers, it dedifferentiates local from imported rice. Consumers generally discounted NPH rice by 33 FCFA (€0.05/kg), or 6% of the total value of TRAD rice. However, those who perceived the GEM product as being "imported" discounted TRAD rice by 11 FCFA/kg (€0.02/kg) – or 2% of its retail market price – and paid price premiums averaging 27 FCFA/kg (€0.04/kg) or 5% for GEM rice. Participants were neither informed about the source of the rice nor its processing method and could hardly believe that rice with physical and eating characteristics similar to those of high-grade imported rice (taste, cleanliness, non-stickiness, whiteness and aroma) was produced locally (Figure 1). However, although fewer participants (16%) perceived TRAD rice as being "imported", those who did for GEM rice were 13% more likely to upgrade to TRAD rice and 10% less likely to upgrade to NPH rice. This reveals the existence of an important market segment (68% of shoppers, Table 1) for locally produced and processed rice.

Table 3: Determinants of consumers' willingness to upgrade (WTU) and willingness to pay (WTP) to upgrade non-parboiled broken rice to alternative rice types

Variable	First hurdle: WTU			Second hurdle: WTP		
	Coefficient	SE[a]	Marginal effect	Coefficient	SE[a]	Marginal effect[b]
NPH[c]	0.524**	0.233	0.123**	-115.492***	34.526	-32.754***
GEM[c]	0.593***	0.207	0.139***	5.081	21.266	15.648
Pre-tasting[d]	0.498***	0.180	0.117***	1.014	18.800	11.885
Post-CIT[d]	-0.040	0.117	-0.009	-1.987	16.956	-1.700
NPH × pre-tasting	-0.528***	0.206	-0.124***	-29.346	28.524	-23.588
NPH × post-CIT	0.001	0.138	0.000	19.530	22.450	7.615
GEM × pre-tasting	0.051	0.239	0.012	3.034	15.055	2.357
GEM × post-CIT	-0.094	0.165	-0.022	21.677	14.413	6.238
GEM_imp	0.564***	0.205	0.132***	-60.981**	27.894	-10.661**
NPH × GEM_imp	-0.424*	0.223	-0.099*	0.672	27.082	-9.519
GEM × GEM_imp	0.127	0.224	0.030	62.015**	24.921	27.010**
Morning	0.060	0.189	0.014	-27.298	18.225	-9.220
Beti	0.307	0.313	0.072	-31.545	35.793	-5.167
Bamiléké	-0.226	0.283	-0.053	37.170	31.094	9.226
Bassa	-0.112	0.383	-0.026	-58.351	66.331	-25.249
Age	-0.007	0.013	-0.002	-1.566	1.429	-0.759
Tertiary education	0.035	0.263	0.008	-36.973	29.263	-13.538
Trader	0.379	0.254	0.089	-16.286	30.553	2.433
Student	0.429	0.310	0.101	27.997	38.886	20.779
Servant	0.562	0.372	0.132	33.909	35.032	26.138
Housewife	0.977	0.595	0.229	-56.202	51.752	0.723
Employed	1.090***	0.320	0.255***	50.041	35.390	44.583
Group membership	0.615**	0.262	0.144**	40.699	33.483	29.982
Tontine	-0.126	0.245	-0.029	-32.307	25.002	-15.447
Cooking housemaid	0.228	0.324	0.053	25.156	37.048	15.024
Lunch preparation time	0.000	0.001	0.000	-0.071	0.167	-0.023
Household size	-0.026	0.043	-0.006	-3.595	4.614	-1.997
Household income	-0.000	0.000	0.000	0.025	0.027	0.000
Female headed	-0.217	0.236	-0.051	21.795	29.939	3.463
Involvement	0.164	0.245	0.039	-2.372	26.250	2.875
Per capita consumption	0.006**	0.002	0.001**	-0.210	0.197	0.052
Hungry	0.189	0.209	0.044	-14.028	26.857	-1.074
Awareness	-0.342	0.226	-0.080	-46.703	33.374	-26.016
Preference parboiled	0.262	0.243	0.061	-31.963	26.091	-6.354
Quality sensitive	0.316	0.276	0.074	16.812	32.687	13.813
Constant	-0.851	0.678		226.789***	83.622	

Note: NPH = non-parboiled homogenous rice; TRAD = traditionally parboiled rice; GEM = rice parboiled through the improved technology; CIT = collective induction treatment. Retail prices were about 350 FCFA/kg (€0.53/kg) for the benchmark and 550 FCFA/kg (€0.84/kg) for TRAD (reference for the product dummies) in April 2012 at a fixed exchange rate of €1 = 655.957 FCFA.
* Significant at α = 10%; ** significant at α = 5%; *** highly significant at α = 1%
[a] Standard errors are robust and cluster corrected
[b] Mean partial effect of the variables on the unconditional expected value of WTP
[c] The coefficient of this dummy has to be interpreted as relative to the reference, i.e. TRAD
[d] The coefficient of this dummy has to be interpreted as relative to the reference, i.e. second round (post-tasting)
Sigma (error variance)   = 96.314*** (12.841)
Log pseudolikelihood   = -4621.644
No. of observations   = 972
Source: own calculations

Finally, the insignificance of our collective induction treatment variables suggests an absence of negative (or positive) WOM in the surveyed population and that our results are robust to aggregation. We believe that subjecting the CIT to the same Vickrey auction and making it binding – an innovation to its first application (Demont *et al.* 2013b) – has made the CIT more efficient in inducing WOM exchange among participants, as it generated increased incentives to achieve group consensus on

valuation (which was successful in 94% of the cases). Further research is warranted to determine whether the CIT is also incentive compatible.

5. Conclusions

In this paper, we demonstrate how experimental methodologies based on auctions can be used in order to assess how consumers value a quality upgrade in the market stemming from an improved processing technology. Our field experiments have shown that the majority of consumers are willing to pay quality premiums for local rice, particularly if it has characteristics of imported rice. The rice product obtained through the improved technology developed by IRAD was the most preferred product due to the uniformity, form and colour of the grains obtained through the technology. Moreover, our attempt to capture consumers' perceived quality dedifferentiation through the survey paid off through a better understanding of the conditions under which urban consumers are willing to pay for enhanced quality of locally produced rice. The majority of consumers (erroneously) confounded locally produced GEM rice with its competing product. More importantly, our double-hurdle model revealed that those who did paid price premiums of 5% for the improved local product. This suggests that the major value of the GEM technology lies exactly in the fact that it successfully dedifferentiates locally produced parboiled rice from imported rice. In this experiment, we kept the varietal component constant, which allowed us to focus purely on consumers' perceived quality valuation of rice processed through alternative processing technologies. A major limitation of this methodological choice is that it excluded the competing product, i.e. imported rice, from the set of our products to be auctioned, as this would have confounded processing with varietal effects. Future experiments are needed in order to confirm whether GEM rice is successfully dedifferentiated from imported rice in a side-by-side comparison.

Despite this limitation, we found that quality dedifferentiation through investment in post-harvest processing infrastructure can help tailor local rice to urban consumer standards, which is one of the first recommendations for rendering local rice competitive with imported rice in import-biased markets (Demont 2013). The price of imported parboiled rice was around 500 FCFA/kg at the time of the experiment. Hence, the average price premium of 139 FCFA/kg for GEM rice recorded during the last auction round (relative to the benchmark, which is priced at 350 FCFA/kg) suggests some scope for competitive pricing. Moreover, the Cameroonian rice market is growing rapidly and the segment of urban consumers who are willing to pay for rice quality is also expected to grow. We expect that, once post-harvest processing infrastructure is upgraded, investment in productivity will be more effective in improving the competitiveness of local rice, as it will enable Cameroonian rice farmers to serve urban markets.

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Appendix
Consumer Valuation of an Improved Rice Parboiling Technology: Protocol of experimental auctions implemented in Mokolo Market, Yaoundé (Cameroon), April 2012

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1   Background and objectives

The CIDA-DFATD[6]/IRAD[7]/AfricaRice[8] project on "Enhancing food security in Africa through improvement of post-harvest handling, marketing and the development of new rice-based products" has as ultimate outcome to increased food security and sustainable livelihoods among rice value chain actors in Cameroon, Ghana, Mali, Nigeria, Senegal, Sierra Leone and Uganda. This project aims at strengthening the capacity of local rice farmers, processors and traders in target countries by allowing them to apply new technologies and techniques for achieving best rice-based products. One of the outcomes of this project is to gain a better understanding of consumer preferences for rice. This will allow for the production what consumers want in terms of quality and price. In order to know the preferences and the price the consumer is willing to pay for local rice that has undergone different transformation processes, IRAD organized experimental auctions sessions on rice in Yaoundé in April 2012.

The experimental auctions aimed at providing empirical support for the following research question: *Is the consumer prepared to pay for post-harvest and processing qualities of local rice and, if yes, what is consumers' willingness to pay (WTP) for post-harvest quality of local rice through (i) purification and homogenization, (ii) traditional parboiling, and (iii) an improved parboiling technology?*

2   Program and itinerary

Date	Activity	People involved
November 2011	Literature review	AKOA ETOA J. Mireille
4-9 December 2011	Training on experimental auctions in Kampala (Uganda)	Matty Demont, AKOA ETOA J. Mireille.
19 December 2011	Restitution of training workshop on experimental auction held in Uganda to rice postharvest team at IRAD	AKOA ETOA J. Mireille

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[6] Canadian International Development Agency, Department of Foreign Affairs Trade and Development of Canada
[7] Institut de Recherche Agricole pour le Développement
[8] Africa Rice Center

December 2011 – April 2012	Literature Review Visit of Mokolo Market in Yaoundé Development of the research question and protocol Purchase of rice at Ndop (Cameroon North-West region) Parboiling of rice purchased Purchase of material	AKOA ETOA J. Mireille, Dr Sali NDINDENG, MAPIEMFU Delphine Epse LAMARE, TANG Erasmus
24-25 April 2012	Training of 16 researchers from the IRAD on experimental auctions (Co-animator, recruiters, auctioneers, enumerators, cooking team).	AKOA ETOA J. Mireille
25 April 2012	Preparation of the room	AKOA ETOA J. Mireille, Sali NDINDENG, NGOME Francis, Éric Joël NOSSI, Valentine NCHINDA, Francis ETAME, Tite BEBOM, Honoré TEKEU, Boniface BINDZI
	Training of the cooking team (Stella T. TIEBONTSE epse ATANGA and Theresia Keng NDUM epse TIEMAH)	AKOA ETOA J. Mireille
	Training of Co-animator-Auctioneer (Precillia TATA Epse NGOME, Violette MBAH TIFUH), the recruiters/enumerators (Valentine NCHINDA, Francis ETAME, Precillia TATA Epse NGOME) and the data entry team (Eric Joël NOSSI, Marie Noël MELIE epse TEMGUE)	AKOA ETOA J. Mireille
26 April 2012	Experimental auction sessions 1–2	AKOA ETOA J. Mireille, Precillia TATA Epse NGOME, Violette MBAH TIFUH
27 April 2012	Experimental auction sessions 3–4	AKOA ETOA J. Mireille, Precillia TATA Epse NGOME, Violette MBAH TIFUH
28 April 2012	Experimental auction sessions 5–6	AKOA ETOA J. Mireille, Precillia TATA Epse NGOME, Violette MBAH TIFUH
30 April 2012	Experimental auction sessions 7–8 Cleaning of the room and distribution of rice left to all staff members	AKOA ETOA J. Mireille, Precillia TATA Epse NGOME, Violette MBAH TIFUH

3 Preparation

First, a literature review on experimental auctions was conducted. Then, a researcher, AKOA ETOA J. Mireille travelled to Kampala (Uganda) to receive training on experimental auctions organized by AfricaRice. Upon her return she trained the other members of post-harvest team at IRAD. Next, a visit to Mokolo market was undertaken in order to develop the research question and protocol of the experimental auctions that would be held in Yaoundé. This market is the most important and largest market of the town. All types of consumers visit it and all types of rice can be found there. The research question and the protocol were subsequently developed and the rice was purchased in Ndop rice sector development hub in the Cameroon North-West region (the most important local rice production area in the Great-South[9] Cameroun). The variety selected was *Tox 3145* because it was the most popular variety for the production of raw and parboiled rice. The rice was parboiled in the Laboratory of Food Science and technology, IRAD-Cameroon, using the Grain quality enhancer, energy Efficient and durable Material (GEM) parboiling technology (GEM rice). Raw, milled rice was purchased from UNVDA and one part was sorted to produce 95 percent whole grains (non-parboiled, homogenous rice) while the other part was left unsorted (non-parboiled broken rice). Traditional parboiled rice was also purchased from Ndop market. Other materials for the experimental auction were purchased in the Mokolo market in Yaoundé.

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[9] The Great-South Cameroon is made of Center, South, East, Littoral, West, North-West and South-West regions.

From the 24th to the 25th of April 2011, a training on experimental auctions was held for 16 researchers and other staff members from IRAD. The first part of that training (24th April 2011) was theoretical and the second part was practical (25th April 2011). On the second day, the room was prepared and the team was divided into an animator, a co-animator, recruiters, auctioneers, enumerators, a cooking team and trained respectively in the domains concerned. The room was the amphitheater of IRAD Nkolbisson, which is five kilometers from Mokolo market. Inside a banner was extended on the front wall. The front stage featured a table displaying four bags containing different rice types. The 15 tables reserved for the participants were divided into three rows of five tables (Figure 1).

Figure 2. Preparation of the laboratory

4   Design

We purposely selected the benchmark and three alternative rice types such that they would be different only in a bundle of post-harvest processing quality attributes that are relevant to rice value chain upgrading. On the Cameroonian rice market, the following rice types are common: imported homogenized parboiled rice, imported homogenized non-parboiled rice, local non-homogenized non-parboiled rice and local traditionally parboiled rice. In order to purely focus on quality attributes generated through upgraded post-harvest processing, we kept the varietal component constant by using a single rice variety, i.e. *Tox 3145,* processed into four different end-products:

1)   Non-parboiled broken (NPB) rice (benchmark) priced at 350 FCFA/kg (€0.53/kg);
2)   Non-parboiled homogenous (NPH) rice;
3)   "Traditionally parboiled" (TRAD) rice, i.e. rice parboiled through the traditional technology; and
4)   Rice parboiled using the GEM parboiling technology (GEM rice).

The benchmark (NPB) had a high percentage of broken grains and its quality was inferior to the three alternatives in the auction. The NPH rice was non-parboiled high-grade *Tox 3145* rice with about 95 percent head grain yield (5 percent of broken rice) and 1 percent of impurities thanks to cleaning and grading. As the parboiled rice types (TRAD and GEM) had lower percentages of broken grains—which is the main reason for the use of this processing technology (Rao and Juliano, 1970)— these products were not further cleaned and graded. The TRAD rice was *Tox 3145* rice parboiled by local parboilers in *Ndop,* using the traditional parboiling technology (Ndindeng et al., 2014). The milled rice produced through the latter technology was darker, not homogenous and had impurity levels of up to 4 percent. The "GEM rice" was *Tox 3145* rice parboiled at IRAD using the GEM parboiling technology (Ndindeng et al., 2014). The improved parboiled rice had better physical (high head grain yield, low level of cracked and burnt grains, high whiteness value) and sensory quality (high swelling ratio, non-sour taste) than parboiled rice produced using the traditional method. Head grain yield was 95 percent and impurity levels were smaller than 0.02 percent. Hence, the difference between NPB (benchmark) and NPH is grain quality (purity and homogeneity), the difference

between NPH and TRAD is the parboiling processing and the difference between TRAD and GEM was the added-value of the improved parboiling technology.

In order to simulate a market setting, we presented the four rice types in four plain white half-filled 50 kg bags on a table in the front part of the closed amphitheater room (Figure 2A), such as they are typically presented on the market. The rice types were also presented on the participants' tables in four dishes, each one containing one kilogram of uncooked rice of each type. However, in order to avoid lining-up bias (Demont *et al.*, 2012), we avoided presenting the rice types in a linear fashion on the individual tables but instead presented them in a quadrangular way (Figure 2B). During the experiment, participants could examine the visual (purity and homogeneity) and sensory (taste and aroma) quality attributes of the uncooked rice types (taste is typically tested by biting on the uncooked grains).

A   B

Figure 3. (A) Linear projection on the presentation table in front of the room and (B) quadrangular presentation of the alternative rice types on the individual tables (pink dish = Non-parboiled broken (NPB) *Tox 3145* rice = benchmark; blue dish = Non-parboiled homogenous (NPH) *Tox 3145* rice; green dish = *Tox 3145* rice parboiled through the improved technology (GEM); orange dish = "Traditionally parboiled" (TRAD) *Tox 3145* rice)

We chose the Vickrey (1961) second-price auction mechanism, where in a group context participants submit sealed bids on a product and the highest bidder buys the product at the second price. In combination with the endow-and-upgrade method, this implies that the bids represent the price premiums bidders are willing to pay in order to upgrade the benchmark rice to an alternative rice type. The winner exchanges his/her benchmark for the upgrade and all losing bidders retain their benchmark. The second-price auction is incentive compatible because bidders cannot be made better off by misrepresenting their actual value, i.e. their weakly dominant strategy (i.e. a strategy that yields at least as good an outcome as any other) is to bid their real value for the good (Lusk and Shogren, 2007). This auction mechanism has proven to be successful for assessing consumers' willingness to pay (WTP) for rice quality attributes in the African context (Demont and Ndour, 2015). The experiment was conducted verbally in the languages French and *Pidjin*.

We conducted three bidding rounds separated by two within-subjects treatments i.e. (i) a sensory test, aimed at assessing the impact of post-cooking quality attributes on WTP, and (ii) a collective induction treatment (CIT) aimed at assessing the impact of social cognition or so-called word-of-mouth (WOM) communication on WTP (Demont et al., 2013).

The experimental auctions were conducted over the course of four days and organized into eight sessions with two sessions per day (one session in the morning and one session in the afternoon). Each experimental session involved ten steps:

1. **Recruitment:** The recruiters went to Mokolo market in Yaounde with the help of a car. In this market, they dispersed and approached women coming from and going to the market. The

recruitment was done randomly in order to avoid self-selection and self-recruitment. To convince the participants, a flyer showing pictures of the realization of experimental auctions in other African countries was presented to them (Figure 3). The recruiters explained to participants that they were going to participate in a 2.5-hour market test and receive a participation fee of 3,000 FCFA "for their taxi back home." The latter pretext is commonly used in Africa to detach pecuniary endowments from their "gift" or "payment-for-service" context. It elegantly avoids the fee being seen as a *quid pro quo* for which participants should reciprocate (Lusk and Shogren, 2007), and which may bias the bids (Loureiro et al., 2003). Every time a woman was convinced, the recruiter gave her a voucher for participation to the experimental auction and invited her to take place in the car. Fifteen women aged in the range of 19–65 years were recruited each session.

Figure 4. Recruitment of the participants

2. **Introduction:** The animator started the experimental session in French language*,* with translations to *Pidjin*. We did not use any labels on the rice bags presented on the table in front of the room; the only function of the presentation table was to associate the rice types on the individual tables to a real market context of alternative rice types presented in 25 kg or 50 kg bags. Each plate on the individual tables contained one kilogram of the rice type and corresponded to a bag on the presentation table in front of the room. During the experiment, participants could examine the visual (purity and homogeneity) and sensory (taste and aroma) quality attributes of the uncooked rice types. The auction procedures were explained to the participants. First, the endow-and-upgrade method was carefully explained to participants. Previous experience demonstrated that price premiums elicited through the endow-and-upgrade method were more reliable after "calibration," i.e. providing the absolute market price of the benchmark *Tox 3145* (350 FCFA/kg retail price). However, any price information on the alternative rice types was not revealed to the participants. Secondly, the second-price auction mechanism was explained. The animators and the co-animator collected WTP values in a random way, avoiding any perception of a linear relationship or ranking among the alternative rice types. The participants did not know that the four dishes contained the same local rice variety.

3. **Training session with biscuits:** Following Shogren *et al.* (1994), commonly known brands of biscuits were used for the auction procedure (Figure 4). Each participant received a packet of *Glucobon* biscuits and was then asked to bid on two alternative types of biscuits: *Nice* and *Riya* biscuits. One round was conducted with an evaluation in order to ensure that all participants fully comprehended the auction mechanism.

Figure 5. Training session with biscuits

4. **Individual auction 1:** The animator (and co-animator) explained to participants that a similar procedure will be used for the four rice types, repeated over three individual and one collective auction trials, but without price posting, and that one rice type would be randomly selected and one bidding round was binding. A two-stage approach was used to elicit WTP (Haines et al., 1988). For each alternative rice type, the animator first asked which product the participant preferred between the benchmark and the upgrade. If the woman chose the benchmark, the animators asked whether she would still choose the benchmark if both products were priced equally. If she responded positively, the animators recorded a dash (WTP<0); if she responded negatively, the animators recorded a zero (WTP=0). If the alternative was chosen, the animator asked the woman the WTP to upgrade to one kilogram of the alternative rice type. Responses were recorded privately for each participant. During the auction rounds, a first survey questionnaire was administered to the participants that had completed price elicitation. The survey aimed at obtaining socio-demographic data.

5. **Sensory test:** Between the first two individual auction rounds, a sensory test was included as a between-subjects treatment during which the participants could experience the sensory quality attributes (aroma, taste, texture and stickiness) and observe the swelling capacity of the cooked rice types (Figure 5). Each participant was presented four dishes with cooked samples of the four rice types and was asked to taste the rice types. Animators asked the participants to rinse their mouths between the tasting of different rice types.

Figure 6. Sensory test

6. **Individual auction 2:** The same procedure was used as in step 4 in order to obtain post-sensory WTP for the alternative rice types.

7. **Collective induction treatment (CIT)** (Figure 6): Animators asked participants to split in three groups of five and gather around three separate tables and attempt to achieve a consensus on their collective WTP (CWTP) to upgrade the benchmark rice into each alternative rice type. The collective auctions were incentive compatible as they were also subject to the Vickrey second price mechanism. Following common practices in group research, no specific method of doing so was imposed or implied. Groups were left alone during the discussion that followed to avoid bias from the researchers. After consensus, the group reported the CWTP values. The CIT has been successfully used as a mechanism to elicit WOM exchange between participants on valuation of rice quality as it provides incentives for participants to reveal knowledge, information and opinion leadership about the value of the products under research (Demont et al., 2013).

Figure 7. Collective Induction Treatment (CIT)

8. **Individual auction 3:** The same procedure was used as in step 4 in order to obtain post-collective induction WTP for the alternative rice types.

9. **Survey:** A second survey questionnaire was administered to collect specific information on consumer preferences and awareness of the alternative rice types used in the experiment. The survey was conducted after the rice auctions to avoid revealing the study's objectives (Corrigan and Rousu, 2008). To test group success, the survey included a question on whether or not the participants agreed with the CWTP values reached through group consensus (Cartwright, 1971; Ito et al., 2009; Sniezek and Henry, 1989).

10. **Closing ceremony:** The animator randomly selected one rice type and one of four bidding rounds as binding, deducted the second price from the participation fees of the winning bidders and distributed the rice and the adjusted participation fees to the participants. Participants posed for a group photograph in front of the room (Figure 7).

Figure 8. Group picture of the IRAD staff and women recruited for one of the experimental auction sessions

5   Data entry

An input template was created in Microsoft Excel 2007 on the basis of different bids and questions of both types of questionnaire. Data entry was done simultaneously with the auctions (Figure 8).

Figure 9. Data entry during the experimental auctions

6 Learning curves

The eight experimental auction sessions were conducted successfully. The average duration of sessions was 1:49h, but decreased over the course of four days. The average time of recruitment was 1:36h and varied between morning and afternoon sessions. Finally, the average participation rate was around 16 percent and (Figure 9).
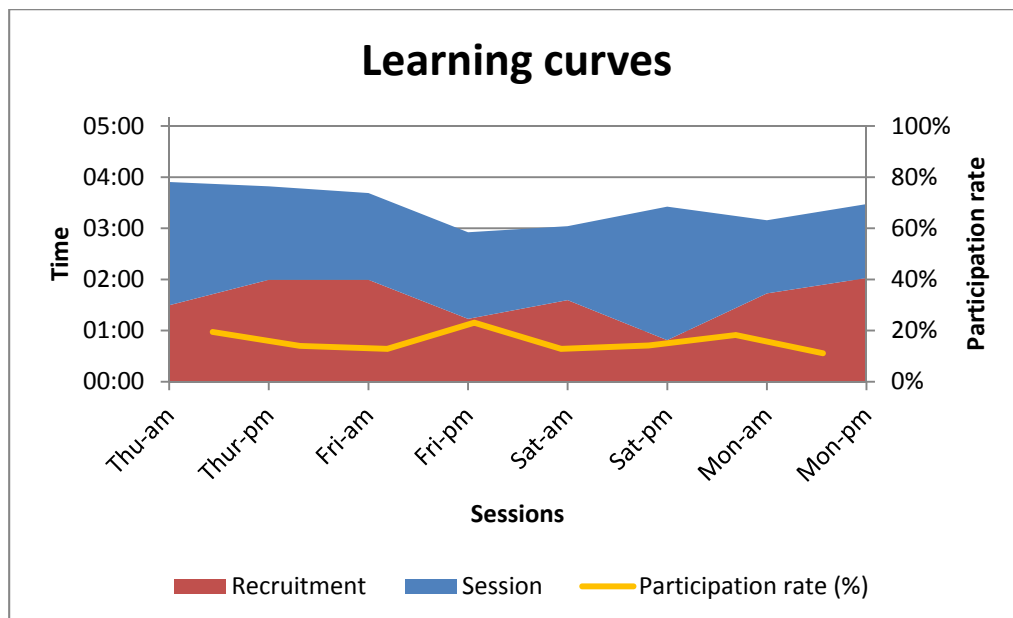

Figure 10. Learning curves of the experimental auctions conducted by the team

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