



The retail market prices of fonio reveal the demand for quality characteristics in Bamako, Mali.

Sandrine Dury, Véronique Meuriot, Geneviève Fliedel, Sandy Blancher, Fanta Bore Guindo, Djibril Drame, Nicolas Bricas, Lamissa Diakite, Jean-François Cruz

► To cite this version:

Sandrine Dury, Véronique Meuriot, Geneviève Fliedel, Sandy Blancher, Fanta Bore Guindo, et al.. The retail market prices of fonio reveal the demand for quality characteristics in Bamako, Mali.. 2007. <halshs-00190897>

HAL Id: halshs-00190897

<https://halshs.archives-ouvertes.fr/halshs-00190897>

Submitted on 23 Nov 2007

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

The retail market prices of fonio reveal the demand for quality characteristics in Bamako, Mali

Sandrine DURY¹,
Véronique MEURIOT¹,
Geneviève FLIEDEL²,
Sandy BLANCHER¹,
Fanta BORE GUINDO³,
Djibril DRAME³,
Nicolas BRICAS¹,
Lamissa DIAKITE³,
Jean-François CRUZ².

1 CIRAD, UMR MOISA, F-34000 Montpellier, France.
sandrine.dury@cirad.fr

2 CIRAD, UMR QUALISUD, F-34000 Montpellier, France.

3. IER, Institut d'Economie Rurale, Bamako, Mali.



Paper prepared for presentation at the 106th seminar of the EAAE

**Pro-poor development in low income countries:
Food, agriculture, trade, and environment**

25-27 October 2007 – Montpellier, France

Copyright 2007 by [authors]. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Abstract

African consumers' expectations concerning quality of food products are great. In spite of constrained budgets, we showed that market retail prices revealed quality preferences of the consumers and not only production costs. In very poor countries like Mali, food innovation is limited by the very low purchasing power of the population. However, technological food product or process innovations are possible and sometimes valuable. Demand driven innovation may lead to open new markets, opportunities for small and medium scale enterprises and to improve consumers' welfare. Based on this assumption, technical research was done to provide new food products. In this paper, using both sensory test and a hedonic price approach, we estimated consumer demand for different characteristics of fonio, a West African cereal, and showed that poor consumers do have quality requirements and actually pay for it. We showed that the shadow or hedonic price paid for quality characteristics is small but significant. A comparison of sensory test and market study showed a convergence between what people say they prefer and what they really pay for. Results were consistent and showed directions for technological improvement of the product and its production process. The Partial Least Square method was used to estimate hedonic prices of the different modalities of fonio quality traits. This method was interesting since it solved the Ordinary Least Square method's colinearity problems.

Acknowledgements: *This work was financed through the European Inco project FONIO "Upgrading quality and competitiveness of fonio for improved livelihoods in West Africa". The Moisa-Sustainable Consumption team members are warmly thanked for their comments on an earlier version of this paper.*

Context and field of the study:

Food post-harvest activities have increased tremendously in the last 30 years in sub-Saharan Africa to accompany the demographic transition toward urbanization. This is a very difficult task to assess the macro-economic impact on income generation since most of these activities are in the “informal” sector, and concern many single working women (Broutin and Bricas, 2006). However, these authors showed at the same time the enormous changes currently on-going in the food supply in African cities, the innovativeness of the stakeholders, as well as the scattered nature of the evidences and study about these changes. Our study is part of a larger program dealing with the upgrading of food quality and competitiveness of fonio processing and gives an insight on the valuation of quality on both traditional and new segment of this cereal market.

Post harvests research or development programs lead either by public or private operators are based on changes concerning food products. Food innovation is a risky, difficult and long process, especially in very poor countries where purchasing power is weak. One should guess in advance if new product will be interesting and accepted by eaters, processors and purchasers. Most eaters express preferences when testing or tasting a “new product”, and explain rational process to choose the type of product they prefer. However, it is difficult to say in advance if they will pay, and how much for this new food or new attribute, and hence if the proposed innovation may become a commercial success. In Mali, the country where our study was carried out, studies about demand for infant food characteristics (see Sanogo and Masters, 2002 for example) showed that mothers were ready to pay for quality and for quality certification.

Different methods are used in marketing studies or economics, based on consumers’ surveys about their willingness to pay for new attributes or products. All these methods, even if quite sophisticated like conjoint analysis or market experiments, use declarations or artificial context of purchase. In our work, we design a protocol in order to capture the real purchases in retail markets of real differentiated existing products. We have made comparison of what people say they like, what product they buy and what price really pay for existing characteristics, using the classical hedonic approach (Rosen, 1972).

We are focusing on fonio, (*Digitaria exilis*) a cereal grown in West Africa, mainly in Guinea, Mali, Burkina Faso. This cereal is a “minor” product in terms of production (in Mali for instance, it represents less than 1% of all cereals consumed, and whole production in Africa is about 250 000 metric tons), but is well appreciated by most consumers who know it, and consumed occasionally for family or religious events (Konkobo-Yameogo *et al*, 2004). These authors shows also that the consumption is constrained both because of high prices and long and difficult processing.

Fonio processing is indeed a very long and complex task. Its tiny grain (less than 1 mm) makes dehusking and milling, traditionally done by women using a pestle and mortar, highly laborious. After threshing, fonio paddy grain is still surrounded by husks. Like rice, processing paddy fonio into milled fonio needs two steps. The first step, known as dehusking, removes husks from paddy grain to get the whole grain. The second step, the milling, removes bran (pericarp and germ) from the whole grain. Dehusking and milling fonio grain require four to five successive poundings alternated with as many winnowings. The productivity of this work is very low. It takes nearly one hour to mill just one or two kilos of fonio paddy. Moreover, before cooking or precooking milled fonio, all bran, dust and sand must be eliminated by washing it several times which increases processing time and effort. Thus, mechanizing all the processing steps seems to be essential both to reduce the laboriousness of women work and improve the quality and availability of marketed fonio product (Cruz, 2004). Several research and development projects aimed to foster the revival of fonio commodity chain by improving processing techniques and providing new designed equipments for a mechanization of the main post harvest operations. Once fonio is milled and

cleaned, the cooking process is also a long and technical task. It requires three successive steam cooking. Since the mid nineties, several small scale enterprises have developed a new product: the pre-cooked fonio. After achieving all the milling and cleaning, they realize the first cooking, they dry the product, and then seal it in plastic bags of one kg. Konkobo-Yameogo *et al*, (2004) have shown an expanding interest from urban consumers for fonio and the rapid emergence of small scale enterprises providing pre-cooked fonio.

In Bamako, consumers do not buy paddy for food consumption, but they can chose in-between different “traditional products” and several brands of pre-cooked “new products”. “Traditional products” are usually divided, by all the buyers and sellers, into three main categories:

- ✓ *decorticated* or *pre-milled*¹ fonio which is actually a mixture of paddy, dehusked and milled grains in various proportions, plus more or less sand, dust and bran. A few stakeholders of the market chain like restaurant keepers or traders are able to subdivide this broad category into subgroups according to region or country of origin, or to quality of the milling (they give quality grades to different lots). However, these subdivisions are not unanimous among traders and all final buyers.
- ✓ *milled and not washed*² which contains milled grain plus dust and sand,
- ✓ *milled and washed*³ which is milled clean grain.

Traditional and new products differ mainly according to their place in a technological process (from less to more processed) but they are also sold in different places and to different people: « traditional products » are sold in open markets, while pre-cooked products are sold in small supermarkets or in small scale enterprise.

Data collection

The field part of the study was organised into two main activities. The first one intended to determine, using individual interviews, focus groups techniques, sensory tests, the habits and preferences of several types of consumers and stakeholders at different stage: purchase, processing including cooking, and eating. The second step aimed to collect market data concerning fonio purchases in different places of Bamako, chosen to be representative of the selling places in the city. This survey was implemented during September and October 2006. 174 purchases of traditional products and 65 of new products were observed in markets and supermarkets. Data collected concerned the price really paid, and the characteristics of (i) the supply (type of market, supermarkets) of (ii) the product itself (type, size, colour... estimated by the buyer it/herself) of (iii) the buyer (age, education level, sex...) and of (iv) the destination of the product (given, or eaten at home, or processed prepared in a meal or another).

Six focus groups were organized to check the list of quality traits collected through individual interviews and synthesize general data on local population behaviours. In order to avoid the emergence of leaders during the discussion, each focus group was composed of 6 persons recruited during individual interviews from a same group of stakeholders. Thus, there was successively a focus group of “big” processors, “small” processors, restaurant (cheap and expensive) cookers, traditional fonio consumers, precooked fonio consumers. After a general discussion on “what is for you a good fonio when you buy it, when you process it and when you consume it” following a list of questions, the 6 persons were asked to talk about 10 different types of fonio bought from retailers during individual interviews and justify their preference : a fonio from Guinea 1st quality, a fonio from Guinea 2nd quality, a fonio from Guinea 3rd quality, a fonio from Koutiala, Mali, a fonio

¹ “*Décortiqué*”

² “*Blanchi non lavé*”

³ “*Blanchi lavé*”

from San, Mali, a roasted fonio from Guinea, a milled and washed fonio from Mali, a milled and washed fonio from Guinea, a “new” fonio from Mali (harvested this year), an “old” fonio from Mali.

Sensorial tests were conducted in order to have a better perception of the quality and consumer sensory preferences. Rank tests and triangular tests were performed. Rank tests were performed with 3 groups of 20 persons, 60 persons in total, who were asked to range five types of cooked fonio from the most preferred to the least preferred and precise for what reasons. Four different fonios (from Guinea, San, Bougouni, Dogon plateau) were first bought in the market, one of them (fonio from Guinea) was also parboiled in IER (soaked, steamed and dried). These five types of fonio were then milled with GMBF⁴ fonio dehuller, washed and cooked in optimal conditions for each one (various cooking time and quantity of water added) before being served in a same plate, in same quantity and at the same time to each person of the group.

Triangular tests were performed with the 6 persons of 5 of the 6 focus groups, 30 persons in total, in order to determine if they could differentiate two types of cooked fonio judged very close in the previous test. Three samples were presented to each person: two came from the same cooked fonio and the third one from the other. The question was: what sample is different from the two others? There are 6 possibilities to present samples in a plate: AAB, ABA, BAA, BBA, BAB, ABB. Samples were coded. To know if there is a significant difference between the two fonios, the number of correct answers must be counted and compared to the value in the table of binomial law for a probability of 1/3.

Model and method of analysis

Following Rosen (1974) and Lancaster (1966) a product (a good) can be considered as a « *package of characteristics* » or a « *bundle of attributes* ». According to Rosen, in a competitive market, market prices reveal the preferences of the consumers for a specific combination of the characteristics.

In addition to the quality characteristics of the product itself, we supposed that prices also depend of the partners of the transaction, since information might be distributed in a heterogeneous way. This is the reason why we included characteristics of the seller and the buyer in the hedonic model. The model can be written as following:

$$p(z) = p(z_1, z_2, \dots, z_n)$$

where p is the unit price of the good and z_i is the quantity of characteristics i incorporated in good z .

Regressing a quantitative variable over a large number of qualitative variables generates problems of colinearity because qualitative exogenous variables are less discriminant (modalities of each characteristic are in small numbers: for instance there is only four different colours) and the exogenous variables are often closely related (cleanliness with colour for instance). The OLS estimate drops the variables which are the most collinear in the dataset. The complete estimation cannot be achieved. The PLS method, due to Wold (1984), allows to exceed the colinearity problem at the time of estimate the coefficients of variables. It combines several techniques:

1. Projection of the variables on an axe (component), itself linear combination of the exogenous variables (Principal Component Analysis principle). One repeats the process on the residuals of the regression.
2. Linear estimate between the two first principal components which are orthogonal.

⁴ GMBF = Guinée Mali Burkina France

Because the estimate is realised between orthogonal components, we cannot obtain the t-Student coefficient to control the level of significance of the variables: we use the Jackknife criteria and the VIP table. (Tenenhaus, 1998).

Results of interviews: declared preferences by consumers when eating, processing or buying fonio

By interviewing all the eaters (including all different stakeholders of the fonio market chain) on “*what’s for you a good fonio when eating it*”, gustative but also visual and olfactive criteria have been standing out, with a particular emphasize on gustative criteria. The question concerned the *foyo* recipe which is a steamed fonio (*foyo* recipe, which is the most common recipe). Interviewed persons prefer first a well cooked, with a soft consistency (30/30), swollen, not sticky and with no sand (30/30). Grains must be individual (27/30), smooth (28/30), not rough (25/30). Visually, colour must be light (20/30), with a minimum of paddy, herbs and other impurities (26/30). A sugary (23/30) and wild (10/30) smell are well appreciated while dusty and old smell must be avoid (9/30).

The unanimous quoted quality attributes for home processing were the level of milling and the level of cleanliness. These attributes determine the duration of the processing, they were quoted both by professionals (street restaurant keepers, processors) and simple consumers. Professionals were able to talk longer about the characteristics of the grain itself: they said that some grains were breakable while others did not break when milled. When soaked into water for cleaning, some grains become smooth and lose starch, while others remained whole. They said the good grains were “mature”, which is an image since all grain are mature when harvested. However, it reflected a real difference in technological properties of grain.

When buying fonio, all buyers said they prefer white, well decorticated and clean fonio. They usually think that fonio imported from Guinea was cleaner, better decorticated, whiter, and more “mature” than fonio coming from Mali, especially the dryer areas of Mali.

Results of the sensory tests

Among the 60 persons who participated to the rank test, 2 were put aside because of their incoherent answers. Considering the 58 persons left, cooked fonios were ranked in a decreasing order of preference as followed: Bougouni, Guinea, Dogon, San and in the last position fonio from Guinea parboiled in IER. The most preferred cooked fonio were fonio from Bougouni and fonio from Guinea.

According to Friedman test and using a rank sum analysis, we found that the panel has appreciated differently the five samples and there was not a significant difference of preference between fonio from Bougouni and fonio from Guinea. These two fonios appeared very close in the ranking. By looking at the percentage table, we noticed that when fonio from Bougouni came first, fonio from Guinea came in second position at 79.3 %, and on the other way, when fonio from Guinea came first, that is fonio from Bougouni which arrived just after at 71.4 %.

At the question “*For what reasons do you prefer this fonio*”, the most frequently criteria named were first colour and taste then consistency; grain size, smell and cleanness arriving quite after. Colour was named as the first criteria at 50 %, taste at 25.9 % and consistency at 15.5%.

Table 1 : Sensory test: number of citations per criteria and as 1st criteria\$

Criteria	Number of criteria citations	1 st criteria	
		Frequency	%
Colour	52	29	50.0
Taste	52	15	25.9
Consistency	43	9	15.5
Size	15	3	5.2
Smell	25	1	1.7
Cleanness	8	1	1.7

*all samples were clean and well milled

Discussion

Altogether, for everybody, and at each stage (purchase, processing, eating), cleanliness, and milling degree are essential quality requirements. A light colour is also quoted by everybody. These are vertical quality attributes and we ought to find difference in prices for the different level of these attributes. On the opposite, results are not clear for the other attributes. Texture of the grain (“maturity”) is quoted mainly by professionals. Concerning size, big grains were sometimes considered as good quality, when for other persons, small grains are appreciated, and others were indifferent to grain size. Origin is an indicator of cleanliness and good milling, but is not always associated with good taste.

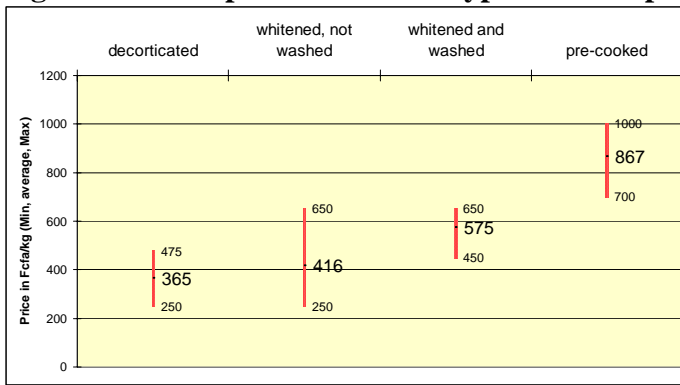
We do not have any quantitative data about another common recipe in Bamako, *djouka*, a brown colour salted meal, based on fonio and roasted groundnut. It was very often said by interviewees that brownish or “immature” grains were used to do *djouka*.

Results of the retail prices’ analysis

The market prices are essentially determined by technical status of the products. The average price of the 239 observed fonio purchases reached 538 CFAF/Kg⁵ and 85% of the variation of retailed price was explained by the type of fonio. An analysis of variance (ANOVA) showed that average price of each of the four main types of fonio was significantly different from each other (level of significance 1%).

⁵ 656 CFAF = 1 Euro

Figure 1: Retail prices of several types of fonio products in Bamako- Mali, October 2006



From the less to the most processed fonio, the price was multiplied by a factor of two to four (from 250 to 1000 CFAF/kg). The difference between average prices gives the average market value of milling (50 CFAF/kg), of washing (160 CFAF/kg) and pre-cooking + packaging (290 CFAF/kg). At this stage, it is not clear to identify what is due to the processing costs, what is due to market segmentation or a monopole, and

what is due to preferences of consumers in these prices' differences. For a series of reasons, one can suppose that traditional products are in competition (everyone knows the product, each seller has at least 2 or 3 different types of fonio) while for pre-cooked, very few suppliers have the product, it is mostly sold in supermarkets, where no traditional products can be found. Thus, in the case of traditional fonios, we can suppose that prices are really reflecting both supply and demand sides, and thus preferences of consumers, and willingness to pay for the different attributes. In the case of pre-cooked product, it is not so clear. When we analyse each type separately, we can show what really counts apart from the level of processing.

Prices of *decorticated* fonio depend mainly on recipe, grain origin, milling degree, and grain colour.

During the period of the survey, the prices of decorticated fonio ranged from 250 until 475 CFAF/kg. We supposed that variations in prices were linked with (i) the different characteristics of the products themselves (in the group of what is called “decorticated”) including the purchase location and with (ii) the expertise of the consumers, or ability to recognise the different characteristics. The R2 of the PLS regression was 0.4 which was good for such a regression and indicated a relative good fit of the model. The model parameters are presented on Table 2. The significant modalities are in bold in the table. When the VIP value is above 0.8, the parameter of the variable is considered as being statistically different from zero. The result of the regression can be written as follows:

$$\begin{aligned}
 P_{\text{fonio}} = & 360,696 \\
 & + 2,463(\text{Medina market}) - 2,059(\text{Lafiabougou market}) - 1,572(\text{Magnambougou market}) \quad \text{place of purchase} \\
 & - 5,021(\text{badly milled}) + 5,021(\text{quite or very well milled}) \quad \text{milled degree} \\
 & - 0,285(\text{very dirty}) - 0,736(\text{dirty}) + 0,898(\text{clean}) \quad \text{cleanliness} \\
 & + 4,505(\text{white}) + 12,462(\text{cream white}) - 1,157(\text{grey}) - 4,812(\text{red, brown, not white}) \quad \text{colour} \\
 & + 1,679(\text{big}) + 1,002(\text{small}) - 5,077(\text{do not know}) \quad \text{grain size} \\
 & + 4,572(\text{Guinea}) - 5,685(\text{Mali}) + 0,996(\text{do not know}) \quad \text{origin} \\
 & - 5,858(\text{Djouka}) + 4,889(\text{other salted meal}) + 7,262(\text{do not know}) \quad \text{recipe} \\
 & - 2,691(\text{for sale or gift}) - 0,558(\text{week-end meal}) + 3,038(\text{special event meal}) \\
 & + 0,996(\text{regular meal}) + 7,135(\text{illness}) \quad \text{occasion} \\
 & + 0,102(\text{household consumption}) - 2,576(\text{processing for sale in a small restaurant}) \\
 & + 4,377(\text{processing for a gift}) - 0,183(\text{gift : no home process}) \\
 & + 7,135(\text{processing for sale in a pre-cooked type}) \quad \text{destination} \\
 & + 2,675(\text{mother or other woman in the family}) - 3,254(\text{employee}) \\
 & + 2,1(\text{father or other man in the family}) - 2,732(\text{child, young of the family}) \quad \text{status of the buyer} \\
 & - 3,054(\text{moins de 20 ans}) + 3,751(\text{entre 21 et 35 ans}) - 3,316(\text{entre 36 et 50 ans}) \quad \text{age of the buyer} \\
 & - 0,183(\text{man}) + 0,945(\text{woman}) \quad \text{sex of the buyer} \\
 & + 0,928(\text{employee}) - 2,391(\text{independent worker}) - 2,446(\text{others}) + 4,71(\text{housewife}) \quad \text{activity of the buyer} \\
 & \text{of production of fonio} - 1,146(\text{region with no production of fonio}) \quad \text{region of origin of the buyer} \\
 & - 1,042(\text{primary school}) - 1,513(\text{secondary school}) + 2,264(\text{lycee or more}) \\
 & + 0,872(\text{other}) \quad \text{education level of the buyer}
 \end{aligned}$$

Note that each exogenous variable is binary, and takes the value 0 or 1.

P_{fonio} , the endogenous variable is quantitative; it is the unit price of fonio in CFAF/kg.

The most significant (first rank of VIP) characteristic of the model was fonio recipe: all modalities were different from zero and the parameters take the expected sign: when a consumer wants to prepare *djouka*, she/he buys a cheaper fonio than when she/he wants to prepare *foyo*. Grain origin, grain colour and milling degree were also very significant and with the expected parameters: positive for Guinea and negative for Mali, positive for white colour and negative for brown colour, positive for well milled and negative for badly milled. A comparison of means, done with an ANOVA using the Fisher test, for each characteristic confirms these results. The four characteristics that have a significant effect on average price are recipe, grain origin, colour and milling degree.

Other significant modalities were more difficult to analyse. Destination such as “processing for a sale in a small restaurant” was significant and negative while “processing for a gift” was positive. These results can be explained by the fact that women who cook for these street restaurants are used to buy fonio in large quantities and are specialised in very low cost food. On the opposite, someone who buy fonio in order to cook it and to give it, will not buy such large quantities, and may be, not in a regular rhythm. Characteristics of the buyer are less significant and difficult to analyse at this stage.

It was quite surprising that cleanliness level was not significant. During interviews it was always quoted as important, but the model showed the level of cleanliness as perceived by the buyer had no impact on the price of the decorticated. On one side, it could be argued it was a bias of the survey based on interviewees’ perceptions, and not on physical measures. People may not have understood the question or they may be over-optimistic regarding the product they just have bought. On another side, other technological characteristics, collected with the same methodology, appeared to be significant, and coherent with empirical knowledge. At this stage, our interpretation consisted in saying that while buyers were able to assess milling degree, grain colour, size and origin, by themselves or with indications of the sellers, they are not able to assess the level of cleanliness during the purchase. This will be discovered when they go home and process the product. Each specific type was usually associated with a certain idea of a level of cleanliness for most buyers. Cleanliness was actually not a real issue inside this type of decorticated fonio for the majority of individual buyers, who bought fonio very rarely (from once a week to once a month), in very small quantities (in our survey, 80% of the purchases of decorticated or milled fonio weighted less than four kilograms). Since some retail and wholesale markets are very close to each others, one should be cautious not to make any confusion with wholesale markets where professionals such as restaurant keepers, and small scale entrepreneurs bought their decorticated fonio. These stakeholders were different and had greater expectations concerning quality. They bought larger quantities (from may be 10 kg every day to 500 kg every month), on a regular basis, and they really paid different prices for different level of cleanliness of decorticated fonio (our interviews). The same regression done at the wholesale market about larger quantities would have shown different results concerning level cleanliness.

Prices of milled fonio depend mainly on environment characteristics linked to supply and buyers, and less to characteristics of the grain (except for colour)

Analysis of variance was conducted within each characteristic and showed that average prices for the different purchase locations, colours, sizes, destinations, status of the buyer, sex of the buyer, activities of the buyer were different from each other (at 1% significance level), occasion, education level (at 5% level). The PLS regression and the VIP criteria gave more detailed results (see Table 2).

Compared to decorticated fonio, the milling degree had no effect on price any longer which is understandable since the type is more homogeneous. The recipe had the correct sign (minus for *djouka* and plus for other salted meal) but was not significant any longer since very few people buy

this kind of fonio to process it and sale it in large quantities in street restaurants. Origin was not significant any longer. Level of cleanliness gave incoherent results. Colour remained the only common significant characteristic.

Characteristics of buyers were here more significant: men, civil servants, higher educated persons have paid a higher price compared to women or housewives or less educated persons. In addition, the location was significant: Prices in Magnambougou market and at the Niger riversides were higher than in Medina Koura and Korofina markets. This seemed logical and linked to the customers since Magnambougou is located in a wealthier area, and Niger riversides' purchasers are usually richer than people going to other markets.

Prices of pre-cooked fonio depend mainly on supply characteristics (brand and purchase location).

For precooked fonio, only purchase location and brand had a significant effect on the unit price average (ANOVA test). All other variables (quality, buyer characteristics, etc...) had a minor effect on price. The product was quite standardized and variations in technological quality are low. Besides, neither supply systems nor brands are really in competition. Each purchase location has a price policy and each processor as well. Because the product is new, one can supposed that consumers are not accustomed yet to the product and, as the do not have the prices in mind, they do not compare. In the case of these precooked fonios, prices result from a supply policy but not from the meeting between suppliers and purchasers.

Discussion and conclusion

We showed that fonio price was mainly determined by the grain milling degree. The four existing types of fonio, known by individual buyers at the retail markets, explained almost 90% of the price variation. In that sense, the market was well segmented for that product. In addition, for each type of fonio, the hedonic price estimation using PLS method showed that different attributes had a significant value.

For the decorticated fonio, the main determinants of the price variation around the average were the final recipe, grain colour, grain origin, and grain milling degree. Specific characteristics of buyers (related to their idiosyncratic competence or socio-cultural specificities) and supply (market places) play a second and minor role. Geographic origin of the grain was a proxy of level of cleanliness. Buyers, in spite of the fact that they claimed to look for clean fonio (no dust, no sand) did not have many ways to check this attribute when they buy the good, and used the origin as a mean to estimate *ex ante* the level of cleanliness. Decorticated fonio is a heterogeneous category in terms of technological characteristics compared to milled fonio and price variations are mainly linked with technological characteristics. For the milled fonio, the main determinants of price variation were the purchase location, the grain colour, the size of the grain, the occasion, the destination, the sex of the buyer, the activity of the buyer, and its level of education. Final recipe, milling degree and grain origin had no influence on price. For the precooked product, the main determinants of price variation were place of purchase and brands. Intrinsic characteristics of the product have little influence on the variation of price. Results of the hedonic models on the market prices were consistent with results from interviews and the sensory tests, and revealed the preference of consumers. It was an argument for saying that the fonio market is efficient for the traditional products (decorticated and milled).

This study contributes to the programming of technological and agronomic research since it gives quantified results concerning preferences of the buyers. It clearly showed that cleanliness, milling degree and colour are vertical attributes for almost all buyers. For decorticated fonio, which is the

less processed and cheapest product, geographical origin was a valuable attribute since it gave indication on the other characteristics (cleanliness in particular). For more processed and more standardized products, origin had no influence on price. Size of the grain did not really contribute to the price for most products except for pre-cooked fonio.

This study did not tackle the question of access to the products which remain expensive compared to other cereals (2 to 3 times more expensive in terms of unit price). However, other analysis, based on the same surveys, not presented here, showed that consumers' profiles, as well as final uses differed from one type to another. Decorticated and milled fonio are bought mainly by women (90% of the buyers), who did all the final processing (pounding, cleaning) by themselves, and who often cooked this fonio for income generating activities (25% of the buyers of decorticated fonio processed it for sale in small restaurants). Milled and washed fonio as well as pre-cooked fonio were more often bought by men (30% of pre-cooked buyers), who belonged to higher income class (civil servants), and who gave fonio to their spouse. This fonio is usually eaten at home or given. It is never used in income generating activity. Other research is on going to assess the impact of the development of these new products on income generation and distribution. The hypothesis is that it creates new activities for small scale processors and their employees; it generates new incomes since it reaches new consumers, who were reluctant to clean and pound the milled or decorticated products. One risk is that the supply will not meet this growing demand and the price may increase. If that happens, the actual decorticated and milled products may reach higher prices that would deprive poor women of their income generating activity.

References

BRICAS N., BROUTIN C. (2006). Agroalimentaire et lutte contre la pauvreté en Afrique subsaharienne. Le rôle des micro et petites entreprises. Collection Etudes et Travaux. Editions du Gret. 128 p.

CRUZ J.F. (2004). Fonio: a small grain with potential. *LEISA, magazine on low external input and sustainable agriculture. Valuing crop diversity*, vol. 20, no 1, p.16-17

KONKOBO-YAMEOGO C., CHALOUB Y., KERGA A., BRICAS N., KARIMOU R., NDIAYE J-L. (2004). La consommation urbaine d'une céréale traditionnelle en Afrique de l'Ouest : le fonio. *Cahiers Agricultures*, vol. 13, no 4, p. 125-128.

LANCASTER K. J. (1966). A New Approach to Consumer Theory. *The Journal of Political Economics*, vol. 74, p. 132-156.

ROSEN S. (1974). Hedonic Prices and Implicit Markets: Product differentiation in Pure Competition. *The Journal of Political Economy*, vol. 82, no 1, p.34-55.

TENENHAUS M. (1998). *La régression PLS – Théorie et pratique*. Edition Technip, Paris.

SANOGO D. AND MASTERS WA. (2002). A market-based approach to child nutrition: mothers' demand for quality certification of infant foods in Bamako, Mali. *Food Policy*, vol. 27, no 3, p. 251-268.

WOLD S., RUHE A., WOLD H. & DUNN III, W.J. (1984). The collinearity problem in linear regression. The partial least squares (PLS) approach to generalized inverses. *SIAM J. Sci. Stat. Comput*, vol. 5, no 3, p. 735-743.

Table 2: Parameters of the PLS regression for *decorticated fonio*.

		parameters	VIP*>0.8	VIP rank
	Constant	360,696		
Purchase location	Medina market	2,463	1	16
	Lafiabougou market	-2,059		
	Magnambougou market	-1,572		
Milling degree	badly milled	-5,021	1,9	4
	quite or very well milled	5,021	1,9	3
Cleanliness degree	very dirty	-0,285		
	Dirty	-0,736		
	Clean	0,898		
Grain colour	White	4,505	1,6	9
	cream white	12,462	1,8	7
	Grey	-1,157		
	red, brown, not white	-4,812	1,9	6
Grain size	Big	1,679		
	Small	1,002		
	do not know	-5,077	1,3	12
Grain origin	Guinea	4,572	1,7	8
	Mali	-5,685	2,1	2
	do not know	0,996		
Recipe	Djouka	-5,858	2,3	1
	other salted main meal	4,889	1,9	5
	do not know	7,262	1	14
Occasion	for sale or gift	-2,691	1,1	13
	week-end meal	-0,558		
	special event (familial/religious) meal	3,038	0,8	22
	regular meal	0,996		
	Illness	7,135		
Destination	household consumption	0,102		
	processing for a sale in a small restaurant	-2,576	0,9	21
	processing for a gift	4,377	1	17
	gift (no home process)	-0,183		
	processing for sale in a pre-cooked type	7,135		
Buyer status in the family	mother or other woman	2,675	1	15
	Employee	-3,254		
	father or other man	2,100		
	child, youngster	-2,732	0,9	18
Buyer age	less than 20 years	-3,054	0,9	20
	between 21 and 35 years	3,751	1,3	11
	between 36 and 50 years	-3,316		
Buyer sex	Man	-0,183		
	Woman	0,945		
Buyer job	Employee	0,928		
	self employed worker	-2,391	0,9	19
	Others	-2,446		
	Housewife	4,710	1,5	10
Buyer origin	region of fonio production	0,866		
	region with no fonio production	-1,146		
Buyer education level	primary school	-1,042		
	secondary school	-1,513		
	high school	2,264		
	Other	0,872		

Table 3: Descriptive statistics of prices for *decorticated fonio*

Characteristics		Frequency		Unit Price CFAF/kg	
		N	N % column	Average	Standard Deviation
Purchase location	Medina market	28	48,3%	371	38
	Lafiabougou market	8	13,8%	356	18
	Magnambougou market	22	37,9%	360	31
Milling degree	bad milled	23	39,7%	350	26
	quite well milled	33	56,9%	373	35
	Very well milled	2	3,4%	400	0
Cleanliness degree	very dirty	9	15,5%	364	28
	Dirty	25	43,1%	363	33
	Clean	24	41,4%	368	36
Grain colour	White	18	31,0%	381	29
	cream white	2	3,4%	425	71
	Grey	14	24,1%	361	27
	red, brown, not white	24	41,4%	351	28
Grain size	Big	14	24,1%	371	27
	Small	37	63,8%	367	32
	do not know	7	12,1%	343	45
Grain origin	Guinea	20	34,5%	380	38
	Mali	19	32,8%	346	13
	do not know	19	32,8%	368	35
Recipe	Djouka	28	48,3%	350	26
	Other salted main meal	28	48,3%	378	34
	do not know	2	3,4%	400	0
Occasion	for sale or gift	26	44,8%	358	22
	Week-end meal	4	6,9%	363	32
	Familial or religious event	8	13,8%	378	31
	Regular meal	19	32,8%	368	46
	Other	1	1,7%	400	.
Destination	Familial consumption	31	53,4%	365	32
	processing for a sale in a small restaurant	14	24,1%	355	20
	processing for a gift	5	8,6%	385	34
	gift (no home process)	7	12,1%	364	56
	processing for sale in a pre-cooked type	1	1,7%	400	.
Buyer status in the family	mother or other woman	36	62,1%	370	39
	employee	4	6,9%	350	0
	father or other man	3	5,2%	375	25
	child, youngster	15	25,9%	355	19
Buyer age	less than 20 years	10	17,5%	353	18
	between 21 and 35 years	42	73,7%	370	32
	between 36 and 50 years	5	8,8%	350	61
Buyer sex	Man	7	12,5%	364	24
	woman	49	87,5%	366	35
Buyer job	employee	12	21,1%	369	28
	self employed worker	28	49,1%	359	31
	others	6	10,5%	354	25
	housewife	11	19,3%	384	44
Buyer origin	region of fonio production	29	51,8%	367	41
	region with no fonio production	27	48,2%	362	23
Buyer education level	primary or religious school	23	40,4%	362	34
	secondary school	6	10,5%	358	34
	high school or more	7	12,3%	375	32
	Other	21	36,8%	368	35
Total		58	100,0%	365	33

Table 4: Milled fonio: descriptive statistics and parameters of the model

Characteristics	Modalities = variables of the model	Descriptive statistics (price in CFAF/kg)			Results of the model	
		N	Average	Standard Deviation	Parameter	VIP rank
Total		99	416,21	52,98	constant = 431,614	
Purchase location	Medina Koura market	18	392	35	-7,08	15
	Korofina market	44	394	16	-9,30	6
	Lafiabougou market	11	400	0	-4,31	
	Magnambougou market	21	450	32	10,19	8
	Niger Riversides	5	590	55	43,21	1
Milling degree	Bad milled	2	400	0	-3,91	
	Quite well milled	22	417	28	0,11	
	Very well milled	75	417	59	0,31	
Grain colour	White	79	403	30	-15,54	3
	Cream white	11	505	77	23,46	2
	Grey	5	445	97	7,16	
	Red/brown/not white	4	400	0	-3,99	
Grain size	Big	23	425	37	2,77	
	Small	38	431	76	5,64	14
	Do not know	38	396	14	-7,72	9
Grain origin	Guinea	67	422	54	4,02	
	Mali	4	419	38	0,62	
	Do not know	28	403	51	-4,45	
Recipe	Djouka	30	403	24	-4,47	
	Other salted meal	69	422	61	4,47	
Occasion	For sale or gift	21	401	24	-4,64	
	Week-end meal	18	414	32	-0,67	
	Familial or religious event	13	390	50	-7,02	18
	Ordinary meal	45	433	66	7,07	11
	Other	2	400	0	-3,91	
Destination	Familial consumption	40	443	69	10,56	5
	Processing for a sale in a small restaurant	26	404	15	-3,77	
	Processing for a gift	11	389	54	-7,32	
	Gift (no home process)	22	395	15	-6,30	17
Buyer status in the family	Mother or other woman	74	413	49	-3,09	
	Employee	7	411	28	-1,40	
	Father	3	550	132	32,57	4
	Other household member	15	408	22	-2,19	
Age	Less than 20 years	16	405	19	-3,24	
	Between 21 and 35 years	73	418	57	1,19	
	Between 36 and 50 years	8	431	70	3,86	
Buyer sex	Man	8	466	103	12,69	12
	Woman	88	412	45	-9,58	13
Buyer job	Employee	10	408	24	-2,29	
	Self employed worker	24	424	46	2,48	
	Student	10	400	0	-4,26	
	Civil servant	9	478	93	15,99	7
	Unemployed	3	400	0	-3,95	
	Retired	4	450	100	8,31	
	Housewife	37	401	44	-5,60	16
Buyer origin	region of fonio production	57	414	46	-1,46	
	region with no fonio production	40	421	63	1,80	
Buyer education level	primary or religious school	43	411	30	-2,35	
	secondary school	10	463	94	12,15	10
	high school or more	12	423	60	1,80	
	Other	32	408	55	-2,93	

Table 5: Pre-cooked fonio: descriptive statistics and parameters of the model

Characteristics	modalities = variables of the model	descriptive statistics (price in CFAF/kg)			Results of the model	
		N	Average	SD	Parameter	VIP rank
Total		65	867	88	constant = 874,483	
Purchase location	At the processing unit	12	858	76	4,553	
	Speciality store	26	792	27	-55,107	1
	Supermarket 1	2	1 000	0	85,484	6
	supermarket 2 (Badalabougou)	11	879	29	1,784	
	Supermarket 3 (Hippodrome)	11	995	15	51,369	2
	supermarket 4 (Hippodrome)	2	1 000	0	92,527	7
	supermarket 5 (Hippodrome)	1	830		-15,932	
Brand	brand-1	6	800	0	-34,238	9
	brand-2	1	1 000		83,788	18
	brand-3	2	900	71	-8,960	
	brand-4	1	850		7,923	
	brand-5	16	850	89	-4,370	
	brand-6	15	790	39	-40,739	4
	brand-7	1	825		-24,197	
	brand-8	18	953	54	43,287	3
	brand-9	2	830	0	-19,947	
	brand-10	3	933	58	47,318	
Grain colour	Blanc	18	865	87	1,145	
	Cream white	27	875	91	3,189	
	Brown, red, grey, not white	20	858	87	-4,711	
Grain size	Big	7	936	94	15,704	5
	Small	24	856	86	-8,291	
	Do not know	30	858	84	2,614	
	several different sizes	4	874	95	-3,943	
Grain origin	Guinea	2	975	35	8,972	13
	Mali	1	850		-8,294	
	Do not know	62	864	88	-3,224	
Recipe	Djouka	7	914	107	12,117	19
	other salted meal	53	866	87	-5,881	
	Other	5	810	22	-3,930	20
Occasion	for sale or gift	8	838	69	3,052	
	week end	25	876	72	6,013	
	familial or religious meal	9	827	83	-22,951	
	ordinary meal	23	883	107	4,309	
Destination	household consumption	55	875	88	8,208	12
	Processing for sale	1	800		-10,608	
	Gift (no home process)	8	819	84	-9,524	14
	Other	1	850		7,923	
Status of the buyer	Mother	39	849	80	-12,885	11
	Employee	4	911	86	-0,452	
	Father	13	875	91	7,074	
	other member of the family	9	911	105	16,653	15
Buyer age	less than 20	2	900	141	10,385	
	Between 21 and 35	15	889	100	-1,504	
	Between 36 and 50	31	862	81	-1,770	
	more than 51	17	853	87	2,065	
Buyer sex	Man	19	862	88	1,309	
	Woman	46	869	89	-1,309	
Buyer job	Employee	13	858	74	-2,057	
	independant worker	6	892	102	-3,335	
	Student	4	950	100	11,938	10
	Civil servant	31	862	87	7,145	
	Retired	5	859	89	-0,324	
	Housewife	6	838	101	-21,964	
Buyer origin	region of production of fonio	29	879	90	4,725	
	region with no production	35	861	83	1,147	
Buyer education level	primary school	13	902	91	8,652	16
	secondary school	23	843	78	-6,917	17
	more than secondary school	29	870	91	0,798	

¹ Note that VIP= Variable Importance in the Projection = 3.11 for rank = 1 ; VIP = 0.86 for rank = 20