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Effects of the border closure Benin-Nigeria on the marketing of *Clarias gariepinus*

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Abstract
The *Clarias* is consumed in Africa and Benin. Despite its important role in food, its sector is subject to many constraints, including marketing in Nigeria. The objective of this study is to assess the marketing of smoked *Clarias* in southern Benin in the face of the Nigerian border closure. It is made in the Oueme department. Individual surveys based on structured questionnaires were conducted with 30 fish farmers and 45 processors. From the results obtained, three Nigerian markets are known for the sale of smoked *Clarias*, of which Badagri is the main destination. The actors in this activity are mostly adults with an average experience over 20 years. Fish farming is mainly the prerogative of men (83.33%) while processing and marketing are the only privilege of women (100%). The closure of the Nigerian border has led to a decrease in the annual fish production of the respondents from 8,960 kg to 7,491.96 kg as well as a decrease in the quantity of smoked fish from 6,249.24 kg to 2,319.96 kg after the border closure. The study shows a decline in the level of income of fish farmers and commercial processors, especially in the achievement of food security in their households. The marketing of smoked fish in Nigeria appears to be a profitable activity for processors.

Keywords: Smoked fish, marketing, border, department, Ouémé

1. Introduction
In developing countries, annual per capita consumption of fish has increased steadily from 5.2 kg in 1961 to 20 kg in 2014 [1]. Fish also accounts for 17% of animal protein intake globally, and more than 50% in developing countries [1]. It also plays an important role in the economy of these countries through trade and exports, particularly in the coastal states of West Africa [2]. In Benin, fishing has been a major source of income for vulnerable fishing communities across generations and a source of animal protein, sometimes the only one accessible to poor segments of the population living near water bodies and isolated communities in rural areas [3]. However, in the fisheries sub-sector, there are problems of post-capture losses of up to 20% despite the efforts of women fish processors every year. These losses generally lead to a decrease in income and in the number of fish available for food [4]. In order to find a solution to this situation and given the important role that smoked fish plays in low-income households, it is necessary to know the main organizations that preside over the structuring of this activity, which is the processing and marketing of smoked *Clarias*. The processing of fishery products appears to be a lucrative sector for improving the living conditions of coastal communities. More than a simple survival activity, transient, fish smoking can be considered as a permanent well-paid job [5]. The general objective of this study is to take stock of the marketing of smoked fish from Benin to Nigeria in the face of the closure of the Nigerian border in order to characterize the actors and the marketing circuit and finally determine the effect of the closure of the Nigerian borders on the marketing of smoked *Clarias* in the department of Ouémé and to evaluate the level of food security of the actors in the sector in Benin

2.1 Material and Methods
2.1.1 Study Area
The study was conducted in the department of Ouémé in southern Benin from September 2019 to February 2020. Ouémé Department is located in southeastern Benin bordered by the Atlantic Ocean and the Littoral Department to the south, the Plateau Department to the north, the Atlantic Department to the west, and the Federal Republic of Nigeria to the east.

With an area of 1,281 km², the department of Ouémé has nine (9) communes, namely Adjara, Akpro-Missérété, Avrankou, Adjohoun, Bonou, Dangbo, Sèmè- Kpodji, Aguégués and Porto-Novo the administrative capital of Benin. These communes are subdivided into 52 Arrondissements, and 405 villages and city districts [6]. The communes of Avrankou, Porto-Novo, and Sèmè-Podji are the ones covered by this study. Fig I provide details on the different communes involved

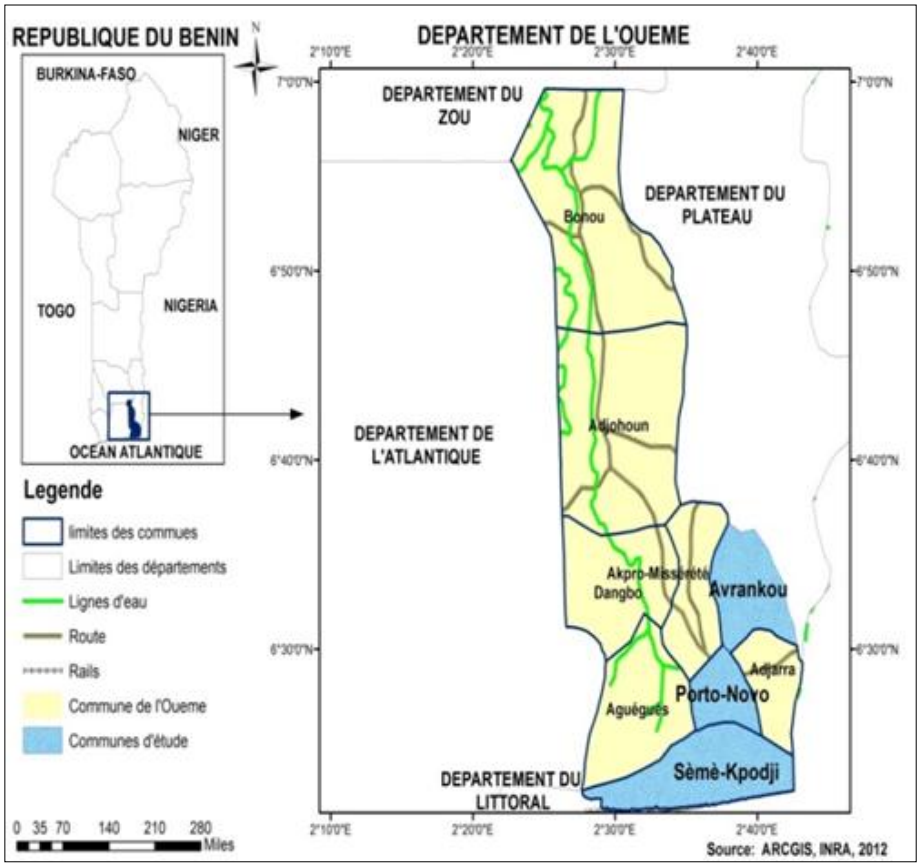

Fig 1: Geographic location of the study area

2.2 Data collection and processing

2.2.1 Sampling and choice of survey sites

Sampling was carried out at three levels: department, commune and catfish farms (fish farmers and processors). The communes of Avrankou, Porto-Novo and Sèmè-Podji were chosen not only for their high representativeness of fish farmers, but also for their geographical location (border with Nigeria) and the high presence of female *Clarias* smokers in these communes. As for the farmers, the snowball method was used for their selection. In total, 30 fish farmers and 45 women processors were surveyed. Table I shows the distribution by commune.

Table I: Distribution of respondents by municipality

Municipality	Processors	Fish farmers
Avrankou	13	14
Porto-Novo	11	07
Sèmè-Podji	21	09
Total 1	45	30
Total 2	75	

2.2.2 Data collection and analysis phase

This phase consisted of collecting both qualitative and quantitative data from the different categories of actors sampled, based on questionnaires developed using the results of the documentary study and the exploratory phase. The main technique used for data collection was interviews using structured questionnaires.

2.2.3 Data collection tools

In order to achieve the objectives of this study, various data analysis tools and methods were used. Descriptive statistics using frequency tables made it possible to characterize the different actors in the marketing circuit of smoked *Clarias* to Nigeria from the department of Ouémé.

2.2.4 Data analysis tools

The analysis of the effect of the closure of the Nigerian borders on the marketing of smoked *Clarias* is done at the level of the actors, based on three criteria Quantity of fish marketed before and after the Nigerian border closure Sales price before and after the closure of the Nigerian border Evaluation of the food security of the stakeholders in the sector. The data collected from the respondents was coded, entered and processed with the Excel. 2013 spreadsheet. Descriptive statistical analyses were performed using SPSS software

3. Results and Discussion

3.1 Characterization of the actors

3.1.1 Fishermen

Fish farming is mainly done (83.33%) by men against 16.7% of women and with an average experience of 20 years. They have an average age of 52 years. These results are similar to those obtained by [7] in their study census of fish farmers in Benin. Their households have an average of 8 members. The majority of fish farmers 93.3% are married. More than half

89% practice fish farming as their main activity. No fish farmer or fisherman practices fish smoking. These results are contrary to those obtained by the [8], which states that most of the fish product is transformed by the fishermen on site into smoked fish. The majority (93.1%) use family and casual labor and 63.33% of fish farmers have employees with an average of 2. 80% belong to an association such as GBEVIVI, WEVIGBE, FeBePA, FeNaPiB, etc. 70% of the fish farmers are educated. Overall, 63.3% of fish farmers use their own funds to finance their activity and 6.7% use a loan from different structures in the area. The amount they borrow is on average 4,000,000 CFA francs with an average repayment rate of 17%. More than half (83.34%) of the fish farmers have received technical support. Table II presents the characteristics of the fish farmers.

Table II: Characteristics of fish farmers

Variables	Workforce (n)	Fréquencies	Meaningful tests
Age			
[25 à 34]	n= 02	6,7	***
[35 à 44]	n= 03	10,0	
[45 à 59]	n= 17	56,7	
Superieur à 60	n= 08	26,7	
Sex			
Male	n= 25	83,33	***
Feminine	n= 5	16,67	
Instruction			
Yes	n= 21	70	**
No	n= 9	30	
Experience			
[5 à 9]	n= 04	13,3	**
[10 à 14]	n= 07	23,3	
[15 à 19]	n= 04	13,3	
Superieur à 20	n= 15	50,0	
Marital status			
Married	n= 28	93,3	***
Single	n= 2	6,7	
Membership of an association			
Yes	n= 24	80	***
No	n= 6	20	
Training			
Yes	n= 21	70	***
No	n= 9	30	

3.1.2 The women processors

Fish processors are only married women (100%). This percentage was found by [9] in their study on the evaluation of the microbiological quality of artisanally smoked fish in Togo and a similar result was obtained by [10] and [11] in Benin and Côte d'Ivoire respectively. In the traditional configuration, men are responsible for catching and women handle processing and marketing [12]. On the other hand, [13] in their study in southern Benin showed that 15% of men practice the activity of smoking fish. The most represented age group is 35 to 44 years old, which shows that fish smoking is done by the youth. The smoking of fish is undertaken under own funds. However, they take out credit for raw materials from fishermen and/or fish farmers and short-term equipment credit from a relative who is a processor. As [14] points out in their study on the socio-economic analysis of fish smoking in artisanal maritime fisheries on the coast of Benin. More than half (79.1%) of the women processors have received technical support, mainly on smoking techniques, hygiene and fish conservation before and after smoking, contrary to the work of [10], in their study on the performance of an improved smoking device (Chorkor oven) on the quality of smoked fish in southeast Benin, where 95% of the women processors are illiterate and none of them have received training These results are the work of various structures that have provided technical support to these women, including ACMA, PADA, etc. The industry is characterized mostly (73.3%) by illiterate women as pointed out by [15] in their study on the adjuevan production chain in Côte d'Ivoire and [13] on the microbiological quality of horse mackerel during the smoking process in Benin. According to [16] on sanitary standards and international trade, female traders in West Africa have not received as much formal education as their male counterparts. This trend is the same for the 95.6% mixed labor force and the 4.4% family labor force. The majority (62.22%) of female processors sell their products in the Badagri market, 26.67% sell in Illara and 11.11% in Yawi in Nigeria. Table III presents the characteristics of the processors.

Table III: Characteristics of processors

Variables	Workforce (n)	Fréquencies	Meaningful tests
Age			
[25 à 34]	n= 04	8,9	**
[35 à 44]	n= 22	48,9	
[45 à 59]	n= 19	42,2	
Sexe			***
Masculin	n= 0	0	

Féminin	n= 45	100	
Marital status			
Married	n= 0	0	***
Single	n= 45	100	
Membership of an association			
Yes	n= 12	26,7	**
No	n= 33	73,3	
Expérience			
[10 à 14]	n= 05	11,1	***
[15 à 19]	n= 04	8,9	
Supérieure à 20	n= 36	80	
Membership of an association			
Yes	n= 17	37,8	NS
No	n= 28	62,2	
Training			
Yes	n= 28	62,2	**
No	n= 17	37,8	

3.2 Smoking of catfish for the Nigerian market

Smoking is a processing technique that consists in subjecting a foodstuff to the combined action of heat and smoke from burning wood, which gives it a sought-after color and aroma. Smoking is also above all a very old technique of conservation of perishable proteinic foodstuffs during which they undergo an important dehydration. The transformation of fresh fish into smoked fish is done in several stages. After purchase, fresh fish are sorted according to their size and state of degradation. These results are similar to those of [17] in their study on the processing and conservation of the main fish species of economic interest in the department of Fresco in Côte d'Ivoire. Some fish are used in the household diet. Only fish that do not show signs of spoilage and are in good physical condition are selected for sale. They are then generally washed in basins or containers before being smoked. Processors use three types of ovens: traditional clay ovens, barrel ovens, and improved "chokor" ovens. The processors also use three types of fuel: firewood, coconut shell and charcoal, all of which affect the nature of the smoked fish. In general, women processors using traditional ovens are exposed to respiratory diseases due to the smoke and heat to which they are exposed. These results are similar to the results of [1] in Côte d'Ivoire. There are four types of smoking: cold smoking (ToC < 30 OC), hot smoking (ToC > 60 OC), spray smoking and electrostatic smoking. For our purposes, hot smoking is used.

3.2.1 Smoking of fish from firewood and coconut shells

Smoking from firewood is found mainly in the commune of Porto-Novo. This fuel generates a medium smoke with high heat and less odor on the fish. The organoleptic characteristics are acceptable according to the respondents.

The smoking of fish using coconut shells is observed much more in the commune of Sèmè-Podji. Burning with coconut shells is slow, the heat is constant and generates enough smoke with a strong smell on the fish. This fuel is the least expensive and also available. However, this smoke can cause lung and eye problems for those who practice smoking. This fuel contains toxic substances such as carbon monoxide and hydrogen sulfide (H2S) that can cause neurological disorders in the consumer that processors ignore.

3.2.2 Smoking of fish from coal

Processors in the commune of Avrankou mainly use improved ovens called "chokor ovens", which use charcoal as fuel. This fuel makes the fish much more attractive after smoking. This allows them to sell their products more quickly on the Nigerian market before their colleagues who use other types of fuel. Smoking from charcoal is very fast but more expensive. Among the ovens used by the fish processors (smokers), improved ovens are better for smoking fish due to the massive emission of CO2 gas and polycyclic aromatic hydrocarbons, carcinogenic compounds for the consumer that are deposited directly on the smoked fish. These results corroborate those of [18] who proposed the improved oven "Chorkor" as a technique for improving the smoking of fish in Abidjan and those of [19] on the state of knowledge of the processing and conservation of artisanal fishery products in Abidjan.

We can retain that the choice of fish with a good shape and fuel are very important, because it conditions the quality of the finished product (aroma, taste and color). This color goes from golden yellow to brown depending on the fuel used. Figures II, III, IV show the different types of ovens used by the processors and fig V shows the technological diagram of fish smoking.

Fig 2: Barrel oven with *Clarias*

Fig 3: Modern ovens « Chorkor »

Fig 4: *Clarias* in a clay oven

3.2.3 Marketing channel for smoked *Clarias*

In Nigeria, the main markets for smoked *Clarias* from Benin are Badagri in the south, Illara in the center and Yawi in the north. In addition, it is important to note that processors frequent all these different markets, but with varying frequency. The Beninese and Nigerian fish farmers/fishermen are the first links in the chain and the final consumers are the last links in the circuit. Since the devaluation of the Nigerian currency (Naira) in 2016, some processors in the department of Ouémé go there to get fresh fish at a low price. They then come to smoke these fish and resell them on the Nigerian market. Figure check it shows the marketing circuit for *Clarias gariepinus*.

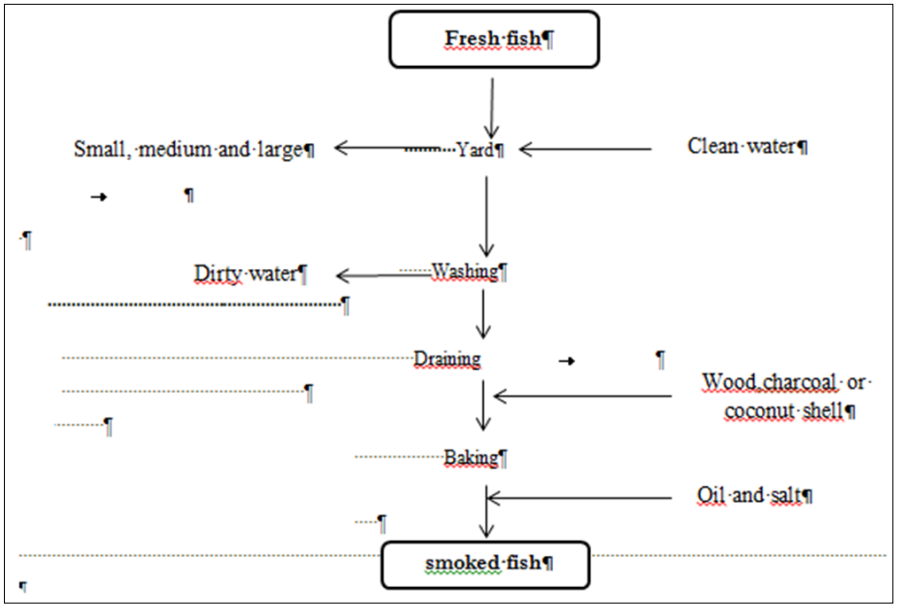

Fig 5: Technological diagram of processing fresh fish into smoked fish

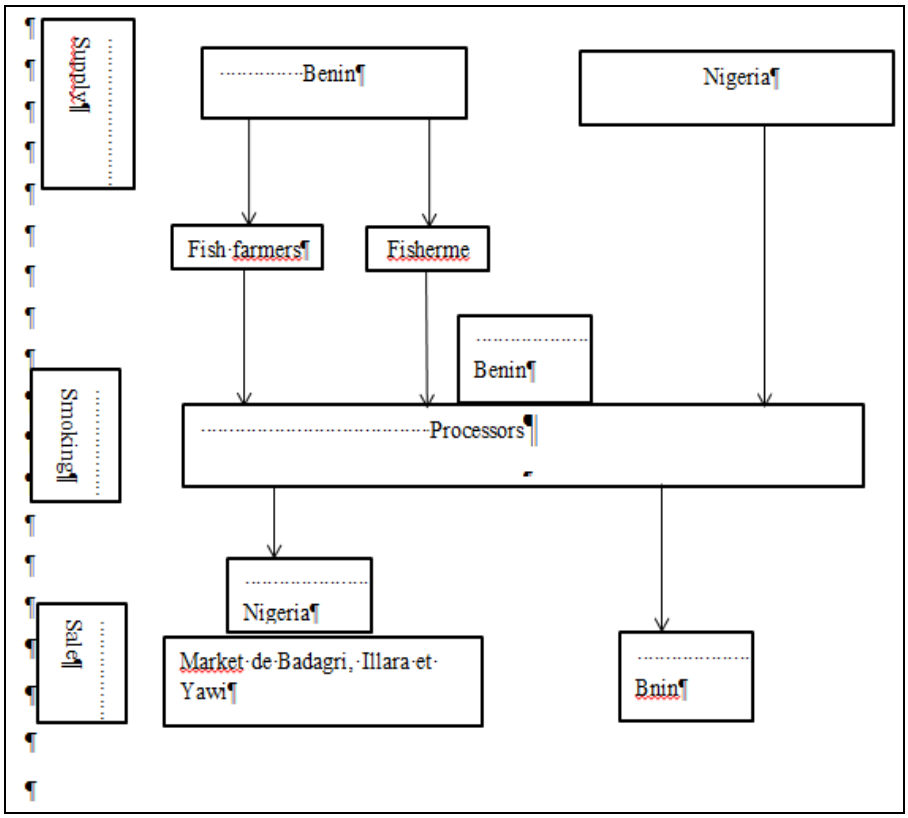

Fig 6: Circuit of marketing for fish in department of Oueme

3.3 Price fluctuation of *Clarias* on the Nigerian market

The fish farmers' organization has a range on the price per kilogram of fish. This range is from 500 to 1500F CFA. The average size of *Clarias* sold varies from 150g to 500g gram. The sales methods are variable, i.e., sale by the kilogram 90%, sale in piles and by ponds 5% and 1% respectively. These results are contrary to those obtained by [17]. The places of sale are also highly variable by the fish farmers namely fish farm sites, home and the market. 100% of the respondents sell their fish at the fish farm sites, contrary to the results of [20]. As with the purchase, the price is obtained after haggling. The purchase price of fresh *Clarias* from fish farms has dropped significantly due to constraints related to accessing the Nigerian market, which is the largest consumer of smoked *Clarias*, and also due to the fact that the cost of transport borne by processors is high. As [21] point out. Despite the difficulties of accessing the Nigerian market by processors, the selling price of smoked *Clarias* has remained unchanged in the neighboring eastern market. According to 100% of the fish farmers, the price of *Clarias* has dropped significantly. This is not only due to the fall of the Naira currency but also to the closure of the Nigerian border with neighboring countries. When fresh fish is procured, if three fish weighing 1 kilogram, it is bought at 1200F CFA and the quarantine is sold, after smoking, at 18000F CFA Table IV provides information on some prices of *Clarias*.

Table IV: The purchase and sale price of fish from processors

Nomber of fresh for kg	Purchase price (FCFA) of fresh fish after closing	Quantity sold	Selling price of smoke fish (F CFA)
3	1.200	Quarantine	18. 000
4	1.100	Quarantine	14. 000
5	1000	Quarantine	12. 000
6	900	Quarantine	9. 000

3.3.1 Units of measurement for *Clarias*

The actors use various units of measurement for the marketing of fish. Fresh fish is sold in kilograms according to the majority (90%) and in heaps at 8% and 2% per pond or basin. As for smoked fish, they are sold in quarantine according to 80% of respondents, in rods at 15% and in piles at 5%. These results are contrary to those obtained by [17], but similar to those found by [20].

3.3.2 Cost of production of *Clarias* in ponds and in ponds

At the pond level, to produce 1 kg of marketable *Clarias*, the fish farmer spends an average of 1136.11F CFA. It can be seen that feeding is the level where the fish farmer invests the most, 400.90F CFA are necessary to feed one kg of *Clarias*, which is a rate of 38.58% on the total production cost. As for the structure of the ponds, to produce 1 kg of merchant *Clarias*, the fish farmer spends an average of 1231.07F CFA, feeding is the level where the fish farmer invests the most with 461.90F CFA to feed one kg of *Clarias*, which is a rate of 37.52% on the total production cost. Table V shows the production costs of fish farmers in ponds and ponds.

Table V: Cost element of production fish farmers in ponds

Element	Coûts en F CFA/kg	
	Pond	Bowl
Fry	194,31	194,31
Food	400,90	461,90
Cleaning and fertilizatio costs	12,81	15,81
Electricity	45,78	75,74
Workforce	207,29	203,29
Amortization	165,89	175,89
Financial expense	109,13	104,13
Total	**1136,11**	**1231,07**

3.3.3 Cost of smoking *Clarias*

Analysis of the data collected on the costs of smoking *Clarias* with firewood reveals that to produce 1 kg of merchant *Clarias*, women processors spend an average of 1342.94F CFA. In contrast, to produce 1 kg of merchant *Clarias* with charcoal, they spend an average of 1352.96 CFA francs. On the other hand, to produce 1 kg of merchant *Clarias* with coconut shell, it is necessary to spend an average of 1340.98F CFA. The cost structure shows that fresh fish is the level where processors invest much more. As pointed out by [22] in his study on fish processing in Senegal, the cost structure of fresh fish is much higher than that of fresh fish. Table VI shows the smoking costs of processors.

Table VI: Element of processors' smoking costs

Elements	Firewood	Coal	Coconut shell
	Cost in F CFA/Kg		
Fresh fish	1197,11	1197,11	1197,11
Salt	4,10	4,10	4,10
Oil	5,13	5,13	5,13
Combustible	8,06	19,08	7,10
Workforce	9,41	9,41	9,41
Transport costs	19,02	19,02	19,02
Amortization	99,11	100,11	99,11
Total	1342,94	1353,96	1340,98

3.4 Effect of the closure of Nigerian borders on the marketing of smoked fish and food security

3.4.1 Effects of border closure on quantities and transaction prices traded

The average production of *Clarias* before the closure of the Nigerian borders is 746.67 kg and it dropped to 624.33 kg and the average annual production of smoked fish before the closure of the Nigerian borders is 6249.24 kg and it dropped considerably to 2319.96 kg. Table VII shows us the effect of the border closure on the quantities and prices of *Clarias*.

Table VII: Effect of border closure on quantity and prices of *Clarias* among processors

Settings	Before	After	Effects
Average quantity of fish in Kg	6249,24	2319,96	Production reduction
Purchase/Kg	1500	1342,94	Lower price
Selling price/Kg	1700	1700	Constant
Cost of transport	11453,28	31866,60	increase
Motorbike Motorbike			
Means of transport	Car	Motorized boats	Change

3.4.2 Means of transporting smoked fish to the Nigerian market

After smoking, processors must sell their products on local markets and the Nigerian market. Before the closure of the Nigerian borders, they used to go to the Nigerian market by car for the most part and two-wheeled motorcycles for some. But since the closure of the borders they no longer have access to Nigeria by legal means. But since they have to sell their products to be able to support themselves and their families, they need a way to get there. The only appropriate way is to go through the bypass through the water where the control will be less by the Nigerian security agents. The loading of the transformers and their products is done from the lagoon of Porto Novo in two places on both sides, in the South i.e. on the side of Porto-Novo having the name Maria-Tokpa and in the North i.e. on the side of Djrègbè having the name Adjadjè. As for the landing, it is done on the Nigerian territory at the level of the sites named CMS, LIVERPOOL, ABOUDOSSO, TRESFIES.

3.5 Stakeholders' point of view on the contribution of fish farming and smoking to food security in their households

3.5.1 Fishermen

About 50% of fish farmers think that fish farming contributes little to the improvement of their income, while 23.33% say that it contributes a lot. On the other hand 26.67% think that this activity is not profitable. 13.34% and 23.33% of respondents respectively think that fish farming does not contribute at all to the improvement of their living conditions and to the improvement of their food and nutritional security situation. More than half of the fish farmers (60%) perceive that their activity contributes little to the improvement of their food security situation. The monthly income from fish farming is mainly used to feed the household.

3.5.2 Processors

The majority of women processors (57.77%) believe that smoking fish contributes to improving their income. More than 35.56% of the women processors perceive that their activity contributes greatly to the improvement of their food and nutritional security situation. The processing activity allows women processors to provide for their families. As pointed out by [23] on the whole, the monthly profits that women make from smoking fish are allocated first to feeding their households.

4. Conclusion

The main objective of this study is to evaluate the effect of the closure of the Nigerian border in order to characterize the actors, the marketing circuit and to evaluate the level of food security of the actors in the sector in southern Benin. In view of the results obtained, only one circuit takes into account the marketing of smoked *Clarias* with three links, namely "Fish farmers/Fishermen - Processors/Traders - Consumers". The Nigerian market is the main destination for smoked *Clarias* marketed in the department of Ouémé. Since the closure of the Nigerian borders, the processors no longer have the possibility of crossing the Nigerian territory by land. They were able to find a way to sell their products in Nigeria via the river, using motorized boats from the lagoon of Porto-Novo. The loading is done at two levels which are Maria tokpa and Adjadjè. As for the disembarkation, it is done on the Nigerian territory at the level of the sites named CMS, LIVERPOOL, ABOUDOSSO, TRESFIES. This closure of the border has led to a significant drop in the production of smoked fish. This decline has led to a drop in the income of the actors, which will lead to a critical situation of food security within the households of the actors of the fish sector.

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