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Valuing environmental attributes of food products in a polluted environment: what are the preferences of Guadeloupean consumers?

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Abstract

Product qualification and differentiation processes based on environmental attributes are part of the process of the ecologisation of food systems. They provide a better understanding of food consumption behaviour, insofar as they help to promote sustainable production systems. These issues are particularly relevant in the French West Indies, where consumers make little use of objective quality signals such as labels, brands or sustainability claims. To assess consumer sensitivity to the environmental attributes of fruit and vegetables, a real choice experiment was conducted with a sample of 88 Guadeloupean consumers. Assessments produced by a mixed logit model showed that price had a significant discriminating impact on the utility of products for consumers. The results also reveal that consumers expressed a preference for environmental attributes that varied according to the type of product. We observed that sensory perception is influenced by the recognition of quality labels and that local production is not associated with respect for the environment.

Keywords: food consumption behaviour, environmental quality, willingness to pay, experimental economics.

JEL Classification: C91, D12, Q0, Q13

Valorisation environnementale des biens alimentaires en milieu pollué : quelles préférences des consommateurs Guadeloupéens ?

Résumé

Les processus de qualification et de différenciation des produits basés sur des attributs environnementaux participent des démarches d'écologisation des systèmes alimentaires. Ils invitent à mieux comprendre les comportements de consommation de biens alimentaires dans la mesure où ils contribuent à promouvoir des systèmes de production durables. Ces enjeux font particulièrement sens aux Antilles françaises où les consommateurs ne recourent guère à des signaux objectivés de qualité tels que les labels, les marques ou les allégations. Afin d'évaluer la sensibilité des consommateurs aux attributs environnementaux de produits maraichers, une expérience de choix a été réalisée sur un échantillon de 88 consommateurs guadeloupéens. L'estimation d'un modèle mixed logit montre que le prix a une incidence significative discriminante sur l'utilité des consommateurs mais que ces derniers expriment une préférence pour les attributs environnementaux variable selon le type de produits. Nous observons aussi que la perception sensorielle est influencée par la reconnaissance des signes de qualité et que la production locale n'est pas associée au respect de l'environnement.

Mots-clefs : Comportement alimentaire, qualité environnementale, consentement à payer, économie expérimentale.

Classification JEL : C91, D12, Q0, Q13

1. Introduction

The regulatory push for the ecologisation of food systems raises questions about how far we can actually go beyond our existing production and consumption models, which are rooted in the productivist paradigm. Society's aspirations for the development of local, environmentally friendly and socially responsible agriculture gain more and more currency. Given this context, understanding pro-environmental consumer behaviour (Barber *et al.*, 2014; Cecchini *et al.*, 2018) is of major interest insofar as it can help to promote sustainable production systems.

This article examines consumer recognition of the environmental attributes of fresh food products (fruit and vegetables). As far as environmental considerations are concerned, the question of the variables involved in the process of qualifying food products (differentiation and singularisation) to which consumers are sensitive makes particular sense in the French West Indies. The French West Indies have experienced an unprecedented episode of soil pollution. This environmental pollution is due to several decades of using a specific but toxic pesticide (chlordecone) to control the black banana weevil. As a consequence, more than 25% of the Utilised Agricultural Area is affected by chlordecone, which contaminates both terrestrial and aquatic resources. It has been highlighted (Ferdinand, 2015) that the effects of this pesticide are widespread (a wide range of environmental spheres have been impacted), long-term (the terrestrial resources have been contaminated for the next centuries) and harmful (the pollution is a genuine public health problem).

In fact, pollution does not affect local products in the same way. Not all products reach the same level of contamination. In the French West Indies, satisfying local demand come from two main sources (imports and local production) and are sold through different distribution channels (both long and short chains). Imported products (all categories combined) come mainly from mainland France (60% of the value of imports). Fresh tropical products from the Caribbean and Latin America basin compete directly with local production (Marzin *et al.*, 2021). These imports are largely sold through big retail chains, while local produce is mainly sold at open-air markets (communal and farmers' markets) and on farms (Angeon and Fréguin-Gresh, 2022).

As part of the agroecological transition of food systems, many innovative initiatives are being developped, with all that this implies in terms of changing practices, transforming production and distribution systems, changing consumption patterns, renewing public policies etc. These initiatives are reflected in a profusion of information systems that contribute to the process of qualifying food products by integrating environmental considerations. From this perspective, we

can observe the development of information systems attesting to the specific characteristics of food products. These information systems can take a variety of forms: sustainability claims (e.g. 'free from pesticide residues'), endorsements (e.g. 'from a farm of high environmental value'), public standards (e.g. official quality signs such as organic agriculture labels) or private standards, typically brands (e.g. private labels). In parallel, more implicit product qualification and evaluation processes conducted by consumers exist. These are based on less objective criteria such as the interpersonal relationships consumers may have with producers, a grower's reputation etc.

Local fruit and vegetables result from of a wide diversity of agricultural systems (size, degree of specialisation, capital intensity and degree or gradient of ecologisation). As diverse as these agricultural systems are, their practices are rarely referenced. This lack of referencing means that the environmental attributes of products from these systems cannot be promoted.

In the French West Indies, there are few labelling schemes relating to the agroecological (AE) attributes of local products, with the notable exception of the national *Agriculture Biologique* (AB, i.e. organic) label. Similarly, unlike in mainland France, where a variety of quality standards coexist, including labels, claims from producers and collective or private brands, few of these standards apply to local produce in the French West Indies. This difference in the profusion of quality signs raises the question of how food consumption standards are disseminated in the French West Indies. Based on this observation, this article aims to provide the keys to understanding Guadeloupean consumers' trade-offs when it comes to the environmental characteristics of food products. To this end, a real choice experiment was conducted with 88 consumers.

The aim of the choice experiment was twofold. The first objective was to determine the extent to which the environmental characteristics of food products influence consumer choices in a context of strong environmental pollution. The second was to determine whether the potential impact of environmental characteristics varies according to product type. For this reason, the experiment was conducted using a basket of goods. Finally, in order to determine the extent to which these trade-offs could be called into question with regard to the organoleptic qualities of products, participants sensorially evaluated tomatoes, one of the products included in the basket, that had been grown using different production approaches.

This article is divided into four sections. Following the introduction, the second section presents the data collected and the methodologies employed. It sets out the hypotheses and the tools used

to test these hypotheses. The third section presents the results of empirical analysis. These results describe the determinants of the consumption trade-offs made during the experiment, consumers' sensory characterisations of environmental characteristics and beliefs linked to the environmental quality of local products. Finally, the fourth section discusses the results and draws our conclusions.

2. Materials and methods

The above objectives led us to define an experimental protocol and questionnaire designed to test several hypotheses concerning Guadeloupean consumers' preferences for the environmental characteristics of food products.

The first hypothesis (H1) assumes that Guadeloupean consumers prefer food products derived from less input-intensive agriculture. The Kannari study (ANSES, 2018) showed detectable concentrations of chlordecone (this pesticide has received the most media attention in the French West Indies) in 90% of the general population in Martinique and Guadeloupe. It therefore seems credible to think that following this major pollution of the islands and their inhabitants, local consumers would be aware of the problems surrounding the use of plant protection products.

The second hypothesis (H2) assumes that Guadeloupean consumers' trade-offs in favour of environmental characteristics will vary according to food products. This hypothesis is based on the fact that chlordecone does not affect all fruit and vegetables in the same way (Cabidoche and Lesueur-Jannoyer, 2012; Clostre *at al.*, 2017) and that the consumption of certain food products therefore leads to a greater exposure to chlordecone among consumers (AFSSA, 2007). For example, eating roots and tubers grown in contaminated soil increases the risk of exposure. The question here is to determine to what extent consumers modify their choices according to perceived differences in exposure depending on the types of plant consumed.

The third hypothesis (H3) sets out that consumers perceive organoleptic differences for the same foodstuff depending on its production method. Sensory characteristics remain an essential criterion in food purchasing behaviour (Mahele *et al.*, 2015). It seemed appropriate to test the extent to which production methods modify consumers' sensory perceptions.

The final hypothesis tested (H4) posits that Guadeloupean consumers believe local products are environmentally friendly. According to the French government and ANSES (referral no. 2018-SA-0166), the individuals most exposed to the risk of chlordecone contamination are mainly supplied through informal channels (self-production, donations, roadside and certain open-air

markets), through which the majority of locally produced foodstuffs pass. So it seems that, despite the health crisis linked to pollution, some consumers remain confident in the environmental qualities of local produce.

A sample of Guadeloupean consumers was used to provide empirical evidence to validate or reject these hypotheses. The methodology adopted to test these four hypotheses was based on a combination of several methods: experimental economics using a choice experiment, sensory analysis and survey questionnaires to study beliefs about production methods.

2.1. Consumer recruitment

The experimental sessions took place in May 2019. The choice experiment was conducted with 88 participants in six experimental sessions. Recruitment criteria focused on the consumption and purchasing of local produce and was designed to ensure that participants were willing to take part in an economic experiment, with the potential purchase of a basket of food products. Participants also had to be involved in household food purchasing decisions (only one participant per household could be selected).

Participants were brought together in a closed workspace, allowing them to rationalise their decisions individually. Standard socio-demographic criteria for building a sample were followed (gender, age and socio-professional category).

Table 1 describes the socio-demographic characteristics of the sample based on 2018 INSEE census data.

Table 1: Socio-demographic characteristics of the sample

Socio-demographic characteristics		Frequency (%) in the sample used	INSEE census data for Guadeloupe 2018
Gender	Men	**40.91**	**45.94**
	Women	**59.09**	**54.05**
Age	Under 30	**27.27**	**34.86**
	Between 30 and 39	**23.86**	**9.88**
	Between 40 and 49	**21.59**	**13.96**
	Between 50 and 59	**14.77**	**15.80**
	60 and over	**12.50**	**25.51**
Educational level	No diploma	**3.53**	**35.4**
	Brevet des collèges (BEPC)	**4.71**	**5.9**
	BEP, CAP or equivalent	**14.12**	**18.2**
	Baccalaureate (Bac)	**20.00**	**17.8**
	BTS, DEUG, degree or equivalent (Bac+2 to Bac+3)	**32.94**	**9.5**
	Engineering or Master's degree or equivalent (Bac+4 to Bac+5)	**23.53**	**7.9**
	PhD or equivalent (Bac+6 and above)	**1.18**	**5.3**
Professional situation	Student	**16.09**	**11.5**
	Looking for work	**17.24**	**20.3**
	In employment	**55.17**	**50.3**
	Other inactive	**11.50**	**13.9**
Socio-professional category (in work only N=114)	Farmers	**2.63**	**1.91**
	Craftsmen, shopkeepers and business owners	**10.53**	**11.00**
	Managers and professionals (lawyers, doctors, architects etc.)	**17.54**	**11.58**
	Intermediate occupations (nurse, teacher, executive secretary etc.)	**28.95**	**25.10**
	Employees (sales, cashier, nursery assistant, postal worker etc.)	**35.09**	**33.82**
	Labourers (gardener, bricklayer, warehouse staff etc.)	**5.26**	**16.52**

2.2. Revealing preferences for environmental characteristics: a choice experiment

In order to test hypotheses H1 and H2, a choice experiment was conducted with the sample group described above. The experimental protocol was based on discrete choice methods. These methods have traditionally been developed within a hypothetical framework, aiming in particular to evaluate individuals' preferences for the isolated characteristics of goods. Choice experiments are based on the Lancasterian approach, according to which the utility derived by an agent when consuming a good does not come from the product itself, but from the attributes that characterise it. In a choice experiment, participants must reveal their preferences by making choices from a set of alternatives (Adamowicz *et al.*, 1998; Street and Burgess, 2007). The

alternatives proposed are defined in terms of attributes that characterise the good. Each attribute is made up of several levels, enabling the good to be defined as a whole.

The experimental design was generated to maximise D-efficiency using Fedorov's modified algorithm (Carlsson and Martinsson, 2003). Each participant was asked to choose between two baskets 16 times (i.e. 16 sequential choice situations). In each choice situation, two baskets were presented to the participants, along with an exit option (allowing them to choose neither basket). Each basket comprised four products[1] (plantain, cucumber, lettuce and cherry tomatoes), whose attributes are described in Table 2. In order to limit declarative bias, an incentive mechanism for the sale of the baskets was employed, so that the choice declared by the participants is implied since it is materialised by an act of purchase. The actual purchase is made at the end of the experiment for one of the 16 randomly selected choice situations. So, at the end of the session, each participant bought the basket he or she had chosen in the situation he or she drew at random (and therefore paid the price announced on the choice card). The exit option corresponded to the case where the participant ticked the 'None' box on both baskets. This meant the participant could not buy either of the baskets on offer. As participants did not know which situation would be drawn at the time of the choice, participants had to be attentive to each situation. In the absence of available, actually observed data, this methodological choice also made it possible to characterise consumer trade-offs.

In order to determine the extent to which the evaluation of the environmental characteristic could vary according to the type of food product, we chose to focus on a basket of fruit and vegetables. Each product in the baskets was defined according to its price and production method. Three price levels were used: minimum, average and maximum. Three production methods distinguished the products: conventional (Conv, a production method allowing synthetic chemical inputs to be used), agroecological (AE) without reference to a quality standard or brand, and an organic farming label (Org, complying with strict specifications excluding all use of synthetic pesticides). To ensure that all participants were familiar with the different production methods, a summary of input use corresponding to each production method was distributed to all participants at the start of the experiment.

[1] The products chosen are part of the usual diet of Guadeloupean consumers (ORSAG, 2010[1]). Each basket offered contained the following products: lettuce (Iceberg variety), Cocktail tomatoes, cucumber (Eureka variety) and plantain (French Horn variety). These locally produced crops are destined for domestic demand. Between 2000 and 2015, coverage rates for all varieties combined were 100% for plantain and cucumber and 85% for lettuce and tomato (Agreste, 2017)[1]. As these crops are widespread in Guadeloupe and popular with consumers, it was then possible to consider the varieties available for each of them according to the three production methods sought.

For each choice, participants could choose between two baskets of goods, each comprising four products[2]: 1 kg of plantain, 1 kg of cucumber, 1 bag of lettuce (500 g) and 250 g of cherry tomatoes. These quantities correspond to commonly observed purchasing practices. The choice of these products was motivated by the fact that the characterisation of chlordecone contamination mechanisms in plants varies from product to product. Cabidoche and Lesueur-Jannoyer (2012) and Clostre *et al.*, (2017) have shown that bananas and tomatoes are not very sensitive to its active ingredient and can therefore be grown without risk in contaminated soils. In contrast, lettuces and cucumbers are described as intermediate or moderately sensitive crops which need to be considered with caution since, depending on the degree of soil contamination, they may exceed the maximum residue level of 20 µg/kg for plants. This information has been the subject of a wide-ranging communication campaign by public institutions (decentralised departments of the Ministry of Agriculture) aimed at both the farming community and the general public since the 2000s.

Each basket was considered to comprise of eight attributes, with each attribute comprising three levels (cf table 2).

Table 2: Attributes of proposed baskets of goods

Attributes / Levels	Plantain price	Tomato price	Lettuce price	Cucumber price	Production method plantain	Production method tomato	Production method lettuce	Production method cucumber
Low	1.4 €	18 €	0.45 €	0.9 €	Conv	Conv	Conv	Conv
Medium	2.3 €	3 €	0.8 €	1.5 €	AE	AE	AE	AE
High	3.1 €	4.5 €	1.3 €	2 €	Org	Org	Org	Org

When analysing choice data, we needed to understand the impact of product attributes on participants' utility levels. To do this, we used discrete choice models to estimate the contribution of each attribute to the level of utility, taking into account each choice situation and each basket composition during the choice situation. A logit model with random parameters was estimated,

[2] The products chosen are part of the usual diet of Guadeloupean consumers (ORSAG, 2010[2]). Each basket offered contained the following products: lettuce (Iceberg variety), Cocktail tomatoes, cucumber (Eureka variety) and plantain (French Horn variety). These locally produced crops are destined for domestic demand. Between 2000 and 2015, coverage rates for all varieties combined were 100% for plantain and cucumber and 85% for lettuce and tomato (Agreste, 2017)[2]. As these crops are widespread in Guadeloupe and popular with consumers, it was then possible to consider the varieties available for each of them according to the three production methods sought.

taking into account the heterogeneity of preferences and the panel data structure. The utility that an individual *i* derives from choosing alternative *a* in choice situation *t* is given by U_{iat}:

$$U_{iat} = x_{iat}\beta_i + w_{iat}\alpha + z_{it}\delta_a + \varepsilon_{iat} \quad (1)$$

β_i are random coefficients that vary over individuals in the population and x_{iat} is a vector of alternative-specific variables. α are fixed coefficients on w_{iat}, a vector of alternative-specific variables. δ_a (resp. γ_a) are fixed-alternative-specific coefficients on z_{it}, a vector of case-specific variables. ε_{iat} is a random term that follows a type I extreme value distribution.

The probability that individual *i* chooses alternative *a* at the time *t*, conditional on the random parameter β_i is:

$$P_{iat}(\beta) = \frac{e^{x_{iat}\beta_i + w_{iat}\alpha + z_{it}\delta_a}}{\sum_{a=1}^{A} e^{x_{iat}\beta_i + w_{iat}\alpha + z_{it}\delta_a}} \quad (2)$$

We considered random coefficients for the variables characterising environmental quality, thus assuming that preferences for environmental quality are heterogeneous across participants. It follows that the vector x_{iat} contains 12 dichotomous variables: three levels of pesticide use (conventional (*ref.*), agroecological and organic) for each of the four products (tomato, cucumber, lettuce and plantain). We considered Gaussian-distributed coefficients. w_{iat} contains the price variables for each product[3], so three price levels were considered (low (*ref.*), medium and high) for each of the four products. An alternative specific constant was included to consider the opt-out option.

2.3. Sensory evaluation of environmental characteristics

As the organoleptic dimension remains a decisive criterion in food consumption choices, we felt it was important to determine the extent to which sensory perception was differentiated according to production method (hypothesis H3). After the choice experiment, participants were asked to make hedonic evaluations (5-point Likert scale) of tomatoes for each of the production methods described above. These evaluations covered seven different sensory descriptors linked to appearance (colour), texture (firmness and juiciness) and taste (acidity, bitterness, sugar

[3] In defining the experimental design, the price of each product in the basket was considered as a differentiated attribute. This is based on the assumption that price sensitivity varies across products. However, since the total price of the basket appeared in the choice experiment, we also tested a specification in which the total price of the basket (and not the prices per product) was taken as the explanatory variable. The results on environmental characteristics by product remain robust to this new specification (results available on request from the authors).

content and overall appreciation). At the time of this initial sensory evaluation, consumers had no information on the products being assessed. They were then invited to evaluate three cherry tomatoes, this time with information on the production method for each tomato.

2.4. Measuring beliefs about local farming practices

Finally, participants were asked to complete a questionnaire. The aim was to obtain information for testing hypothesis H4. The questionnaire included the socio-demographic characterisation of participants, and questions (5-point Likert scale from 'strongly disagree' to 'strongly agree') relating to participants' beliefs about the :

- Sustainability of local farming practices
- Environmental quality of food products by place of distribution
- Sanitary quality of food products, depending on where they are distributed
- Confidence in products based on their place of production (local or imported)

3. Results and discussion

The purpose of analysing the results is to understand the interest consumers place on the environmental attributes of local food products. More precisely, they allow us to define whether consumers express a more marked environmental sensitivity for certain products. The results obtained were organised around the four hypotheses formulated earlier. We will begin by describing consumption trade-offs with regard to environmental characteristics (3.1), then present sensory perceptions of environmental quality (3.2), followed by a description of our surveyed consumers' beliefs about the environmental quality of local produce in relation to production and distribution sites (3.3), and finally we discuss these results as a whole (3.4).

3.1. Consumption trade-offs

The results of consumer choices were analysed. In particular, the impact of product attributes on participants' utility levels was assessed. To do this, we used discrete choice models to estimate the share of each attribute on the utility level, taking into account each choice situation and each basket composition during this choice situation. Consumers in the experimental economics sessions made 16 binary choices (between two baskets), including an exit option (allowing them not to buy any basket). We therefore have 1,408 choice observations. To analyse these choices, we used a logit model with random parameters.

The ASC variable represents the participants' exit option, which corresponds to buying none of the proposed baskets (Barreiro-Hurle *et al.*, 2018). It is significant and negative, showing that respondents have a strong preference for choosing one basket over none. The parameters whose standard deviations are reported were estimated as random parameters, namely environmental attributes and the exit option.

Table 3: Results of the random-parameter logit model (500 Halton draws)

Variables	Estimates	Standard deviations	Variables	Estimates	Standard deviations
ASC	-5.166***	2.895***	Cucumber conventional	Ref.	
	(0.763)	(0.389)			
			Cucumber AE	0.908***	-0.0634
Tomato price	-0.589***			(0.147)	(0.287)
	(0.0557)		Cucumber Org	1.076***	0.132
Cucumber price	-0.713***			(0.139)	(0.278)
	(0.145)		Lettuce conventional	Ref.	
Lettuce price	-0.710***				
	(0.126)		Lettuce AE	0.654***	-0.128
Plantain price	-0.721***			(0.139)	(0.257)
	(0.0818)		Lettuce Org	0.774***	0.136
Tomato conventional	Ref.			(0.138)	(0.384)
			Plantain conventional	Ref.	
Tomato AE	0.960***	0.0425			
	(0.136)	(0.321)	Plantain AE	0.640***	0.401**
Tomato Org	1.510***	0.712***		(0.147)	(0.190)
	(0.160)	(0.156)	Plantain Org	1.055***	0.420**
				(0.152)	(0.195)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

H1: Guadeloupean consumers prefer food products derived from less input-intensive agriculture.

The results show that environmental characteristics are systematically valued for all products in the basket. When consumers have a level of knowledge on production methods (a level assured in our experiment by the dissemination of information describing the three levels of input use), there is indeed a consumer preference for environmentally virtuous practices. Hypothesis H1 is therefore empirically verified as soon as consumers have information on the environmental quality of products.

Guadeloupean consumers are also highly price-sensitive, whatever the product in the basket. The data show a significant negative effect of price on participants' utility levels.

H2: Choices made by Guadeloupean consumers in favour of environmental characteristics vary according to food product.

The estimates in Table 3 show that preferences for cropping practices vary according to product. From this perspective, two product categories can be distinguished. For the first type of product, the environmental attribute induces an increase in utility indifferently to the production method. For these products, agroecological and organic farming practices do not appear to be differentiated by consumers in terms of utility gains. The products in this category are cucumbers and lettuce.

For the second type of product, the value of the environmental characteristic increases with the reduction in inputs. For example, organically grown tomatoes and plantains generate higher levels of utility than agroecologically grown products, which are themselves more highly valued than conventionally grown products.

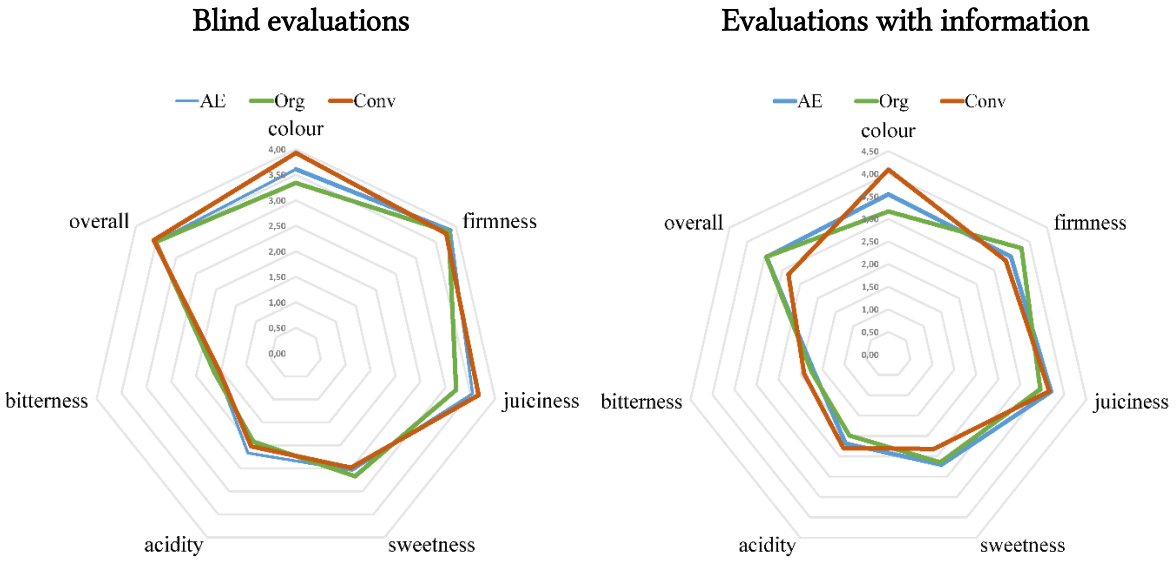
3.2. Sensory characterisation of environmental characteristics

H3: Consumers perceive organoleptic differences for the same product depending on its production method.

Seven sensory descriptors were evaluated to determine the extent to which consumers are able to differentiate products by sensory criteria according to their production method (in this case, three production modes). As sensory perceptions can be influenced by the level of information available on the products being evaluated, each consumer was asked to evaluate three tomatoes from the three selected production methods according to our seven sensory descriptors. The first time this was done blind, followed by a second iteration where participants were aware of the production system used for the tomatoes at the time the seven descriptors were evaluated.

Based on these assessments, it was then possible to determine a sensory profile for the different products and draw up a sensory map allowing us to situate the sensory characteristics of each product according to the seven descriptors selected. Figure 1 shows the profiles of the three production methods according to the level of information available at the time of the evaluation.

Figure 1: Sensory profiles according to the level of information at the time of evaluation



These sensory maps show graphically that the sensory profiles of the three products from the three production methods are very similar for all descriptors when the products are evaluated blind. The only differentiating descriptors appear to be colour and juiciness. We note that when participants had information to hand, the profiles remained similar, but there seemed to be a noticeable change in overall appreciation.

These initial findings were confirmed by Kruskal-Wallis tests, which showed that the only descriptors for which there was a significant difference according to production method are colour and juiciness. In the sensory evaluation with information to hand, four out of seven descriptors were evaluated as significantly different: colour (p value < 0.001), firmness (p value = 0.034 for the difference between Org and conventional), sweetness (p value = 0.035 for the difference between AE and conventional) and overall appreciation (for which there is a significant difference between AE and Org and between Org and conventional).

So, consumer sensory differentiation is more intense when information about the product being evaluated is available. This seems to suggest that sensory perception is influenced by consumer beliefs about product quality.

3.3. Beliefs about environmental quality

H4: Guadeloupean consumers believe that local products are environmentally friendly.

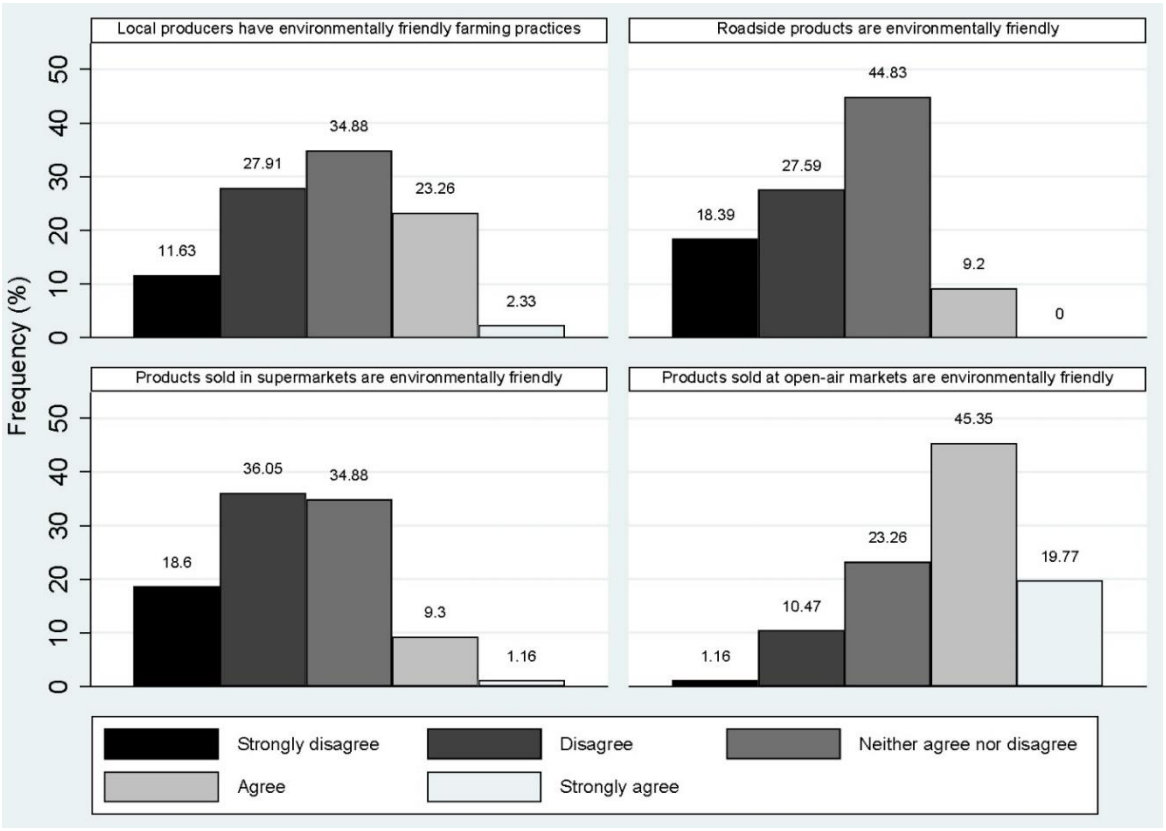
In light of the above results, we sought to refine our understanding of consumer beliefs about production methods. Figure 2 shows the response frequencies per question on environmentally friendly products.

The first question asked consumers whether they thought that the practices of local producers were environmentally friendly. Almost 35% of respondents were unsure, while around 40% considered local production practices to be environmentally unfriendly. We can therefore conclude that hypothesis H4 has not been verified.

The next three questions asked consumers to indicate where their products were distributed. Participants were asked to indicate their level of agreement with the fact that products available by the roadside retailers, in supermarkets or at open-air markets are environmentally friendly. It is clear that consumers perceive the environmental quality of products sold at open-air markets to be higher than at other points of sale.

Finally, when participants were asked about their confidence in imported or local food products, it emerged that the proportion of people who had no confidence in product quality was similar for both imported products (27.58%) and local products (24.13%). In consumers' minds, local products are not systematically associated with respect for the environment. In contrast, the type of distribution channel seems to be a factor in differentiating and appreciating the environmental quality of local fresh produce.

Figure 2: Frequency of responses per question on perceived respect for the environment



3.4. Discussion

Consumers regularly evaluate food products. With the assertion of general societal aspirations in favour of fresh approaches to production and consumption models, the question of the effective importance of environmental attributes in consumers' qualification-differentiation of products is of major interest. An abundance of literature on this subject shows that consumers use environmental attributes as a signal to encourage the act of purchase (Vanclay *et al.*, 2011; Bazoche *et al.*, 2014; McFadden and Huffman, 2017; Muller *et al.*, 2019) but also as a constitutive attribute of the good that explains why this characteristic is sought after for its own sake, since the consumer derives utility from it (Bougherara and Combris, 2009; Loo *et al.*, 2015). From this point, the environmental attribute has a value in its own right, reflected in the price of the good and expressed through a consumer's willingness to pay.

When compared with the literature, our findings on the purchasing behaviour of Guadeloupean consumers raise three issues. These include the legibility of product information systems and the specificity of agroecological food products. In addition, the environmental value of certain goods calls for a better identification of the cognitive biases that can influence consumer choice.

Legibility of information systems attesting to the environmental characteristics of goods

The fact that consumers do not express a significant preference for organic-labelled products is a result contrary to that found in the literature. Indeed, the literature tells us that France's organic label is a one which consumers know and trust (Bazoche *et al.*, 2014). Guadeloupean consumers do not seem to pick up on the information conveyed by the organic label and the specific commitments it incorporates. The label does not appear legible. This is evidenced by the fact that buyers regularly confuse local produce with organic products at local open-air markets (Fréguin-Gresh *et al.*, 2020). Short distribution channels (in particular direct sales at open-air markets) are the preferred means of marketing and distributing local produce. In these markets, the objectivised quality of products is not established (products are not accompanied by distinctive signs: there are no labels, additional information or product claims). This leaves space for culturally rooted quality assessment procedures where the origin and unique nature of the exchange form the environmental attribute. However, in these purchasing configurations, problems of information asymmetry are obvious as producers are the only ones who know what production method has been used. It should be noted that producers are not always present at open-air markets, particularly communal ones, which are mostly occupied by retailers involved in the market transaction with consumers. (Angeon and Fréguin-Gresh, 2022). In these cases, the protagonists in the exchange find themselves in a situation of shared uncertainty about the quality of the goods and their environmental characteristics.

For the most part, these products come from small-scale family farming (known by its French initials as PAF), whose practices reflect various forms of ecologisation, with no observable sign of differentiation and no means of verifying quality. PAF production systems are numerous in the French West Indies, accounting for more than 70% of all farms (Agreste, 2018[4]). They provide a wide range of ecosystem services (food supplies, soil restoration, landscape aesthetics and the preservation of natural and cultural heritage) in line with contemporary values of conscious consumerism. While these production systems are considered to bring together a wide diversity of virtuous practices (Ozier-Lafontaine *et al.*, 2018), they are rarely involved in labelling processes. As a result, so-called agroecological goods presented as such on outdoor markets, by their very nature, specifically raise the issues of opportunism and consumer confidence in products.

[4] Agreste (2018). Memento of agricultural statistics: Guadeloupe.

The specificity of agroecological food products: indeterminate goods

The case of Guadeloupe's open-air markets highlights more broadly the fact that agroecological food products are not backed by a clear and homogeneous information system. As defined in France's 2014 law on the future of agriculture, food and forestry (Loi n°214-1170), agroecological production systems must observe practices that reduce the consumption of energy, water, fertilisers, plant protection products and veterinary medicines, in particular antibiotics. Furthermore, they should be based on biological interactions and the use of ecosystem services and the potential offered by natural resources, in particular water resources, biodiversity, photosynthesis, soils and air, maintaining their capacity for renewal from both a qualitative and quantitative point of view. They should also contribute to mitigating and adapting to the effects of climate change. Such a broad definition of agroecological production systems does not specify a precise range of practices and production methods. As a result, it leaves room for variable interpretation, resulting in actions that are more or less at odds with conventional practices, but which nonetheless claim to be agroecological. As a result, the goods produced by these systems also have different environmental characteristics.

As observed by Fouilleux and Goulet (2012) with regard to sustainable certification and Barjolle *et al.* (2016) with regard to private sustainability standards, the reference to agroecology differs considerably from one actor to another, with the result that they can position themselves in contradictory logics. The definitional vagueness accompanying these approaches does not preclude reference to agroecology, but it does make it difficult to assess both production systems and their resulting products[5]. The environmental attributes of so-called agroecological goods are not identifiable.

In this respect, agroecological goods are akin to indeterminate goods (Lupton, 2001, 2006). From the point of view of the specific information asymmetry problems they generate in terms of consumer acquisition of quality information, this type of good forms a category in its own right. They are distinguished from search goods (Nelson, 1970), experience goods (Nelson, 1970) and credence goods (Darby and Karni, 1973). Search goods are those for which information about the good is obtained by examining it before purchase. In the case of experience goods, information on the quality of the good is acquired in its use, i.e. by consuming it. Finally, credence goods are those for which information on the quality of the good cannot be obtained

[5] A notable example is France's high environmental value (known as HVE) certification, a label approved by the Ministry of Agriculture, which alone offers three certification levels and is the subject of much controversy.

by the consumer before or after acquiring the good, due to the prohibitive costs associated with acquiring the information, requiring the consumer to resort to the expertise of a third party (expert). Alongside credence goods, indeterminate goods share the need for expertise to attest to product quality.

Markets for search, experience and credence goods can collapse as a result of moral hazards and adverse selection problems arising from information asymmetries on the actual quality of the goods. In particular, asymmetric information situations specific to credence goods have received considerable attention in the literature. They give rise to opportunistic behaviour, expressed in strategies for manipulating either the construction of quality or the information reported (Bougherara and Grolleau, 2004). In the first case, producers define environmental quality criteria that are at odds with consumer expectations. This situation of information asymmetry illustrates the case of moral hazards corresponding to *ex post* opportunism (Grolleau and Caswell, 2006). The second case is where producers provide incorrect information on the environmental characteristics of goods or their production practices. It characterises a situation of adverse selection and *ex ante* opportunism.

The collapse of markets for indeterminate goods stems mainly from disagreements between experts on the quality of goods (impossibility of ruling on proven quality[6]), or from uncertainties about their characteristics (i.e. unknown health and environmental impacts of certain production technologies). In these situations of imperfect or uncertain information, consumers turn away from products.

The low level of interest in the environmental attributes of food products in Guadeloupe is a result that runs counter to the literature[7] and to the general societal aspirations expressed by various categories of stakeholders: consumers due to repeated health crises and consequent loss of utility, public stakeholders for reasons of responsibility, producers and distributors for ethical and also economic reasons (higher returns from added value).

Giving consumers additional information through an informational signal is not enough to reduce information asymmetry. Trust in this information (Golan *et al.*, 2000; Larceneux, 2010)

[6] For example, it is not possible to certify *ex post* the specifics of the production process: has the good produced complied with the principles of the circular economy? Is it carbon neutral or biodiversity friendly?

[7] The literature indicates a strong consumer interest in the environmental characteristics of goods (Tobler *et al.*, 2011; Grunert *et al.*, 2014).

and the cognitive abilities of individuals (Muller and Prevost, 2016) appear to be essential determinants of their decision-making processes.

Consumption trade-offs and cognitive biases

The reasons for the differentiated valuation of environmentally virtuous types of production according to product still need to be explored. Plantains and tomatoes are the two goods in the basket that are most highly valued when they are produced either agroecologically or according to organic farming specifications. However, we might also have expected this to be the case for lettuce and cucumbers, both of which are sensitive to input use, particularly chlordecone. While bananas and tomatoes are not very sensitive to its active ingredient and can therefore be grown without risk on contaminated soils, this is not the case for lettuces and cucumbers (Cabidoche and Lesueur-Jannoyer, 2012; Clostre *et al.*, 2017).

The fact that plantains are more highly valued when grown organically raises questions, and suggests that this consumption choice is partly due to the reputational effects on banana crops of the chlordecone health crisis. Similarly, the low environmental value for lettuce and cucumbers raises questions about consumers' ability to appropriate information. It calls for analysis of the cognitive biases that influence consumption choices. These biases can be of several kinds: optimism bias (no risk of being affected, feeling of invincibility), confirmation bias (favouring routine, well-established arguments), cognitive dissonance (discrepancy between beliefs and actual behaviour) etc.

As food products differ in their sensitivity to pesticides, so do the risks to consumers. Consumption practices must therefore evolve in line with real risks. Thinking about appropriate signals should encourage virtuous consumer choices.

While Guadeloupean consumers remain generally sensitive to food prices, we came to the conclusion that product quality is an important factor in consumption choices. The provision of information on the environmental characteristics of products influences their utility for individuals. So, improving information signals on production methods would help to consolidate demand and ensure that producers get a better economic return from their products.

4. Conclusion

In this article, we focus on the recognition of the environmental quality of products. This question is part of the economic literature on the quality of goods, which analyses these goods as a determining variable in the functioning of markets. Just like price, product quality appears to be a factor on which the principles of competition are based. In this respect, we have used an original case study in Guadeloupe to explore consumer trade-offs in favour of the environmental attributes of food products. Our work, based on an experimental economics protocol, feeds into research on the agriculture-environment-food nexus in this island territory.

No study of this type had been conducted in the French West Indies, and investigating consumer preferences in terms of environmental attributes is a key factor in responding to societal issues in a context where high levels of soil pollution have impacted the sanitary quality of local produce. Consequently, understanding what drives consumer behaviour is of undeniable relevance in these areas, particularly for the development of local agriculture.

We have shown that the sale of market garden produce in the French West Indies illustrates a situation of indeterminate goods (whose characteristics are unobservable) that highlight specific configurations of information asymmetry and uncertainty. This situation penalises both consumers and producers. On the supply side, producers do not receive the level of remuneration they might expect because the price of produce incorporating environmental attributes is aligned with that of conventionally produced products. On the demand side, consumers do not perceive the environmental quality of goods and so suffer a loss of utility.

Agroecological goods appear to be a unique category of goods that specifically raise the question of the socio-technical mechanisms that need to be implemented to resolve the credibility and trust issues facing agents. In this respect, one of the questions posed is to understand to what extent the agroecological approaches to which producers are committed could be remunerative, and to study the processes of legitimisation, recognition and valorisation through which they pass.

By causing disruption to the supply of food goods from beyond the island through port and airport closures, the Covid-19 health crisis rekindled consumer interest in local production. This raises the question of the match between local production and consumption systems and, more broadly, of the sustainability of the process of winning back local markets. It also raises the

question of the extent to which potential demand for local products is sufficiently high to constitute a condition for the development of supply chains.

To this end, our work should be pursued in two directions. First, we need to identify the consumer categories that are driving these local pro-environmental consumption dynamics. Second, we need to deepen our understanding of the attributes of food consumer goods to which the population is sensitive. This will involve analysis of consumers' preferences, the extent to which reference to the local environment is taken into account and their beliefs about farmers' practices.

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