Are Portuguese consumers ready to understand the risks from pesticide use?

CRISTINA AMARO DA COSTA[1], MAGDA AGUIAR FONTES[2] AND JOSÉ LIMA SANTOS[3]

Jel codes: D12, C12, C13, Q13

Abstract

Understanding consumer perceptions and attitudes towards the use of pesticides in agriculture and its risks is of utmost importance to redirect them towards food products produced in farming systems which use less or no pesticides. Based on data from a survey of 725 Portuguese urban consumers, three groups were identified: non buyers, occasional buyers, habitual buyers, considering their attitudes towards and knowledge of fruit and vegetables from integrated pest management. Knowledge about pesticides and certification systems affects preferences and should be considered as a key issue for market strategies and agricultural policies, and to ensure that consumers are able to define a healthy diet and to understand the influence of their food choices on the environment.

Keywords: *attitudes, sustainable use of pesticides, integrated pest management, correspondence analysis, cluster sampling.*

Résumé

Comprendre les perceptions et les attitudes des consommateurs à l'égard de l'usage des pesticides en agriculture et de ses risques est très important pour pouvoir les réorienter vers des aliments produits par des systèmes agricoles qui utilisent moins de pesticides, ou n'en utilisent pas du tout. En s'appuyant sur les données d'une enquête menée auprès de 725 consommateurs urbains au Portugal, on a identifié trois différents groupes de consommateurs, *non acheteurs*, *acheteurs occasionnels* et *acheteurs habituels,* compte tenu de leurs attitudes et de leur niveau de connaissance des fruits et légumes produits suivant la méthode de protection intégrée. La connaissance des pesticides et des systèmes de certification influe sur les préférences des consommateurs. On devrait donc reconnaître que cet aspect est fondamental pour élaborer les stratégies de marché et les politiques agricoles et, en même temps, permettre aux consommateurs de définir un régime alimentaire sain et comprendre l'influence de leurs choix alimentaires sur l'environnement.

Mots-clés: attitude, utilisation durable des pesticides, protection intégrée, analyse des correspondances, échantillonnage en grappes.

1. Introduction

The use of chemical inputs such as fertilizers and pesticides has contributed to an unprecedented growth in agricultural production and productivity while entailing tremendous costs for environmental and human health. Empirical evidence from medical and ecotoxicological studies reveals non-negligible hazards to human health and ecosystems (Calhau, 2011; Pimentel and Greiner, 1997; OECD, 2008; Torres, 2011), in most cases due to the use of pesticides which are frequently detected in water and food crops (Pimentel and Greiner, 1997; Cerejeira and Silva, 2011; OECD, 2008), poison farmers following field exposure (Costa and Teixeira, 2011) and affect flora (Pimentel and Greiner, 1997) and fauna (Torres, 2011).

In the last two decades, consumer concerns with exposure to chemicals, as pesticides, have significantly risen. One third of European consumers selected ''The impact on our health of chemicals used in everyday products'' as one of the environmental issues that caused the greatest concern and about 19% of them spontaneously cited chemicals, pesticides and other substances as major risks (EC, 2005, 2008, 2010).

Growing environmental awareness has led people to question modern agricultural practices. This has a direct impact on the demand for safer food from environmentally friendly schemes such as integrated pest management (IPM)[1], which are based on a sustainable use of pesticides and are less damaging to the environment and healthier than conventionally grown foods (Saba and Messina, 2003; Lockie *et al.*, 2004; Bonti-Ankomah and Yiridoe, 2006; Roitner-Schobesberger *et al.*, 2008; Vecchio et al., 2013).

Evidence of consumer awareness of food safety and preferences for improving environmental sustainability of agriculture resulted in the design and application of new policy tools such as eco-labeling of fresh produce, agri-environmental schemes, and rules for the proper use of pesticides (European Parliament and Council of the European Union, 2009). These policies aimed at supporting the sustainable use of pesticides, within environmentally friendly farming systems, such as IPM, and reflected policymakers' beliefs that these farming systems deliver environmental and

[1] Instituto Politécnico de Viseu, Estrada de Nelas, Quinta da Alagoa, 3500-606 Viseu, Portugal, Corresponding author: amarocosta@esav.ipv.pt
[2] Faculdade de Medicina Veterinária/Universidade Técnica de Lisboa, Portugal.
[3] Centro de Estudos Florestais (CEF), Instituto Superior de Agronomia/Universidade Técnica de Lisboa, Portugal.

[1] Integrated pest management (IPM) is an environmentally friendly practice which aims to maximize the reduction of pesticide use, the restriction of the most dangerous ones and replacement with safer ones. IPM relies upon prevention of pests and diseases exploiting the action of natural enemies, reduction of control measures based on risk estimate and careful decision making, integration of all control measures, with preference for biological, biotechnical and genetic measures, use of chemical control only as a last resource, and exclusion of toxic and very toxic products and of those which cause water contamination or induce resistance.

health benefits and at the same time contribute to stabilize rural communities and improve rural development by providing more employment opportunities than conventional farming (Tranter *et al*., 2009).

Being a European member state, Portugal applies the European harmonized regulation on agricultural products intended for human consumption, such as fruit and vegetables (e.g., organic farming, integrated pest management, sustainable use of pesticides, national origin and traditional production systems). The enforcement of Food Safety laws is the responsibility of the Portuguese Food Safety and Economic Agency and the Ministry of Agriculture and Sea, whereas inspections, from production to consumption, are carried out by private independent organizations, according to the type of certification. In Portugal, the fruit and vegetables sector represents 36% of the agricultural production, with 12% of consumers being concerned with product quality, origin or certification system and about 10 % preferring to by certified fruit and vegetables (Portugal Foods, 2012; Forum do consumo, 2014)

In this way, understanding consumer perceptions towards the use of pesticides in agriculture and demand for safer food might provide key information to policy makers in order to introduce agriculture support policies and programmes that ensure a reduction of pesticide use and its risk to consumers, producers and the environment.

In the last 20 years, a large number of studies on consumer perceptions of safer foods obtained from environmentally friendly production systems were carried out to assess the knowledge of and reasons for consumers to purchase or not to purchase safer foods based on a wide array of food safety and quality issues, including health risks and multiple impacts associated with pesticide use, as well as quality attributes and food certification (McEachern and McClean, 2002; Wier and Calverley, 2002; Cranfield and Magnusson, 2003; Diamantopoulos *et al*., 2003; Saba and Messina, 2003; Lockie *et al*., 2004; Vermeir and Verbeke, 2006; Idda *et al.*, 2008; Roitner-Schobesberger *et al.*, 2008; Travisi and Nijkamp, 2008; Tsakiridou *et al*., 2008; Briz and Ward, 2009; Forbes *et al*., 2009; Gracia *et al*., 2010; Kuhar and Juvančič, 2010).

Consumer choice for safer food is a complex phenomenon that takes into account individual motives, from quality and healthfulness considerations, to collective or social interests, such as a better environment. These factors can be grouped into two categories: perceptions and attitudes (such as perceptions of health benefits, food safety, environment, knowledge of agricultural practices and certification systems, attitudes towards shopping attributes, agricultural practices and beliefs such as 'green' and pro-social ones) and personal characteristics (age, gender, family size, education, income and relation urban/rural) (Kotler and Armstrong, 2009).

Consumer preferences for these products are based on their perceptions of quality, which are usually mediated by previous knowledge of the relevant environmental and health issues and by the existence of a certification process. However, consumers are often unable to make informed purchase decisions because the benefits associated with sustainable and safer products are poorly communicated or confused and because they have limited knowledge of agricultural production practices, namely pesticide use and risks (Vermeir and Verbeke, 2006; Forbes, 2009).

Without this fundamental knowledge and demand for safe food, the potential for a sustainable use of pesticides clearly has limitations. Therefore, it is essential to know which consumers are willing to purchase fruit and vegetables from sustainable agricultural systems, knowing that these practices have lower environmental impacts and significant health benefits but they lead, at the same time, to higher production costs which result in higher production food prices at the consumer level.

Several studies attempt to define consumer typologies with respect to safe food from farming systems grounded on a sustainable use of pesticides, based on behavior. Gil *et al*. (2000) classified consumers according to their inclination towards natural food and a balanced life ('likely consumers', 'organic food consumers', 'unlikely consumers', 'unlikely mature consumers', 'unlikely young consumers'). McEachern and McClean (2002) proposed three distinct groups of consumers, 'complacents' – who possess a strong focus on price and never purchase; 'conceivables' – who occasionally buy - and 'committed' – who always buy. Roitner-Schobesberger *et al.* (2008) analyzed differences between 'never heard organic', 'organic non-buyers' – who have heard but never purchased any organic products - and 'organic buyers'.

In Portugal, as far as we know, there are no studies focused on Portuguese behaviour and perceptions towards such products. This knowledge is essential to support agricultural policies, as it is necessary to identify which factors influence behaviour (perceptions, attitudes, knowledge, socioeconomic characteristics), to improve the adoption of a sustainable use of pesticides, from the farmer and/or retailer to the consumer.

Thus, it would be of major interest to understand, for each national or regional reality, if the preference for safe food obtained from environmentally friendly farming systems is more influenced by knowledge about these systems or by the existence of a certification system and the presence of a label, since each of these factors will affect differently the definition of the most appropriate policy tools to support the sustainable use of pesticides, respectively based on training and disseminations programmes or on well-designed marketing strategies.

The purpose of this paper is to understand consumer perceptions and attitudes towards fruit and vegetables from farming systems based on a sustainable use of pesticides such as IPM. More specifically, we are particularly interested in understanding whether consumers' knowledge about the sustainable use of pesticides and the existence of quality certified systems, as well as their general attitudes towards health and the environment versus the economic performance (among other factors,) influence their purchase behaviour towards fruit and vegetables from these farming systems.

With these underlying objectives, the main research questions that need to be addressed are the following: (1) is it possible to identify groups of consumers in terms of pur-

chase behaviour towards fruit and vegetables from farming systems based on a sustainable use of pesticides such as IPM?; (2) do consumer perceptions, knowledge and attitudes influence their purchase behaviour towards safer, healthier and environmentally friendly products?

Most of the literature dedicated to study the behaviour and the key factors leading consumers to purchase safer, healthier and environmentally friendly products used exploratory techniques, such as principal component analysis (Gil *at al*.; 2000; McEachern and P. McClean, 2002; Roitner-Schobesberger *et al*., 2008), correspondence and multiple correspondence analysis (Idda *et al*., 2008) or factor analysis (Campbell *et al*., 2010; Olivas and Bernabéu, 2012), to identify the issues motivating consumers towards safe and healthier consumption. After this exploratory stage, some have used cluster analysis techniques to identify market segments (Gil *at al*., 2000). Some studies used the purchasing intensity, the level of knowledge or some structural or linear regression equation models to establish consumers‘ differentiation (Roitner-Schobesberger *et al*., 2008; Campbell *et al*., 2010; Olivas and Bernabéu, 2012).

In the present study, data from a survey of Portuguese consumers was used to find relationships between consumer perceptions, knowledge and preferences for fruit and vegetables from farming systems grounded on a sustainable use of pesticides such as IPM through a correspondence analysis, after which, a cluster analysis was used to group consumers in terms of purchase behaviour. Consumers were profiled, using a Cross-Tabulation or ANOVA tests, to identify which variables might be of interest and significance for future strategies and policies.

2. Methods

2.1. Data and survey

A survey was conducted among the Portuguese urban population (Lisbon Metropolitan area)[2] by a professional market research agency in 2008. Questionnaires were applied by a trained team of interviewers to respondents aged more than 18 years who were usually responsible for their household shopping.

The questionnaire was developed based on several works cited in the literature (Madureira, 2001; Cranfield and Magnusson, 2003; Saba and Messina, 2003; Lockie *et al*., 2004; Loureiro and Umberger, 2005; Roitner-Schobesberger, 2006) and submitted to successive pre-tests. After implementing the pre-test, some questions were clarified and shortened. Overall, 725 valid questionnaires were obtained.

The questionnaire included a first section dealing with consumer attitudes, knowledge and consumption behaviour and a second section related to consumer awareness and perceptions of environmental externalities of pesticide use in agriculture, referring to pesticide risks and impacts.

The questionnaire gathered additional information about the respondents' socio-economic conditions and some debriefs closed the survey, in order to explore whether the respondents had a reasonably good comprehension of the questionnaire.

2.2. Exploratory factor analysis - Correspondence analysis

The main issues motivating consumers to purchase safer and healthier food were identified with a correspondence analysis - an exploratory data technique for categorical data. Correspondence Analysis (CA) is ideal to analyze data, when no specific hypotheses are pre-established and the amount of data doesn't allow getting a clear idea of the most important variables, by extracting the most significant dimensions (Palmer, 1993; Doey and Kurta, 2011). In our study, the significance of differences across consumers was based on 'attitudes and motives' and 'knowledge and perceptions' variables (Table 1), using contingency tables and the chi-square statistic (at a 5%-level of significance).

Table 1 - *Attitudes and motives' and 'knowledge and perceptions' variables.*

attitudes and motives	**knowledge and perceptions**
preferred shop typology	*have knowledge about certification systems*
hypermarkets	environmentally friendly systems
supermarkets	other certification systems
groceries	not specifying a certification system
open-air market	never heard
reasons for choosing shop typology	*familiarity and understanding of integrated pest management and organic farming concepts*
home/work proximity	specify the concept
quality	relate with sustainable practices
variety	relate with restrictions of pesticides/fertilisers
certification	relate with environmental protection
low prices	relate with healthier and natural products
information used for fruits and vegetables choice	inconsistent knowledge
origin	*perceptions of environmental impacts associated with agricultural practices*
certification system	species conservation
production system	landscape quality
not concerned	pesticide poisoning
experience in buying certified fruits and vegetables	water pollution
experience in buying certified fruits and vegetables	*perceptions of the consequences of pesticide use*
certified fruits and vegetables ever purchased	contamination of water for public use
integrated pest management	intoxications and poisoning
organic farming	species loss
designation of origin or geographical indication	long term effects on health
other quality system	no perception
neither	*opinion on how agricultural effects on health and environment should be minimized*
certified fruits and vegetables purchasing frequency	environmentalist opinion (at all costs),
never purchased	economicist opinion (without causing employment problems and without increasing prices)
20% of purchased occasions	Indifferent (cannot be minimized).
40% of purchased occasions	
60% of purchased occasions	

2.3. Cluster analysis

After the correspondence analysis, a cluster analysis based on the same variables was used to identify groups of individuals that were more similar to one another than they were to individuals in other clusters. This methodology has been widely used in segmentation studies (Saba and Messina, 2003; Fischer and Hanley, 2007; Kornelis *et al.*, 2007). The hierarchical Ward method was used specifying the maximum number of clusters allowed (three clusters). The final clusters were obtained with a k-means cluster analysis, using the previous cluster means as cluster seeds.

In order to better understand and profile these three clusters, a series of Cross-Tabulation and ANOVA tests were carried out to relate the mean values of these clusters with consumers' 'attitudes and motives', 'knowledge and perceptions' and socioeconomic characteristics.

3. Results and discussion

3.1. Socioeconomic characteristics

Table 2 shows the socio-demographic characteristics of the survey sample. When comparing our drawn sample with country statistics, the household profiles, such as age, family size, family income, are shown to be identical (INE, 2011), except for the education level: about 41% of respondents have a high education level, whereas 17% have only have a basic school level.

The sample comprises s a majority of females (62%), as expected, because the questionnaire was addressed to respondents who are usually responsible for shopping in their household, with an average age of 40 years. Family size is approximately 2.7 with a mean family income of 1278.58 €. Most respondents (73.4%) have always lived in the city and 56% of respondents work in areas related to agriculture, environment, health or food. The sample average monthly basket of fruit and vegetables is 47.57 € and for 78% of the respondents the monthly basket is less than 48 €.

More than 62% of the respondents usually prefer to buy fruit and vegetables in hypermarkets and supermarkets. At the time of choosing, an important share of respondents try to have information about the origin (62%), but only 26% and 15% are concerned about the certification or farming system, respectively. Almost 18% of the respondents indicate that they know the existence of healthier and more environmentally friendly farming systems (Figure 1a. and 1b.). Almost 55% of the respondents have never purchased certified fruit and vegetables, and less than 1% chooses certified products on more than 60% of purchasing occasions (Figure 1c.).

Concerning awareness and perceptions of environmental externalities of pesticide and fertilizer use in agriculture (Figure 1e. and 1f.), respondents are more concerned with the lost of landscape quality, while pesticide use is perceived as having a negative impact through the contamination of water for public use. More than two thirds of the respondents have an *'economicist opinion'*– they believe that agricultural effects on health and the environment should be minimized without causing employment problems and without generating price increase; moreover, some respondents (22,9%) have an *'environmentalist opinion'* – they believe that agricultural effects on health and the environment should be minimized at all costs (Figure 1g.). We also found a small number of respondents (10.2%) who were *'indifferent'* to the effects that agriculture might have on health and the environment.

Table 2 - *Sample characteristics (n= 725).*

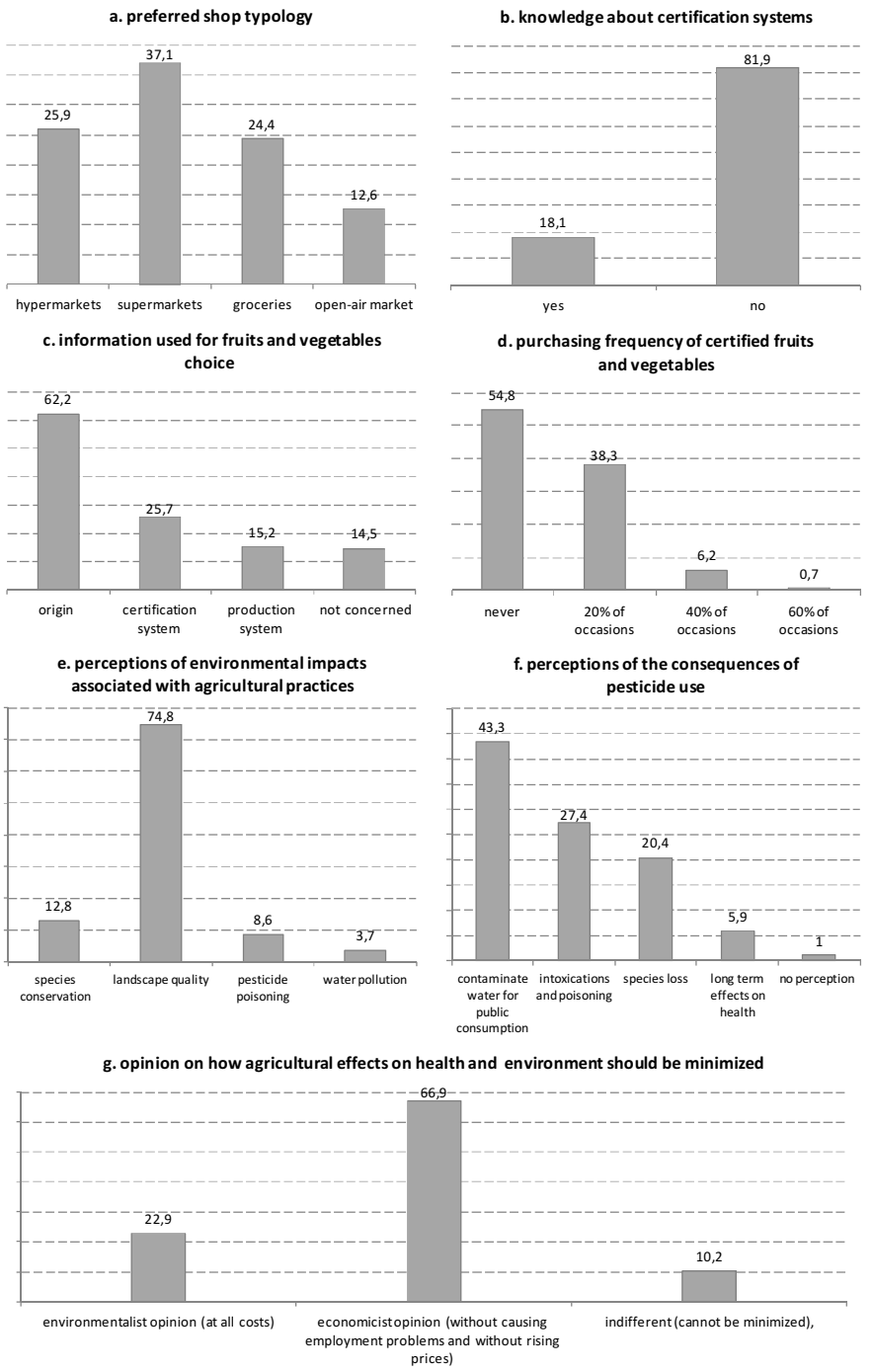
Characteristic	Valid percentage (%)
gender	
male	38.2
female	61.8
age	
≤ 35	49.8
36 – 55	30.1
> 56	20.1
Mean ± S.E	40.302 ± 16.326
family size	
1 - 2	51.4
3 - 4	40.0
≥ 5	8.6
Mean ± S.E	2.652 ± 1.292
family income	
< 600	18.9
601 – 750	16.3
751 – 1025	18.3
1026 – 1325	19.0
1326 – 2500	16.9
> 2500	10.6
Mean ± S.E	1278.58 € ± 625.28 €
education	
primary (ISCED 0-2)	16.7
secondary (ISCED 3-4)	42.1
tertiary (ISCED 5-6)	41.2
Mean[a] ± S.E	4.49 ± 1.44
relation with agriculture	
rural	11.4
suburban	15.2
urban	73.4
occupation	
agriculture/environment/health/food	55.7
other sector	14.6
unemployed/retired/other	29.7
fruit and vegetables monthly basket	
≤ 28	33.6
29 - 48	35.4
49 - 72	14.8
73 - 88	12.5
>100	3.8
Mean ± S.E	47.57 € ± 25.78 €

3.2. Correspondence analysis

The correspondence analysis used to identify possible relations between '*attitudes and motives'* and *'perceptions and knowledge'* was significant, with a high chi-square statistic showing a high correspondence between the groups of variables (Critical Chi-square of 443.399, with a p-value < 0.0001).

The inertia gives the total variance explained by each dimension in the model. There is no formal criteria according

Figure 1 - *Main 'Attitudes and motives' and 'knowledge and perceptions' of sample respondents (in percentage, n= 725)..*



to which dimensions for analysis based on proportion of inertia should be kept or rejected, but some authors argue that the number of axes considered should retain over 80% of accumulated inertia (Doey and Kurta, 2011), in the present case, dimensions F1 and F2. This first two components together can explain 87.6% (54.2% and 33.4%) of the variation in the model (Figure 2); for this reason, two components can be used in order to select variables associated with consumer 'attitudes and motives' and 'knowledge and perceptions'. The total variance explained is 12,4%, which indicates that knowing something about 'attitudes and motives' explains 'knowledge and perceptions' variables on that amount and vice versa. Variables with similar profiles are mapped close to one another in the two biplot dimensions, whereas points mapped far away from one another have very different profiles.

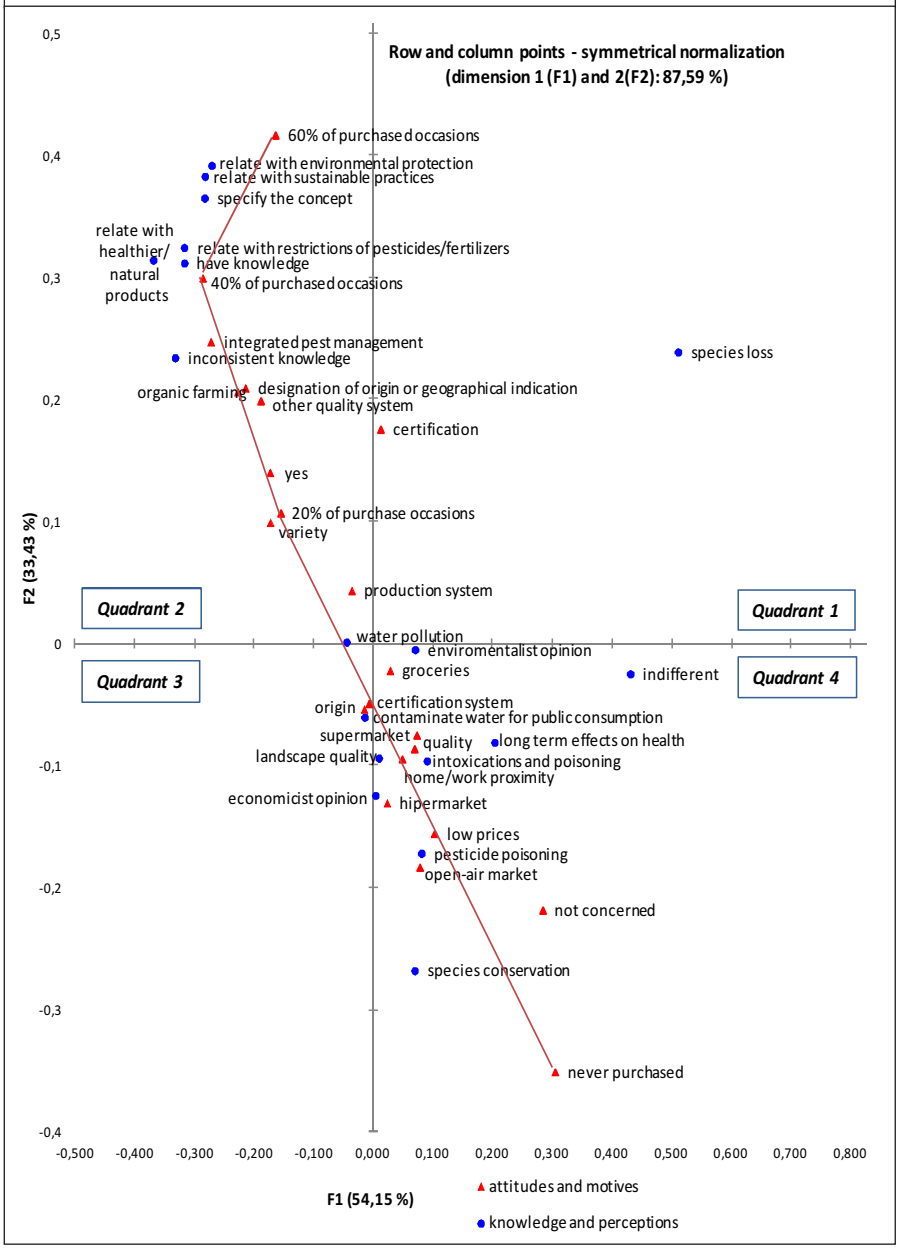
The first dimension (F1) clearly separates consumers who usually purchase certified fruit and vegetables from the others (60, 40 and 20% of purchasing occasions are mapped on the side opposite to never purchased) (Figure 2). This result can be interpreted as a clear suggestion to use this dimension to differentiate consumers.

The second dimension (F2) mostly reflects the identification of buyers who have knowledge about the sustainable pesticide use and IPM concepts and those who don't know anything about this issue and are not concerned with quality and food safety. This dimension also discriminates consumers' reasons for choosing shop typology and opinion on how agricultural effects on health and environment should be minimized.

Based on variables that are mapped closely, it is possible to say that consumers most experienced in buying certified fruit and vegetables are concerned with product certification for quality and food safety (Figure 2 - Quadrant 2). These consumers have knowledge about healthier and environmentally friendly farming systems, are well informed about IPM concepts, understand the relation between IPM and the sustainable use of pesticides and the associated environmental and health benefits.

Another group of consumers includes those who prefer to buy fruit and vegetables based on low prices, and purchase them usually in open-air markets and hypermarkets (Figure 2 - Quadrant 4). These consumers are not concerned with origin, certification or farming system, and have never purchased any kind of certified fruit and vegetables. They don´t know anything about IPM or the sustainable use of pesticides, and aren't concerned about safe or healthier fruit and vegetables. This group includes consumers who state that they are in favour of the implementation of policy measures that might contribute to the reduction of agricultural effects on health and the environment without causing employment problems or the rise in fruit and vegetables prices – '*economicist opinion'*.

Figure 2 - A *biplot displaying 'attitudes and motives' and 'perceptions and knowledge' towards IPM and OF products on two dimensions.*



A third group of consumers includes those that reveal a tendency to buy fruit and vegetables in groceries and supermarkets, based on home or work proximity. They are usually concerned with having information related to production and certification systems, as well as with product origin. When asked about risks associated with agriculture, they reveal to be more concerned with the impact on water pollution and landscape quality, as well as with risks caused by pesticide use, such as pollution of water for public use, intoxications, poisoning and long-term effects on health. Consumers with this profile usually have '*environmentalist opinion'*, meaning that agricultural effects on health and environment should be minimized at all costs.

Therefore, it seems possible to divide consumers based on their behaviour towards their preferences for safe and healthier fruit and vegetables in three groups: 'habitual buyers', 'occasional buyers' and 'non buyers'. The 'occasional buyers' are consumers who cannot be included in the other groups as they seem to be concerned with food and environmental quality, and at the same time are not really interested in consumption of certified safe and healthier food.

Summing up, knowledge about the concepts associated with IPM and the sustainable use of pesticides and the existence of certified quality systems seems to be strongly related to purchase behaviour, as well as to other perceptions and attitudes. Thus, it will be important to identify segments of consumers in terms of purchase behaviour towards fruit and vegetables from more environmentally friendly schemes, in order to improve our understanding of Portuguese consumers and to find out the best strategies for different market segments, especially concerning those with lower preferences for these products who are not aware of the importance of a healthy diet and don't understand the influence of their food choices on environmental quality.

3.3. Cluster analysis

To identify consumer segments based on respondents' 'attitudes and motives' and 'perceptions and knowledge', a hierarchical cluster approach was conducted to find which respondents are associated with the profiles obtained by the correspondence analysis. The three clusters - *'non buyers', 'occasional buyers'* and '*habitual buyers'* - were identified with 43%, 14% and 43% of the respondents, respectively. To explain the consumer behavior in each cluster, the variables related to 'attitudes and motives' and 'perceptions and knowledge' with a higher significance in each cluster were systematized (Table 3).

The first cluster - *'non-buyers`* - includes consumers who have never purchased any kind of certified fruit and vegetables, reveal a preference for buying fruit and vegetables in supermarkets and fresh markets, based on home or work proximity and are not concerned with origin, certification and farming systems. Consumers in this cluster state that they don't know anything about healthier and environmentally friendly farming systems and, when confronted with impacts of agriculture on the environment and health, they are more concerned with species loss, pesticide poisoning and pesticide long term effects on health. In their opinion a-

Table 3 - *Cluster means for segmentation variables: One-Way ANOVA.*

attitudes and motives				
preferred shop typology				
hypermarkets	0.201 [a]	0.485 [a,b]	0.247 [b]	16.725 (< 0.0001)
supermarkets	0.379	0.354	0.369	0.111 (0.895)
groceries	0.274 [a]	0.051 [a,b]	0.276 [b]	16.725 (< 0.0001)
open-air market	0.146	0.111	0.109	1.111 (0.330)
reasons for choosing shop typology				
home/work proximity	0.513 [a]	0.071 [a,b]	0.446 [b]	16.725 (< 0.0001)
quality	0.150	0.111	0.186	1.785 (0.169)
variety	0.067	0.051	0.077	0.426 (0.653)
certification	0.025	0.010	0.032	0.714 (0.490)
low prices	0.245 [a]	0.758 [a,b]	0.260 [b]	16.725 (< 0.001)
information used for fruit and vegetables choice				
Origin	0.618 [a]	0.424 [a,b]	0.689 [b]	16.725 (< 0.0001)
certification system	0.172 [a]	0.313 [a,b]	0.324 [b]	16.725 (< 0.0001)
production system	0.131	0.081 [b]	0.196 [b]	4.848 (0.008)
not concerned	0.166 [a]	0.273 [a,b]	0.083 [b]	16.725 (< 0.0001)
experience in buying certified fruits and vegetables	0.003 [a,c]	0.202 [a,b]	0.990 [b,c]	16.725 (< 0.0001)
certified fruit and vegetables ever purchased				
integrated pest management	0.000 [a]	0.020 [a,b]	0.138 [b]	16.725 (< 0.0001)
organic farming	0.000 [a,c]	0.101 [a,b]	0.535 [b,c]	16.725 (< 0.0001)
designation of origin or geographical indication	0.000 [a,c]	0.071 [a,b]	0.465 [b,c]	16.725 (< 0.0001)
other quality system	0.000 [a,b]	0.101 [a,b]	0.497 [b,c]	16.725 (< 0.0001)
neither	0.003 [a]	0.000 [a,b]	0.067 [b]	16.725 (< 0.0001)
certified fruit and vegetables purchasing frequency				
never purchased	1.000 [a,c]	0.798 [a,b]	0.013 [b,c]	16.725 (< 0.0001)
20% of purchased occasions	0.000 [a,c]	0.172 [a,b]	0.837 [b,c]	16.725 (< 0.0001)
40% of purchased occasions	0.000 [a]	0.030 [a,b]	0.135 [b]	16.725 (< 0.0001)
60% of purchased occasions	0.000	0.000	0.016	3.349 (0.036)
knowledge and perceptions				
have knowledge about certification systems	0.000 [a]	0.030 [a,b]	0.410 [b]	16.725 (< 0.0001)
familiarity and understanding of integrated pest management and organic farming concepts				
specify the concept	0.000 [a]	0.000 [a,b]	0.083 [b]	16.725 (< 0.0001)
relate with sustainable practices	0.003 [a]	0.000 [a,b]	0.048 [b]	8.773 (0.000)
relate with restrictions of pesticides/fertilisers	0.003 [a]	0.030 [a,b]	0.385 [b]	16.725 (< 0.0001)
relate with environmental protection	0.003 [a]	0.010 [a,b]	0.067 [b]	16.725 (< 0.0001)
relate with healthier and natural products	0.000 [a]	0.000 [a,b]	0.163 [b]	16.725 (< 0.0001)
inconsistent knowledge	0.000 [a]	0.000 [a,b]	0.029 [b]	6.108 (0.002)
perceptions of environmental impacts associated with agricultural practices				
species conservation	0.131	0.232 [b]	0.093 [b]	6.633 (0.001)
landscape quality	0.723	0.717	0.782	1.732 (0.178)
pesticide poisoning	0.108 [a]	0.040 [a]	0.077	2.482 (0.084)
water pollution	0.038	0.010	0.045	1.274 (0.280)
perceptions of the consequences of pesticide use				
Contamination of water for public use	0.373 [c]	0.485	0.478 [c]	4.166 (0.016)
intoxications and poisoning	0.261	0.333	0.269	1.021 (0.361)
species loss	0.248	0.141	0.179	3.698 (0.025)
long term effects on health	0.092 [a]	0.040 [a]	0.071	1.561 (0.211)
no perception	0.025 [a]	0.000 [a]	0.003	3.913 (0.020)
opinion on how agricultural effects on health and environment should be minimized				
environmentalist opinion	0.255 [a]	0.030 [a,b]	0.266 [b]	16.725 (< 0.0001)
economicist opinion	0.615 [a]	0.919 [a,b]	0.644 [b]	16.725 (< 0.0001)
indifferent	0.131 [a]	0.051 [a]	0.090	3.100 (0.046)
Number of respondents	314	99	312	
Percentage of respondents	43%	14%	43%	

Note: Method K-means cluster, n=725.
[a,b,c] Scores in the same row with a the same superscript are significantly different at p<.05 (post hoc Least Significant Difference and Tamhan multiple comparison tests).

vegetables in groceries, based on product quality, variety and certification, and try to get information about origin, production and certification systems. They are the most experienced in buying certified fruit and vegetables, choosing certified products in 20-60% of cases. These consumers not only state that they know the existence of healthier and environmentally friendly farming systems, but they are also really informed about the sustainable use of pesticides and IPM. In fact, they can link these concepts with sustainable agricultural practices, such as biological control, soil conservation, prohibition of the use of genetically modified organisms, restrictions on the use of pesticides and fertilizers, as well as with associated environmental and health benefits. In this group, consumers believe that agricultural effects on health and the environment should be minimized at all costs with this - '*environmentalist opinion'* – and they seem to be concerned with the impact of agriculture on landscape quality and water pollution.

A smaller percentage of consumers (14%), who reveal that they have some appetence for certified fruit and vegetables, are in fact '*occasional buyers'* with limited experience in buying certified fruit and vegetables. In this case, consumers have stated a preference for buying fruit and vegetables in hypermarkets, based on low prices. Besides stating that they know the existence of healthier and more environmentally friendly systems, they only relate the concepts with general association to the use of pesticides and fertilizers. When asked about risks associated with agriculture, they state that they are concerned with species conservation and have the perception that pesticide use might contaminate water for public use and cause intoxications and poisoning. These consumers have an '*economicist opinion'*.

Finally, attitudes and perceptions were examined for any socioeconomic differences between clusters, namely sex, age, family size, family income, education level, relation

gricultural effects on health and the environment cannot be minimized even with the implementation of policies that support more sustainable farming systems, and their purchasing behaviour is neither influenced by their knowledge about the sustainable use of pesticides nor by the existence of a certification system – '*indifferent'*.

We found a considerable number of consumers (43%) who can be described as '*habitual buyers*' of fruit and vegetables from environmentally friendly farming systems. These consumers have a preference for buying fruit and

Table 4. Cluster profiling: Cross-Tabulation (values given in percentage) and One-Way ANOVA

Characteristic	Cluster 1 *'non buyers'*	Cluster 2 *'occasional buyers'*	Cluster 3 *'habitual buyers'*	Chi-square Significance level	F (Sig. Level)
gender					
male	37.3	39.4	38.8	0.895	
female	62.7	60.6	38.8		
age					
≤ 35	53.5	61.6	46.2	0.049	
36 – 55	28.7	23.2	29.8		
> 56	17.8	15.1	24.0		
Mean ± S.E	30.22 ± 14.57 [a]	28.17 ± 14.19 [b]	32.80 ± 15.38 [a,b]		4.494 (0.011)
family size					
1-2	52.2	45.5	52.6	0.140	
3-4	37.6	42.4	41.7		
≥ 5	10.2	12.1	5.8		
Mean ± S.E	2.16 ± 1.34	2.33 ± 1.37	2.06 ± 1.21		1.687 (0.186)
family income					
< 600	22.71	28.26	11.64	0.000	
601 – 750	19.66	13.04	13.82		
751 – 1025	18.98	13.04	19.27		
1026 – 1325	17.29	25.00	18.91		
1326 – 2500	11.86	14.13	23.27		
> 2500	9.49	6.52	13.09		
Mean ± S.E	1181.61 ± 606.09 [a]	1177.66 ± 582.96 [b]	1413.90 ± 636.02 [a,b]		11.538 (0.000)
education					
primary (ISCED 0-2)	19.43	20.20	19.82	0.026	
secondary (ISCED 3-4)	44.27	32.32	42.95		
tertiary (ISCED 5-6)	36.31	47.47	44.23		
Mean ± S.E	4.24 ± 1.46 [a]	4.55 ± 1.56	4.63 ± 1.38 [a]		3.281 (0.038)
relation with agriculture					
rural	10.51	11.11	12.50	0.876	
suburban	14.33	17.17	15.38		
urban	75.16	71.71	72.12		
occupation					
agriculture/environment/health/food	53.50	48.48	60.26	0.146	
other sector	14.01	16.16	14.74		
unemployed/retired/other	32.48	35.35	25.00		
fruits and vegetables monthly basket (€)					
≤ 28	38.85	34.34	28.85	0.022	
29 - 48	36.62	33.33	35.57		
49 - 72	12.73	15.15	16.99		
73 - 88	10.83	15.15	13.46		
>100	0.95	2.02	5.13		
Mean ± S.E	48.11 ± 20.72 [a]	51.88 ± 22.62	54.36 ± 22.99 [a]		6.352 (0.002)
practices related with concern with environment and health					
not concerned	86.31	82.83	64.74	0.000	
environmental activities	2.23	2.02	3.21		
consumer defense activities	10.19	11.11	26.92		
both activities	1.27	4.04	5.13		

Note: a,b Scores in the same row with a the same superscript are significantly different at p<.05 (post hoc Least Significant Difference and Tamhan multiple comparison tests).

with agriculture, occupation, monthly basket of fruit and vegetables and practices that reveal concerns with environment and health (member of environmental or consumers defense association). This was done by using either cross-tabulations or analysis of variance, as appropriate.

The analysis of the socioeconomic characteristics showed some significant differences among clusters (Table 4). '*Habitual buyers'* tend to be older and have higher incomes. In this case, the income difference between '*habitual buyers'* and those who are '*non buyers'* is significant (p=0.0001). The '*non buyers'* are consumers with lower education, while the '*occasional buyers'* and '*habitual buyers'* are more educated. In the '*habitual buyers'* almost all consumers have secondary or higher education (only 20 % have a lower level of education) and a larger average monthly basket of fruit and vegetables. These consumers are older and have a higher income when compared with the other groups. Differences in behaviour related to concern with the environment and health, such as being a member of environmental or consumer associations, were found between *'habitual buyers'* and those who are '*non-buyers'* who seemed to have no concern about these issues.

4. Conclusions

In this study, an attempt has been made to identify and illustrate consumers` perceptions and attitudes towards the use of pesticides in agriculture and its risks for human health and the environment that seems to influence the consumption of fruit and vegetables from farming systems that use less or no pesticides, based on a Portuguese case study. The identification and characterization of consumers and their behavior will help understand and interpret their preferences for safer and healthier products and thus will contribute to improve the design of rural development policies that aim to achieve a sustainable use of pesticides.

The most significant factor influencing behaviour towards these products was consumers' knowledge about farming systems that use less or no pesticides, such as IPM. Consumers who are informed and can understand the sustainable agricultural practices used in these systems, such as biological control, reduction of pesticides and fertilizers use, among others, are committed to buying certified products. These results are consistent with those found in other countries (Diamantopoulos *et al.,* 2003; Aerstsens *et al.,* 2009; Kuhar and Juvančič, 2010).

Our study allowed the identification of three groups of consumers. The group of '*habitual buyers' includes those* who are the most experienced in buying certified fruit and vegetables and well informed about the use of pesticides in agriculture and its risks to human health and the environment and about certification systems. These consumers recognize the importance of environmental and health benefits associated with agricultural systems that use less or no pesticides and consider that agricultural impacts should be minimized at all costs – *'environmentalist opinion'*. They represent a group of consumers who already purchase safer

and healthier fruit and vegetables and can choose a healthy diet and understand the influence of their food choices on environmental quality.

In contrast, we found consumers who are '*non-buyers*' of fruit and vegetables from certified systems and who make their choices based on low prices. They are not concerned with quality, food safety or environmental risks, don't have any knowledge about the risks from pesticide use and are '*indifferent*' to agricultural effects on health and the environment. These consumers are less aware of the risks due to the use of pesticides and their presence in food.

The third group of consumers, with a slight tendency to buy certified fruit and vegetables, is concerned with information related to production and certification systems and has some knowledge about the use of pesticides in agriculture. They believe that policies directed towards reduction of pesticides in agriculture should be adopted without causing unemployment or increasing prices – '*economicist opinion'*. In this last group, some consumers know the existence of fruit and vegetables from environmentally friendly farming systems, such as IPM, but the majority don´t have a consistent knowledge about these production systems and tend not to understand the complexities and niceties of environmentally friendly practices.

Along with knowledge about the risks deriving from pesticide use, we found that consumers who recognize the importance of certification processes to ensure food safety and the contribution of environmentally friendly farming systems to preserve the environmental quality, are those who buy these products more frequently.

'*Non-buyers'* and '*occasional buyers'*, who are respectively '*indifferent'* or have an '*economicist opinio*n', account for almost 60% of the respondents and represent a significant share of the market and can be better informed about environmental and health benefits associated to the use of pesticides in agriculture in order to change their purchasing behavior and specially to ensure that they became aware of the importance of choosing safe and healthier food and to adopt a healthy diet. At the same time, education and information about these questions will contribute to preserve environmental quality.

Information about agricultural impacts, such as the loss of species and pesticide poisoning, as well as the effect of pesticides in contamination of water for public use, must be reinforced among consumers as they seem to be more sensitive and easy-to-understand issues. At the same time, information about other risks is also essential for public consciousness and should be considered, not only for health and environmental reasons, but also as an important driver to increase consumer demand and contribute to promote the sustainable use of pesticides through environmentally friendly farming.

Simultaneously, consumers with an 'environmentalist opinion' are genuinely interested in health and the environment and prepared to do more about it – '*habitual buyers'* – as they already purchase certified fruit and vegetables and might increase the share of these products in their monthly basket if available.

Indications about the influence of perceptions of agriculture and consequences of pesticide use on consumers' '*economicist'* versus '*environmentalist'* attitudes are not conclusive. Probably, most respondents have not previously devoted a deep reflection to these issues, as they don't have enough knowledge of and, hence, interest in them. Therefore, changing perceptions towards agriculture impacts, which will lead to different personal beliefs about health and environmental benefits resulting from farming systems that use less or no pesticides, will be difficult.

Other studies have found that socio-demographic factors play a role in consumer behavior towards fruit and vegetables produced by environmentally friendly farming systems (Wier and Calverly, 2002; Travisi and Nijkamp, 2008; Tsakiridou *et al*., 2008). Here, socio-demographic factors prove to be relatively unimportant, except for income and monthly basket of fruit and vegetables. Age and education are also related to the purchase of these safe and healthier products.

In sum, despite its exploratory nature, this study reveals some interesting findings that deserve further investigations and attention. In particular, results indicate that knowledge about the use of pesticides in agriculture and the existence of farming systems which tend to reduce the use of pesticides such as IPM clearly makes a difference in consumer behaviour. This is in accordance with other studies (Saba and Messina, 2003; Roitner-Schobesberger *et al.,* 2008; Briz and Ward, 2009) and can be a key issue hampering the development of the demand for fresh fruit and vegetables from IPM. We should also consider that a share of consumers might also change their behaviour through the adoption of marketing strategies based on credence issues associated to quality certified systems.

It is clear that environmentally friendly food cannot sell itself but it needs efficient and customized strategies based on information and environmental and health education, as well as specific quality promotion and distribution strategies and appropriate price policies.

As knowledge improvement, through education and information, is a slow process, especially because the features and benefits associated to sustainable agricultural practices are not easy to accomplish, policies and strategies framed around this issue will only have long-term effects. Thus, they should be proposed along with the promotion of certified quality systems and the inherent certification process should be considered in the framework of the Portuguese rural policy, as consumers seemed to be attracted and ready to believe in the underlying warrantees.

It would be interesting to understand how knowledge and purchasing attitudes are related with willingness to pay for food obtained through farming systems which adopt a sustainable use of pesticides as IPM, in Portugal. A different analysis should be conducted on '*habitual buyers'*, as they probably will be more interested in paying for these products, and on '*occasional buyers*' and '*non-buyers'* who probably need to be better informed and convinced about the greater health and environment benefits of farming systems which use less or no pesticides.

Acknowledgements

This research work was part of the AGRO 545 project "The environmental indicators to assess the integrated pest management, integrated production, organic farming and the sustainable use of pesticides in Portugal".

References

Bonti-Ankomah S. and Yiridoe E., 2006. *Organic and conventional food: a literature review of the economics of consumer perceptions and preferences*. Report. Organic Agriculture Centre of Canada, Nova Scotia.

Briz T. and Ward R., 2009. Consumer awareness of organic products in Spain: an application of multinominal logit models. *Food Policy,* 34: 295-304.

Campbell B., Lesschaeve I. and Bowen A., 2010. Purchase drivers of Canadian consumers of local and organic produce. *Hortscience,* 45(10): 1480-1488.

Cerejeira M. and Silva E., 2011. Avaliação do risco aquático de pesticidas individuais e sua mistura em águas superficiais. *Revista de Ciências Agrárias,* 35(2): 32-42.

Costa C. and Teixeira J., 2011. Efeitos genotóxicos dos pesticidas. *Revista de Ciências Agrárias,* 35(2): 19-31.

Cranfield J. and Magnusson E., 2003. Canadian consumer's willingness-to-pay for pesticide free food products: an ordered probit analysis. *International Food and Agribusiness Management,* 6(4): 13-30.

Diamantopoulos A., Sinkovics R. and Bohlen G., 2003. Can socio-demographics still play a role in profiling green consumers? A review of the evidence and an empirical investigation. *Journal of Business Research,* 56 (6): 465–480.

Doey L. and Kurta J., 2011. Correspondence Analysis applied to psychological research. *Tutorials in Quantitative Methods for Psychology,* 7(1): 5-14.

EC, 2005. *Special Eurobarometer: Attitudes of European citizens towards the environment*. http://ec.europa.eu/envi ronment/archi ves/barometer/pdf/report_ebenv_(2005)_04_22_en.pdf.

European Parliament and Council of the European Union, 2009. *Directive (2009)/128/EC of the European Parliament and of the Council of 21 October (2009) establishing a framework for Community action to achieve the sustainable use of pesticides*. JOCE, L 309: 71-86.

Forbes S., Cohen D., Cullen R., Wratten S. and Fountain J., 2009. Consumer attitudes regarding environmentally sustainable wine: an exploratory study of the New Zealand marketplace. *Journal of Cleaner Production,* 17: 1195-1199.

Forum do Consumo, 2014. *Consumo Consciente, responsável e sustentável*. Forum do Consumo and European Recycling Platform, Lisboa.

Gil J., Gracia A. and Sánchez M. 2000. *Market segmentation and willingness to pay for organic products in Spain*. *International Food and Agribusiness Management Review,* 3: 207-226.

Gracia A., De Magistris T. and Barreiro-Hurlé J., 2010. Why do we buy organic? Integrating knowledge, attitudes and concerns in a simultaneous equation model for Spanish consumers. *119th EAAE Seminar*, *Capri, Italy, June, 30th –July, 2nd.*

Idda L., Madau F. and Pulina P., 2008. T*he motivational profile of organic food consumers: a survey of specialized stores customers in Italy*. 12th EAAE Congress, Gent - Belgium, August 26-29.

INE, 2012. *Inquérito às Despesas das Famílias 2010/2011*. Instituto Nacional de Estatística, Lisboa.

INE, 2011. *Censos 2011*. Instituto Nacional de Estatística, Lisboa. http://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_base_dados

Kornelis M., de Jonge J., Frewer L. and Dagevos H., 2007. Consumer selection of food safety information sources. *Risk Analysis,* 27(2): 327-335.

Kotler P. and Armstrong G., 2009. *Principles of Marketing*. 13th ed., Pearson Global Edition, New Jersey, pp. 158-189.

Kuhar A. and Juvančič L., 2010. Determinants of purchasing behaviour for organic and integrated fruits and vegetables in Slovenia. *Agricultural Economics Review,* 11(2): 70-83.

Lockie S., Lyons K., Lawrence G. and Grice J., 2004. Choosing organics: a path analysis of factors underlying the selection of organic food among Australian consumers. *Appetite*, 43: 135-146.

Loureiro M. and Umberger W., 2005. Assessing consumer preferences for country-of-origin labeled products. *Journal of Agricultural & Applied Economics,* 37(1): 49–63.

McEachern M. and McClean P., 2002. Organic purchasing motivations and attitudes: are they ethical? *International Journal of Consumer Studies,* 26: 85-92.

OECD, 2008. *Environmental Performance of Agriculture in OECD Countries since 1990.* OECD, Paris, France.

Olivas R. and Bernabéu R., 2012. Men's and women's attitudes toward organic food consumption. A Spanish case study. *Spanish Journal of Agricultural Research,* 10(2): 281-291.

Pimentel D. and Greiner A., 1997. Environmental and socio-economic costs of pesticide use. In: Pimentel, D. (ed.). *Techniques for reducing pesticide use: economics and environmental benefits.* Chichester: John Wiley and Sons, pp. 51-78.

PortugalFoods, 2012. *Portugal excepcional estratégia de internacionalização do sector agro-alimentar 2012-2017*. PortugalFoods - Pólo de Competitividade e Tecnologia Agro-Alimentar, Maia, pp. 17-42.

Roitner-Schobesberger B., 2006. *Consumer perceptions of organic foods in Bangkok, Thailand*. MSc Thesis University of Natural Resources and Applied Life Sciences, Vienna, pp. 51-54.

Roitner-Schobesberger B., Darnhofer I., Somsook S. and Vogl C., 2008. Consumer perceptions of organic foods in Bangkok, Thailand. *Food Policy*, 33: 112-121.

Saba A. and Messina F., 2003. Attitudes towards organic foods and risk/benefit perception associated with pesticides. *Food Quality and Preference,* 14: 637–645.

Torres L. 2011. Efeitos subletais dos pesticidas nos artrópodos auxiliares. *Revista de Ciências Agrárias,* 35(2): 43-52.

Tranter R., Bennett R., Costa L., Cowan C., Holt G., Jones P., Miele M., Sottomayor M. and Vestergaard J., 2009. Consumers' willingness-to-pay for organic conversion-grade food: evidence from five EU countries. *Food Policy,* 34: 287-294.

Travisi C. and Nijkamp P., 2008. Valuing environmental and health risk in agriculture: A choice experiment approach to pesticides in Italy. *Ecological Economics*, 67: 598-607.

Tsakiridou E., Boutsouki C., Zotos Y. and Mattas K., 2008. Attitudes and behavior towards organic products: an exploratory study. *International Journal of Retail & Distribution Management,* 36(2): 158-175.

Vecchio R, Annunziata A. (2013). Consumers' attitudes towards sustainable food: a cluster analysis of Italian university students. New Medit, vol 12, n.2, pp. 47-56 .

Vermeir I. and Verbeke W., 2006. Sustainable food consumption: exploring the consumer "attitude–behavioural intention' gap. *Journal of Agricultural and Environmental Ethics*, 19: 169–194.

Wier M. and Calverly C., 2002. Market potential for organic food products in Europe. *British Food Journal*, 104(1): 45-62.