# A report on the efficient way to take into account the consumer WTP in order to improve the European regulation of pesticides for fresh and processed agricultural products

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**Brief description of the deliverable:**
From some work on experimental economy carried out in several European countries (Portugal, France, Greece and the Netherlands), we assess the willingness to pay (WTP) of consumers for various levels of environmental certification of food products (particularly organic farming and Integrated Pest Management production strategies). With the help of this assessment we are able to define a multi-criterion procedure for the public authorities with the aim of securing the participation of consumers in a collective effort to reduce pesticides in agriculture.

**Followed methodology / framework applied:**
Measure of Willingness to Pay, via experimental economics; Estimation of consumers' surplus, Multicriteria-approach.

**Target group(s):**
Experimental economics research units.

**Key findings / results:**
We show how European consumers may have relatively uniform expectations *vis-à-vis* the reduction of pesticides in the fruit and vegetable sector. When this reduction is publicly certified, consumers' willingness to pay increases as a function of the level of reduction. Organic farming is clearly approved in all the countries and very often enables a doubling of the consumers' WTP. On the other hand, partial reduction via public or private Integrated Pest Management is, other things being equal, only accorded low value. As part of a multi-criterion approach to public policies, we show how the simultaneous use of several regulatory instruments (information, taxation, subsidy) favours responsible environmental behaviour on the part of consumers.

**Interactions with other WPs deliverables / joint outputs**

| WP no. | Relevant tasks | Partner(s) involved | Context of interaction |
|---|---|---|---|
| 5 | 5.2 | WU and LEI | Experimental auction for Netherlands (October 2010) |

Project no. **212120**

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**Theoretical Developments and Empirical Measurement of the External Costs of Pesticides**

Collaborative Project

SEVENTH FRAMEWORK PROGRAMME
THEME 2
Food, Agriculture and Fisheries, and Biotechnology

# Deliverable 4.5

Bazoche, P., Bunte, F., Combris, P., Giraud-Héraud, E., Seabra Pinto, A., Tsakiridou., E.

Report on the efficient way to take into account the consumer WTP in order to improve the European regulation of pesticides for fresh and processed agricultural products.

## Extended summary

This study contributes to the assessment of consumer willingness to pay for the reduction of pesticides for fruit and vegetables. We give the main results of experiments carried out for apples in different European countries (Portugal, France, Greece and Netherlands). We studied several systems of good agricultural practices, some of them signaled to consumers, ranging from strategies of Integrated Pest Management (IPM) to organic production methods.

We obtain a relatively homogeneous behavior of European consumers. In all four countries there is a significant premium for apples produced with reduced pesticide use. Premiums are statistically significant. Moreover, the absolute premium for the organic apple compared to all other apples is always significant. Conversely, we obtain a relative performance of IPM certification, even if the WTP for IPM is always higher than the wtp for the regular.

The impact of sensory characteristics to explain the WTP is mostly highly significant (for every countries and every variety of apples). However this feature has a weaker effect than information on pesticide reduction. In all four countries more information about pesticides reduction has a very significant impact on the WTP for the organic apple.

With the results that we have obtained with the experimental market during the TEAMPEST project, we confirm in this deliverable that it is possible to assess the alternatives for having consumers contribute in favour of improvement to environmental practices. We have in particular shown that the certification and labelling of products with these types of characteristics are necessary to have consumers make their choice. However, improving public information in this domain would favour the catalysing role of responsible social behaviour.

The estimation of WTP (through experimental procedures) is fairly convincing, especially since consumers' behaviour across the European territory is seen to be highly homogenous. With this estimation, purchasing behaviour and market share can be forecast for the various types of certification. We show then how it can be in the interest of the public authorities (European regulation on pesticide reduction) to anticipate changes in the prices of food products in the final market. Although some pricing (such as that observed in organic farming) is much too high to allow real environmental effectiveness, it is paradoxical to see that some European consumers show a real interest in this type of food (today, organic products are no longer the preserve of a class of sporadic purchasers) and that on the other hand, the prices practised are out of proportion to the WTP of consumers, even though this is high. Inversely, the taxation of pesticides does not appear to pose major problems if it is transferred wholly or partially on to the price of the product. This taxation would have the advantage of allowing the subsidising of more environmentally friendly practices, particularly IPM procedures. The latter certification could thus become a new reference for consumers.

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## I. Introduction

The use of pesticides (insecticides, fungicides, herbicides) has been one of the factors in the great leap forward of farming production during the last fifty years. Today, however, certain negative consequences of the dissemination of these products in the environment are starting to appear (water pollution, reproductive problems in birds, the emergence of resistance by pests etc.). The impact on human health, the health of farmers and consumers, is raising serious questions. Assessing the health impact of pesticides is moreover beset with difficulties: the real influence in the long term of limited doses absorbed, multi-factor origins of some of the illnesses concerned etc.

Reclassification procedure, removal of substances from sale: for over twenty years, the European public authorities have regularly reinforced the regulatory framework on the use of pesticides. The "pesticide package" was definitively adopted by the Council of the European Union in 2009. This set of texts introduces the strictest criteria on the authorisation for sale of pesticides for farming use and plans to ban twenty or so products estimated to be of concern. Furthermore, a directive obliges the Member States to adopt a national action plan to reduce the use of these products.

Several European countries have already drawn up plans to reduce the risks related to pesticides. Without waiting to know precisely how to assess these risks, these countries have introduced quantitative objectives, in terms of indicators of volume, and more recently by the TFI (treatment frequency index)[1], a notion introduced by Denmark. Others such as the Netherlands and Germany (which has developed an environmental indicator) set themselves the objective of reducing the environmental risk. The United Kingdom relies on a monitoring scheme and recommendations, without any constraining objective, in combination with incentive measures and encouragement to farmers to seek training. France has chosen a policy based on results with the "Eco-phyto" plan, with the target of reducing the use of pesticides by half by 2018. Stricter than the European directive, this plan also provides for the banning of 53 substances, potentially the most harmful. Moreover, to promote best practices in farming, the French government has implemented a number of measures for the grant of environmentally friendly practices or conversion to organic farming. These contracts have

[1] The TFI (treatment frequency index) corresponds to the number of standardised doses applied per hectare and per year. This indicator provides a unit that is valid for widely differing products, and thus enables calculations with data comparable from one crop to another. The national TFI is the average of TFIs calculated per type of crop.

evolved from territorial exploitation contracts (CTE), to become contracts for sustainable agriculture (CAD), and finally as agro-environmental measures (MAE) which are financed from national and European funds (FEADER).

Thus, there is no single model for European regulation to achieve a reduction in the use of pesticides, solutions being adapted to national and local contexts. What is certain is that the environmental and health urgency is not leading the public authorities to adopt any sort of "welfarist" approach *i.e.* which would take into account the individual preferences of stakeholders, consumers in particular. This position is doubtless justified[2], but it would still be useful to know how far consumers would be willing to participate in this collective effort, *i.e.* to "accept" any price increases on food products. At the very least, it is always necessary to have quantitative knowledge of the lowering of consumer surplus following the introduction of a public policy on the environment and health, if only to anticipate any difficulty in implementation.

From a micro-economic point of view, the term "accept" corresponds to an increase in surplus both individually and collectively, since an increase in price with no visible compensation necessarily carries a lowering of surplus. So it is illusory to imagine consumer acceptance without any display of the efforts made by the producers. This display can be by a wide range of product labelling, with logos defined by the public authorities or by private initiatives, and it is not uncommon for logos to correspond to higher prices on the markets (as for example in the case of the certification of organic products).

In this deliverable we assess the change in the consumer surplus by considering both the signalling of farming practice on pesticides and a potential modification in the market prices of various products. We show how this modification of price ratios (from taxation policies or on the other hand from subsidies) can lead to a switch by consumers to more environmentally friendly products and modify their surplus (criterion No.1). Alongside this we show how the environmental balance sheet for food consumption is or is not improved after the implementation of these public policies (criterion No.2). And finally, we survey the budgetary cost of public policies and consider that the deficit from subsidising good farming practice should be limited or even compensated by taxing of products using pesticides (criterion No.3).

[2] For a presentation of the various critiques of welfarist evaluations of social well-being, see Sen (1970a, 1970b, 1979, 1985, 1999). For a presentation of non-welfarist proposals, see in particular Sugden (1993) and Pattanaik (1994), the special issue of 1990 of the review 'Recherches Economiques de Louvain' and that of 2004 of the review 'Social Choice and Welfare'.

This multi-criterion approach (*i.e.* the "efficient way to take into account the consumer WTP in order to improve the European regulation of pesticides") is applied through the experimental markets that we have set up in 4 E.U. countries (France, Greece, the Netherlands, Portugal). It involves the use of standard procedures to assess the willingness to pay (WTP) of consumers for various types of certification related to the use of pesticides. The product we chose for our experiments was the apple, which is the most widely produced fruit in the E.U. and also the most widely consumed in many countries. Of its characteristics we chose the sensory aspect and the labelling of products at three different levels of pesticide reduction: a standard level corresponding to compliance with the regulations, total absence of pesticides of chemical origin (corresponding to organic certification) and an intermediate level of pesticide reduction of the order of 50% (corresponding to Integrated Pest Management or a geographical indication including an equivalent reduction in pesticides in the production schedule).

In the first part we state the general principles of our experiments (experimental protocol and incentive procedure to reveal the WTP). The results suggest a relatively homogeneous behavior of European consumers. It appears that the organic system improves very significantly, the WTP, while the intermediate solutions, related to IPM, get results much more mixed. However, we show how this last assessment is largely dependent on the sensory characteristics or reference to an origin of production.[3] Moreover, in all four countries more information about pesticides reduction has a very significant impact on the WTP for the organic apple. For the IPM apple, improving information about pesticides reduction has no significant impact on the WTP, but in every country but Netherlands there is a significant decrease of the WTP for the regular apple. Indeed, while the labels may convey positive messages to consumers about the production conditions, they may simultaneously stigmatize the conventionally produced product by highlighting perceived problems. The net economic result for producers can be negative since consumers may decrease their WTP for the conventional product that dominates the market.

The results that we obtained on the implementation of public policies are nevertheless in considerable contrast with the first impression provided by the WTP; for the markedly high levels of consumers' WTP in favour of organic products are not sufficient to deduce that efforts should be directed solely to this mode of production. We show how the intermediate

[3] We obtain a relative performance of IPM certification. However, the WTP for IPM is always higher than the wtp for the regular and always less than the WTP for the PDO and the organic.

solution of subsidising integrated production can be just as effective in orienting consumption towards more environmentally friendly products. Moreover the potential price increases of conventional products[4] would not necessarily carry with it a drastic reduction in consumer surplus, which would allow the proposed subsidies to be compensated, to balance the overall budget of the policy.

Finally, we show how the price levels seen today in the E.U. do not appear to us to be effective from the point of view of the social optimum and orientation of consumers' buying behaviour in favour of more environmentally friendly products. While the prices of organic products are considerably too high for the financial means of consumers (explaining the niche markets for this type of product that are seen throughout Europe), the price levels of conventional products could be raised without penalising consumers too much in the process. Thus it is necessary to estimate consumers' WTP at the same time as price changes are observed in order to appreciate the effectiveness of public policy tools in environmental issues.

**II. Data harmonization of the experiments and descriptive statistics**

In our experimental markets (see deliverable 4.2, 4.3, 4.4) we keep four situations (dropping the health information situation in Greece):

- 1 blind tasting
- 2 stickers (visual observation of apples with stickers)
- 3 information on guarantee on pesticide use
- 4 full information (pesticide use info + tasting)

and four apples:

- regular (reg)
- integrated pest management (ipm)
- protected denomination of origin (pdo)
- organic (org)

in four countries:

[4] Following taxation of pesticides, through a partial transfer of this taxation on to the price of the final product or through the rarefying of the offer following a reduction in the use of pesticides by farmers.

1. **France (Dijon)**

   The wtp for the organic apple, is corrected for its small size by adding, for each participant, the difference in wtp between the regular apple and the small regular. This correction is made only for step 2 and 3 (At step 4 the small regular has a higher wtp due to its good taste compared to the regular).

2. **Greece (Tessaloniki)**

   We drop situation 1 (blind tasting), situation 5 (health information), apple 3 (retailer's) and apple 6 (variety sticker).

3. **Netherlands (The Hague)**

   We drop apple 5 (organic +), and one participant (id=103) who didn't complete the whole task (no price in the last situation)

4. **Portugal (Lisbon))**

   We drop apple 3 (retailer's). We add step1 data which have been collected separately for "Gala" and "Granny". For each participant we keep the variables corresponding to the preferred apple (t1,t2,t3 or t4,t5,t6) t2 and t5 correspond to both ipm and pdo apples.

The descriptive statistics are the following,

- Number of participants in each country

| country | Freq. | Percent | Cum. |
|---|---|---|---|
| France | 107 | 26.42 | 26.42 |
| Greece | 100 | 24.69 | 51.11 |
| Netherlands | 98 | 24.20 | 75.31 |
| Portugal | 100 | 24.69 | 100.00 |
| Total | 405 | 100.00 | |

All participants gave one WTP for one kg of each apple, in each situation.

- Mean WTP in each country by step and apple

| | step and apple | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | | | | 2 | | | |
| country | reg | ipm | pdo | org | reg | ipm | pdo | org |
| France | 0.99 | 1.39 | 1.48 | 1.10 | 1.14 | 1.42 | 1.62 | 1.57 |
| Greece | 1.16 | 0.97 | 1.11 | 0.96 | 1.09 | 1.06 | 1.31 | 1.18 |
| Netherlands | 1.16 | 1.18 | 1.02 | 0.96 | 1.20 | 1.17 | 1.07 | 1.17 |
| Portugal | 0.83 | 0.81 | 0.81 | 0.73 | 0.61 | 0.89 | 0.99 | 1.01 |

| | step and apple | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3 | | | | 4 | | | |
| country | reg | ipm | pdo | org | reg | ipm | pdo | org |
| France | 1.01 | 1.45 | 1.64 | 1.67 | 0.81 | 1.52 | 1.63 | 1.40 |
| Greece | 0.95 | 1.13 | 1.33 | 1.60 | 1.08 | 1.07 | 1.29 | 1.36 |
| Netherlands | 1.20 | 1.19 | 1.19 | 1.34 | 1.17 | 1.22 | 1.21 | 1.12 |
| Portugal | 0.57 | 0.86 | 0.97 | 1.11 | 0.61 | 0.72 | 0.89 | 0.94 |

As is always verified in the experimental markets, we obtained relatively low WTP compared to market prices recorded at the time of the experiments (see further in Section 4). Nevertheless there is already a relative homogeneity of a country to another.

## III. Main Results

To summarize the main results of our experiments, we asked five questions to help understand consumers' expectations regarding pesticide reduction.

**Question 1: Is there a significant premium for apples produced with reduced pesticide use ?**

For each participant, we compute the premiums for ipm, pdo and organic compared to the regular apple:

- $wtp_i(imp)–wtp_i(regular)$
- $wtp_i(pdo)-wtp_i(regular)$
- $wtp_i(org)-wtp_i(regular)$

and we average the premiums over all participants in each country.

**Premiums for each apples compared to the regular**
**(ipm-reg ; pdo-reg ; org-reg) (euros)**

| country | step and apple 3 reg | ipm | pdo | org |
|---|---|---|---|---|
| France | 0.000 | 0.441 | 0.632 | 0.659 |
| Greece | 0.000 | 0.173 | 0.372 | 0.644 |
| Netherlands | 0.000 | -0.017 | -0.011 | 0.134 |
| Portugal | 0.000 | 0.290 | 0.405 | 0.542 |

**P-values for premium=0** (Ho: premium=0 rejected if P<0.05)

| country | apple reg | ipm | pdo | org |
|---|---|---|---|---|
| France | - | 0.0000 | 0.0000 | 0.0000 |
| Greece | - | 0.0063 | 0.0000 | 0.0000 |
| Netherlands | - | 0.6669 | 0.8455 | 0.0422 |
| Portugal | - | 0.0000 | 0.0000 | 0.0000 |

We obtain the following result,

**Result 1**

We obtain a relatively homogeneous behavior of European consumers. In all four countries there is a significant premium for apples produced with reduced pesticide use. Premiums are statistically significant in all cases excepted in the Netherlands for IPM and PDO apples. This could be due to the fact that the regular apple is presented with a sticker, which is not the case in the other three countries. This point will be investigated with a complementary experiment.

**<u>Question 2</u>: What about the polar case of organic production?**

We compute the premiums for the organic apple for each participant:

- $wtp_i$(organic)–$wtp_i$ (regular)
- $wtp_i$(organic)-$wtp_i$(ipm)
- $wtp_i$(organic)-$wtp_i$(pdo)

and we average the premiums over all participants in each country.

**Premiums for organic apples compared to the three other apples (org-reg ; org-ipm ; org-pdo) (€/kg)**

| | Premium for org compared to | | | |
|---|---|---|---|---|
| country | reg | ipm | pdo | org |
| France | 0.659 | 0.218 | 0.027 | 0.000 |
| Greece | 0.644 | 0.471 | 0.271 | 0.000 |
| Netherlands | 0.134 | 0.151 | 0.145 | 0.000 |
| Portugal | 0.542 | 0.252 | 0.137 | 0.000 |

Using the same method as previously, we test the statistical significance of all the premiums

**P-values for dwtp=0** (Ho: premium=0 rejected if P<0.05)

| | org compared to | | | |
|---|---|---|---|---|
| country | reg | ipm | pdo | org |
| France | 0.0000 | 0.0012 | 0.7111 | - |
| Greece | 0.0000 | 0.0000 | 0.0000 | - |
| Netherlands | 0.0422 | 0.0096 | 0.0055 | - |
| Portugal | 0.0000 | 0.0000 | 0.0005 | - |

**Relative premiums for organic apples compared to the three other apples (org-reg ; org-ipm ; org-pdo) (%)**

| | step and apple 3 | | | |
|---|---|---|---|---|
| country | reg | ipm | pdo | Total |
| France | 62.50 | 17.86 | 6.25 | 27.68 |
| Greece | 95.27 | 50.42 | 31.66 | 58.90 |
| Netherlands | 18.88 | 14.22 | 9.07 | 14.11 |
| Portugal | 85.28 | 30.52 | 16.40 | 41.81 |
| Total | 64.82 | 28.13 | 15.76 | 35.61 |

We obtain the following result,

**Result 2 (Significant premium for organic products)**

The absolute premium for the organic apple compared to all other apples is always significant except in France when the organic is compared to the pdo. This can be viewed as an indication of the high wtp for pdo products in France. In relative terms premiums for organic apples are higher in Greece and Portugal than in France and Netherlands.

**<u>Question 3</u> : Is there a premium for the intermediate case of ipm certification ?**

We compute the premiums for the ipm apple for each participant:

- $wtp_i$(ipm)–$wtp_i$ (regular)
- $wtp_i$(pdo)-$wtp_i$(ipm)
- $wtp_i$(org)-$wtp_i$(ipm)

and we average the premiums over all participants in each country

**Premiums for ipm apples compared to the three other apples (in €/kg)**

| | step and apple | | | |
|---|---|---|---|---|
| | 3 | | | |
| country | reg | ipm | pdo | org |
| France | 0.441 | 0.000 | 0.191 | 0.218 |
| Greece | 0.173 | 0.000 | 0.199 | 0.471 |
| Netherlands | **-0.017** | 0.000 | **0.006** | 0.151 |
| Portugal | 0.290 | 0.000 | 0.115 | 0.252 |

**Corresponding P-values**

| | step and apple | | | |
|---|---|---|---|---|
| | 3 | | | |
| country | reg | ipm | pdo | org |
| France | 0.0000 | - | 0.0000 | 0.0012 |
| Greece | 0.0063 | - | 0.0018 | 0.0000 |
| Netherlands | 0.6669 | - | **0.8866** | 0.0096 |
| Portugal | 0.0000 | - | 0.0000 | 0.0000 |

We obtain the following result,

**Result 3 (relative performance of IPM certification)**

| |
|---|
| We obtain a relative performance of IPM certification. However, the WTP for IPM is always higher than the wtp for the regular and always less than the WTP for the pdo and the organic. |

**<u>Question 4</u>. Is there any impact of sensory characteristics and information about pesticide use on WTP when participants are fully informed?**

For each apple we run a regression of the WTP at step 4 (information + taste) on WTP at step 1 (taste) and WTP at step 3 (information):

| country and apple | Impact of wtp1 & wtp3 on wtp4 | | | | | |
|---|---|---|---|---|---|---|
| | wtp1 | P>\|t\| | wtp3 | P>\|t\| | wtp1≠wtp3 | |
| France | | | | | | |
| reg | 0.2212 | 0.0130 | 0.5294 | 0.0000 | 0.0752 | ▶ 7% chance of being wrong |
| ipm | 0.2259 | 0.0030 | 0.7783 | 0.0000 | 0.0004 | |
| pdo | 0.2381 | 0.0009 | 0.8008 | 0.0000 | 0.0000 | |
| org | 0.4536 | 0.0000 | 0.4441 | 0.0000 | 0.9398 | ▶ wtp1=wtp3 |
| Greece | | | | | | |
| reg | 0.3903 | 0.0000 | 0.6977 | 0.0000 | 0.0356 | |
| ipm | 0.1868 | 0.0085 | 0.7893 | 0.0000 | 0.0000 | |
| pdo | 0.0711 | 0.1881 | 0.9534 | 0.0000 | 0.0000 | |
| org | 0.2413 | 0.0022 | 0.6668 | 0.0000 | 0.0014 | |
| Netherlands | | | | | | |
| reg | 0.3869 | 0.0000 | 0.3352 | 0.0003 | 0.7278 | |
| ipm | 0.2413 | 0.0161 | 0.6701 | 0.0000 | 0.0281 | |
| pdo | 0.2281 | 0.0105 | 0.7645 | 0.0000 | 0.0001 | |
| org | 0.1148 | 0.2351 | 0.6701 | 0.0000 | 0.0006 | |
| Portugal | | | | | | |
| reg | 0.4371 | 0.0000 | 0.3359 | 0.0005 | 0.4623 | |
| ipm | 0.5588 | 0.0000 | 0.3583 | 0.0000 | 0.1865 | |
| pdo | 0.0822 | 0.2597 | 0.9308 | 0.0000 | 0.0000 | |
| org | 0.2666 | 0.0012 | 0.7311 | 0.0000 | 0.0006 | |

The impact of taste (wtp1) and information (wtp3) is always highly significant. Note that the impact of information is always higher than the impact of taste, except for the organic apple in France, the regular in Netherlands, the regular end ipm in Portugal where they are not significantly different. After that we ask if variation in WTP between step 3 and 4 is explained by individual deviation from the mean at step1.

**WTP variation between step3 and step 4**

| country \ apple | reg | ipm | pdo | org |
|---|---|---|---|---|
| France | -0.198 | 0.067 | -0.016 | -0.270 |
| Greece | 0.123 | -0.054 | -0.031 | -0.238 |
| Netherlands | -0.036 | 0.031 | 0.016 | -0.218 |
| Portugal | 0.043 | -0.137 | -0.082 | -0.176 |

This table shows that the wtp for the organic apple always decrease in step4 compared to step3.

**WTP for taste at step1 (deviation from the individual mean)**

| country | apple reg | ipm | pdo | org |
|---|---|---|---|---|
| France | -0.247 | 0.149 | 0.241 | -0.144 |
| Greece | 0.110 | -0.085 | 0.062 | -0.087 |
| Netherlands | 0.083 | 0.097 | -0.061 | -0.119 |
| Portugal | 0.034 | 0.013 | 0.013 | -0.059 |

This table shows that the organic apple is always less appreciated than the mean in step1.

**Regression of wtp4-wtp3 on sensory appreciation at step1**:

Impact of taste in step1 (deviation from the individual mean) on the variation of wtp between step3 and step4 (coef of taste and corresponding P-value on the second line)

| country | apple reg | ipm | pdo | org |
|---|---|---|---|---|
| France | .0321378 | -.0194674 | .2054883 | .6047344 |
| | 0.7721 | 0.8049 | 0.0617 | 0.0001 |
| Greece | .1880714 | .0046092 | .0770801 | .2194573 |
| | 0.0975 | 0.9544 | 0.2516 | 0.1025 |
| Netherlands | .4143884 | .1730086 | .1461373 | .0256005 |
| | 0.0023 | 0.1863 | 0.1874 | 0.8694 |
| Portugal | .2611328 | .822116 | .1263376 | .1291849 |
| | 0.0477 | 0.0004 | 0.4077 | 0.1802 |

**Result 4 (Influence of sensory characteristics)**

The impact of sensory characteristics to explain the WTP is mostly highly significant (for every countries and every variety of apples). However this feature has a weaker effect than information on pesticide reduction.

**<u>Question 5</u> : Do the consumers need more information on reducing pesticide?**

We estimate the change in wtp (euros) after information on pesticide use reduction (step 3 - step 2)

| country | step and apple 3 reg | ipm | pdo | org |
|---|---|---|---|---|
| France | -0.128 | 0.032 | 0.025 | 0.099 |
| Greece | -0.135 | 0.069 | 0.018 | 0.418 |
| Netherlands | -0.001 | 0.020 | 0.121 | 0.168 |
| Portugal | -0.042 | -0.028 | -0.016 | 0.098 |

**P-values for dwtp=0** (Ho: dwpt=0 rejected if P<0.05)

| country | apple reg | ipm | pdo | org |
|---|---|---|---|---|
| France | 0.0013 | 0.3387 | 0.4124 | 0.0455 |
| Greece | 0.0018 | 0.1582 | 0.6842 | 0.0000 |
| Netherlands | 0.9809 | 0.6568 | 0.0003 | 0.0000 |
| Portugal | 0.0547 | 0.3145 | 0.2964 | 0.0025 |

**Average change in wtp after information on pesticide-use reduction and corresponding P-values**

| country | mean(dwtp) | P-values |
|---|---|---|
| France | 0.007 | 0.785 |
| Greece | 0.093 | 0.002 |
| Netherlands | 0.077 | 0.001 |
| Portugal | 0.003 | 0.835 |

To test whether the variation in wtp between step 2 and step 3 is significantly different from 0, for each country and each apple we performed an OLS regression of wtp on a dummy variable for step3, step 2 being the reference (intercept). Robust estimation of standard errors permits all observation to have a different variance. Participants' sensitivity to information on pesticide use reduction varies according to apple and country is the following:

- in every country but Netherlands: significant decrease of the WTP for the regular apple.
- in all four countries: no significant impact on the WTP for the ipm apple
- in Netherlands <u>only</u>: significant impact on the WTP for the pdo apple (which was clearly underestimated in step 2)
- in all four countries: information has a very significant impact of on the WTP for the organic apple

For the four apples considered here, the average WTP increases significantly only in Greece and Netherlands

**Result 5 (a negative effect of information**

In all four countries more information about pesticides reduction has a very significant impact on the WTP for the organic apple. However, there is no significant impact on the WTP for the IPM apple, and in every country but Netherlands there is a significant decrease of the WTP for the regular apple.

## IV. Assessing consumers' contribution to a public policy of pesticide use reduction

To assess the impact of information and compare different scenarios of public intervention trough taxes and subsidies, we use three indicators: a pesticide-use index, the consumer surplus and the state surplus.

### PUI : Pesticide Use Index

The pesticide-use index (PUI) measures the pesticide content of the average basket bought by consumers under different price hypotheses. We constructed the index with the following pesticide-use quantities (normalized to 1 for the regular apple):

| reg | ipm | pdo | org |
|---|---|---|---|
| 1 | 0.5 | 0.5 | 0 |

The pesticide-use index (PUI) is the weighted sum of each apple's index, using market shares as weights. The PUI varies between 0 and 1. The PUI is equal to zero when only organic apples are sold on the market, and equal to one when only regular apples are sold on the market. So (1-PUI)*100 is the percentage reduction of pesticide use.

### CS : Consumer Surplus

Individual consumer surplus is the difference between willingness to pay and market price of the chosen apple in euros per kilo. Overall consumer surplus (CS) is the weighted sum of indivual surpluses, using market shares as weights. It is the surplus

generated by a composite basket of one kg. Consumer Surplus (CS) is in euros for one kg of apples (see annex at the end of the deliverable).

**BI : Budget impact**

The Budget impact is the weighted sum of taxes and subsidies in euros for a composite basket of 1 kg of apples, using market shares as weights. Budget Impact is in euros for one kg of apples

To illustrate our approach, we perform the evaluation of these indicators for the case of the experiment conducted in France. To compute the initial values of market shares of the different apples we use the following prices. They are actual market prices observed at the time and place of the experiment and rounded to the closest 0.05€:

| apple | mrkt prices (€/kg) | |
|---|---|---|
| reg | p1 | 1.15 |
| ipm | p2 | 1.85 |
| pdo | p3 | 3.40 |
| org | p4 | 3.95 |

To compute the impact of taxes and subsidies, we use multiplicative coefficients, rather than absolute values in euros, to facilitate further comparison between countries. Initial market prices {p1,p2,p3,p4} become {p1*t1,p2*t2,p3*t3,p4*t4} where ti >1 represents a tax and ti<1 a subsidy. For each set of coefficients {t1,t2,t3,t4}, we compute market shares and derive the three defined indicators.

## IV.1 Information Policy

The effectiveness of reinforcing the information on pesticides can be measured through the difference in the results obtained between step 2 and step 3 of our experiments. Our approach starts off from the following remark. When consumers buy apples in a real market, they usually have a choice between several varieties of apple and several types of certification which in principle are shown by stickers on the fruit. Nevertheless, it is not at all certain that consumers really know the meaning of these stickers from the point of view of the efforts

made by the producers in pesticide reduction. For this reason, before beginning step 3 of our experiment, we informed consumers precisely on the meaning of the stickers.

The variation in WTP between step 2 and step 3 is thus explained by this policy of informing, which enabled us to measure the effects on the PUI and CS criteria there is no effect on the BI criterion since in our case the information is produced at zero cost). We obtain the following results.

| step | apple | price | choice | mktshare | PUI | CS |
|---|---|---|---|---|---|---|
| 2 | reg | 1.15 | 93 | 86.92 | 0.935 | 0.071 |
| 2 | ipm | 1.85 | 14 | 13.08 | 0.935 | 0.071 |
| 2 | pdo | 3.40 | 0 | 0.00 | 0.935 | 0.071 |
| 2 | org | 3.95 | 0 | 0.00 | 0.935 | 0.071 |
| 3 | reg | 1.15 | 87 | 81.31 | 0.907 | -0.022 |
| 3 | ipm | 1.85 | 18 | 16.82 | 0.907 | -0.022 |
| 3 | pdo | 3.40 | 2 | 1.87 | 0.907 | -0.022 |
| 3 | org | 3.95 | 0 | 0.00 | 0.907 | -0.022 |

**Tab 1.** Information policy Impact of information between step 2 and step 3.

Giving information to consumers about pesticide use actually decreases both the PUI and the average consumer surplus. This derives from the fact that the value of the regular apple decreases when consumers learn that other apples are produced using less pesticides. Note however that changes remain very small. Some attention should be given to price systems that would leave the consumer surplus unchanged after full information has been disclosed.

## IV.2 Taxation of pesticide-use

The question of pesticide taxation is the main hypothesis of the TEAMPEST project to reduce the use of pesticides by farmers. The final consequences for consumers of such a policy on pricing are not easy to measure. They depend on the type of products considered (especially whether the product is fresh or processed). They also depend on whether or not the operators pass this tax on partially or totally to the final product. Moreover, this tax can have the effect of reducing the use of pesticides on the conventional product, which may reduce the yields.

All this means that an increase in the price of the product is likely when pesticides are taxed. In what follows, we give the results obtained for a multiplying coefficient of the conventional product that can go up to 50% for the conventional product and 25% for

products from Integrated Pest Management (the approach allowing reduced use of pesticides). Thus in table 2 below, the apple reg is taxed up to 50% of its price. The apples IPM and PDO are taxed by an amount of 50% of this tax (in absolute value). Figure 1 measures the change in indicators as a function of this tax.

| apple | price | t | new price | mktshare | PUI | BI | CS |
|---|---|---|---|---|---|---|---|
| reg | 1.15 | 1 | 1.15 | 81.31 | 0.907 | 0.000 | -0.022 |
| ipm | 1.85 | 1 | 1.85 | 16.82 | 0.907 | 0.000 | -0.022 |
| pdo | 3.40 | 1 | 3.40 | 1.87 | 0.907 | 0.000 | -0.022 |
| org | 3.95 | 1 | 3.95 | 0.00 | 0.907 | 0.000 | -0.022 |
| reg | 1.15 | 1.5 | 1.73 | 71.03 | 0.855 | 0.546 | -0.573 |
| ipm | 1.85 | 1.25 | 2.31 | 28.04 | 0.855 | 0.546 | -0.573 |
| pdo | 3.40 | 1.25 | 4.25 | 0.93 | 0.855 | 0.546 | -0.573 |
| org | 3.95 | 1 | 3.95 | 0.00 | 0.855 | 0.546 | -0.573 |

**Tab 2.** Prices, choices, market shares, PUI, BI and CS when the taxation coefficient of the regular (resp IPM) apple varies from 1 to 1.5 (resp 1 to 1.25)

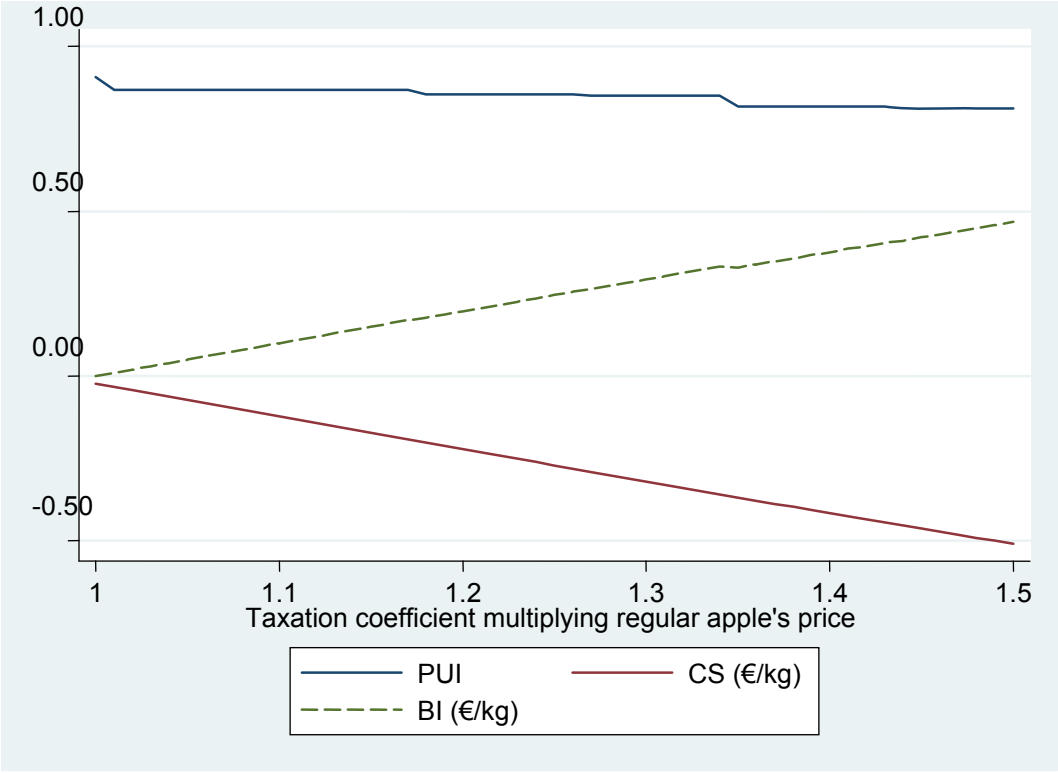


**Figure 1:** Pesticide-use index, Consumer surplus and State surplus variations according to the taxation coefficient of regular, ipm and pdo apples

We observe that a high tax on pesticides, leading to a price increase on conventional apples of the order of 50%, and on IPM apples of 25%, does not result in any substantial reduction in

the consumption of conventional products (the loss in market share for these products is of the order of 10%), whereas the consumer surplus is greatly diminished (of the order of 55 centimes per kg of apples consumed). We also note the low environmental gain achieved by this policy (PUI criterion).

### IV.3 Subsidizing the organic production

The second policy that we tested consisted this time in subsidising organic products. For, given the high WTP of consumers for this type of product, it seems reasonable to envisage a substantial increase in surplus by a reduction in the prices currently seen in the markets. Table 3 below gives the results when we assume (through a subsidy of 50% of the price) that these products are brought down to a level comparable with IPM products.

| apple | price | t | new price | mktshare | PUI | BI | CS |
|---|---|---|---|---|---|---|---|
| reg | 1.15 | 1 | 1.15 | 81.31 | 0.907 | 0.000 | -0.022 |
| ipm | 1.85 | 1 | 1.85 | 16.82 | 0.907 | 0.000 | -0.022 |
| pdo | 3.40 | 1 | 3.40 | 1.87 | 0.907 | 0.000 | -0.022 |
| org | 3.95 | 1 | 3.95 | 0.00 | 0.907 | 0.000 | -0.022 |
| reg | 1.15 | 1 | 1.15 | 61.68 | 0.668 | -0.554 | 0.111 |
| ipm | 1.85 | 1 | 1.85 | 9.35 | 0.668 | -0.554 | 0.111 |
| pdo | 3.40 | 1 | 3.40 | 0.93 | 0.668 | -0.554 | 0.111 |
| org | 3.95 | .5 | 1.98 | 28.04 | 0.668 | -0.554 | 0.111 |

**Tab 3.** Prices, choices, market shares, PUI, BI and CS when the subsidy of the organic apple is equal to .5

As may be expected, the organic farming subsidy is seen to have a non-negligible effect on the gain in market share of these products (which goes from 0% to 28%). This results in a big progression in the Pesticide Use Index which goes from .997 to .668. The consumer surplus is slightly improved (which is logical since this is a simple subsidy policy). Nevertheless the State budget is deprived of 50 centimes per kg of apples sold. We then compute the impact of a continuous decrease of the organic apple price from the actual organic apple price to the IMP apple price.

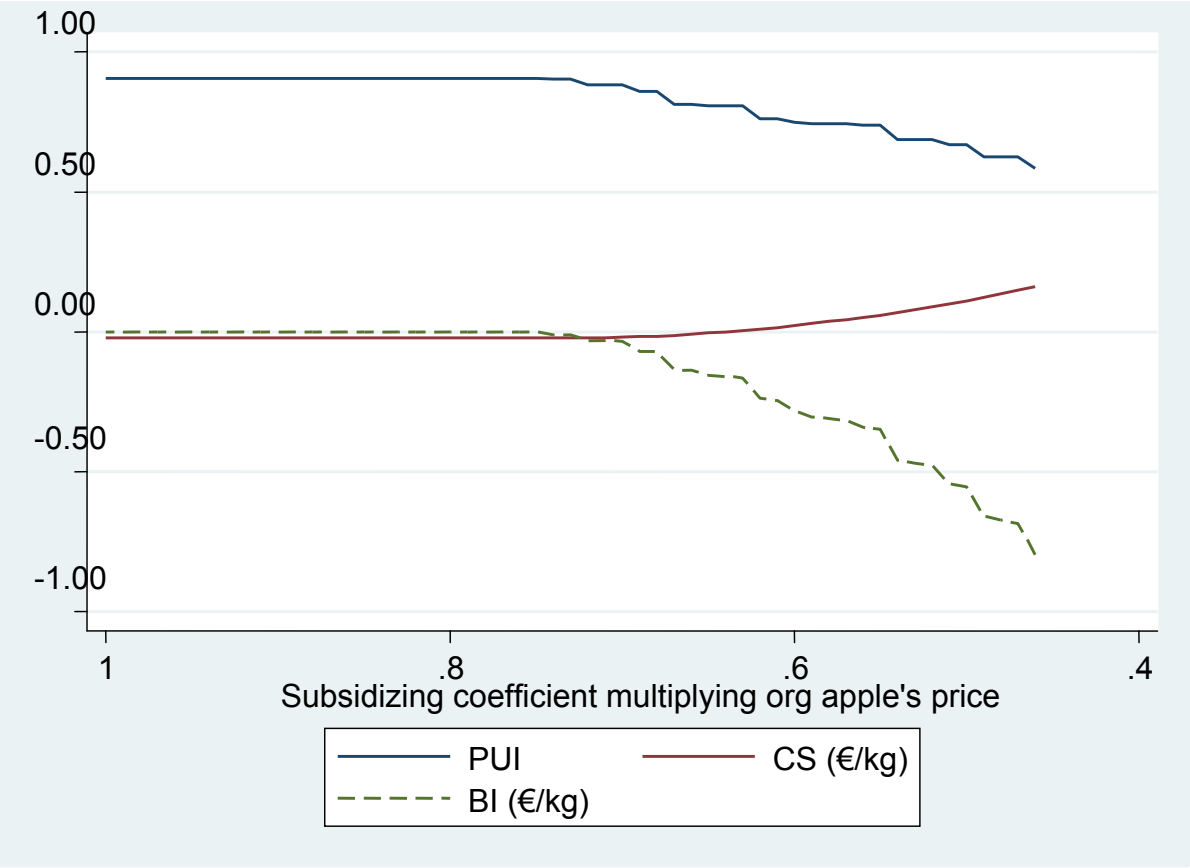


**Figure 2:** Consumer surplus and PUI variations according to the reduction of the organic apple price

Figure 2 shows the effectiveness of the subsidy to organic farming. Nevertheless, the large decrease in State budget (criterion BI) is never compensated by the improvement in PUI criterion. One of the problems that arises in publicly subsidising organic farming is the real cost of such a policy with regard to its effectiveness. For the current high price of products from this mode of production remains disproportionate in relation to the average consumer WTP (even if this is in fact larger than any other mode of certification). If this price does reflect the production costs (especial the cost of labour), it is clear that a substantial subsidy would be necessary to achieve a shift in demand, in order to cause a substantial improvement.

## IV.4 Subsidizing the IPM production

In this scenario, the ipm apple price is subsidized to encourage consumers to switch from the reg to the ipm. We test the impact of an increasing subsidy to the ipm apple up to the point where the price of the ipm apple is equal to the price of the reg apple.

| apple | price | t | new price | mktshare | PUI | BI | CS |
|---|---|---|---|---|---|---|---|
| reg | 1.15 | 1 | 1.15 | 81.31 | 0.907 | 0.000 | -0.022 |
| ipm | 1.85 | 1 | 1.85 | 16.82 | 0.907 | 0.000 | -0.022 |
| pdo | 3.40 | 1 | 3.40 | 1.87 | 0.907 | 0.000 | -0.022 |
| org | 3.95 | 1 | 3.95 | 0.00 | 0.907 | 0.000 | -0.022 |
| reg | 1.15 | 1 | 1.15 | 6.54 | 0.533 | -0.657 | 0.317 |
| ipm | 1.85 | .62 | 1.15 | 93.46 | 0.533 | -0.657 | 0.317 |
| pdo | 3.40 | 1 | 3.40 | 0.00 | 0.533 | -0.657 | 0.317 |
| org | 3.95 | 1 | 3.95 | 0.00 | 0.533 | -0.657 | 0.317 |

**Tab 4.** Prices, choices, market shares, PUI, BI and CS when the subsidy of the organic apple is equal to .62 (IPM apple price subsidized to be equal to the org apple price)

The public policy proposed here is again very costly for the State budget (more than 65 centimes per kg of apples sold). Nevertheless, we observe that, as suggested by the intuition above, the PUI criterion is sharply improved (at 0.533) while consumers are also more satisfied compared with the policy of organic farming subsidies (gain of 20 centimes). We observe that in this case IPM captures almost the whole of the market (market share 93.46%), clearly demonstrating the attractiveness of the product. We then compute the impact of a continuous decrease of the IPM apple price between the IPM apple price and the reg apple market price,

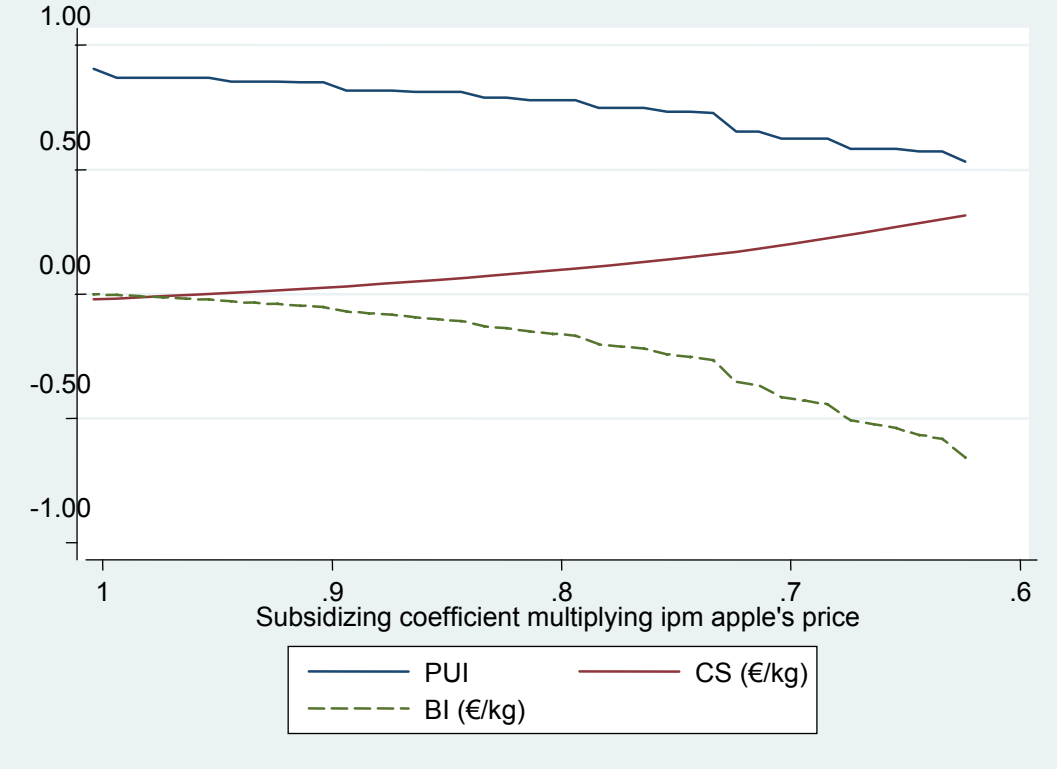


**Figure 3**: Consumer surplus and PUI variations according to the reduction of the ipm apple price

## IV.5 Combined effect of taxation and subsidy

The combination of various instruments of public policy that we mentioned above can enable a budgetary balance to be restored while maintaining the same level of PUI. Table 5 below shows how effective is the use of several instruments. Here we consider the extreme case where pesticide tax results in a price rise of the order of 50% in the price of a conventional apple, while the subsidy to organic farming is relatively moderate (0.85 and 0.7 in this scenario).

| apple | price | t | new price | mktshare | PUI | BI | CS |
|---|---|---|---|---|---|---|---|
| reg | 1.15 | 1 | 1.15 | 81.31 | 0.907 | 0 | -0.022 |
| ipm | 1.85 | 1 | 1.85 | 16.82 | 0.907 | 0 | -0.022 |
| pdo | 3.40 | 1 | 3.40 | 1.87 | 0.907 | 0 | -0.022 |
| org | 3.95 | 1 | 3.95 | 0.00 | 0.907 | 0 | -0.022 |
| reg | 1.15 | 1.45 | 1.67 | 15.89 | 0.575 | -.002 | -0.270 |
| ipm | 1.85 | .95 | 1.76 | 81.31 | 0.575 | -.002 | -0.270 |
| pdo | 3.40 | .95 | 3.23 | 1.87 | 0.575 | -.002 | -0.270 |
| org | 3.95 | .85 | 3.36 | 0.93 | 0.575 | -.002 | -0.270 |
| reg | 1.15 | 1.5 | 1.73 | 22.43 | 0.556 | -.004 | -0.329 |
| ipm | 1.85 | 1 | 1.85 | 64.49 | 0.556 | -.004 | -0.329 |
| pdo | 3.40 | 1 | 3.40 | 1.87 | 0.556 | -.004 | -0.329 |
| org | 3.95 | .7 | 2.77 | 11.21 | 0.556 | -.004 | -0.329 |

**Tab 5.** Prices, choices, market shares, PUI, BI and CS when the taxation coefficient of the regular and IPM apple varies and when the subsidy of the organic apple is equal to .85 and .7.

Thus a similar level of PUI (here, 0.556) is obtained with a BI parameter close to zero. This result is obtained through a rebalancing of market shares with different certifications (in particular 64.49% for the IPM apple, 22.43% for the regular apple and 11.2% for the organic apple). Note that this policy has the consumer contribute to a value of 30 centimes per kg of apples purchased.

## V. Policy recommendations.

With the results that we have obtained with the experimental market during the TEAMPEST project, we can confirm that it is possible to assess the alternatives for having consumers contribute in favour of improvement to environmental practices. We have in particular shown that the certification and labelling of products with these types of characteristics are necessary to have consumers make their choice. However, improving public information in this domain would favour the catalysing role of responsible social behaviour. The estimation of WTP (through experimental procedures) is fairly convincing, especially since consumers' behaviour across the European territory is seen to be highly homogenous.

With this estimation, purchasing behaviour and market share can be forecast for the various types of certification. We show then how it can be in the interest of the public authorities (European regulation on pesticide reduction) to anticipate changes in the prices of food products in the final market. Although some pricing (such as that observed in organic farming) is much too high to allow real environmental effectiveness, it is paradoxical to see that some European consumers show a real interest in this type of food (today, organic products are no longer the preserve of a class of sporadic purchasers) and that on the other hand, the prices practised are out of proportion to the WTP of consumers, even though this is high.

Consequently, for the markedly high levels of consumers' WTP in favour of organic products are not sufficient to deduce that efforts should be directed solely to this mode of production. We show how the intermediate solution of subsidising "Integrated production" can be just as effective in orienting consumption towards more environmentally friendly products. Moreover the potential price increases of conventional products[5] would not necessarily carry with it a drastic reduction in consumer surplus, which would allow the proposed subsidies to be compensated, to balance the overall budget of the policy.

Finally, we show how the price levels seen today in the E.U. do not appear to us to be effective from the point of view of the social optimum and orientation of consumers' buying behaviour in favour of more environmentally friendly products. While the prices of organic products are considerably too high for the financial means of consumers (explaining the niche

[5] Following taxation of pesticides, through a partial transfer of this taxation on to the price of the final product or through the rarefying of the offer following a reduction in the use of pesticides by farmers.

markets for this type of product that are seen throughout Europe), the price levels of conventional products could be raised without penalising consumers too much in the process.

Thus, the taxation of pesticides does not appear to pose major problems if it is transferred wholly or partially on to the price of the product. This taxation would have the advantage of allowing the subsidising of more environmentally friendly practices, particularly IPM procedures. The latter certification could thus become a new reference for consumers.

Note in conclusion that the aim of this work was simply to demonstrate the principles of our approach. Thus it is necessary to estimate consumers' WTP at the same time as price changes are observed in order to appreciate the effectiveness of public policy tools in environmental issues. It goes without saying that the illustrations of our multi-criterion procedure (which stands in contrast to a purely 'welfarist' approach) will subsequently be extended to all the European countries that we have selected for the TEAMPEST project and published in the specialised journals.

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