Pesticides Uses in Crop Production: What Can We Learn from French Farmers Practices?

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Preliminary version

Abstract

This article focuses on the demand system of French farmers concerning pesticides uses. We estimate the demand elasticities of herbicides, insecticides and fungicides with respect to pesticide expenditure, and considering crop differentiation. Then we compare two indexes that are used in agronomic literature to measure the intensity of pesticides uses. We retain a Linear Approximated Almost Ideal Demand System (LA/AIDS) specification. A Full-Information Maximum Likelihood estimation procedure is used for dealing with the problem of censored dependent variable. We consider two cross-sections observed in 2001 and 2006 covering pesticides uses of three crops. We confirm the previous results of the literature that farmers response to price variation is very low, with higher prices response in 2006 than in 2001. Moreover, we find that conditional herbicides expenditure elasticities are often higher than insecticides expenditure elasticities, but lower than those of fungicides. We find higher own-price elasticities for herbicides and fungicides than for insecticides, which is the less used. Finally, application dose seems statistically better to explain herbicides decision, whereas treatment frequency index appears better for insecticides and fungicides. However, most of elasticities are closed for dose and treatment frequency index.

Keywords: Pesticides; LA/AIDS; Elasticities; Censored System of Equations, Two-Step procedure, Quasi Maximum Likelihood, Full-Information Maximum Likelihood.

JEL Classification: C30, C31, C34, L11, Q11, Q12.

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1 Introduction

France is the third largest user of pesticides in the world. Its production's system seems to be very dependent on the use of these products. In 2007, the Environment Round Table, i.e. "Grenelle de l'Environnement", proposed more than 250 environmental commitments. The French government made an important commitment to reduce the use of pesticides by 50% during the next ten years. Nevertheless, the use of pesticides is often the only mean for farmers to maintain their yields by a better control of pest damages, see Lichtenberg and Zilberman (1986). A taxation system could be a solution to reduce pesticides uses. Under several assumptions, its level could be evaluated if demand relative to prices of treatments is known. For the time being, only few applied economic studies focus on this topic. Micro data on prices and individual uses of French farmers allow analyzing individual decision of treatments and estimating a complete system of demand on pesticides uses.

Agricultural economics literature on pesticide use is concentrated especially on marginal productivity measurements, yields losses caused by pest damages and economics evaluations of banning pesticides, see Fernandez-Cornejo, Jans and Smith (1998) and Sexton, Lei and Zilberman (2007) among others. At French level, the recent work of Butault et al. (2010) estimates the impact of reducing pesticides uses on farmer productivity merging individual data on cost and pesticides uses. Our analysis completes this work by taking disaggregated data on the pesticides prices into account. Our approach allows to analyze the sensitivity of farmers to the price of the pesticides.

This article focuses on the estimation of demand system of French farmers concerning pesticides uses. Estimations of conditional demand elasticities of herbicides, insecticides and fungicides are computed considering crop differentiation. Finally, we compare two indexes that are used in agronomic literature to measure the intensity of pesticides uses. In this perspective, a Linear Approximated Almost Ideal Demand System (LA/AIDS) specification is retained. The use of products data is the major source of estimation problem. This problem comes from the fact that many categories of products have positive as well as zero applications (i.e. censored dependent variable). If censoring is not considered, elasticities of expenditure, and direct prices elasticities of demand are biased. Following Shonkwiler and Yen (1999), hereafter SY, a specific estimation procedure is used for dealing with this problem.

This article is organized as follow: in Section 2, we review the literature concerning applied works on pesticides uses. Section 3 describes the censored demand LA/AIDS specification. In Section 4, the description of the data is done. The results of estimates are given and discussed in Section 5. The paper ends with some concluding remarks.

2 Background

Previous studies in analysis of pesticides uses are numerous. Surveys of important issues underlying this research are contained mainly in Fernandez-Cornejo et al. (1998) or more recently in Carpentier et al. (2005) or Sexton et al. (2007). This literature includes three main axes which are marginal productivity measurements or demand analysis of pesticides, yield losses caused by pest damages and economic evaluations of banning pesticides. The first axis concerns the pesticide productivity. It was initiated by Headley (1968) at aggregated level and by Fisher (1976) at micro level. The main results concern U.S. agriculture, see Fernandez-Cornejo et al. (1998). Marginal productivity of pesticides expenditure is very high in absolute value. Marginal costs of reducing pesticides uses for health and environmental considerations are relatively high. These results were first obtained by Campbell (1976) and have been corroborated by recent studies. For example, Fernandez-Cornejo (1992) showed that in the short run, a 10% reduction of pesticides uses would reduce farmer's income by 17%[1]. More generally, to reduce pesticide use by 25%, studies based on U.S. or Netherlands data mentioned a level of tax between 31 and 227%, see "Expertise collective INRA-Cemagref" (2005). Arndt (1999) estimated the demand for three chemical families of herbicides[2] using farm data. He showed that price elasticity is very limited. So, pesticide taxes do not appear to be an effective tool to reduce pesticide use, and the effect of taxes varies over region and government policies in the U.S., see Zilberman and Millock (1997). The introduction of Genetically Modified

[1] The data concerns corn on Illinois for 1986.

[2] The three chemical families are: Atrazine, Cyanazine and M-A, which is made from a composite of Metolachlor and Alachlor.

Organism (GMO) set up new researches. Researcher measure gains or losses if GMO's seed are chosen instead of insecticides at the level of cost production function, see Sexton et al. (2007) or Horna et al. (2008).

The second axis completes the first axis by introducing pest damages to measure the impact of pesticide use on productivity. The model, initiated by Lichtenberg and Zilberman (1986), hereafter LZ., introduces the functional forms that captures the specificity of the pesticides for controlling the pest damages. LZ tried to control the potential effects on the value of marginal product inputs. Following LZ, two kinds of studies have emerged. On one hand, theoretical articles tested the different specifications for the damage function by assuming that the cost of applying pesticides just equals the value of reduced damages caused by pest, see Chambers and Lichtenberg (1994), or Fox and Weersink (1995). On the other hand, empirical articles were limited by the scarcity of data on pest damages. Norwood and Marra (2003) introduced in LZ framework the number of treatments applied by a farmer as a proxy for pest population and argue that it enables to reach the "true pesticide productivity". Chambers, Karagiannis and Tzouvelekas (2010) used a panel data set of Greek olive producer. They measured how pesticide application biases the optimal use of other inputs by the introduction of a pest pressure covariate. Their results suggested that pesticides are under-used by farmers. This conclusion confirms those of studies that conclude on the underestimation of marginal pesticide productivity, see Carrasco-Tauber and Moffitt (1992).

Moreover, chemical inputs are often aggregated (see Carrasco-Tauber (1992)), considering both fertilizers and pesticides (Fernandez-Cornejo (1992)), except for Desbois, Butault and Surry (2010). These authors merged accountancy data (FADN) with the "enquêtes pratiques culturales" (hereafter PK) to estimate farmer's expenditure and cost function for different categories of treatments introducing regional dimension, type of farming and economic size. More generally, pesticide use is analyzed among other agricultural inputs: Fernandez-Cornejo (1992) considers seven inputs including pesticides, Carrasco-Tauber and Mofitt (1992) focus on chemical inputs. These examples of disaggregated analysis among inputs connect the use of pesticides to other inputs measuring complementarities and substitutions. Carpentier and Weaver (1997) underlined the importance of this point. Indeed homothetic separability assumption would imply that the level of directs inputs have no effects on the productivity of a particular pesticide. Correlation between chemicals is demonstrated, but this relation varies among studies. For Lansink and Peerlings (1996), fertilizers and pesticides are complements whereas they are substitutes for Fernandez-Cornejo (1992) or Lim, Shumway and Honeycutt (1993). Lansink and Silva (2004) showed that fungicides and fertilizers are complements at low application levels of pesticides. This result implies positive interactions between these inputs when farmers minimize pesticides uses. Otherwise, herbicides and other pesticides are locally complementary for fungicides.

While economic literature focuses on productivity or demand analysis of pesticides, agronomic literature, and especially entomology analyzes pesticide reduction. Meissle et al. (2009) consider the case of maize to propose potential long-term solutions to decrease pesticide use. Mechanical weed control, fertilization or plowing could reduce herbicide inputs. Micro biological control is proposed instead of insecticide inputs. For example, a biological solution to fight against corn borer is to use Trichogramma. Rolland, Oury, Bouchard and Loyce (2006) underline that the choice of resistant varieties decreases fungicide inputs. Moreover, an increase in energy prices influences positively pesticide use, see Miranowski (1980). This result has been confirmed by Bayramoglu and Chakir (2010) on French panel data. It is important to underline that empirical analysis were limited by the scarcity of exhaustive data. In 1991, the setting of "directive Nitrates"[3] leads European countries to control for the respect of regulation and imposes them to lead survey on agricultural conduct to verify it. At French level, the PK provides the main source of information of the recent reports, see EcoPhyto R&D (2010). For the crop year of 2005-2006, it reveals that the mean treatment cost is about 134 euros/hectare with a great variability among crops[4]. Treatment cost per hectare for bread wheat is closed to the mean, whereas it is about 200 euros for rape, and 87 euros for sunflower. Around 70% of pesticides uses are made by field crops, i.e. 45% of the utilized agricultural area. In this context, Butault et al. (2010) estimate the impact of reducing pesti-

[3] This regulation directive imposes to European countries to control the level of polluting inputs in water.

[4] Calculations are made from FADN data on the total expenditure in pesticide inputs.

cide use on farmer productivity merging individual data on cost and pesticides uses for France. They set up scenarii to simulate the impact of reducing this input, but do not measure price sensitivity of farmers. Our analysis overpasses this work by taking disaggregated data on the pesticides prices into account. Our approach allows to analyze the sensitivity of farmers to the price of the pesticides.

3 Censored demand system

Since the seminal paper of Deaton and Muelbauer (1980), the Almost Ideal Demand System (AIDS) has become very popular in applied economics and widely adopt by agricultural economists, see Taljaard et al. (2004). The AIDS popularity can be ascribed to several reasons, mainly related to its flexibility, linearity and completeness (i.e. adding-up, homogeneity and symmetry conditions). Earlier studies on demand systems estimation have used aggregate time series data and a SURE approach in the spirit of Zellner (1962). To overpass the consequences of an aggregate level (representative consumer, *etc.*), researchers have led to consider micro data sets. However, this micro level presents often a major estimation problem, i.e. many items of the demand system are censored. For example, cross-section expenditures data involve positive as well as zero purchases. Heien and Wessels (1990) underline the economic implications of censored information and have developed a two-step procedure. Since this key study, several statistical procedures accommodate censored dependent variables in a demand system, see Tauchmann (2005). Here, we focus on the demand for pesticides. Price-taking farmers are supposed to determine their optimal level of pesticide use by maximizing their profits. The AIDS model is usually specified, in budget-share form, as:

$$w_j = \alpha_j + \sum_{j=1}^{M} \gamma_{jl} \ln p_j + \beta_j \ln(X/P^*) \qquad j = 1, ..., M, \tag{1}$$

where w_j is the budget share from group j ($j = 1$ (herbicides), 2 (insecticides) and 3 (fungicides)), X, the total expenditure generated by the products in the demand system, p_j, the price of the group j. P^* is the Stone price index[5] given by $\ln P^* = \sum_{j=1}^{N} \overline{w}_j \ln p_j$. The demand system that incorporates this price

[5]The Stone's price index is computed using the budget share evaluated at the mean of the sample.

index is called a Linear Approximated AIDS, namely LA/AIDS, see Blanciforti and Green (1983). α_j, β_j and γ_{jl} are the demand parameters. Demographics are incorporated into (1) through α_j, and theoretical restrictions imposed are $\sum \alpha_j = 1$, $\sum \beta_j = 0$ (adding-up), $\sum \gamma_{lj} = 0$ (homogeneity), and $\gamma_{lj} = \gamma_{jl}$, for all l, j (symmetry), see Yen, Kan and Su (2002) among others.

For any given plot, some categories of products have positive as well as zero applications, implying a censored dependent variable. If censoring is not considered, estimation procedures produce biased and inconsistent parameter estimates. A non-linear generalization of the multivariate tobit system is used to deal with censoring, see Amemiya (1974, 1984), Lee (1978), SY (1999), Yen, Lin and Smallwood (2003) or Tauchmann (2005). The censored demand system is defined as:

$$w_{ij}^* = f(x_{ij}^{'}, \eta_j) + \varepsilon_{ij} \tag{2}$$

$$d_{ij}^* = z_{ij}^{'}\theta_j + v_j \tag{3}$$

$$d_{ij} = \begin{cases} 1 \text{ if } d_{ij}^* > 0 \\ 0 \text{ if } d_{ij}^* \leqslant 0 \end{cases} \tag{4}$$

$$w_{ij} = d_{ij} w_{ij}^* \qquad i = 1, ..., N, \ j = 1, ..., M \tag{5}$$

where w_{ij} and d_{ij} are the observed dependent variables, w_{ij}^* and d_{ij}^*, their corresponding latent variables. The vectors of exogenous variables are x_{ij} and z_{ij}. η_j and θ_j are the vectors of parameters. Direct Maximum Likelihood (ML) estimation of censored demand system is difficult when censoring occurs in multiple equations as the likelihood function generally involves multiple integrals. Several authors have developed feasible and reliable alternative estimation procedures.

In 1990, Hein and Wessells (hereafter HW) proposed a two-step procedure. In a first step, a probit regression is estimated to determine the probability that a given group get zero-share expenditure. Using this regression, the inverse Mills ratio is computed for each group. In the second step, the censoring latent variables are introduced using the inverse Mills ratios in a Seemingly Unrelated Regression (SUR) framework to estimate the demand system. SY (1999) underline that HW procedure has been used extensively in the empirical literature. Nevertheless, SY (1999, p. 973) emphasize the "internal inconsistency in the HW model". Using a Monte Carlo experiment, they showed that HW estimator is inconsistent and performs poorly. So, SY proposed a two-step approach based on the full sample instead of nonlimit observations. The system of equations (2) can be written as :

$$w_{ij} = \Phi(z_{ij}^{'}\theta_j)f(x_{ij}^{'}, \eta_j) + \delta_j\phi(z_{ij}^{'}\theta_j) + \xi_{ij} \quad (6)$$

where $\Phi(\cdot)$ and $\phi(\cdot)$ are respectively the cumulative and probability density functions. In a first step, the ML probit estimators give $\widehat{\theta}_j$. In a second step, we compute $\Phi(z_{ij}^{'}\widehat{\theta}_j)$ and $\phi(z_{ij}^{'}\widehat{\theta}_j)$, and then estimate the parameters of (6) by ML or SUR procedure. Nevertheless, the disturbances of (6) are heteroskedastic, see SY (1999, p. 974). So, efficiency could be achieved by using a weighted system estimator. The procedure of SY was applied to a system of linear demand functions for cigarettes and alcohol in Su and Yen (2000)[6]. In 2002, Yen, Kan and Su described a procedure to compute the covariance matrix of the second-step estimator under heteroskedasticity. This framework is used to estimate a translog demand system for household consumption of fats and oils in the U.S. Tauchmann (2005) showed that SY estimator is often less efficient than some competing two-step estimators from multivariate Heckman family model given certain parameter assumptions.

An alternative approach to estimate a censored demand system was developed by Perali and Chavas (2000)[7], hereafter PC. They proposed, in a first step, to estimate each demand equation in unrestricted form using Jackknife methodology. Then, in a second step, the demand parameters are obtained by imposing the cross-equations restrictions by using Minimum Chi-Square (MCS) Estimator. The PC and SY approaches are consistent but suffer in efficiency. To deal with this problem, Yen and Lin (2002), Yen, Lin and Smallwood (2003) and Yen, Fang and Su (2004) have proposed to estimate a censored demand system using the Quasi Maximum Likelihood (QML) Estimator[8]. This procedure is built for imposing adding-up in a censored demand system as underlined Yen, Lin and Smallwood (2003). Several studies such as Dong, Gould and Kaiser (2004) underline that the adding-up issue has not been adequately

[6]See also Hutasuhut, Chang, Griffith, O'Donnell and Doran (2001) or Yen, Kan and Su (2002) among others.

[7]This paper extends the procedure used by Browning and Meghir (1991), Blundell, Pashardes and Weber (1993), Browning and Chiappori (1998).

[8]Harris and Shonkwiler (1997) have also used a Quasi Maximum Likelihood approach to estimate a multivariate Tobit type formulation. See also Blundell and Meghir (1987) or Pudney (1989) for a description of alternative approaches when data used have relatively large proportions of zero observations.

examined or ignored in censored demand systems. The QML estimator differs from equation-by-equation Tobit estimators in that cross-equation correlations are accommodated, thus improving efficiency. Yen and Lin (2002) compared the QML and Full-Information Maximum Likelihood (FIML) estimators. They investigated the beverage consumption among children and adolescents in the U.S. They showed that the QML estimator performs as well as the FIML estimator. The main advantage is that the QML approach is more tractable in large systems with many censored dependent variables. In the current situation, with three budget share, the FIML is implemented to estimate the demand system.

4 Data description

Our data set concerns the farmer demand of pesticides. The data set is drawn from several sources mainly from two surveys collected by the Statistical Department of French Ministry of Agriculture: the PK and IPAMPA[9]. PK survey is conducted to observe farmers agricultural practices, including pesticide use, at plot scale[10]. The prices of pesticide products come from the IPAMPA.

We have merged PK and IPAMPA data using the name of pesticide product used on each plot. We aggregate each expenditure to compute the total expenditure by category of treatments per plot. Three main categories of treatments are retained (herbicides, insecticides and fungicides) to avoid the problem of missing prices. Moreover, we focus on three crops which are close in term of practices: tender wheat, durum wheat and barley. Our analysis focuses on two cross-sections. They concern 893 plots in 2001 and 709 in 2006 for three fields crops. Following Table 1, the first cross-section (i.e. 2001) contains about 58.4% of tender wheat (resp. (54.3% in 2006), 32.8% of barley (resp. 31.8%), and 8.7% of durum wheat (resp. 13.8%). These variations illustrate the turnover between the different crops.

Prices are derived as the value per hectare of treatment[11] and are computed according to two rules:

[9]This acronym means "agricultural means of production purchasing price index". This index is made to track trends in the prices of goods and services used by farmers for their farm operation. These prices are taken from the retailers of farming products.

[10]i.e. including mainly the use of several inputs (pesticide, fertilizer, plowing, *etc.*) for the selected plot as well as detailed demographic characteristics of each farmer.

[11]Moschini (1995) showed that the Stone's price index is not invariant to changes in the units of measurement

1. The budget for the type j is the aggregation of the costs of all the treatments of this type. For each treatment, this cost is the price of the product used weighted by the application dose, namely DOSE. This aggregation rule captures partially the heterogeneity between the actives ingredients contained in the pesticide products.

2. To overpass this restriction, an agronomic index is introduced because it enables to aggregate products with very different active ingredients, see Pingault et al. (2009). This index is the treatment frequency index (hereafter TFI) which is defined as the ratio between the applied dose and the legal dose. Compared to the variable DOSE, the price of each product used by farmer is weighted by the TFI index.

[INSERT Table 1 HERE]

Expenditure variables are inflated by general index of input prices (i.e. IPAMPA, base 100 in 2000). Then prices are normalized with respect to the sample mean price per category of treatment. Quantities per plot are defined as the total cultivated area associated to the plot. Indeed, at an aggregated level, the degree of pesticide use is linked to the total cultivation area of a crop. The high proportion of zero in dependent variable suggests that is it important to deal with censoring (see Table 1). 88.8% of plots do not apply insecticides in 2001 (resp. 94.2% in 2006), and 20.8% do not use fungicides in 2001 (resp. 25.53% in 2006). Herbicides uses are lightly affected by censoring. The level of censoring highly depends on the cultivated crop (see Table 2). In 2001, 87.9% (resp. 95.6% in 2006) of bread wheat plots did not used insecticides. The level of censoring for fungicides budget share is included between 15.7% for barley in 2001 and 37.2% for durum wheat the same year. Finally, in 2001, 9.74% of the sample uses the three categories of treatment in 2001, 66% used 2, and 24.30% only used one category (see Table 1). In 2006 the uses are respectively 29.5%, 65.4% and 5.08%.

[INSERT Table 2 HERE]

prices, this is the reason why the units of all categories were homogenized. So prices are all normalized as the price for one kg (resp. litter) per hectare.

Moreover, to measure the relation between pesticide expenditure and agricultural output, we introduce a yields index. It is computed as the ratio between the observed yield on the plot and its mean by year and crop, that enables to control for crop yield heterogeneity. Indeed, the mean observed yield is 55.69 q/ha in 2001 (resp. 58.80), with a great heterogeneity among crop. More precisely, the observed plots reports a mean yield of 58.73 q/ha in 2001 (resp. 62.59 in 2006) for tender wheat, 43.43 (resp. 40.19) for tender wheat and 53.53 (resp. 60.42) for barley. These observations are few lower than the sample mean yields for France for this two years. Biological evidence illustrates the importance of allowing for interactions among inputs and practices. The selected technical variables on practices used are: fertilization (either organic or inorganic), plowing, mechanical weeding, yields (see Table 1). In 2001, 10% of plots have been organically fertilized (resp. 9.3% in 2006), and more than 98.7% for inorganic fertilization (resp. 97.2%). A plowing dummy is also introduced, because it concerns about 85.1% of the plot use in 2001, and 66.3% in 2006. Mechanical weeding is made on 3.4% of plots in 2001 (resp 0.6% in 2006).

The seasonal and spatial nature of crop production also influence practices. We introduce climate regional data for each group of regions. This enables to control heterogeneity between the two crop years of our data. Indeed, in 2000/2001 unfavorable climate conditions led to low-level yields. On the opposite, 2005/2006 is characterized by hot climatic conditions associated with low plant disease that hurts yields only for some crops (e.g. wheat, barley or rape). The climatic data are the rainfalls over 2001 and 2006 per region and a mean temperatures of the two seasons of treatments per region (i.e. autumn 2001 (resp. 2005) and spring 2001 (resp. 2006)).

Table 3 reports the Pearson correlation matrix. First, the samples are characterized by weak correlations among the different budget share categories and agricultural inputs dummies. The correlation between herbicides budget share and mechanical weeding is significantly at 0.7 in TFI_{2001} and 0.21 in DOSE_{2006}. Moreover, yields are positively correlated with insecticides and fungicides budget share. Indeed, pest attack hurts yields. In 2001, this fact is illustrated by a positive and significant correlation of 0.08 among insecticide budget share and yields. The level of correlation is higher between fungicide and yields. The correlation varies from 0.25 to 0.31. Furthermore, in agriculture inorganic fertilization is used to increase yields. This result is confirmed in our samples with a significant coefficient of 0.10 in 2001. The effects of fertilization on pesticide expenditure do not appear clearly. This result is consistent with previous studies, see mainly Lansink and Peerlings (1996). Indeed the correlation between organic fertilization and herbicide is set at 0.12 in TFI_{2001} and DOSE_{2006}, and inorganic coefficient is significantly negative. Likewise, organic fertilization is negatively correlated with fungicides budget share. The correlation varies from -0.08 to -0.13. Finally, the weak negative correlation between Farmer's age with insecticide budget share could illustrate the idea of Huffman (2001) that farmers human capital and knowledge influence their choice to provide efficient treatments.

[INSERT Table 3 HERE]

5 Estimation results and discussion

Using three categories of treatments and ten demographics, the AIDS specification is first estimated without the fungicide equation. This way to proceed is suggested by Pudney (1989) to address the adding-up restriction. The results are reported in Tables 4 and 5. The first two columns report the FGLS (1) and SY Two-Step (TS) procedure (2) results. For the TS procedure, in a first step a univariate probit for the choice of treatment category is estimated by Maximum Likelihood. These estimations are used to compute the density and the cumulative functions, respectively $\phi(.)$ and $\Phi(.)$. Then, the augmented system (see eq. (6)) is estimated by FGLS on the whole sample, and robust covariance matrix is computed following White (1980).

Drichoutis, Klonaris, Lazaridis and Nayga (2008) underlined the importance of the adding-up restriction. Yen et al. (2002) have shown that the SY procedure may not satisfy in general this assumption. So, Yen et al. (2003) proposed a practical procedure for imposing the adding-up. This approach is based on QML or FIML. Last, we estimate the demand system using FIML (3) (i.e. last column of Tables 4 and 5).

This FIML approach is applied to three categories of treatments following Dong, Gould and Kaiser (2004). It enables to control for both upper and lower bound of the dependent budget share of treatment. The estimations are provided for four samples considering the price of the aggregated treatments per category on one plot for DOSE and TFI. Moreover, 2001 and 2006 practices are compared with the estimation of one system per year. This approach leads to four set of estimates per specification. Tables 4 and 5 present the estimation results without the estimated coefficients of dummies[12].

Each procedure provides very close results for the error standard deviations (σ_{w_j}). For herbicides equation, it is around 0.23 in DOSE_{2001}, and 0.26 in TFI_{2001}. They are lower for insecticides equation, and vary from 0.03 to 0.08 for all set of estimates. The correlation coefficients provide an interesting result. The coefficients tend to -0.1 in 2001 between herbicides and insecticides, and are similar for TFI and DOSE. On the opposite, they tend to differ in 2006. The higher degree of correlation is between herbicides and fungicides for all the samples, with a coefficient always higher than -0.9. In 2006, they are significant justifying the estimation of the demand equation within a system. The selectivity regressors in (2) (δ_{w_j}) are statistically significant, at a level of 5%, for insecticides and fungicides equations, suggesting that correcting bias is relevant for this category of treatment.

Moreover, the demographic variables are never significant for all the situations. For example, inorganic fertilization always decreases herbicide budget share, whereas organic fertilization increases it only in 2001. Plowing influences only insecticides application in DOSE_{2001}. Mechanical weeding is never significant to explain pesticides treatments. On one hand, yield negatively influences herbicides budget share. For example, an increase of 1q/ha of yields would decrease herbicides budget share by 0.25% in DOSE_{2001} or 0.35% in TFI_{2001}. On the other hand it positively influences insecticides and fungicides budget share with estimated coefficients close from zero for insecticides and included between 0.22 and 0.31 for fungicides. Moreover, we find a positive influence of spring temperature in 2001 to explain herbicides, and negative for insecticides with no significant effect for rainfall. On the opposite, temperature is not relevant in 2006, but rainfall of the seed-time year is positively related to herbicides and negatively to insecticides and fungicides.

[INSERT Tables 4 and 5 HERE]

[12] Available upon request from the authors.

To measure price sensitivity of farmers, we compute expenditure and prices elasticities of demand at the sample means of the explanatory variables. The system is estimated considering pesticide expenditure and the other inputs are not included, so we compute conditional elasticities. The elasticities of the reference group are computed applying theoretical restrictions, and their variances are estimated through gradient for (1) and (2). We first compute these elasticities for the whole sample, and second by crop, see Tables 6 and 7.

[INSERT Tables 6 and 7 HERE]

As expected elasticities of the censored categories of treatment, which are mainly related to insecticides, decrease for the two cross-sections using SY framework. Nevertheless, they are not always invariant on the choice of reference group when censoring occurs, see column (2) of Tables 6 and 7. They decrease if insecticide is set as reference category instead of fungicide. Expenditure elasticities are mainly close to the unit value, positives and significants at 1%. These elasticities suggest that pesticides are mainly considered as normal good, illustrating that demand is inelastic to pesticide expenditure variations. For example, our estimated expenditure elasticity for a 1 % increase in total pesticide expenditure would increase the demand for herbicides by 0.9% in all the samples excepted for TFI_{2006}, where it will increase by 1%. The exception is for fungicides. Pesticide expenditure elasticities are often higher than 1, so fungicides expenditure will increase if pesticide expenditure increases too. This result confirms agronomic results. More precisely, these elasticities are higher for durum wheat than for tender wheat or for barley. This result could justify that some fungicides treatments could be prevent by choosing treated varieties of crops. Finally, the confidence intervals are reported in Tables 6 and 7 according to a level of 99%. They enable the comparison between estimated elasticities among the differents samples. Indeed, the elasticities are generally higher for TFI respect to DOSE. Nonetheless, for herbicides the confidence intervals often overlap. This is not true for pesticide expenditure of insecticides and fungicides. Moreover, confidence intervals overlap between TFI_{2001} and TFI_{2006}. This result is valid for the two DOSE cross-sections.

Own-price elasticities for herbicides and fungicides are included between 0.7 and 1, in absolute value, indicating a low response to change in the pesticides prices. The own-price elasticities for insecticides are higher than 1 indicating either it illustrates the fact that: the input is technically important to maintain a constant level of production; or their is no or few substitutes for this input which lead to the same efficiency. Let us remind that in application to the directive 91/414/CE and the REACH regulation (2003) many products have been banned between 2001 and 2006. Durum wheat is smaller market in term of agricultural utilized area, so higher estimated elasticities are justified by the weak number of products for this crop leading to few substitutes for insecticides. The estimate results confirm this fact because estimated own-price elasticities are lower in 2001 than in 2006. This result remains valid for DOSE and TFI.

Cross price elasticities are not reported[13]. They are mainly significantly negative illustrating complementarities between the categories of treatments.

6 Conclusion

This article focuses on estimating a demand system of pesticides uses of French farmers. The econometric methodology proceeds first by estimating a standard system of equation, and censoring is introduced in the spirit of SY *via* a two-step estimation procedure. We have also considered the FIML estimator to deal with adding-up restrictions and efficiency as suggested by Yen et al. (2003).

The analysis of pesticides practices helps to answer the following questions: How taxes could affect pesticides uses? Is a unique tax efficient to reduce pesticides uses? In term of public policy, this led to measure the effect of a tax on quantities applied by farmer. These first results in terms of estimated elasticities illustrates the fact that unique tax on pesticides products is inefficient, but for more consistency regulatory cost on setting such a tax should be introduced to perform full conclusions. For further research it would be interesting to overpass homogeneity assumption of products, and consider on product differentiation to estimate demand of farmer and understand the influence of products individual characteristics

[13]They are available upon request from the authors.

to justify farmer choices.

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Table 1: Descriptive Statistics

Variable	Associated parameter	2001, N=893 Doses Mean (Std. Dev)	TFI Mean (Std. Dev)	Proportion of zero	2006, N=709 Doses Mean (Std. Dev)	TFI Mean (Std. Dev)	Proportion of zero
Budget Share							
Herbicides	w_1	0.492	0.521	4.93	0.558	0.615	4.65
		(0.307)	(0.356)		(0.301)	(0.357)	
Insecticides	w_2	0.011	0.032	88.80	0.007	0.019	94.22
		(0.051)	(0.112)		(0.04)	(0.096)	
Fungicides	w_3	0.496	0. 447	20.83	0.435	0.365	25.53
		(0.306)	(0.347)		(0.306)	(0.348)	
Composition and demographics							
Dummies (yes=1 ; no=0)							
Tender wheat		58.45			54.30		
Durum wheat		8.73			13.82		
Barley		32.81			31.88		
Reg1	λ_1	11.87			10.72		
Reg2	λ_2	28.56			25.67		
Reg3	λ_3	16.57			13.40		
Reg4	λ_4	13.77			14.81		
Reg5	λ_5	24.08			26.23		
Reg6	λ_6	5.15			9.17		
Plowing	λ_7	85.11			66.29		
Organic fertilizer	λ_8	9.97			9.31		
Inorganic fertilizer	λ_9	98.66			97.18		
Mechanical weeding	λ_{10}	3.36			0.56		
Continuous variables							
Yield	λ_{11}	55.69			58.80		
		(17.57)			(17.14)		
Age	λ_{12}	46.03			47.99		
		(10.72)			(10.05)		
Distribution of the number of treatment type							
1 type of treatment		24.30			29.48		
2 type of treatments		65.96			65.44		
3 type of treatments		9.74			5.08		

height *Source : Personal computation.*
For w_j, DOSES (resp TFI) are used to compute mean budget share if real DOSE (resp. TFI) are used.
Reg_i are the following :
Reg1: Bretagne, Basse-Normandie, Pays de la Loire;
Reg2: Ile de France, Champagne-Ardennes, Picardie, Haute-Normandie, Centre, Nord Pas-de-Calais;
Reg3: Lorraine, Alsace, Franche-Comté;
Reg4: Bourgogne, Rhône-Alpes, Auvergne;
Reg5: Poitou-Charentes, Aquitaine, Midi-Pyrénées, Limousin;
Reg6: Languedoc-Roussillon, Provence-Alpes-Cote-d'Azur.
Yield is measured in quintal per hectare.

Table 2: Level of Censoring per Crop and Year

Crop	Year	w_1	w_2	w_3
Bread Wheat	2001	4.98	87.93	21.26
	2006	3.64	95.58	27.79
Durum Wheat	2001	1.28	94.87	37.18
	2006	6.12	88.78	31.63
Barley	2001	5.80	88.74	15.70
	2006	5.75	94.25	19.03

Table 3: Pearson's Correlation Coefficients

			w_1		w_2		w_3		Org. Fert.		Inorg. Fert.		Plowing		Mech. Weed.		Age		Yield
DOSE	2001	w_1	1.000																
		w_2	-0.116	‡	1.000														
		w_3	-0.986	‡	-0.051		1.000												
		Org. Fert.	0.132	‡	0.007		-0.134	‡											
		Inorg. Fert.	-0.071	†	0.012		0.069	†	-0.026		1.000								
		Plowing	0.076	†	-0.052		-0.067	†	0.024		0.006		1.000						
		Mech. Weed.	0.143	‡	-0.012		-0.142	‡	0.021		0.022		-0.027		1.000				
		Age	0.056	*	-0.085	†	-0.042		-0.040		0.018		0.000		0.059	*	1.000		
		Yield	-0.327	‡	0.083	†	0.315	‡	-0.180	‡	0.051		-0.029		-0.001		-0.120	‡	1.000
	2006	w_1	1.000																
		w_2	-0.129	‡	1.000														
		w_3	-0.988	‡	-0.026		1.000												
		Org. Fert.	0.094	†	0.016		-0.098	‡	1.000										
		Inorg. Fert.	-0.161	‡	0.024		0.159	‡	-0.151	‡	1.000								
		Plowing	0.007		-0.025		-0.003		0.116	‡	0.023		1.000						
		Mech. Weed.	0.047		-0.011		-0.046		0.041		-0.215	‡	-0.026		1.000				
		Age	0.037		0.032		-0.042		-0.099	‡	-0.056		0.014		-0.019		1.000		
		Yield	-0.303	‡	-0.023		0.309	‡	-0.108	‡	0.103	‡	-0.040		-0.096	†	-0.018		1.000
TFI	2001	w_1	1.000																
		w_2	-0.232	‡	1.000														
		w_3	-0.950	‡	-0.085	†	1.000												
		Org. Fert.	0.120	‡	-0.033		-0.112	‡	1.000										
		Inorg. Fert.	-0.051		0.000		0.052		-0.026		1.000								
		Plowing	-0.051		0.009		0.049		0.024		0.006		1.000						
		Mech. Weed.	0.068	†	0.015		-0.075	†	0.021		0.022		-0.027		1.000				
		Age	0.046		-0.070	†	-0.025		-0.040		0.018		0.000		0.059	*	1.000		
		Yield	-0.326	‡	0.156	‡	0.284	‡	-0.180	‡	0.051		-0.029		-0.001		-0.120	‡	1.000
	2006	w_1	1.000																
		w_2	-0.228	‡	1.000														
		w_3	-0.964	‡	-0.041		1.000												
		Org. Fert.	0.072	*	0.013		-0.078	†	1.000										
		Inorg. Fert.	-0.101	‡	0.034		0.094	†	-0.151	‡	1.000								
		Plowing	-0.106	‡	-0.017		0.113	‡	0.116	‡	0.023		1.000						
		Mech. Weed.	0.028		-0.015		-0.025		0.041		-0.215	‡	-0.026		1.000				
		Age	0.020		0.006		-0.022		-0.099	‡	-0.056		0.014		-0.019		1.000		
		Yield	-0.239	‡	-0.010		0.248	‡	-0.108	‡	0.103	‡	-0.040		-0.096	†	-0.018		1.000

*Level of significance : ‡=1% ; †=5% ; *=10%.*

Table 4: Estimation of the Demand System with DOSE for 2001 (N=893) and 2006 (N=709)

		Uncensored Demand System		Censored Demand System						
		FGLS (1)		SY Two-Step procedure (2)				FIML[i] (3)		
		Ref. Fungicides		Ref. Fungicides		Ref. Insecticides				
		w_1	w_2	w_1	w_2	w_1	w_3	w_1	w_2	w_3
		Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.
2001	Intercept	1.0710*	0.1293	1.8466†	0.2990‡	1.3626*	-0.7975*	1.110	0.033	-0.140
		0.5647	0.0985	0.7883	0.0978	0.7800	0.4840	0.798	0.486	0.835
	Price_{herb}	0.1334‡	-0.0129‡	0.1603‡	-0.0157‡	0.1497‡	-0.1461‡	0.136‡	-0.014‡	-0.122‡
		0.0097	0.0018	0.0117	0.0023	0.0119	0.0118	0.014	0.001	0.014
	Price_{ins}	-0.0129‡	0.0353‡	-0.0157‡	0.0445‡	-0.0036	-0.0386‡	-0.014‡	0.027‡	-0.014‡
		0.0018	0.0018	0.0023	0.0023	0.0049	0.0053	0.001	0.001	0.001
	Price_{fng}	-0.1205‡	-0.0225‡	-0.1446‡	-0.0288‡	-0.1461‡	0.1847‡	-0.122‡	-0.014‡	0.136‡
		0.0096	0.0020	0.0116	0.0027	0.0118	0.0133	0.014	0.001	0.015
	Expenditure	-0.0742‡	-0.0060‡	-0.1007‡	-0.0163‡	-0.0797‡	0.0990‡	-0.115‡	-0.005‡	0.120‡
		0.0079	0.0014	0.0104	0.0025	0.0101	0.0126	0.012	0.001	0.012
	Org Fert.	0.0543†	0.0057	0.0337	0.0140†	0.0771†	-0.0811†	0.087‡	0.043†	-0.086†
		0.0266	0.0046	0.0338	0.0065	0.0332	0.0349	0.033	0.020	0.034
	Inorg Fert.	-0.1473†	0.0070	-0.2844‡	0.0003	-0.2080†	0.2248†	-0.152‡	0.014	0.152†
		0.0667	0.0116	0.0899	0.0180	0.0884	0.0971	0.055	0.057	0.071
	Plowing	0.0341	-0.0103†	0.0538*	-0.0080	0.0416	-0.0355	0.034	-0.055‡	-0.036
		0.0235	0.0041	0.0286	0.0052	0.0285	0.0281	0.038	0.016	0.039
	Age	-0.0001	-0.0003‡	-0.0002	-0.0003	-0.0001	0.0005	-0.001	0.000	0.001
		0.0007	0.0001	0.0009	0.0002	0.0009	0.0009	0.001	0.001	0.001
	Mech. Weed.	0.0028	-0.0073	0.0176	-0.0121	-0.0106	0.0058	-0.005	0.006	0.002
		0.0475	0.0083	0.0571	0.0114	0.0570	0.0617	0.068	0.040	0.069
	Yield	-0.2122‡	0.0148‡	-0.2706‡	-0.0057	-0.2590‡	0.2484‡	-0.257‡	0.104‡	0.247‡
		0.0286	0.0050	0.0349	0.0082	0.0347	0.0421	0.040	0.028	0.041
	Autumn_{t-1}	-0.0109	0.0034	-0.0128	0.0053	-0.0274	0.0178	0.008	-0.028	-0.006
		0.0362	0.0063	0.0434	0.0072	0.0435	0.0386	0.054	0.029	0.055
	Spring_t	0.0622‡	-0.0071*	0.0773‡	-0.0042	0.0702‡	-0.0653‡	0.082†	0.005	-0.084†
		0.0212	0.0037	0.0255	0.0045	0.0254	0.0244	0.032	0.014	0.033
	Rain_{t-1}	-0.0010‡	0.0000	-0.0008†	-0.0001	-0.0011‡	0.0011‡	-0.002‡	0.000	0.002‡
		0.0003	0.0001	0.0004	0.0001	0.0004	0.0004	0.000	0.000	0.000
	Rain_t	0.0004	0.0000	0.0005	0.0000	0.0003	-0.0003	0.001	-0.000	-0.001
		0.0004	0.0001	0.0005	0.0001	0.0005	0.0004	0.001	0.000	0.001
	δ_{w_j}			-3.7235‡	-0.5485‡	-0.1598	1.4831†			
				1.3819	0.1446	1.2539	0.6874			
	σ_{w_j}	0.2316	0.0426	0.2352	0.0428	0.2371	0.2333	0.2915	0.073	0.2993
	ρ_{w_1,w_2}	-0.1000		-0.0770				-0.0151		
	ρ_{w_1,w_3}					-0.9364			-0.9978	
	ρ_{w_2,w_3}									-0.0256
	SSR	46.3513	1.5703	46.0639	1.5284	46.8398	45.3212			
	R^2	0.4624	0.3297	0.4533	0.3469	0.4441	0.4561			
	LL							177.18		
	AIC							-182.37		
2006	Intercept	-1.6615	0.0638	-0.8700	0.4779‡	1.2685	-0.8642	-1.3716‡	0.0268	2.3498‡
		1.0104	0.1515	1.4623	0.1037	1.4114	0.6397	0.3568	1.4620	0.3568
	Price_{herb}	0.1262‡	-0.0040†	0.1501‡	-0.0048†	-0.1405‡	0.1907‡	0.1250‡	-0.0049‡	-0.1201‡
		0.0108	0.0016	0.0132	0.0022	0.0133	0.0152	0.0174	0.0017	0.0176
	Price_{ins}	-0.0040†	0.0393‡	-0.0048†	0.0491‡	0.1369‡	-0.1405‡	-0.0049‡	0.0231‡	-0.0182‡
		0.0016	0.0019	0.0022	0.0025	0.0131	0.0133	0.0016	0.0047	0.0016
	Price_{fng}	-0.1222‡	-0.0353‡	-0.1454‡	-0.0443‡	0.0035	-0.0502‡	-0.1201‡	-0.0182‡	0.1383‡
		0.0105	0.0022	0.0129	0.0029	0.0044	0.0061	0.0176	0.0016	0.0176
	Expenditure	-0.0736‡	-0.0086‡	-0.1035‡	-0.0154‡	-0.0825‡	0.1107‡	-0.1830‡	-0.0017‡	0.1847‡
		0.0093	0.0014	0.0136	0.0021	0.0126	0.0132	0.0200	0.0006	0.0201
	Org Fert.	0.0239	0.0015	0.0271	0.0033	0.0141	-0.0178	0.0538	0.0417	-0.0550
		0.0318	0.0048	0.0382	0.0068	0.0381	0.0433	0.0523	0.0709	0.0525
	Inorg Fert.	-0.2115‡	0.0057	-0.1961‡	0.0010	-0.2669‡	0.2838‡	-0.2310†	0.0158	0.2383†
		0.0577	0.0086	0.0725	0.0166	0.0706	0.1046	0.1130	0.0585	0.1145
	Plowing	-0.0296	-0.0023	-0.0432*	-0.0025	-0.0246	0.0321	-0.0458	-0.0213	0.0459
		0.0206	0.0031	0.0248	0.0040	0.0247	0.0255	0.0301	0.0409	0.0301
	Age	0.0006	0.0002†	0.0006	0.0002	0.0003	-0.0005	0.0010	0.0007	-0.0010
		0.0009	0.0001	0.0011	0.0002	0.0011	0.0011	0.0013	0.0020	0.0013
	Mech. Weed.	-0.0556	-0.0187	0.0914	-0.0295	-0.0493	0.0144	-0.0661	-0.0182	0.0820
		0.1226	0.0183	0.1710	0.0286	0.1668	0.1807	0.3797	0.0921	0.3763
	Yield	-0.2020‡	0.0123†	-0.2557‡	-0.0217	-0.2584‡	0.2609‡	-0.2437‡	0.0341	0.2399‡
		0.0390	0.0058	0.0471	0.0139	0.0470	0.0856	0.0634	0.0969	0.0636
	Autumn_{t-1}	0.0426	0.0075	0.0085	-0.0116	-0.1721†	0.1882‡	0.0251	0.0191	-0.0287
		0.0731	0.0110	0.0866	0.0089	0.0861	0.0559	0.0445	0.1153	0.0443
	Spring_t	-0.0409	-0.0051	-0.0020	0.0086	0.1286*	-0.1480‡	-0.0299	-0.0038	0.0312
		0.0642	0.0096	0.0773	0.0085	0.0766	0.0532	0.0427	0.1058	0.0426
	Rain_{t-1}	0.0090‡	-0.0002	0.0089‡	-0.0004†	0.0039	-0.0038‡	0.0109‡	-0.0018	-0.0109‡
		0.0021	0.0003	0.0026	0.0002	0.0025	0.0013	0.0006	0.0032	0.0006
	Rain_t	-0.0035‡	0.0001	-0.0036‡	0.0001	-0.0021‡	0.0022‡	-0.0044‡	0.0005	0.0044‡
		0.0007	0.0001	0.0008	0.0001	0.0008	0.0005	0.0004	0.0011	0.0004
	δ_{w_j}			-0.4375	-0.7587‡	-0.0076	1.5689			
				2.0398	0.1592	1.7868	0.9703			
	σ_{w_j}	0.2447	0.0370	0.2504	0.0381	0.2530	0.2447	0.3252	0.2765	0.3257
	ρ_{w_1,w_2}	-0.2111		-0.2147				-0.0271		
	ρ_{w_1,w_3}					-0.9579			-0.9994	
	ρ_{w_2,w_3}									0.0146
	SSR	40.7176	0.9297	40.6938	0.9435	41.5533	38.8748			
	R^2	0.3986	0.4226	0.3969	0.4131	0.3842	0.4146			
	LL							1020		
	AIC							-1868		

*"Note" : Level of significance : ‡=1% ; †=5% ; *=10%.*

[i] *For $DOSE_{2006}$, we report the QML results.*

Table 5: Estimation of the Demand System with TFI for 2001 (N=893) and 2006 (N=709)

		Uncensored Demand System		Censored Demand System						
		FGLS (1)		SY Two-Step procedure (2)				FIML (3)		
		Ref. Fungicides		Ref. Fungicides		Ref. Insecticides				
		w_1	w_2	w_1	w_2	w_1	w_3	w_1	w_2	w_3
		Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.	Estimates Std. Err.
2001	Intercept	0.8069	0.3150†	1.6674*	0.9028‡	1.1845	-1.2553*	1.0898	-0.0218	-0.0686
		0.6562	0.1393	0.8950	0.1525	0.8894	0.6506	1.3274	0.3870	1.5225
	$Price_{herb}$	0.1203‡	-0.0154‡	0.1475‡	-0.0210‡	0.1486‡	-0.1323‡	0.1595‡	-0.0199‡	-0.1395‡
		0.0064	0.0014	0.0080	0.0019	0.0080	0.0080	0.0148	0.0033	0.0164
	$Price_{ins}$	-0.0154‡	-0.0800‡	-0.0210‡	0.1188‡	-0.1323‡	0.2327‡	-0.0199‡	0.0836‡	-0.0636‡
		0.0014	0.0025	0.0019	0.0032	0.0080	0.0097	0.0033	0.0031	0.0039
	$Price_{fng}$	-0.1049‡	0.0955‡	-0.1265‡	-0.0978‡	-0.0163‡	-0.1005‡	-0.1395‡	-0.0636‡	0.2032‡
		0.0064	0.0025	0.0079	0.0032	0.0034	0.0049	0.0164	0.0039	0.0182
	Expenditure	-0.0163*	-0.0113‡	-0.0292†	-0.0214‡	-0.0071	0.0383‡	-0.0537‡	-0.0115‡	0.0652‡
		0.0097	0.0021	0.0126	0.0029	0.0122	0.0126	0.0193	0.0039	0.0209
	Org Fert.	0.0697†	0.0004	0.0537	0.0178*	0.1150‡	-0.1141‡	0.1071*	-0.0247	-0.1142*
		0.0307	0.0065	0.0382	0.0095	0.0376	0.0424	0.0550	0.0169	0.0598
	Inorg Fert.	-0.1481*	0.0055	-0.2921‡	-0.0402	-0.1806*	0.3033‡	-0.1611*	0.0117	0.1547
		0.0771	0.0163	0.1018	0.0263	0.1000	0.1172	0.0954	0.0414	0.1306
	Plowing	0.0076	-0.0071	0.0257	0.0059	-0.0011	-0.0140	0.0220	-0.0170	-0.0178
		0.0271	0.0058	0.0328	0.0076	0.0327	0.0340	0.0630	0.0138	0.0674
	Age	0.0003	-0.0004†	0.0006	-0.0005†	0.0008	-0.0002	-0.0022	-0.0004	0.0025
		0.0008	0.0002	0.0010	0.0002	0.0010	0.0011	0.0017	0.0005	0.0018
	Mech. Weed.	0.0574	-0.0285†	0.0381	-0.0263	0.0708	-0.0455	0.0296	-0.0048	-0.0113
		0.0544	0.0116	0.0650	0.0161	0.0650	0.0719	0.1089	0.0288	0.1176
	Yield	-0.2721‡	0.0471‡	-0.3553‡	-0.0151	-0.3086‡	0.3254‡	-0.3432‡	0.1039‡	0.3147‡
		0.0325	0.0069	0.0393	0.0152	0.0390	0.0653	0.0724	0.0216	0.0789
	$Autumn_{t-1}$	-0.0532	0.0062	-0.0803	-0.0052	-0.0894*	0.0737	-0.0321	0.0239	0.0224
		0.0418	0.0089	0.0500	0.0107	0.0499	0.0477	0.0848	0.0244	0.0954
	$Spring_t$	0.1013‡	-0.0178‡	0.1300‡	-0.0069	0.1079‡	-0.1031‡	0.1648‡	-0.0257†	-0.1650‡
		0.0246	0.0052	0.0294	0.0066	0.0294	0.0295	0.0552	0.0108	0.0606
	$Rain_{t-1}$	-0.0007*	0.0000	-0.0002	-0.0001	-0.0007	0.0007*	-0.0020‡	-0.0001	0.0021†
		0.0004	0.0001	0.0005	0.0001	0.0005	0.0004	0.0008	0.0002	0.0008
	$Rain_t$	0.0002	-0.0001	0.0000	-0.0002†	-0.0003	0.0003	0.0004	0.0001	-0.0005
		0.0005	0.0001	0.0006	0.0001	0.0006	0.0005	0.0010	0.0003	0.0011
	δ_{w_j}			-3.7911‡	-1.5335‡	1.0066	2.3062†			
				1.4163	0.2253	1.2757	0.9404			
	σ_{w_j}	0.2719	0.0786	0.2732	0.0774	0.2763	0.2738	0.4313	0.0861	0.4647
								0.0173	0.0041	0.0194
	ρ_{w_1,w_2}	-0.1145		-0.1075				-0.0882		
	ρ_{w_1,w_3}					-0.9495			-0.9872	
	ρ_{w_2,w_3}									-0.0639
	SSR	63.8736	5.3392	62.1658	4.9898	63.5710	62.4400			
	R^2	0.4452	0.5222	0.4490	0.5525	0.4365	0.4193			
	LL							260.09		
	AIC							-348.1824		
2006	Intercept	-1.9299*	0.2861*	-2.1068	0.6042‡	0.5308	-0.6585	-2.0043	0.2187	2.7905
		1.1500	0.1632	1.5639	0.1198	1.5362	0.7532	2.2553	1.2232	2.3264
	$Price_{herb}$	0.1157‡	-0.0120‡	0.1488‡	-0.0147‡	0.1521‡	-0.1435‡	0.1323‡	-0.0153‡	-0.1170‡
		0.0076	0.0011	0.0098	0.0016	0.0097	0.0097	0.0159	0.0028	0.0163
	$Price_{ins}$	-0.0120‡	-0.1003‡	-0.0147‡	0.1393‡	-0.0086†	0.2672‡	-0.0153‡	0.1013‡	-0.0860‡
		0.0011	0.0023	0.0016	0.0029	0.0038	0.0119	0.0028	0.0033	0.0045
	$Price_{fng}$	-0.1037‡	0.1123‡	-0.1342‡	-0.1246‡	-0.1435‡	-0.1237‡	-0.1170‡	-0.0860‡	0.2030‡
		0.0075	0.0022	0.0097	0.0030	0.0097	0.0066	0.0163	0.0045	0.0171
	Expenditure	0.0223†	-0.0093‡	0.0156	-0.0137‡	0.0363†	-0.0113	0.0020	-0.0091†	0.0071
		0.0113	0.0016	0.0157	0.0023	0.0145	0.0142	0.0174	0.0039	0.0180
	Org Fert.	0.0501	0.0072	0.0592	0.0105	0.0505	-0.0637	0.0830*	0.0108	-0.0883*
		0.0361	0.0051	0.0434	0.0077	0.0433	0.0490	0.0499	0.0239	0.0509
	Inorg Fert.	-0.2743‡	0.0165*	-0.3167‡	0.0217	-0.3833‡	0.3537‡	-0.3204‡	0.0310	0.3281‡
		0.0657	0.0093	0.0811	0.0191	0.0796	0.1214	0.1062	0.1329	0.1100
	Plowing	-0.0236	-0.0023	-0.0174	-0.0015	0.0006	0.0109	-0.0033	-0.0241	0.0119
		0.0234	0.0033	0.0285	0.0046	0.0283	0.0289	0.0370	0.0191	0.0381
	Age	0.0007	0.0003‡	0.0010	0.0003	0.0006	-0.0009	0.0012	0.0003	-0.0015
		0.0010	0.0001	0.0012	0.0002	0.0012	0.0012	0.0015	0.0007	0.0016
	Mech. Weed.	-0.0454	-0.0349*	0.0418	-0.0602*	-0.1291	0.0965	-0.0794	-0.0204	0.0996
		0.1392	0.0198	0.1900	0.0316	0.1865	0.2008	0.2526	0.2286	0.9749
	Yield	-0.2951‡	0.0327‡	-0.3386‡	-0.0006	-0.3453‡	0.3111‡	-0.3458‡	0.0632*	0.3443‡
		0.0435	0.0062	0.0524	0.0172	0.0524	0.1085	0.0663	0.0355	0.0687
	$Autumn_{t-1}$	0.0328	0.0132	0.0538	0.0065	-0.1406	0.1570†	0.0337	0.0234	-0.0534
		0.0830	0.0118	0.0973	0.0103	0.0972	0.0650	0.1748	0.1039	0.1794
	$Spring_t$	-0.0363	-0.0063	-0.0486	-0.0028	0.0911	-0.1182*	-0.0399	-0.0170	0.0520
		0.0729	0.0104	0.0864	0.0097	0.0859	0.0614	0.1546	0.0944	0.1586
	$Rain_{t-1}$	0.0084‡	-0.0009‡	0.0093‡	-0.0010‡	0.0036	-0.0021	0.0096†	-0.0009	-0.0092*
		0.0024	0.0003	0.0028	0.0002	0.0028	0.0015	0.0046	0.0026	0.0048
	$Rain_t$	-0.0029‡	0.0002†	-0.0033‡	0.0002†	-0.0016*	0.0013†	-0.0034†	0.0002	0.0034†
		0.0007	0.0001	0.0009	0.0001	0.0009	0.0006	0.0014	0.0008	0.0015
	δ_{w_j}			1.5481	-0.9083‡	1.1686	1.1837			
				1.9080	0.1859	1.7169	1.1670			
	σ_{w_j}	0.2793	0.0562	0.2821	0.0586	0.2843	0.2731	0.3448	0.0821	0.3547
								0.0139	0.0146	0.0157
	ρ_{w_1,w_2}	-0.1460		-0.1471				-0.1025		
	ρ_{w_1,w_3}					-0.9533			-0.9883	
	ρ_{w_2,w_3}									-0.0198
	SSR	53.0519	2.1470	51.6476	2.2287	52.4419	48.3949			
	R^2	0.4136	0.6688	0.4289	0.6558	0.4201	0.4365			
	LL							271.53		
	AIC							-371.07		

*Level of significance : ‡=1% ; †=5% ; *=10%.*

Table 6: Price and Expenditure Elasticities with DOSE for 2001 and 2006

				Uncensored Demand System				Censored Demand System											
				FGLS (1)				SY Two-Step procedure (2)								FIML (3)			
				Ref. Fungicides				Ref. Fungicides				Ref. Insecticides							
				Parameters	Std	[Conf.	Int.]	Parameters	Std	[Conf.	Int.]	Parameters	Std	[Conf.	Int.]	Parameters	Std	[Conf.	Int.]
2001	Expenditure	Total	HERB.	0.834‡	0.018	0.788	0.879	0.948‡	0.005	0.934	0.962	0.959‡	0.005	0.946	0.972	0.743‡	0.027	0.673	0.812
			INS.	0.527‡	0.109	0.245	0.809	0.414‡	0.092	0.178	0.650	0.307	0.310	-0.491	1.105	0.598‡	0.078	0.398	0.798
			FNG.	1.148‡	0.015	1.111	1.186	1.067‡	0.006	1.052	1.083	1.057‡	0.007	1.038	1.076	1.221‡	0.023	1.162	1.280
		Tender Wheat	HERB.	0.832‡	0.018	0.786	0.878	0.949‡	0.005	0.935	0.962	0.959‡	0.005	0.946	0.973	0.740‡	0.027	0.670	0.811
			INS.	0.554‡	0.103	0.288	0.820	0.419‡	0.091	0.185	0.654	0.314	0.307	-0.477	1.104	0.621‡	0.073	0.433	0.809
			FNG.	1.147‡	0.015	1.110	1.185	1.069‡	0.006	1.053	1.085	1.058‡	0.007	1.039	1.077	1.220‡	0.023	1.161	1.279
		Durum Wheat	HERB.	0.878‡	0.013	0.845	0.912	0.962‡	0.004	0.952	0.972	0.970‡	0.004	0.961	0.980	0.812‡	0.020	0.761	0.863
			INS.	-0.539	0.356	-1.456	0.377	-0.794‡	0.281	-1.517	-0.070	-1.121	0.948	-3.564	1.322	-0.308	0.253	-0.959	0.342
			FNG.	1.208‡	0.020	1.155	1.260	1.108‡	0.010	1.083	1.133	1.091‡	0.012	1.061	1.122	1.310‡	0.032	1.227	1.393
		Barley	HERB.	0.825‡	0.019	0.776	0.873	0.941‡	0.006	0.926	0.957	0.953‡	0.006	0.938	0.969	0.729‡	0.029	0.655	0.802
			INS.	0.544‡	0.106	0.272	0.815	0.496‡	0.079	0.293	0.699	0.404	0.266	-0.282	1.090	0.612‡	0.075	0.419	0.805
			FNG.	1.142‡	0.014	1.106	1.178	1.059‡	0.005	1.045	1.073	1.050‡	0.006	1.033	1.066	1.212‡	0.022	1.156	1.269
	Price	Total	HERB.	-0.627‡	0.023	-0.687	-0.567	-0.892‡	0.012	-0.923	-0.861	-0.903‡	0.012	-0.933	-0.872	-0.581‡	0.035	-0.671	-0.490
			INS.	1.805‡	0.146	1.428	2.183	0.612‡	0.083	0.397	0.826	0.530	0.365	-0.411	1.471	-2.067‡	0.077	-2.266	-1.868
			FNG.	-0.816‡	0.015	-0.854	-0.778	-0.934‡	0.007	-0.952	-0.915	-0.922‡	0.015	-0.960	-0.884	-0.869‡	0.011	-0.898	-0.840
		Tender Wheat	HERB.	-0.624‡	0.024	-0.685	-0.563	-0.893‡	0.012	-0.924	-0.862	-0.904‡	0.012	-0.934	-0.873	-0.578‡	0.035	-0.669	-0.487
			INS.	1.644‡	0.138	1.289	2.000	0.596‡	0.082	0.384	0.809	0.516	0.362	-0.416	1.448	-2.005‡	0.073	-2.193	-1.818
			FNG.	-0.818‡	0.015	-0.856	-0.780	-0.932‡	0.007	-0.950	-0.914	-0.920‡	0.015	-0.958	-0.882	-0.871‡	0.011	-0.899	-0.842
		Durum Wheat	HERB.	-0.707‡	0.018	-0.753	-0.661	-0.916‡	0.011	-0.945	-0.887	-0.925‡	0.011	-0.953	-0.896	-0.663‡	0.027	-0.733	-0.593
			INS.	8.112‡	0.476	6.885	9.338	3.918‡	0.255	3.262	4.574	3.667‡	1.117	0.790	6.544	-4.481‡	0.251	-5.128	-3.835
			FNG.	-0.710‡	0.021	-0.763	-0.657	-0.877‡	0.010	-0.903	-0.850	-0.861‡	0.018	-0.906	-0.815	-0.768‡	0.011	-0.796	-0.741
		Barley	HERB.	-0.610‡	0.024	-0.673	-0.547	-0.881‡	0.012	-0.913	-0.849	-0.892‡	0.012	-0.924	-0.861	-0.564‡	0.037	-0.659	-0.470
			INS.	1.707‡	0.141	1.343	2.070	0.386‡	0.072	0.202	0.570	0.316	0.314	-0.493	1.125	-2.029‡	0.075	-2.221	-1.837
			FNG.	-0.827‡	0.014	-0.863	-0.790	-0.945‡	0.006	-0.962	-0.929	-0.934‡	0.014	-0.971	-0.898	-0.879‡	0.011	-0.908	-0.850
2006	Expenditure	Total	HERB.	0.864‡	0.017	0.819	0.908	0.953‡	0.006	0.937	0.969	0.963‡	0.006	0.948	0.977	0.661‡	0.037	0.565	0.757
			INS.	-0.783‡	0.291	-1.533	-0.033	0.088	0.126	-0.238	0.413	-0.674	0.517	-2.005	0.657	0.650‡	0.120	0.341	0.959
			FNG.	1.181‡	0.020	1.129	1.232	1.081‡	0.009	1.058	1.105	1.076‡	0.009	1.052	1.099	1.406‡	0.044	1.292	1.519
		Tender Wheat	HERB.	0.866‡	0.017	0.823	0.910	0.957‡	0.006	0.942	0.972	0.966‡	0.005	0.952	0.979	0.667‡	0.036	0.574	0.761
			INS.	-1.607‡	0.426	-2.704	-0.511	-1.182‡	0.302	-1.960	-0.403	-3.002†	1.236	-6.185	0.180	0.488‡	0.175	0.037	0.940
			FNG.	1.184‡	0.020	1.132	1.237	1.091‡	0.010	1.064	1.117	1.085‡	0.010	1.059	1.111	1.414‡	0.045	1.298	1.530
		Durum Wheat	HERB.	0.891‡	0.014	0.856	0.927	0.958‡	0.006	0.944	0.972	0.967‡	0.005	0.953	0.980	0.730‡	0.030	0.653	0.806
			INS.	-0.020	0.167	-0.449	0.409	0.647‡	0.049	0.521	0.773	0.352*	0.200	-0.164	0.867	0.800‡	0.069	0.623	0.977
			FNG.	1.261‡	0.029	1.187	1.336	1.105‡	0.012	1.074	1.136	1.098‡	0.012	1.068	1.128	1.587‡	0.064	1.423	1.751
		Barley	HERB.	0.821‡	0.023	0.763	0.879	0.942‡	0.008	0.922	0.961	0.953‡	0.007	0.935	0.972	0.555‡	0.049	0.430	0.681
			INS.	-0.727‡	0.282	-1.453	-0.001	0.303‡	0.097	0.055	0.552	-0.278	0.395	-1.294	0.738	0.661‡	0.116	0.362	0.961
			FNG.	1.141‡	0.016	1.101	1.181	1.063‡	0.007	1.044	1.081	1.058‡	0.007	1.040	1.076	1.316‡	0.034	1.228	1.405
	Price	Total	HERB.	-0.693‡	0.023	-0.751	-0.635	-0.906‡	0.015	-0.943	-0.868	-0.917‡	0.014	-0.953	-0.882	-0.586‡	0.032	-0.668	-0.503
			INS.	7.205‡	0.401	6.172	8.238	1.918‡	0.150	1.531	2.305	1.780†	0.748	-0.146	3.706	-4.803‡	0.984	-7.337	-2.268
			FNG.	-0.736‡	0.021	-0.789	-0.683	-0.906‡	0.010	-0.932	-0.880	-0.903‡	0.017	-0.945	-0.860	-0.881‡	0.026	-0.947	-0.815
		Tender Wheat	HERB.	-0.697‡	0.022	-0.754	-0.640	-0.911‡	0.015	-0.949	-0.874	-0.922‡	0.014	-0.957	-0.887	-0.590‡	0.032	-0.671	-0.509
			INS.	10.991‡	0.586	9.481	12.502	5.968‡	0.359	5.043	6.894	5.632‡	1.788	1.028	10.236	-6.560‡	1.438	-10.265	-2.855
			FNG.	-0.729‡	0.021	-0.784	-0.675	-0.891‡	0.011	-0.920	-0.863	-0.888‡	0.017	-0.931	-0.845	-0.875‡	0.026	-0.941	-0.808
		Durum Wheat	HERB.	-0.740‡	0.019	-0.789	-0.691	-0.913‡	0.014	-0.950	-0.876	-0.923‡	0.014	-0.958	-0.889	-0.632‡	0.027	-0.702	-0.563
			INS.	3.695‡	0.229	3.105	4.286	0.134†	0.058	-0.016	0.283	0.084	0.290	-0.663	0.830	-3.174‡	0.563	-4.623	-1.725
			FNG.	-0.582‡	0.030	-0.658	-0.505	-0.870‡	0.013	-0.902	-0.837	-0.866‡	0.018	-0.912	-0.820	-0.745‡	0.028	-0.817	-0.673
		Barley	HERB.	-0.620‡	0.028	-0.693	-0.547	-0.889‡	0.015	-0.928	-0.850	-0.902‡	0.014	-0.939	-0.864	-0.513‡	0.041	-0.618	-0.409
			INS.	6.944‡	0.388	5.944	7.944	1.229‡	0.115	0.934	1.525	1.125†	0.571	-0.345	2.596	-4.682‡	0.953	-7.135	-2.228
			FNG.	-0.813‡	0.016	-0.854	-0.771	-0.934‡	0.008	-0.955	-0.913	-0.931‡	0.015	-0.969	-0.893	-0.948‡	0.025	-1.011	-0.885

*Level of significance : ‡=1% ; †=5% ; *=10%.Confidence intervals are computed at the level of 99%.*

Table 7: Price and Expenditure Elasticities with TFI for 2001 and 2006

				Uncensored Demand System				Censored Demand System											
				FGLS (1)				SY Two-Step procedure (2)								FIML (3)			
				Ref. Fungicides				Ref. Fungicides				Ref. Insecticides							
				Parameters	Std	[Conf.	Int.]	Parameters	Std	[Conf.	Int.]	Parameters	Std	[Conf.	Int.]	Parameters	Std	[Conf.	Int.]
2001	Expenditure	Total	HERB.	0.979‡	0.020	0.926	1.031	0.986‡	0.006	0.970	1.002	0.997‡	0.006	0.981	1.012	0.886‡	0.041	0.780	0.991
			INS.	0.691‡	0.055	0.549	0.832	0.737‡	0.035	0.646	0.827	0.616‡	0.074	0.426	0.806	0.694‡	0.103	0.427	0.960
			FNG.	1.044‡	0.019	0.994	1.094	1.033‡	0.008	1.012	1.054	1.025‡	0.008	1.004	1.046	1.132‡	0.043	1.023	1.242
		Tender Wheat	HERB.	0.981‡	0.019	0.933	1.028	0.986‡	0.006	0.971	1.002	0.997‡	0.006	0.982	1.012	0.896‡	0.037	0.800	0.992
			INS.	0.705‡	0.053	0.569	0.840	0.736‡	0.035	0.645	0.827	0.615‡	0.074	0.425	0.805	0.707‡	0.099	0.453	0.962
			FNG.	1.049‡	0.022	0.993	1.105	1.034‡	0.009	1.012	1.056	1.026‡	0.009	1.004	1.048	1.147‡	0.047	1.025	1.269
		Durum Wheat	HERB.	0.986‡	0.013	0.951	1.021	0.991‡	0.004	0.980	1.001	0.998‡	0.004	0.987	1.008	0.925‡	0.027	0.855	0.994
			INS.	0.337‡	0.118	0.034	0.641	0.388‡	0.082	0.178	0.599	0.109	0.171	-0.332	0.550	0.344	0.222	-0.227	0.914
			FNG.	1.081‡	0.036	0.989	1.173	1.067‡	0.017	1.024	1.111	1.051‡	0.017	1.008	1.094	1.243‡	0.078	1.042	1.444
		Barley	HERB.	0.972‡	0.027	0.904	1.040	0.983‡	0.008	0.963	1.002	0.996‡	0.007	0.977	1.015	0.852‡	0.053	0.715	0.989
			INS.	0.699‡	0.054	0.562	0.837	0.773‡	0.030	0.694	0.851	0.669‡	0.064	0.505	0.833	0.702‡	0.101	0.443	0.961
			FNG.	1.036‡	0.016	0.995	1.077	1.026‡	0.007	1.009	1.043	1.020‡	0.007	1.003	1.037	1.109‡	0.035	1.019	1.199
	Price	Total	HERB.	-0.723‡	0.018	-0.769	-0.676	-0.921‡	0.014	-0.955	-0.886	-0.926‡	0.013	-0.960	-0.892	-0.607‡	0.039	-0.707	-0.507
			INS.	1.503‡	0.067	1.331	1.674	0.471‡	0.039	0.370	0.571	0.450‡	0.151	0.060	0.839	-2.691‡	0.083	-2.903	-2.478
			FNG.	-0.639‡	0.020	-0.690	-0.588	-0.870‡	0.009	-0.894	-0.847	-0.861‡	0.014	-0.897	-0.826	-0.653‡	0.020	-0.705	-0.601
		Tender Wheat	HERB.	-0.747‡	0.017	-0.791	-0.704	-0.923‡	0.013	-0.958	-0.889	-0.928‡	0.013	-0.962	-0.894	-0.638‡	0.036	-0.732	-0.545
			INS.	1.391‡	0.063	1.228	1.554	0.475‡	0.039	0.375	0.575	0.454‡	0.152	0.063	0.845	-2.614‡	0.079	-2.817	-2.412
			FNG.	-0.596‡	0.022	-0.653	-0.540	-0.864‡	0.010	-0.888	-0.839	-0.854‡	0.014	-0.890	-0.818	-0.606‡	0.020	-0.659	-0.554
		Durum Wheat	HERB.	-0.814‡	0.014	-0.851	-0.777	-0.945‡	0.013	-0.978	-0.911	-0.950‡	0.013	-0.983	-0.917	-0.723‡	0.030	-0.800	-0.646
			INS.	4.349‡	0.143	3.982	4.716	2.402‡	0.090	2.170	2.635	2.349‡	0.350	1.448	3.249	-4.635‡	0.177	-5.091	-4.179
			FNG.	-0.320‡	0.036	-0.412	-0.227	-0.718‡	0.017	-0.762	-0.673	-0.703‡	0.018	-0.748	-0.657	-0.308‡	0.022	-0.364	-0.252
		Barley	HERB.	-0.643‡	0.022	-0.699	-0.587	-0.905‡	0.014	-0.940	-0.869	-0.910‡	0.014	-0.945	-0.875	-0.506‡	0.047	-0.628	-0.384
			INS.	1.434‡	0.065	1.268	1.600	0.271‡	0.033	0.185	0.357	0.253*	0.131	-0.084	0.590	-2.644‡	0.080	-2.851	-2.437
			FNG.	-0.707‡	0.016	-0.749	-0.665	-0.898‡	0.008	-0.918	-0.878	-0.890‡	0.013	-0.924	-0.856	-0.726‡	0.020	-0.778	-0.674
2006	Expenditure	Total	HERB.	1.040‡	0.018	0.994	1.086	1.006‡	0.006	0.990	1.023	1.015‡	0.006	1.000	1.030	1.003‡	0.028	0.932	1.075
			INS.	0.416‡	0.099	0.160	0.671	0.717‡	0.047	0.596	0.838	0.483‡	0.156	0.082	0.884	0.438*	0.240	-0.181	1.056
			FNG.	0.957‡	0.031	0.878	1.036	0.999‡	0.013	0.966	1.031	0.991‡	0.012	0.961	1.021	1.020‡	0.050	0.891	1.148
		Tender Wheat	HERB.	1.036‡	0.016	0.994	1.078	1.006‡	0.006	0.991	1.020	1.013‡	0.005	1.000	1.027	1.003‡	0.025	0.938	1.068
			INS.	0.288†	0.121	-0.024	0.599	0.552‡	0.074	0.361	0.744	0.182	0.246	-0.452	0.816	0.314	0.293	-0.440	1.068
			FNG.	0.949‡	0.037	0.854	1.044	0.998‡	0.016	0.956	1.040	0.988‡	0.015	0.950	1.026	1.024‡	0.060	0.869	1.178
		Durum Wheat	HERB.	1.030‡	0.014	0.995	1.065	1.005‡	0.005	0.992	1.018	1.012‡	0.005	1.000	1.024	1.002‡	0.021	0.949	1.056
			INS.	0.371‡	0.107	0.096	0.646	0.838‡	0.027	0.769	0.907	0.704‡	0.089	0.474	0.934	0.395	0.259	-0.271	1.060
			FNG.	0.900‡	0.072	0.714	1.086	0.997‡	0.026	0.929	1.065	0.981‡	0.024	0.919	1.043	1.046‡	0.118	0.744	1.349
		Barley	HERB.	1.075‡	0.034	0.988	1.161	1.010‡	0.010	0.984	1.036	1.023‡	0.009	0.999	1.047	1.006‡	0.052	0.872	1.140
			INS.	0.586‡	0.070	0.405	0.767	0.783‡	0.036	0.691	0.876	0.604‡	0.119	0.298	0.911	0.602‡	0.170	0.163	1.040
			FNG.	0.976‡	0.017	0.932	1.020	0.999‡	0.008	0.979	1.019	0.994‡	0.007	0.976	1.013	1.011‡	0.028	0.939	1.083
	Price	Total	HERB.	-0.822‡	0.019	-0.871	-0.773	-0.943‡	0.017	-0.986	-0.900	-0.947‡	0.016	-0.987	-0.906	-0.790‡	0.033	-0.874	-0.705
			INS.	5.820‡	0.133	5.478	6.163	1.884‡	0.060	1.730	2.039	1.744‡	0.300	0.972	2.515	-6.301‡	0.206	-6.831	-5.771
			FNG.	-0.396‡	0.031	-0.476	-0.316	-0.789‡	0.013	-0.823	-0.755	-0.779‡	0.016	-0.821	-0.737	-0.445‡	0.019	-0.495	-0.395
		Tender Wheat	HERB.	-0.841‡	0.018	-0.888	-0.794	-0.950‡	0.016	-0.993	-0.908	-0.954‡	0.016	-0.994	-0.914	-0.809‡	0.031	-0.888	-0.730
			INS.	7.313‡	0.162	6.896	7.730	3.561‡	0.095	3.317	3.805	3.336‡	0.474	2.116	4.556	-7.465‡	0.251	-8.110	-6.819
			FNG.	-0.278‡	0.037	-0.374	-0.182	-0.730‡	0.017	-0.773	-0.687	-0.719‡	0.016	-0.761	-0.677	-0.333‡	0.021	-0.385	-0.280
		Durum Wheat	HERB.	-0.873‡	0.017	-0.916	-0.830	-0.956‡	0.016	-0.998	-0.913	-0.960‡	0.015	-0.999	-0.920	-0.843‡	0.027	-0.914	-0.772
			INS.	6.343‡	0.143	5.974	6.711	0.655‡	0.034	0.567	0.743	0.576‡	0.172	0.133	1.020	-6.708‡	0.221	-7.278	-6.138
			FNG.	0.400‡	0.073	0.212	0.588	-0.560‡	0.027	-0.629	-0.491	-0.543‡	0.022	-0.599	-0.487	0.315‡	0.031	0.236	0.394
		Barley	HERB.	-0.646‡	0.029	-0.720	-0.571	-0.910‡	0.018	-0.955	-0.864	-0.913‡	0.017	-0.956	-0.869	-0.605‡	0.053	-0.741	-0.469
			INS.	3.836‡	0.094	3.593	4.078	1.210‡	0.046	1.092	1.327	1.103‡	0.230	0.512	1.694	-4.754‡	0.145	-5.128	-4.379
			FNG.	-0.655‡	0.018	-0.700	-0.609	-0.871‡	0.009	-0.893	-0.849	-0.864‡	0.014	-0.900	-0.828	-0.692‡	0.018	-0.737	-0.646

*Level of significance : ‡=1% ; †=5% ; *=10%.Confidence intervals are computed at the level of 99%.*