Environmental and Quality Improvement Practices: Their Analysis as Components of the Value Added in Horticultural Firms

Emilio Galdeano Gomez
Jose Cespedes Lorente
Manuel Rodriguez Rodriguez

Paper prepared for presentation at the X^th^ EAAE Congress
'Exploring Diversity in the European Agri-Food System',
Zaragoza (Spain), 28-31 August 2002

ENVIRONMENTAL AND QUALITY IMPROVEMENT PRACTICES: THEIR ANALYSIS AS COMPONENTS OF THE VALUE ADDED IN HORTICULTURAL FIRMS (*)

EMILIO GALDEANO GÓMEZ
JOSÉ CÉSPEDES LORENTE
MANUEL RODRÍGUEZ RODRÍGUEZ
Department of Applied Economics
University of Almería
La Cañada de San Urbano, s/n
04700 Almería (Spain)
Phone: (+34)950-015812 / Fax (+34)950-015515
e-mail: galdeano@ual.es

Abstract
This paper analyses the effect of environmental and quality improvement practices on the value added of the fruit and vegetable sector. These practices form part of the incentive-based programmes established by the Common Agricultural Policy. Taking the investment in quality-environmental activities as knowledge capital, we propose a specific analysis that evaluates the effect of the factors of the production function and of the current subsidies over the value added. In general, the share of quality-environmental activities in the rise of the product's market value is quite high. The analysis reflects that the expenditure on these activities is still higher than their benefit, and that the current subsidies can hardly be considered encouraging factors for the development of the above-mentioned practices.
Key words: Quality-environmental practices, investment incentives, horticultural firms, value added.

(*) The present study is part of the research project SEC2001-1578-C02-02 financed by the State Office of Scientific and Technological Research (Spanish Ministry of Science and Technology).

1. INTRODUCTION.-

The production and marketing of high quality foods (understanding 'high quality' in the broadest sense[1]: nutritional value, presentation, healthiness, and, above all, environmentally respectful production) have become crucial factors for the competitiveness of the firms operating within the farming systems of Europe and developed countries.

Within this context we find the European Union (EU) sector of fresh fruits and vegetables. The Common Agrarian Policy (CAP) has been fostering (especially since the 1996 Common Market Organisation –CMO-) investments in activities related to the application of environmentally respectful practices and quality improvement practices (basic elements in the value added of the product)[2]. These activities are considered key

[1] The concept of quality is defined by the International Organization for Standarization (ISO) as "the whole of properties and characteristics of a product or service, on which is conferred the suitability to satisfy implicit and explicit needs" (ISO, 1991).

[2] This is so because the products considered in the present study are fruits and vegetables for fresh consumption, whose transformation for marketing is minimal. In the last years, the utilities added to the

factors for the development of the sector, and are included in the so-called Operative Programmes (OP's) of the framing-marketing entities[3].

Nevertheless, the voluntary nature of this farming and quality policy and the up-to-date heterogeneity in the implementation of the practices (systems of normalisation, systems of certification...) [4] cause each firm to behave differently when estimating the cost and profit of these activities[5].

In recent decades, many researches have centred on the analysis of environmental policies[6] yet with exclusive emphasis on the industrial sector, where investments are directed to the fulfilment of compulsory environmental regulation. Accordingly, the analyses draw attention to the impact of such regulation (aimed at the reduction of polluting effects) over business efficiency or growth, using the macro-economic indicators as a basis.

Thus, due to the specific features of the farming firms, especially those working with fresh fruits and vegetables, we opt to carry out here an analysis at micro-economic levels, taken the investments in quality-environmental activities as explanatory components of the production function. References to this type of analysis are found in Garcés and Galve (2001), who focus on the effect of environmental capital on Spanish firms' productivity, though within the framework of restrictive regulation for polluting effects. Likewise, Hitchens *et al.* (2000) or Garcés and Pérez and Pérez (2000) focus on the agri-food industry of Europe and Spain, respectively. The lack of works on farming products for fresh consumption and the orientations of the investment policy already escribed have led us to suggest a more specific model of analysis, taking as reference some empirical studies on the evaluation of the effects of innovative processes or determined investments (measured as stock of knowledge capital) on the business value added: Llorca (2000), Bottasso and Sembenelli (2001), Griliches (1994) or Hall and Mairesse (1995).

The objective of this work is thus to determine the way the value added is

---

product have been focussed on quality-environmental practices (QE) within the organisations of producers (for the farming and marketing activities). Also, we opt to carry out related of the quality-environmental practices (which can sometimes have a different effect on profitability) in this analysis because a complementary and relative balance of the investment in both are required in the incentive programmes.

[3] Though another programmes for this type of practices exist in Spain (basically the agri-environmental programmes of the CAP starting from the 2078/92 EC Regulation) their implementation has been very limited in the fruit and vegetable sector in Andalusia. The generalized development of QE practices in this sector has taken place from 1996 with the Operative Programmes. For this reason, we focus on these incentives.

[4] In countries with traditional protectionist and interventionist farming policies (developed countries), the purpose of integrating farming and environmental policies makes the cluster of economic instruments be reduced to two general types: economic incentives for voluntary actions (*incentive schemes*) and conditioned subsidies (*cross-compliance*). Thus, in the USA, the conservation policy has been developed through the system of conditioned subsidies with compensations calculated in auctions where farmers present the implementation of their conservation programmes while the administration grants the most effective programmes. In the EU, however, the other option has been chosen (Sumpsi *et al.*, 1997).

[5] Thus, the intensification levels of quality-environmental activities depend on the specific demand of the customers of each producing firm.

[6] From the 1990s onwards, some of the most important ones include: Porter (1991), Meyer (1992), Gray and Shadbegian (1993), Van Der Linde (1993), Porter and Van Der Linde (1995), Jaffe *et al.* (1995) and Xepapadeas and Zeeuw (1999). These works draw attention to arguments supporting or rejecting the well-known "Porter hypothesis", which states that the firms operating in sectors affected by environmental debasement problems are compelled to review their producing processes, which helps to detect inefficiencies and to encourage the innovation of better technologies and productive methods.

affected by those Spanish horticultural firms implementing quality-environmental practices, which are resulting in really innovative methods of production and commercialisation. To this end, we have taken a sample of Andalusian (farming-marketing) entities[7] for the period 1997-2000 taking into account a series of homogenous characteristics across them.

The basis for this study is given by the lack of analyses accounting for the value of the CAP's incentive-based programmes in Spain, and by the lack of models allowing the quantification of the cited investments in the sector of fresh fruits and vegetables (products of increasing consumption).

The structure of this work is as follows: Section 2 reviews the issue of estimating CAP's incentives to implement quality-environmental practices within the context of present Operative Programmes. Section 3 describes the data sample and carries out a previous descriptive analysis of the indicators of value added and profitability. Section 4 specifies the model used. Section 5 shows the results of the estimation, and Section 6 concludes.

2. INCENTIVES TO IMPLEMENT QUALITY-ENVIRONMENTAL PRACTICES IN THE OPERATIVE PROGRAMMES.

Nowadays, representative Spanish horticultural firms have a co-operative or associative nature, and, according to Community Regulation, they are classified as Organisations of Fruit and Vegetable Producers (OFVP's). The main objective of these firms is to manipulate and commercialise their associates' (farmers) products in their warehouses and installations linking the farming and marketing activities.

Current demand requirements are resulting in both the intensification of quality-environmental activities and the examination of the farming, manipulative and marketing techniques of horticultural firms. By the same token, these practices have become a top priority for the CAP's new orientations, which attempt to improve efficiency and competitiveness within the agri-food system. To this end, the 2200/96 EC (European Commission)[8] Regulation established operative funds (called Operative Funds and Programmes) to finance the implementation of quality-environmental practices. The capital for such programmes comes from the OFVP associates' contributions (50%) and the subsidies from the European Fund for Farming Orientation and Guarantee (EFFOG).

Generally speaking, one of the most important challenges facing environmental policy is the fixing of subsidy rates which can be considered actual incentives for the application of quality-environmental practices. Sancho *et al.* (1994) or Sumpsi *et al.* (1997), analyse (the last one with a diagram of marginal cost and income curves) this issue within the context of the CAP, where the voluntary nature of the activities implies

[7] In Andalusia, fruits and vegetables equal 50% of the final farming output, and nearly 24% of Spanish output are produced and commercialised (Spanish output equals 20% in the EU). About 50% of Andalusian output are exported, being European markets its chief destination (more than 90%).

[8] The present CMO (continuing, to a great extent, with the principles of the 1035/72 EC Regulation) establish as main objectives of the OFVP the following:

- Assure a programme of production and its adaptation to the quantity and quality demand.
- Promote a concentrated supply and commercialization of the organization members' production.
- Reduce production costs and regulate production prices.
- Promote crop practices, production techniques and residual management environmentally respectful, particularly, to protect the quality of water, soil and countryside and to preserve and/or to promote the bio-diversity.

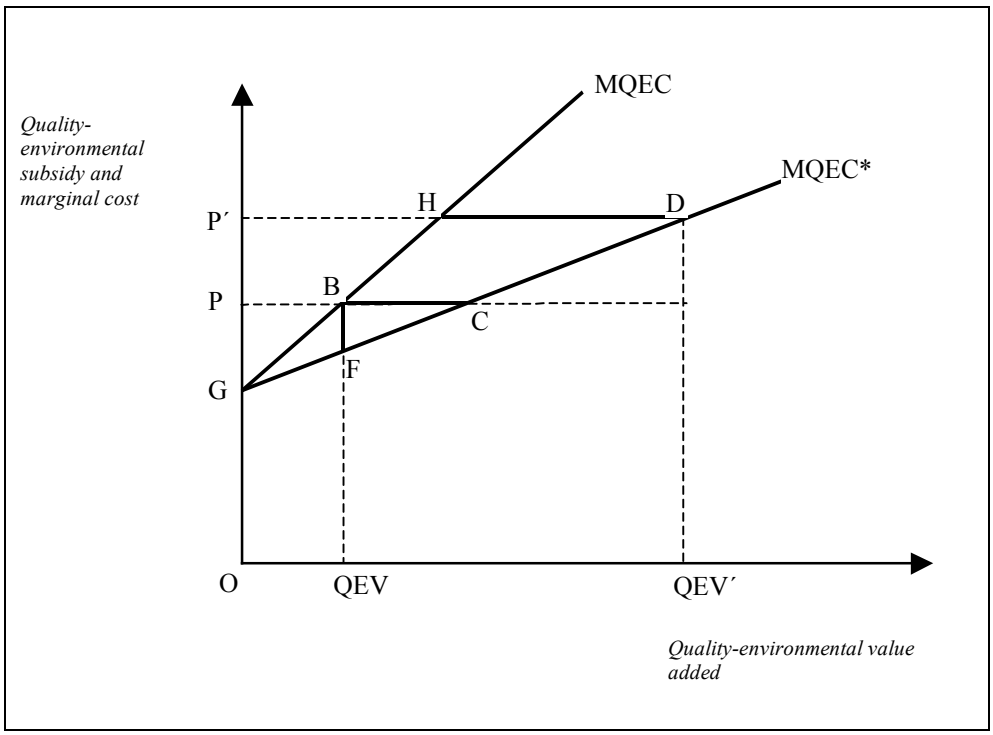
that producers gain sufficient compensation (in terms of profit) as to implement the new practices. Following an analysis similar to that of *Palmer et al.* (1995), the problem of estimating subsidy rates is illustrated in Graph 1:

- The vertical axis shows the level of marginal QE cost, MQEC, and the level of subsidy (P) for the QE actions.
- The horizontal axis shows the level of the quality-environmental value added over the product (QEV)[9].

Therefore, with a subsidy P it can be fostered the introduction of new practices and technology (represented by QE) allowing the reduction of the initial curve MQEC to MQEC*, increasing the initial QEV. But as explained in Sumpsi *et al.* (1997), in the agricultural sector the existence of incentives depend on that the QE expenditure is inferior to the profit obtained with such a reduction (once the subsidy is deducted). This means that the profit (Π) at B must be smaller than the profit at C (Π*): ΠB < Π*C, which implies that, independently of other variables (*ceteris paribus)*, QE expenditure (1-P) < area bounded by GFCB.

The increase of the subsidy rate for environmental practices to P' may be a greater incentive, and may cause agricultural firms to reach a EV' level of shares over the final product. Nevertheless, this depends on ∏H < ∏*D, which involves that QE expenditure (1-P') < area bounded by GFCDHB.

Graph 1. The Incentive to Introduce Quality-Environmental Practices.



In practice, the subsidy programmes can hardly carry out the estimate of marginal cost shares. There can be seasonal differences in the income reduction of the producing and marketing agents, which may be motivated by changes in farming practices, making difficult the estimate of the subsidies granted (OP's are established

[9] Following *Palmer et al.* (1995), MEC, P and EVcan be measured in monetary units (in this case, euros).

beforehand). Consequently, the average value of the OP subsidy is calculated as a percentage over the firm's market value of the product.

The investments forecasted in the Operative Programmes supplied by Andalusian OFVP's for 1997-98 did not go beyond 6% of the sale value of the three preceding years. These investments were near to 8% of the sales from 1999 onwards (Table 1).

Although the OP's can include diverse actions (the entity's general investment, removal of products), the activities relative to quality controls and development of environmental practices enjoy the greatest participation. Between 85% and 95% of the investments are connected with quality-environmental factors (Table A.1, Appendix).

Table 1. Summary of the Operative Programmes 1997-2000

1997 No. Entities	Value of the Sales (euros)	Operative Programme (OP)	OP over Sales (%)
Total: 56	**535,018,260**	**30,602,081**	**5.72**
1998 No. Entities	Value of the Sales (euros)	Operative Programme (OP)	OP over Sales (%)
Total: 56	**691,268,612**	**38,171,625**	**5.52**
1999 No. Entities	Value of the Sales (euros)	Operative Programme (OP)	OP over Sales (%)
Total: 104	**935,418,843**	**71,570,998**	**7.65**
2000 No. Entities	Value of the Sales (euros)	Operative Programme (OP)	OP over Sales (%)
Total: 101	**1,042,741,155**	**82,933,023**	**7.96**

Source: Andalusian Council of Agriculture and Fisheries

Additionally, the establishment of OP's has coincided with tighter quality demands on the part of both consumers and EU food distribution chains[10]. Thus, the period under analyses coincides with the introduction of systems of certification and horticulturally-adapted quality controls in most OFVP's.

3. SAMPLE OF FIRMS AND DESCRIPTIVE ANALYSIS.

As previously mentioned, our analysis is centred on farming-marketing entities and OP's from Andalusia, whose production equals 24% of the national output. This will allow us to work with a more homogenous[11] sample, taking into account the heterogeneity in the implementation of the practices and technology in such entities.

The lack of data[12] on quality-environmental activities within Andalusian

[10]However, recent studies on the sector (Galdeano, 2000) show that sale prices have few increased when compared with previous periods. This fact (like an extension of this study) can also be considered as asymmetry or imperfection in the information of the QE components (Viscusi, 1979, De y Nabar, 1991, Leland, 1979, among others). Also, taking into account the heterogeneity in these practices and the lack of policy control and inspection (Golan *et al.* 2000). In any case, the high profitable firms are slow to invest more capital in practices for the change of their traditional farming and marketing systems.

[11] We work with data from firms sharing the same intensive farming and marketing systems. They sometimes share the same customers, who are represented by EU food distribution chains and importers to the EU.

[12] It is only available the aggregate data from the Andalusian Council of Agriculture and Fisheries

horticultural marketing entities has led us to carry out an individual survey for the firms (shown in Table A.2, Appendix). To make use of the greatest amount of historical information, we analysed a group of firms that presented their OP in 1997 (56 OFVP's)[13].

The data show that the cited practices were initiated in 1997 as a result of the first OP's[14], and that nearly all firm's investment in QE practices (more than 90%) was included in the OP's in order to exploit subsidies to the utmost.

Graph 2 shows the evolution of the economic indicators for value added and profitability determining the differences that may exist between the seasons prior to the generalised investment in the OP activities (the 1994-1996 results accounts were available) and the seasons or years under analysis (1997-2000). The indicators used are the following:

- Value added (VA) obtained from the countable gross value added.
- Value added divided by the output (VAQ)[15], bearing in mind the gap between the output of these entities (reflected in the countable entry of supplies) and their market activity (reflected in the entry of sales[16]). Both amounts were obtained from the annual reports.
- Additionally, we have included the evolution of the sales margin (SM).

By and large, the evolution of the indicators (in real terms) is quite similar: we observe a decrease of profitability, which characterised the sector in the 1990s (Galdeano, 2000), yet a recovery in the values and a change of tendency in the evolution of the indicators is observed from 1998 onwards Such a recovery (though not fully relevant) coincides with the period of intensification of the quality-environmental practices, which may lead to a priori relationship between the two facts.

Graph 2. Evolution of the economic indicators[17].

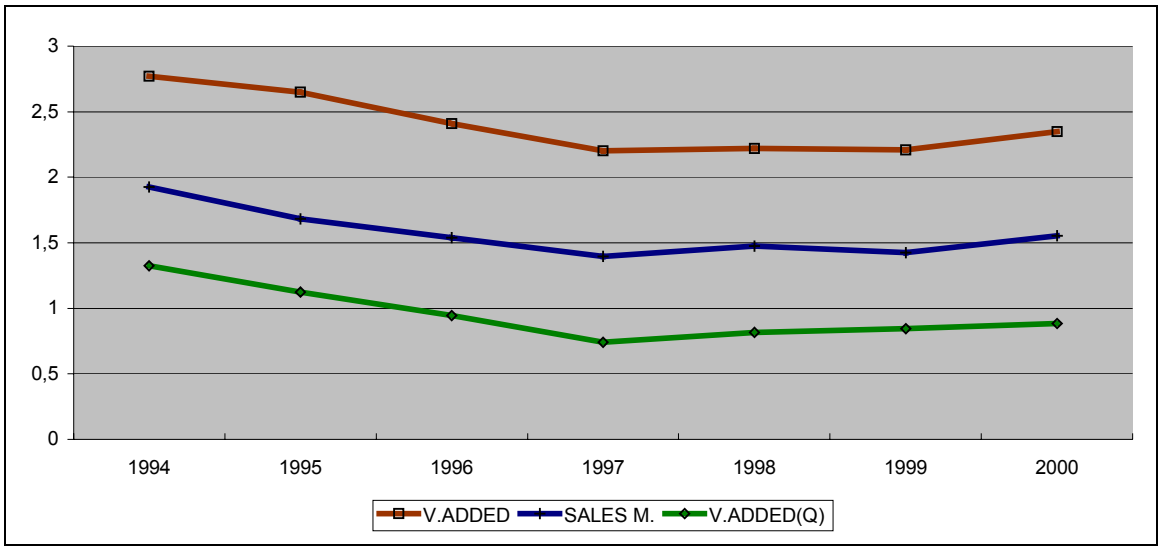
[13] This firm sample equal 74 % of the sector (measured in value of sales). The functioning of these entities is quite homogenous (see footnote 11) as it is their size (the number of workers ranges between 65 and 315).

[14] This is due to the mentioned coincidence between the establishment of these subsidies and the increasing demand requirements on the part of consumers. Therefore, certification and control systems (adapted to the horticultural sector) have been introduced in the most OFVP's (yet in different degrees over the output). For instance: *ISO 9002, Integrated Production System* (Andalusian Council of Agriculture and Fisheries) or *155001UNE* Regulation (*Controlled Production of Protected Cultivation*, AENOR –National Association of Normalisation and Certification-), among others. The period also coincides with the development of somewhat ecological horticultural methods in Andalusia (Ruesga, 2000).

[15] Since they are fully perishable products, there are gaps between the output that OFVP producers are paid for and the actually commercialised output (these gaps are due to product losses in manipulation, packaging, transport, etc). Thus, the firm's gross value added may not reflect the profits in the final price appropriately, whereas the environmental and quality components would be among those profits.

[16] This presupposes that we consider homogenous final products for all firms. For this reason the firms selected for the sample work with the same groups of products (vegetables, above all). These products are offered in lots to common customers, who in the 1990s are represented by EU food distribution chains.

[17] VAQ and VA were divided by ten and a logarithmic scale was used in order to make it possible the observation of the joint evolution of the indicators.



4. MODEL SPECIFICATION.-

The economic analysis of technological innovation or *stock of knowledge capital*, typically represented by research and development (R+D) activities, has been mainly applied to many business sectors[18]. Several studies on the business sector consider the investment in environmental actions part of the knowledge capital because of its innovative effects on technology and productive methods (Porter and Van Der Linde, 1995, Xeppadeas and Zeeuw, 1999, etc). At a microeconomic level, Palmer *et al.*(1995) or Gray and Shadbegian (1993) carry out the same analysis showing a positive correlation with other firm's investments aimed to increase productivity. In our analysis, we consider that quality-environmental investment (QE) is a principal component in the development of new technologies and methods. For the estimate of the QE expenditure over the value added (output), we suggest a multivariate regressive model from the traditional Cobb-Douglas function, expanded here with a measure of knowledge capital as input of the productive process Griliches and Mairesse (1984):

$$VA_{it} = A e^{\lambda t} K^{\alpha}_{it} L^{\beta}_{it} R^{\delta}_{it} e^{eit} \qquad (1)^{19}$$

where VA_{it} is the value added of the firm "i" at period "t", A constant variable, λ measure of the rate of technical change, K_{it} and R_{it} physical and knowledge capital of the firm "i" at "t", L_{it} labour factor, α, β y δ, the elasticities corresponding to the three inputs defined, and e_{it} the error term.

Confining attention to the logarithmic differentiation of the variables, (1) can be rewritten as:

$$\Delta va_{it} = \lambda + \alpha \Delta k_{it} + \beta \Delta l_{it} + \delta \Delta r_{it} + \Delta e_{it} \qquad (2)$$

The knowledge capital is generally calculated from the weighted sum of the

[18] Some of the most important works include Griliches (1984, 1986, 1994), Mansfield (1965), Schmookler (1966), Griliches and Lichtenberg (1984), Hall and Mairesse (1995), Jorgenson and Griliches (1967).

[19] Although it is common to use gross production as measure of the output, we use VA as a better indicator of the quality incorporated to the final product.

(deflated) historical data on R+D investment. However, if data correspond to a short period (as it is the case here, four years), it is impossible to construct a reliable variable reflecting the research capital. Nevertheless, following Llorca (2000), we can use as *proxy* variable a measure based on the firm's expenditure on innovative processes over the value added (RD/VA). Thus, being δ the knowledge capital elasticity respecting the value added, we have that $\delta = \partial VA/\partial R \cdot R/VA$[20]. If we assume the equality of the marginal product across firms ($\partial VA/\partial R$), allowing δ to vary among them, we can infer that the growth rate of productivity depends on the impact of the cited investment (RD/VA):

$$\delta \Delta r = (\partial VA/\partial R \cdot R/VA)\,(\Delta R/R) = (\partial VA/\partial R \cdot \Delta R/VA) = \rho\, \Delta R/VA \cong \rho\, RD/VA \qquad (3)$$

where no RD depreciation is assumed ($\Delta R = RD - \eta R$; $\eta = 0$)[21].

By substituting the RD/VA expression for rd, equation (2) can be rewritten as:

$$\Delta va_{it} = \lambda + \alpha\, \Delta k_{it} + \beta\, \Delta l_{it} + \rho\, rd_{it} + \Delta e_{it} \qquad (4)$$

To determine the incidence of quality-environmental practices over VA, we separate the variable "rd" into "qe" (of a quality-environmental nature[22]) and "ord" (other research and development expenditures).
Thus, equation (4) is now:

$$\Delta va_{it} = \lambda + \alpha\, \Delta k_{it} + \beta\, \Delta l_{it} + \rho\, qe_{it} + \rho'\, ord_{it} + \Delta e_{it} \qquad (5)^{23}$$

Another point to be considered is the assumption (or not) of constant returns to scale in the Cobb-Douglas function. If we assume their existence, we are then implying that the capital and labour elasticities together add one ($\alpha + \beta = 1$)[24], and the equation to be estimated is now expressed in terms of labour productivity:

$$(\Delta va_{it} - \Delta l_{it}) = \lambda + \alpha\, (\Delta k_{it} - \Delta l_{it}) + \gamma\, \Delta l_{it} + \rho\, qe_{it} + \rho'\, ord_{it} + \Delta e_{it} \qquad (6)$$
(where $\gamma = \alpha + \beta - 1$)

Simplifying the notes on the annual growth rate of value added-labour ratio ($\Delta va_{it} - \Delta l_{it}$ substituted by Δval_{it}) and the annual growth rate of capital-labour ratio ($\Delta k_{it} - \Delta l_{it}$ by Δkl_{it}], we obtain:

$$\Delta val_{it} = \lambda + \alpha\, \Delta kl_{it} + \gamma\, \Delta l_{it} + \rho\, qe_{it} + \rho'\, ord_{it} + \Delta e_{it} \qquad (7)$$

---

[20] Note that ∂ is here a derivative symbol to avoid confusion.

[21] We introduce this consideration because the time margin is short and because most of the expenditures are related to changes in systems and processes (rather than fixed assets)

[22] Thus, the percentages of this variable will be similar to those determined in the Operative Programmes (Table A.2), but estimated over VA.

[23] Such R desegregation involves that we start from the following Cobb-Douglas function (1) $VA_{it} = A e^{\lambda t} K^{\alpha}_{it} L^{\beta}_{it} R^{\delta}_{QEit} R^{\delta'}_{ORDit} e^{eit}$

[24] The definition of constant returns to scale involves some controversy about the inclusion of the parameter affecting the research capital in the production function. Following Grilliches and Lichtemberg (1984) we decided not to include it here to avoid the double counting of labour and physical capital inputs.

A further point in our analysis is the use of VAQ_{it} as a dependent variable: in adjusting by kilograms, the profits obtained in the final price are better reflected (as result of the quality-environmental components); in correcting by physical units, VAQ_{it} is a more accurate indicator of the productivity. If variables are adjusted according to the production function, (7) would be:

$$\Delta vaql_{it} = \lambda + \alpha \Delta kl(q)_{it} + \gamma \Delta l(q)_{it} + \rho\, qe(q)_{it} + \rho' ord(q)_{it} + \Delta e_{it} \qquad (7')$$

5. DATA AND RESULTS. -

In line with what has been stated so far, two dependent variables (VA and VAQ) were used.

K is obtained from the firm's inflation-corrected net stock (estimating the private investment deflator from the data of Bank of Spain). K(Q) is the previous value per kilogram sold. To obtain L(Q), the labour input, L, is calculated from the number of hours worked per year and it is divided by the kilograms sold. The variables qe and ord are calculated as percentage (over the value added) of the expenditure on OP actions and as other research investments, respectively.

Table 2 shows the descriptive statistics of the variables in incremental data (1997-1998, 1998-1999 y 1999-2000) except for qe and ord, for which a two-year mean is taken.

Table 2. Descriptive Statistics of the Variables.

Variables	Mean	Typical deviation	Number of observations
Δval	0.091	0.047	280
Δl	0.087	0.051	"
Δkl	0.101	0.035	"
qe	0.069	0.019	"
ord	0.032	0.014	"
(1)			
Δvaql	0.052	0.018	280
Δl(q)	0.013	0.043	"
Δkl(q)	0.063	0.056	"
qe(q)	0.061	0.021	"
ord(q)	0.024	0.011	"

(1) Values multiplied by 10.

The ratio of technical change, λ, which is normally unknown (an unobserved effect) and reflects the growth rate of productivity of the sector or of the specific firm[25],

[25] The normally difficult to be valued λ consists of a specific component for each firm (λ_i), considered constant in time (fixed effects), a common component for the whole sector (λ_{st}) in a given period, and a random component (e_{it}). λ_i can be reflected in the increment of the other variables of the function (by using data in differences can reduce the correlation with explanatory variables). λ_{st} is generally estimated when working with cross-sectional data .

was not estimated. Although it is not a hundred percent correct[26], we consider that effect is constant in time and similar in all sample firms (making allowances for the homogeneity across firms). Bottasso and Sembenelli (2001), López and Sanaú (1999) or Llorca (2000) agree with us when the aim consists in obtaining average data (as it is the case here).

Prior to the estimation, the exogeneity of the explanatory variables was contrasted through the Hausman-Wu test[27] (Table 3).

Table 3. Results of the Hausman-Wu test.

H_0	Test statistics	Degrees of freedom	$\chi^2_{0.05}$
(7) Exogeneity of explanatory variables	5.22	4	9.49
(7') Exogeneity of explanatory variables	7.19	4	9.49

The results show no endogeneity problems for the vector of explanatory variables.

Since the results can be different[28], we considered the assumption (or not) of constant returns to scale. Therefore, four equation were estimated: 7(a) and 7'(a) not assuming returns to scale, and 7(b) and 7'(b) doing so. Table 5 shows the results of the regression through ordinary least squares (OLS) [29] corrected of heteroskedascity.

Taking into account the evolution of the economic indicators observed in Graph 2, two *dummy* variables $d_{98\text{-}99}$ y $d_{99\text{-}00}$ were incorporated (the 1997-98 variable was omitted).

Table 4. Results of the estimation.

Variables	7(a)	7(b)	Variables	7'(a)	7'(b)

[26]Generally, the problem stems from the correlation these specific effects have with both the explanatory variables (fixed effects), especially when no increases are taken, and the error term (random effects).

[27] We used as instrumental variables all explanatory variables lagged in one period. An additional instrumental variable was a growth ratio within the sector calculated from the figures of sales.

[28]Empirical studies normally show that the Δkl coefficient can augment in relation to the coefficients of the qe and ord variables.

[29] As said before, the OLS regression implies that we assume constant coefficients for all factors in time, treating data as *pull* data. In dealing with longer periods, we frequently analyze the random effects of the variables of different periods and differentiate estimators through the Hausman test and the statistical F. This may be taken as a further consideration for future studies when the number of periods is augmented.

Δl	-0.25**	--	$\Delta l(q)$	-0.27**	--
	(-2.17)			(-2.31)	
Δkl	0.42***	0.51***	$\Delta kl(q)$	0.44***	0.53**
	(3.89)	(2.90)		(3.91)	(2.72)
qe	0.19**	0.14**	qe(q)	0.21***	0.15**
	(2.48)	(2.29)		(3.09)	(2.11)
ord	0.12**	0.11*	ord(q)	0.12**	0.10*
	(1.93)	(1.84)*		(2.07)	(1.86)
$d_{98\text{-}99}$	0.07*	-0.03	$d_{98\text{-}99}$	0.09*	0.04
	(1.82)	(-0.86)		(1.79)	(1.26)
$d_{99\text{-}00}$	0.10*	0.06	$d_{99\text{-}00}$	0.14**	0.11*
	(1.90)	(0.92)		(2.05)	(1.87)
R^2 (adjusted)	0.58	0.39	R^2 (adjusted)	0.62	0.51
F	40.34	29.18	F	43.56	37.22

( ) t statistics. *** 1% significant, ** 5% significant , * 10 % significant.

The results show many differences in the influence of the explanatory variables over VA and VA(Q). But if the restriction of returns to scale is imposed, we observe a worse adjustment for R^2 and statistical F, and a slight increase in the coefficients of Δkl and $\Delta kl(q)$ in detriment of the variables of research capital stock. We thus refuse the existence of constant returns to scale.

In 7(a) and 7'(a), the coefficients of the variables qe and qe(q) are significant in relation to the value added (annual growth rate of value added-labour ratio). The variables ord(q) and Δkl, $\Delta kl(q)$ are similarly significant, which may indicate a certain degree of complementarity in the effects of QE investment on the value added. Despite its negative influence on Δval and $\Delta vaql$, the annual growth rate of labour ratio is significant. The *dummy* variables are important, particularly $d_{99\text{-}00}$, indicating the correlation between the QE investment and the increase of the value added.

On these grounds, we assume that quality-environmental investment affects positively the increase of the added value in the Andalusian OFVP's, just as other firm's variables or investment inputs do.

To figure out the actual share of these factors in the added utility of the product, we multiply the coefficients of 7(a) and 7'(a) by the average values of the sample variables [qe, ord, Δkl, qe(q), ord(q) and $\Delta kl(q)$] estimating the effect of the corresponding regressors. Dividing this number by the average value of the dependent variable in the sample, we obtain the percentage of each of the above coefficients, which explains the increases of this variable. Table 5 shows the values obtained.

Table 5. Effect of physical and knowledge capital on val and vaql (%)

qe	Ord	Δkl
14.41 %	4.42 %	46.62 %
qe(q)	ord(q)	$\Delta kl(q)$
24.63 %	5.53 %	53.31 %

The quality-environmental variable shows a greater percentage for the value added-labour ratio per kilogram (24.63) than for the value added-labour ratio (14.41), which is the result of the better adaptation of the first indicator when dealing with the quality-environmental utilities incorporated in the product. In contrast, the percentages

for the growth rate of capital-labour ratio and for other investments in innovation are similar. We observe greater effects on the value added than on ord (4.42 and 5.53) which may suggest that, given the existence of constant returns to scale, the firms analysed have reached their optimal size, and that the total value added will be increased by the quality of the product rather than by the greater efficiency of the quality-environmental factors.

Nevertheless, both percentages are used here to determine if the benefit from the quality-environmental activities is greater than their expenditure (as an approximation to the marginal income and marginal cost). As for the expenditure, we should bear in mind that the subsidies derived from the Operative Programme typically represent 50%t of the expenditure. Thus the contrast between benefit and expenditure can be specified as:

a) (0.1441) Δval with respect to (1 – 0.5) qe → 0.0131 < 0.0345
b) (0.2463) Δvaql with respect to (1 – 0.5) qe(q) → 0.0128 < 0.0305

It follows that the quality-environmental cost is nowadays rather high, and that subsidies are (on their own) poor incentives for the development of quality-environmental practices. Thus, as it is deduced from the works of Galdeano and Céspedes (2001), additional incentives for the practices and innovation analysed in this study can stem from the expectations for greater long-run benefits (consequently, the period studied can still be considered limited) and particularly form the maintenance of market shares before current demand requirements[30].

6. CONCLUSIONS.-

The CAP's current orientations and, above all, greatest market demands do affect the increase of investments in practices related to environment and quality improvement within the Spanish horticultural sector. These practices have a positive effect on the indicators of managerial profitability, especially on that showing the changes of tendency. Although, the share of these activities in the value added (in both of the analyses proposed) is remarkable, it is not sufficient to overcome the implementation costs once the subsidies are deducted. Therefore, investments respond to horticultural firms' necessity to maintain their market position rather than to the profit obtained in the sale price (in which the quality-environmental components are not properly estimated yet). Nevertheless, it is worth pointing out that the analysed activities are of a recent application, so it is likely that their impact will be greater in following years, as it must be the tendency towards a higher expenditure on them.

REFERENCES

-ANDALUSIAN COUNCIL OF AGRICULTURE AND FISHERIES: *Annual Reports (1994-2000)*.

[30] From an economic point of view, consumers may still undervalue the quality-environmental components incorporated to products.

-BOTTASSO, A. y SEMBENELLI, A. (2001): "Market power, productivity and the EU Single Market Program: Evidence from a panel of Italian firms". *European Economic Review*, 45: pp. 167-186.
-DE, S., NABAR, P. (1991): "Economic implications of imperfect quality certification". *Economic Letters*, 37: 333-337.
-GALDEANO, E. (2000): *Estudio de Competitividad de las Entidades Asociativas Andaluzas de Comercialización Hortofrutícola*. Universidad de Almería y Consejería de Empleo y Desarrollo Tecnológico.
-GALDEANO, E. y CÉSPEDES, J. (2001): "Análisis de la incidencia del control de calidad y prácticas respetuosas con el medio ambiente en la rentabilidad de las empresas agroalimentarias" (comunicación). *IV Encuentro de Economía Aplicada* (7-9 de junio).
-GARCÉS, C. y GALVE, C. (2000): "Repercusión de las inversiones en protección del medio ambiente en la productividad de las empresas españolas: un análisis empírico". *Cuadernos de Economía y Dirección de la Empresa*, 8: pp. 33-50.
-GARCÉS, C. y PÉREZ Y PÉREZ, L. (2000): "La protección medioambiental en la industria alimentaria española" (Comunicación). *III Encuentro de Economía Aplicada* . Valencia, junio de 2000.
-GOLAN, E., KUCHLER, F., MITCHEL, L. (2000): "Economics of food labelling". *Economic Research Service*, U.S. Department of Agriculture, Agricultural Economic Report, nº 793.
-GRAY, W.B. y SHADBEGIAN, R. J. (1993): "Environmental Regulation and Manufacturing Productivity at the Plant Level". *Center for Economic Studies Discussion Paper*, n. 96-6, U.S. Departament of Commerce.
-GRILICHES, Z. (1984) (ed.): *R & D, patents and productivity*. National Bureau of Economic Research. Cambridge, Mass.
-GRILICHES, Z. (1986): "Productivity, R&D and basic research at the firm level in the 1970s". *American Economic Review*, 76(5): pp. 141-154.
-GRILICHES, Z. (1994): "Productivity, R&D and the data constraint". *American Economic Review*, 84(1): pp. 1-23.
-GRILICHES, Z. y MAIRESSE, J. (1984): "Productivity and R&D at the firm level" in *R&D, Patents and Productivity*, edited by Z. Griliches, University of Chicago Press.
-GRILICHES, Z. y LICHTENBERG, F. (1984): "R&D and productivity growth and the industry level: Is there still a relationship" in *R&D, Patents and Productivity*, edited by Z. Griliches, University of Chicago Press.
-HALL, B. and MAIRESSE, J. (1995): "Exploring the Relationship between R&D and productivity in French manufacturing firms". *Journal of Econometrics*, 65: pp. 263-293.
-HITCHENS, D., BIRNIE, E., THOMPSON, W., TRIEBSWETTER, U., BERTOSSI, P. y MESSORI, L. (2000): *Environmental Regulation and Competitive Advantage: A Study of Packaging Waste in European Supply Chain*. Edward Elgar Publising Limited.
- INTERNATIONAL ORGANIZATION FOR STANDARIZATION (1991): *ISO 9000 International Satandars for Quality Management.* Geneve.
-JAFFE, A.B., PETERSON, S.R., PORTNEY, P.R. y STAVINS, R. N. (1995): "Environmental Regulation and the Competitiviness of U.S. Manufacturing: What Does the Evidence Tell Us?". *Journal of Economic Literature*, vol. XXXIII (1): PP. 132-163.
-JORGENSON, D.W. y GRILICHES, Z. (1967): "The explanation of productivity change". *Review of Economic Studies*, 34(3): pp. 249-283.
-LELAND, H.E. (1979): "Quacks, lemons and licensing: a theory of minimun quality standars". *Journal of Political Economy*, 87 (6): 1328-1346.
-LÓPEZ, C. y SANAÚ, J. (1999): "Tecnología y crecimiento: análisis en la industria

española, 1986-1992". *Papeles de Economía Española*, 781: pp. 11-25.
-LLORCA, R. (2000): "The impact of process innovations on firm's productivity growth: the case of Spain" (Comunicación). *III Encuentro de Economía Aplicada* . Valencia, junio de 2000.
-MANSFIELD, E. (1965): "Rates of return from industrial R&D. *American Review (Papers and Proceedings)*, 55(2): pp. 531-542.
-MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACIÓN (2000): *Hechos y cifras del Sector Agroalimentario Español 1998*. MAPA. Secretaría General Técnica.
-MEYER, S.M. (1992): *Environmentalism and Economic Prosperity: Testing the Environmental Impact Hypothesis*, MIT Press, Cambridge, mimeo.
-PALMER, K., OATES, W.E., PORTNEY, P.R. (1995): "Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm?". *Journal of Economic Perspectives*, vol. 9 (4): pp. 119-132.
-PORTER, M.E. (1991):"America's Green Strategy". *Scientific American*, 264 (4):p. 96
-PORTER, M.E. y VAN DER LINDE, C. (1995): "Green and Competitive: Ending the Stalemate". *Harvard Business Review*, 73 (5): pp. 120-134.
-RUESGA, A. (2000): "La agricultura ecológica, un sistema agraria sostenible". *Informe Anual del Sector Agrario en Andalucía 1999*: pp. 353-405. Analistas Económicos de Andalucía. Unicaja.
-SANCHO, J., MORENO, F., NAVALTROPO, P. y SANTAOLALLA, A. (1994): *El Medio Ambiente en la PAC: Impactos recientes en la agricultura española*. El Campo. Agricultura y Medio Ambiente. Servicio de Estudios BBV.
-SCHMOOKLER, J. (1966): *Invention and Economic Growth*. Cambridge Ma: Harvard University Press.
-SUMPSI,J.M.,GARRIDO,A.,IGLESIAS,E.(1997):"La política agroambiental de la UE: un análisis desde la perspectiva económica".*Revista de Economía Agraria*,179: 227-265
-VAN DER LINDE, C. (1993): "The Micro-Economic Implications of Environmental Regulation: A Preliminary Framework". *Environmental Policies and Industrial Competitiveness*, Organization of Economic Cooperation and Development (OECD): pp. 69-77.
-VISCUSI, K.W. (1978): "A note on 'lemons' markets with quality certification". *Bell Journal of Economics*, 9(1): 277-279.
-XEPAPADEAS, A. y ZEEUW, A. (1999): "Environmental Policy and Competitiveness: The Porter Hypothesis and the Composition of Capital". *Journal of Environmental Economics and Management*, 37 (2): pp. 165-182.

APPENDIX

Table A.1. Summary of the activities included in the Operative Programmes

Year	Activity	Operative Fund Share (%)

1997	1	48.32
	2	29.12
	3	3.90
	4	15.21
	5	3.45
1998	1	51.18
	2	28.60
	3	4.24
	4	13.18
	5	2.80
1999	1	62.47
	2	25.81
	3	4.11
	4	5.68
	5	1.93
2000	1	63.92
	2	25.94
	3	5.86
	4	2.71
	5	1.57

1.- Agricultural production methods compatible with environmental standards.
2.- Quality improvement in the productive system.
3.- Commercialisation under quality systems.
4.- Methods for the control of phytosanitary standards and provisions.
5.- General expenditures.
Source: Andalusian Council of Agriculture and Fisheries.

Table A.2. Survey of quality-environmental actions.

1. *Specify which quality-environmental actions (following certification systems or farming regulations) and other unrelated innovative practices your firm is implementing:*

(1)- **Farming production methods compatible with environmental standards**
Systems, regulations or technology applied: .....
.....

(2)- **Quality improvement in the productive system**
Systems, regulations or technology applied:.....
.....

(3)- **Commercialisation under quality systems**
Systems, regulations or technology applied: .....
.....

(4)- **Methods for the control of phytosanitary standards and provisions**
Systems, regulations and technology applied:.....
.....

(5)- **Others (specify technological innovations and processes)**.....
Systems, regulations or technology applied:.....
.....

2. *Specify the expenditure or investment in the actions of type (1) "Farming production methods compatible with environmental standards" and its percentage included in the Operative Programmes (according to 2200/96 EC Regulation).*

1991 – Total investment: ..... ptas.
1992 – Total investment: ..... ptas.
1993 – Total investment: ..... ptas.
1994 – Total investment: ..... ptas.
1995 – Total investment: ..... ptas.
1996 – Total investment: ..... ptas.
1997 – Total investment: ..... ptas. ; % included in the Operative Programme: .....
1998 – Total investment: ..... ptas. ; % included in the Operative Programme: .....
1999 – Total investment: ..... ptas. ; % included in the Operative Programme: .....
2000 – Total investment: ..... ptas. ; % included in the Operative Programme: .....

3. *Specify the expenditure or investment in the actions of type (2) "Quality improvement in the productive system" and its percentage included in the Operative Programmes (according to 2200/96 EC Regulation).*

.....

4. *Specify the expenditure or investment in the actions of type (3) "Commercialisation under quality systems" and its percentage included in the Operative Programmes (according to 2200/96 EC Regulation).*

.....

5. *Specify the expenditure or investment in the actions of type (4) "Methods for the control of phytosanitary standards and provisions" and its percentage included in the Operative Programmes (according to 2200/96 EC Regulation).*

.....

6. *Specify the expenditure or investment in the actions of type (5) "Others (not included in the previous ones)" and its percentage included in the Operative Programmes (according to 2200/96 EC Regulation).*

.....