FACTORS RELATED TO THE ADOPTION OF GOOD AGRARIAN PRACTICES (GAP) IN PLASTIC COVERED HORTICULTURE OF SOUTHEASTERN SPAIN

Adriana Bertuglia & Javier Calatrava-Requena

IFAPA-CIFA
Dpt. Agricultural Economics and Rural Studies
Apdo. 2027- 18080 (Granada) Spain
E-mails: **adriana.bertuglia.ext@juntadeandalucia.es**; **javier.calatrava@juntadeandalucia.es**

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ABSTRACT

The adoption by farmers of Good Agrarian Practices (GAP), that favouring the environment and assure food quality and safety, is being a frequent fact.

Considering the plastic covered horticulture, these kind of practices can be of different nature: use of organic fertilizer, made of crops rotations, use of recyclable plastic as greenhouse cover, good management of organic residuals (use of containers), recycling of plastic containers, etc.

This paper, wich try to analyse the adoption of GAP by protected vegetable growers, is based on a survey carried out to 114 farmers in the southeast coastline of Spain, asking for the level of adoption of a set of GAP.

From the information gathered on the survey, an aggregated index of adoption has been performed, and the relationship between this index and some structural and managerial characteristics of the greenhouses, and some sociocultural variables of the growers (age, study, agrarian formation, etc.) has been analyzed, trying to identify factors related to adoption of GAP, which could probably help to design strategies for the increase of the level of GAP adoption in the system.

INTRODUCTION

The increasing requirements of food quality and safety from consumers, and the social concern for enviromental quality and sustainable development, are inducing the agri-food industry in general and the vegetable industry in particular, to increase the quality achievements and control in all phases of the production and marketing process, from farmer to retailer.

This requeriment of quality from the market, it's directly transmitted to the agricultural practices adopted by the farmers, being the main requirements the adoption of environmental safe agricultural practices (residuals maximum limit, use of authorized products, recyclable plastic, etc.) and those that improve also food quality and safety (use of organic fertilizer, pollination with bumblebee,

etc.). In some cases, but not always, the Good Agrarian Practices (GAP) adoption culminates with the request or adhesion by farmers to a quality system and the obteinment of certificated quality labels for his products.

The plastic covered horticulture system in the southeastern spanish mediterranean coast-line account for almost 35000 hectares being the biggest concentration of plastic greenhouses in the world: 85% of the surface belonging to the province of Almeria and 15% in the province of Granada. The system produces about 3 millon mT of vegetables, being tomato, pepper and cucumber the more important crops.

The first pionnering works in GAP adoption are mainly refered to soil conservation techniques and are published mainly in soil journals: Ervin and Ervin (1982), Clearfield (1983), Van Es (1983), Norris and Batie (1985), Nowak (1987), etc.

In the past decade appears works refered to other GAP not necessarily related to soil conservation technologies: Saltier et al. (1994), Fernandez et al. (1994) related to the adoption of GAP in horticulture in Florida, Morris and Potter (1995), Lockie et al. (1995), Adesina and Chianu (2002), Valentin et al. (2004), etc.

In Spain works about the technologies adoption in agriculture are frequent in the last three decades, but specifically dealing with GAP are more recent. Heavily related with this work are, among others, the ones of Calatrava and Sayadi (2002), Parra and Calatrava (2002), Sayadi et al. (2005), Parra and Calatrava (2005), Sayadi and Calatrava (2006), etc.

The PIA 03-777 project , from wich this work is a partial result, includes between its objectives the identification of factors that influence in the adoption of GAP in the protected horticulture. In this sense, in this paper, using a survey to 114 vegetable growers, an analysis of the GAP adoption in the plastic covered horticulture of the southeast coastline of Spain, has been performed. After having defined an aggregated index of adoption of GAP, the main structural figures of the farm and socioeconomical characteristics of the farmers that have a relationship with the adoption of GAP, are identified.

METHODOLOGY

The information used comes from a survey to 114 vegetables growers.

In this survey, in addition to the information about the adoption of certificated labels, information about the fact of adopting or not some practices that promote environment and/or food quality have been gathered.

The questionnaire structure is made in 4 blocks of questions, as follows:

- Generals characteristics of the farm

- Adoption of quality systems: knowledge, aptitudes and opinions

- Agrarian practices related with products and environment quality improvement

- Characteristics of the farmer

The following GAP practices have been taken into account:

1. Leaf analysis
2. Soil analysis
3. Water analysis
4. Integrated horticulture
5. Pollination with bumblebee

6. Organic fertilizers
7. Recyclable plastic cover in the greenhouse
8. Recyclable plastic containers
9. Carrying out of crops rotation
10. Organic residuals management

From these GAP an aggregated index of adoption has been defined as follows:

$$I = \frac{1}{10} \sum_{i=0}^{i=10} \alpha_i$$

where $\alpha_i = 1$ if the practice i it's realized and $\alpha_i = 0$ on the contrary.

The no consideration in the list above of having or not certificated quality labels (EUREPGAP for example), is justified for the possible existence of a strong relationship between this fact and the adoption of the most of the agrarian practices that have been considered. For this reason it's been preferred to use, directly, agrarian practices and not certificated labels. The hypothetical relationship between labels and adoption of GAP has been proved by estimating a small bivariate probit model, where the dependent variable was the fact to have or not a certificated quality label and the independent variable the value of the aggregated adoption index I previously defined.

After that, the above defined index has been used as the dependent variable of a regression model where the independent variables are:

- Surface of the greenhouse (SURF)

- Type of marketing (MARK): though cooperative, SAT[1], private wholesaler, alhóndigas[2]

- To be member of an associative board (MEMBER)

- To have continuity on the activity (DESCE)

- Autoevaluation of the risk assumption (RISK)

- Knowledge of integrated horticulture (INTEG)

- Dedication to agrarian activities: total or partial (AGRDED)

- Reception of formal technical advice (ADV)

- Attendance to agrarian courses (COURSES)

- Reading horticultural periodical (PERIOD)

- Farmers age (AGE)

- General education of the farmer (STUDY)

- Agrarian training level (TRALEV)

A maximum likelihood bivariate o multivariate probit or logit model could be estimated by estratifing, in several strata, the index I, even thought some information about the I variable could be lost. Due to the theoretical lack of normality of I distribution the least squares regression it's suppose to give estimators wich are not the best minima variance umbiased estimators.

Nevertheless, the dimension of the sample and the remark of the postulates of the Central Limit Theorem allow to suppose that there is a strong convergence to normality in the distribution of the index I considering its nature as aggregate variable. On strict theory, the Central Limit Theorem, requires that the variables that join are independent to each other. This independence was tested, and it is almost general, except in the case, as expected, of the three first GAP considered where a

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[1] SAT: Agrarian Transformation Society: A spanish institution similar to cooperatives but usually with small numbers of members.
[2] Alhóndiga: A kind of barter market, traditional in the area, for selling fruits and vegetables.

certain significant relationship ($\alpha \geq 0,05$) appears, as the grower who realizes an analysis (of water, for example) has some probability to realize also other ones (of soils, of leaves).

To confirm the accomplishment, under these circumstances, of the Central Limit Theorem, it was carried out the test of Kolmogorov-Smirnov, as the null hypothesis that the I index has a normal distribution, cannot be rejected ($\alpha \geq 0,01$). For this reason the least square regression model is, in this case, acceptable, and so it was used.

RESULTS

As it was expected, and mentioned in the methodology, there is a strong relationship between the fact of having a certificated quality label and the aggregated index of GAP adoption defined.

The results of the probit model fitted can be seen on Table 1; from these results the graphic on Figure 1 has been designed, where it can be seen the variation of the probability of having a certificated quality label as a function of the value index of adoption of the considered GAP.

An hypothetical farmer who has adopted only two of the practices has a small probability (0,24) to have a certificated quality label, while this probability is very high (0,90) for a grower who has adopted all ones.

In Table 2 it can be seen the frequency distribution of the number of the agrarian practices adopted. One can see a high level of adoption, being the mean of the index of adoption I 0,593 and its standart deviation 0,224 (that means an average of 6 adopted practices).

The agrarian practices more adopted are the use of organic fertilizer, the crops rotation carrying out, the use of recyclable plastic as greenhouse cover and the use of specific containers for the organic residuals produced from the farming (Table 3). It stands out the poor percentage of farmers who performs integrated horticulture, fact confirmed in previous works (Calatrava and Sayadi, 2002) about tropical fruit-growing in the same area. In Table 4 are included the results of the fit of the GAP adoption function after having removed the no significative variables. Model is highly significative (P=0,000) and its $R^2 = 40,56\%$.

It's observed a significant positive relationship between the index of adoption and the total farm surface, in the sense that the probability of adoption of GAP is higher in bigger farms.

At the same time, the number of adopted GAP is higher in the case of farmers knowing what the integrated farming is. It was also found a direct relationship between the farmers risk level and the GAP adoption index.

It doesn´t surprise the inverse relationship between I and the total dedication of growers to agriculture; in fact the total dedication to farming is a characteristic of family farms which have more financial dificulties to invest in new technologies. Generally, the managers whose dedication to agriculture is partial, having other sources of income, are the ones who invest more in the agriculture, favouring the modernization of the farm with the adoption of new agrarian practices that could bring more benefits.

About the characteristics of the farmers, the reading of agricultural reviews has a direct relationship with the adoption of agrarian practices environmentally sustainables and that increase food quality.

No relation was found between I and the type of marketing, the fact to be member of an associative board (Coop. or SAT), continuity in the farm, to receive formal technical advice by clients, the agrarian formation level, the attending of horticulture courses, farmers general educational and the farmers age.

On Table 5 you can see schematically the significance of the different considered variables.

With the idea to go deep into the nature of the relationship between the index of adoption and some variables, it was considered specifically its relationship with the surface, and with the subjective index of risk assumption.

In the case of relationship between the GAP adoption and the surface it was detected a significative quadratic effect (P=0,0034), whose expression is given by:

$$I = 0,433561 + 0,233376\ S - 0,0368198\ S^2$$

From this relation it can be deduced that:

a) Even for very small orchard the average of the number adopted practices is relatively big: it would be 5 for a farm of only 3000 m^2.

b) Increasing orchard dimension (until 2,1 Ha) constantly increased number of GAP adopted.

About the index of risk assumption of the farmer, the best regression with I is the linear one with a R^2=0,408.

The relation is given by:

$$I = 0,211 + 0,063 \text{ Risk} \qquad F = 16,61 \ (P = 0,000)$$

For a grower totally adverse to risk, the average value of the index of adoption would be 0,211 and for a grower with a maximum level of risk assumption, this average would be 0,778.

CONCLUSIONS

- Of the agrarian practices considered in the protected horticulture, that can have a direct or indirect influence in food and/or environment quality, the more highly diffused are the use of organic fertilizers (85,1%) and the crops rotation carrying out with agroecological purposes (78,9%).

- On the contrary, the less adopted, is the integrated horticulture in the greenhouses (7%), being the following, analysis of water quality, much more frequent (50%).

- There is a certain relationship between the fact to realize analysis of different nature (water, leaf and land) in the greenhouses.

- It was detected the expected relationship between the adoption of GAP considered and the fact of having certificated quality labels, in the sense that a higher number of practices adopted by a vegetable grower increases the probability to have a label.

- There is scale effect on the adoption of agrarian practices that favour food or environment quality. This scale effect is significant until surfaces of about 2 Ha, disappearing for larger orchards.

- Despite the clear previous scale effect, the adoption of an important number of agrarian practices is evident even from orchards with very small surfaces, being, for example 5 the average of the number of GAP adopted for an orchard of only 3000 m^2 .

- A relationship between the scaling perception that the grower has of his own level of risk assumption and the adoption of agrarian practices has be found.

- The frequent reading of horticultural publications is directly related with the adoption index of GAP.

- Even thought the integrated horticulture is an innovation minoritly adopted by growers, the fact to know the characteristics of this system of production, is directly related with the aggregated index of adoption used. This relationship isn't strange as the knowledge of the techniques of the integrated horticulture imply a certain level of training of the farmers, and even some of the "integrated" practices are amont the set of GAP considered.

- Part time agriculture is related with the index of GAP adoption, in the sense that for people with an occupation different from agriculture the average index of GAP adoption is higher. This relation isn't surprising as, frequently, the part time growers, with others sources of income, have more inclination to introduce innovations than the traditional full time growers.

- Neither the type of way used by growers to trade, neither the fact to belong to a marketing associative board have a significant relationship with the index of GAP adoption. This is interesting, since usually it could be thougth that a kind of marketing board would be required to its suppliers certains levels of quality in the agrarian practices, but for the coast of protected horticulture in the area, this hypothesis could not be accepted. Probably what is happened is that all marketing boards are developed enough to present the same level of exigence of quality to farmers.

- Neither the general education level of the growers and the attendance to agrarian courses, that usually are factors of adoption of thecnological innovations in others farming systems, have a relationship with the adoption of good agrarian practices.

- The increase of the orchard dimension, and the development of the part time agriculture, seem to be possible elements that favour the adoption of agrarian practices that have an effect on the food and/or environment quality.

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TABLES AND FIGURES

Table 1. Results of the Probit model of de quality-adoption certification

Variable	Coefficient	Typical error	Probability P
Constant	-1,17025	0,36387	0,0013
I	2,47690	0,59294	0,0000

R V = 19,13284
P = 0,000012
PCC = 71,58%

Figure 1: Relationship between the probability to have a certificated quality label and the index of adoption of the GAP considered
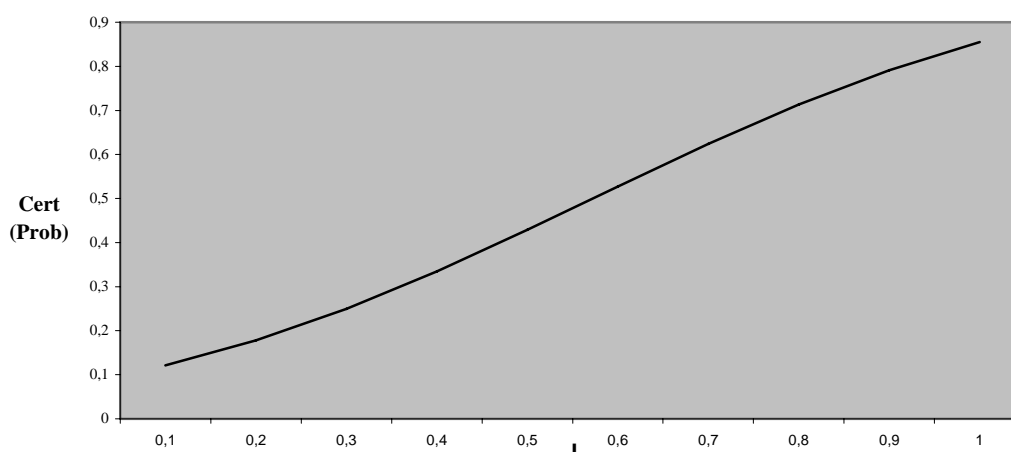

Table 2. Frequency distribution of the number of de practices adopted

Nº practices realizated	1	2	3	4	5	6	7	8	9	10
Frequency (%)	2,6	5,3	8,8	11,4	10,5	21,1	10,5	14,0	14,9	0,9

Table 3. Percentages of GAP adoption

	%		%
Water analysis	50	Crops rotations	78,9
Land analysis	54,4	Recyclable plastic containers	66,7
Leaf analysis	47,4	Organic fertilizers	85,1
Containers org. res.	71,9	Recyclable plastic cover in the greenhouse	71,9
Pollination with bumblebees	58,8	Integrated horticulture	7

Table 4. Function of adoption

Variables	Coefficient	Estadistic-t	Probability P
Constant	0,298071	3,00575	0,0033
SURFGREEN	0,0835769	2,11676	0,0366
RISK	0,0474987	3,67042	0,0004
INTEGR	0,159721	4,28446	0,0000
AGRDED	-0,162953	-2,59571	0,0108
PERIOD	0,108959	2,7689	0,0067

$R^2 = 0,4056$
F = 14,33 (P = 0,0000)

Table 5. **Scheme of relationship between I and the variables initially specified in the model**

VARIABLE	SIGNIFICATION (P)	DIRECTION
- Surface of the greenhouses	S	+
- Level of assumption of risk	S	+
- Knowledge of integrated horticulture	S	+
- Total or part time dedication to the agriculture	S	**-**
- Reading of periodical about horticulture	S	+
- Type of marketing system	N.S.	
- Being member of an associative board (COOP. or SAT)	N.S.	
- To have or not continuity in the agrarian activity (descent)	N.S.	
- To receive or not formal technical advices	N.S.	
- Farmers age	N.S.	
- Level of general education	N.S.	
- Level of agrarian training	N.S.	
- Attendance to courses related to the horticulture	N.S.	