TECHNICAL VERSUS INSTITUTIONAL INNOVATION IN ANDALUSIAN OLIVE TREE ORCHARDS: AN ADOPTION MODELLING ANALYSIS

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Abstract— **A survey carried out among olive tree growers in different districts of southern Spain allows the identification and analysis of factors related with adoption of several technical and institutional innovations. At that respect, a composite numerical index has been performed including all innovations considered, among then the following: changes in orchard structure, non or reduced tillage, use of tree vibrators for harvesting, non conventional methods for fighting pests and diseases, keeping an accounting systems, annual farm planning, level of information and awareness of the European CMO in relation to olive oils, etc. Structural and managerial variables of the orchard and personal characteristics of the grower, related to the composite innovation index, have been identified. In a second step, two similar separate analysis have been made for both technical and institutional innovations, and several conclusions have, finally, been drawn concerning factors that should enhance both types of innovations adoption in Spanish olive orchards.**

Keywords— **Innovation adoption, institutional and technological innovations, olive tree growers.**

I. INTRODUCTION

Olive oil is the only fat that shows a clear increase in world consumption, approaching to 3 millions tones. Spain, with an average of production of 1 million Tm. is the first world producer. Olives groves or pressing occupy in Spain 2,3 million Ha., extending throughout the Spanish mediterranean climatic area, and grouped into more than 350,000 growers. Spanish agrarian final production of olive oil amount to 12,5% of the final spanish agrarian production, and to more than 40% of the final European Union olive oil production. The value generated by spanish olive oil industry surpasses 2,500 millions euros, no counting european subsidies. Moreover, olive growing and harvesting involve about 40 millions workdays/year (MAPA, 2006).

Notwithstanding the enormous economic importance of the olive crop, not to mention its environmental and aesthetic importance, works studying the analysis of these factors affecting the adoption of technological and institutional innovations for olive growers are scarce. Most of the rare existent works deal with adoption of factors related either to efficiency (Calatrava-Leyva, 1997, Calatrava-Leyva y Cañero 1999) or to organic olive production, considered as an innovation (Chinchilla, 1999, Parra y Calatrava-Requena 2005, Parra, De Haro y Calatrava-Requena, 2007). Other works are devoted to adoption of soil erosion Control Practices (Franco y Calatrava-Leyva, 2006 and Calatrava-Leyva et al. 2007)

This paper analyzes the adoption for olive growers of a set of both technical and institutional innovations, identifying factors that affect and could enhance this adoption.

II. METHODOLOGY

From a survey of 254 olive growers in Andalusia (South of Spain), a composite innovation adoption index (I_a) has been performed considering the following characteristics in a binary (yes/non) format:

- Use or not of no tillage or conservation tillage or tillage reduction in its various variants.
- Use or not of some type of technique and/or outside counselling in designing fertilising plans
- Use or not of outside counselling in pest control.
- Use or not of some cultural means of pest and disease control (usually complementary to or in partial substitution for chemical measures).
- Use or not of branch and/or tree trunk vibrators in the harvest (including those

cases where they complement the traditional system).

- Recent adoption (over the last three campaigns) or not of any other technological innovation in the areas of irrigation, crop techniques, mechanisation or other aspects.
- Has extended or not the size of the olive grove.
- Machinery is owned by the enterprise or is rented.
- Keeps accounting records or not.
- Performs or not a yearly "ex ante" planning of the olive grove.
- Receives adequate, up to date information on the CMO for olive oil.

The aggregated adoption index (I_a) is the number of "yeses" provided by the grower, and therefore varies between 0 and 11.

I_a has been considered as a dependent variable, in both an OLS and a multinomial probit models with four strata as follows: <=2, 3 and 4, 5 and 6, >6 . The independent variables in both models were the following:

- Total surface of the olive grove.
- Family or corporate character of the olive grove.
- Inherited or acquired olive grove.
- Grower's age, measured at 5 levels: 30 or under, 31 to 40, 41 to 50, 51 to 60, and over 60.
- Full or partial dedication to olive growing .
- Length of time the grower has been dedicated to olive crops, with four levels: I have always been an olive grower, I have been one for more than 10 years, I have been one for less than 10 and more then 5 years, and I have been for less than 5 years.
- Educational level of olive grower, with four levels: Zero, elementary school, high school, and University studies.
- Agrarian training level of grower: None, Technical Seminars and Courses, Regulated Learning Agrarian Credentials (AVT or University).
- Subscribed or not to agricultural reviews or magazines .
- Uses to read books and/or magazines on olive growing, with the levels: Yes, Sometimes, No
- Acquaintance and frequent visits to the zone's agrarian extension office (SEA), with the following levels:
  - I don't know it
  - Yes, I visit it often
  - Yes, but I rarely go there
  - I know it exists, but I never go there
- Knowledge or not of the existence of the Centros de Investigación y Desarrollo Agrario (Agricultural Research and Development Centers), where the grower can receive information regarding olive tree crops.
- Recent adoption or not of any technological innovation

In a second step, two indexes, I_t and I_i have been calculated by analysing both technical and institutional innovations separately (I_t lies between 0 and 6 and I_i between 0 and 5) and they have been considered as dependent variables in two ordered Probit models with the same independent variables that in I_a model. In order to compare these two indexes, they have been standardized between 0 and 1.

$I'_t = I_t/6$ $\qquad$ $I'_i = I_i/5$

III. RESULTS AND CONCLUSIONS

A. Frequencies and statistics

The variables that make up the technological innovation It index are distributed among the grower sampling as follows:

Variable	%Yes
No tillage or diverse conservation tillage	38.29
Guided fertilising	70.36
Counselling in pest control	84.58
Cultural measures in combating pests and diseases	14.23
Use of tree vibrator in harvesting	74.21
Recent innovation	29.73

The variables that make up the institutional innovation index I_i are distributed among the grower sampling as follows:

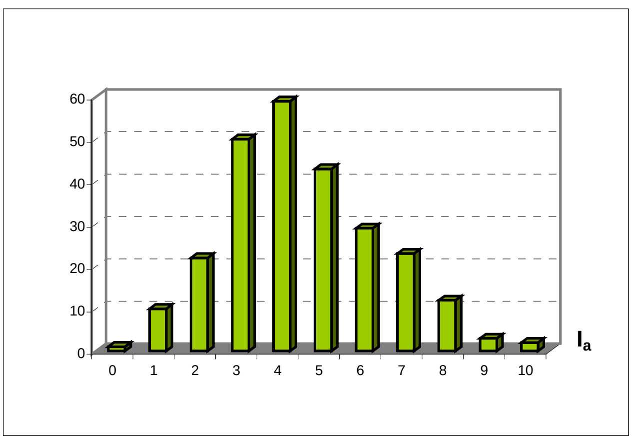
Variable	%Yes
Enlargement of the olive grove	52.85
Machinery rental	36.54
Accounting control	35.06
Advance planning	24.00
CMO information	39.60

Both groups of variables make up the composite adoption index (I_a). Means, medians, modes and variances of the three indexes are as follows:

	Mean	Median	Mode	Variance
I_a	4,46	4	4	3,53
I_t	2,60	3	2	1,.66
I_i	1,86	2	1	1,19

Figure I shows the frequency distribution of the aggregated index I_a

Figure I: Distribution of I_a



B. Factors related to adoption

OLS and Probit models for I_a have been very significant. ($\alpha >= 0.001$) and R2 and PCC (Probability of Correct Classification) are 55.36 and 56.23 % respectively.

Table 1 and Table 2 show the level of significance of regression coefficients of these models. Results are about the same for both models. Table 1 also shows results concerning level of significance for both technical and institutional innovation adoption models.

Table 1 Significance levels of regression coefficients in different models (I)

Significance key:
↑↓ Direct or inverse relationship
Significance: α ≥ 0.1 *
α ≥ 0.05 **
α ≥ 0.01 ***

	All innovations OLS	All innovations Probit
Surface	(***) ↑	(***)↑
Family or corporate character of olive grove	N.S.	N.S.
Inherited or acquired	N.S.	N.S.
Grower's age	N.S.	N.S.
Full or partial dedication	(***) ↓	(***) ↓
Length of time in farming	N.S.	N.S.
Educational level	N.S.	N.S.
Agrarian training	(**) ↑	(**) ↑
Subscription to agric. reviews	(**) ↑	(***) ↑
Reading olive books	N.S.	N.S.
Extension Agencies	(**) ↑	(**) ↑
Research Centre	(***) ↑	(***) ↑
Recent adoption.	(***) ↑	(***) ↑

Table 2 Significance levels of regression coefficients in different models (II)

Significance key:
↑↓ Direct or inverse relationship
Significance: α ≥ 0.1 *
α ≥ 0.05 **
α ≥ 0.01 ***

	Technical innovations Probit	Institutional innovations Probit
Surface	(***) ↑	(*) ↑
Family or corporate character of olive grove	N.S.	N.S.
Inherited or acquired	N.S.	N.S.
Grower's age	N.S.	N.S.
Full or partial dedication	(**) ↓	N.S.
Length of time in farming	N.S.	N.S.
Educational level	N.S.	N.S.
Agrarian training	(***) ↑	N.S.
Subscription to agric.	(***) ↑	N.S.

reviews		
Reading olive books	N.S.	(***) ↑
Extension Agencies	(*) ↑	(***) ↑
Research Centre	(***) ↑	(*) ↑
Recent adoption.	(***) ↑	(***) ↑

There is a scale effect in adoption. This scale effect is more significant for technical than for Institutional innovations adoption. Table 3 includes indexes values for different surface strata. *Partial dedication to growing* likewise *increases the chances of having a higher I_a, and I_t* which is justified, no doubt, by the fact that entrepreneurs with other interests demonstrate less aversion toward risk taking, which goes hand in hand with innovation, and besides, they are liable to invest extra agrarian resources in the technological level of their olive groves. *Institutional Innovation adoption index It is not significantly related to the time of dedication to olive growing*.

The overall innovation adoption index increases with the level of agrarian training of the grower and with the *subscription to agricultural reviews*, and so the technological index, but *both variables are not related (α=0.1) to the institutional innovation adoption index.*

Reading olive related materials has a heavy relationship with the institutional innovation adoption index, but does not influence the technical and the all innovations adoption index. Contact with local extension agencies is significantly related to all indexes, but this relationship is more significant (α>= 0.01) for institutional innovations adoption than for technical one (α= 0.1). On the contrary, knowledge of Research Centres where the grower can receive information regarding olive tree crops, is related to all indexes but this relationship is more significant for technical (α= 0.01) than for institutional (α= 0.1) one. *Extensions Agencies seem to be more related to institutional changes and contacts with Research Centres with technical ones*.

Recent adoption in the last three years is heavily related to all indexes. None of the other characteristics analysed: age, length of time dedicated to olive crops, grower's educational level, family or corporate character of the olive grove, inherited or acquired property, appear (α= 0.1) as factors in the adoption of either technological or institutional innovations.

C. *Relationship between I_i' and I_t'*

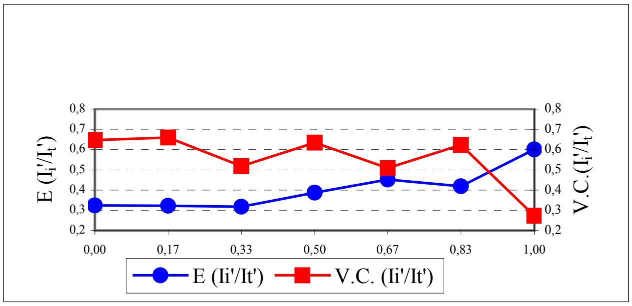
The linear correlation coefficient between I_i' and I_t' is 0.342 (significant for α=0.0001), although the optimal adjustment between both variables is a squared relation in the following form: $I_i' = 0.3063 + 0.2749\, I_t'^2$

This indicates that for olive groves with a null or low technical innovation index there is a practically constant minimal degree of institutional innovation, and that this institutional innovation increases after a certain value for I_t, but always maintaining itself at $I_i <= I_t$. It is as if any increase in I_i' depended on (or was induced by) I_t', which basically agrees with the Institutional Innovation Theory advanced by Ruttan and Hayami (1984) and Ruttan (1985). In order to better illustrate this fact, Figure II displays the expectations (E) and the variation coefficient (V.C.) of the conditional distributions f (I_i' / I_t'), where the above mentioned relationship can clearly be seen once the model's large residual variance has been eliminated.

Table 3: Relationship between adoption indexes and olive grove surface

ORCHARD SURFACE	Ii	It	Ia
Up to 5 Has	1,5000	2,0455	3,5455
5.01 to 10 Has	1,4474	1,9737	3,4211
10.01 to 20 Has	1,7255	2,3333	4,0588
20.01 to 30 Has	1,7222	2,8889	4,6111
30.01 to 40 Has	2,0400	2,8800	4,9200
40.01 to 50 Has	2,2308	2,8462	5,0769
50.01 to 100 Has	2,4583	3,3750	5,8333
More than 100 Has	2,6522	3,6522	6,3043
Mean Value	1,8543	2,6063	4,4606

Figure II: Expectation and variation coefficient of the conditional distribution Ii'/It'



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