#7666 DETERMINANTS OF THE ADOPTION OF AN INTELLIGENT MONITORING SYSTEM AND EFFECTS ON FARMS PERFORMANCE IN TUNISIA

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ABSTRACT

Technology has become essential to the farm organization not only for its effectiveness, but also for its strategic development within its competitive environment. The aim of this study is to assess the extent to which farmers complied with the aspects of precision agriculture for transforming agricultural extension in developing countries using the latest available technologies and research methods.

Considering the observation of the rise of Computerized Management Software Packages and intelligent monitoring in a path of modernization of agricultural techniques, we questioned the main factors influencing the decision to adopt software management, farmers' perception of these management tools and their impact on farm performance. Referring to a theoretical framework focused on innovation and technologies adoption in agriculture, we built the hypothesis of our research: Changes in farming practices, such as the installation of management software, are the result of a process of innovation. This process begins with a technical proposal, which is gradually adopted by farmers based on several factors. On the basis of a sample of 50 agricultural specialized in crop production, with an area of 40 ha or more and spread over the two areas: Grand Tunis and Zaghouan governorates, an econometric analysis (Logit model) has been carried to test this hypothesis and to identify the decisions of adoption factors of the technology management; in our case the software AgriManager produced by the company Ezzayra.

Initially, through a bivariate analysis, it was possible to remove the variables most influencing the choice of operators to adopt computerized management software. Secondly, to overcome the constraint of the model degree of freedom, an analysis in main components identified the main components containing the most significant explanatory variables. These were introduced into the estimated Logit model, which allows several correlations to be drawn between the selected variables and farmers' decision to adopt this innovative technique. These are the variables relating to the characteristics of the holding (total area, crop types, etc.), of the operator (their age, level of education and their formation) and their relational networks. Finally, an analysis of farmers' perceptions of such software has made it possible to identify the expected effects of its adoption in terms of productivity gains, stock management, improving the profitability and efficiency of the exploitation of scarce resources. The partial cost method and the comparison of the situation before and after software are used to confirm the positive effect of intelligent monitoring methods on the economic performance of the farms using this management method.

INTRODUCTION

Technology has become essential to the farm organization not only for its effectiveness, but also for its strategic development within its competitive environment (Bucci et al, 2019; Akullo et al., 2018; Kalirajan and Shand, 2001).

Our research purpose is to contribute to a better understanding of the adoption of new technologies by farms. This study determines technology adoption factors and their consequences for the implementation of management software within large farms to various types of speculation, particularly arboriculture, market gardening and field crops. In this paper, we answer the following two research questions: What are the main factors that influence farmers decision about adopting a new technology for managing agricultural businesses? What changes have been observed in farms that have chosen to use this practice? On the basis of a sample of 50 farmers belonging to the governorates of Manouba, Ben Arous and Zaghouan chosen as study areas, statistical and econometric analyses were carried out in order to identify the determinants of decisions to adopt a new management technology by farms.

MATERIALS AND METHODS

Modelling the Decision to Adopt New Management Technology: Logit model

Logit models are built on the assumption of cumulative logistic distributions allowing an adequate treatment of outliers due to their set ends unlike Probit models (Hurlin, 2003).

We consider a sample of N farms indexed i = 1, .., N. For each farm, we observe whether a certain event has occurred, and we denote yi the coded variable associated with the event.

$$p_i = Prob\ (y_i = 1 | X_i) = F\ (\alpha X_i)$$

where the function F (.) denotes the distribution function. The choice of the distribution function
F (.) is a priori unconstrained for i of the interval [1, N] we have the following form:

$$Y_i = \begin{cases} \mathbf{1} \text{ if the event has occurred: farm i adopts agricultural management software} \\ \mathbf{0} \text{ if the event did not happen for farm i} \end{cases}$$

The decision of adoption a new technology by an operator depends on several factors which are social, economic, related to the environment, climatic, related to the external market, and / or related to the internal characteristics of the operation. The operator's behavior following the choice of technology adoption is correlated with several explanatory variables Xi which will be taken from the principal component analysis.

The variables collected from the database collected are: age, education level, agricultural training, exploitation area, olive groves, type of culture: market gardening and arboriculture or field crops, irrigation, difficulties in recruiting labor, exportation, information about management software and sources of this information.

The number of explanatory variables is equal to 17 and the number of observations is 50. The degree of freedom is dof = 50-17 + 1= 32. This low degree of freedom does not permit a good estimate of the logit model. Hence, we carry out a principal component analysis to reduce the number of variables without affecting the quality of the information.

Data

Data for farmers are generally unavailable or not up to date. In addition, there is a lack of information about the management systems adopted by the farms and the conditions affecting the decision to change agricultural technics. The field study is essential to succeed in filling this gap and producing the needed data for our research. The conduct of surveys covering technical, social and economic aspects among operators allows the creation of a database necessary for the analysis of their situation, their characteristics, their responses and attitudes

towards the adoption of new management technologies. The sample is made up of 50 farmers, spread over 2 zones, Grand Tunis (Ben Arous and Mannouba) and Zaghouan. The minimum area is 40ha. The cultures adopted are widely varied: arboriculture, market gardening and field crops. Among the 50 farms visited, only 22 use software as a means of management, which corresponds to 44% of the sample studied.

RESULTS AND DISCUSSION

The Adoption of New Management Technology in Agriculture Factors - Principal Component Analysis

This analysis gives 15 components. The first 6 components explain 74% of the information. However only 4 first components are significant (Table 1) and will be taken in the model

Table 1. Component matrix

	Component Coefficients					
	α_1	α_2	α_3	α_4	α_5	α_6
X1 : Age	-,466	,253	,107	-,275	,275	,185
X2 : Education level	-,029	-,686	-,145	,440	,252	-,048
X3 : Agricultural training	,136	-,180	-,068	,281	,595	,357
X4 : Exploitation area	,156	-,236	,950	-,033	,053	,020
X5 : Olives	,654	,322	,016	-,011	,026	,391
X6 : Market gardening and arboriculture	,859	,078	-,133	-,269	,170	,030
X7 : Field crops	-,713	,261	,178	,133	,203	,298
X8 : Irrigation	,888	,098	-,151	-,231	,120	-,034
X9 : Difficulties in recruiting labor	-,101	,202	,013	-,436	,392	,254
X10 : Exportation	,278	-,284	,906	-,089	,005	-,029
X11 : Information about management software	,335	,382	,107	,610	-,193	-,225
X12 : source 1	,029	,573	,165	,384	,295	-,196
X13 : source 2	,054	,234	,030	,197	,675	-,434
X14 : source 3	-,203	,676	,190	-,305	-,128	-,248
X15 : source 4	,160	,378	,113	,521	-,288	,514
Sig of components	(*) 0,003	(*) 0,024	(*) 0,013	(*) 0,097	(**) 0,561	0,361

(*) : significant (**) : not significant

Each principal component group set of explanatory variables such as:
C 1: age, olive tree plantations, market gardening and arboriculture, field crops and irrigation.
C 2: level of education and sources of information 1 and 3.
C 3: the total area of exploitation and export.
C 4: difficulties in recruiting labour, information on management software and source of information.

Logistic Regression: Logit Model

The overall significance test gives a result <5% which reveals the high significance of the model. The maximum likelihood test gives a result equal to 24.6 which complies with the acceptance standards of the model.

Table 2. Model estimation result

Explanatory variable	C_1	C_2	C_3	C_4	Constant
Coefficient	6.663	-4.092	19.343	1.403	2.041

The results of the regression test show that:

- $\_C_1$ increases with: The young age, the increase in the areas planted with olive trees, market gardening and arboriculture, the reduction in the area of the farm and irrigation.
- Given the positive correlation proved in the model, this induces an increase in Y which tends towards 1 signifying a choice for the adoption of management software.
- $\_C_2$ decreases with: The increase in the level of education, The non-use of media and collective interest groups as sources of information. This leads Y to tend towards 1, which support the choice of adopting management technology.
- $\_C_3$ increase in line with Y: The increase in the total area of the farm concerned and exportation.
- $\_C_4$ also increases: Have ease of recruiting labor, Be informed about management software, and the influence of neighbouring farmers.

Effect of Adoption on Performance

Overhead costs were not recorded in the operating account, which leads to erroneous results in the calculation of gross operating income, in cost control and in generating the need for financial resources. The figure shows the share of each type of expense in the total cost recognized.

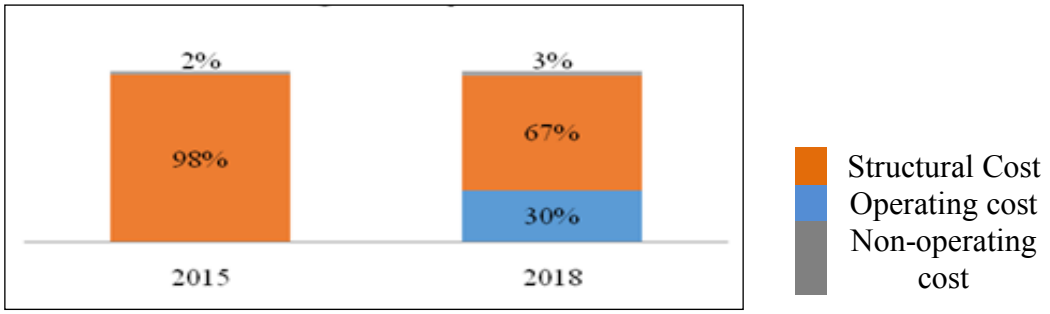

Figure 1. The part of each type of load in the total cost

It emerges that by changing the management mode, the farm has managed to reduce the share of its expenses allocated to the consumption of raw materials, the purchase of inputs, transport, and energy costs as well as personnel costs. This mainly comes down considering structural loads.

The personnel costs for the year 2015 were only 2168 TND. Correcting the above costs is essential to be able to compare between the two studied and to take inflation into account. Each cost will be divided by the GDP deflator for the corresponding year. The GDP deflators for the years 2015 and 2018 have the respective values 3.4 and 5.6.

- Results show that operating expenses as well as some production expenses clearly decreased from 2015 to 2018. The main findings are as follows:
- The increase of workers costs with 33% due to the inclusion of labor compensation for permanent and occasional workers.

- The decrease in the costs of delegated work with 9%. The value of this charge is around 5,000 TND (actual cost). This reveals the decrease in subcontracting due to the lack of workforce resources for carrying out daily or exceptional work such as repairing equipment. There is therefore a better allocation of this resource as well as an optimization of the execution of work orders.
- The other consumption charges decrease with 16% due to the savings in mechanical traction energy and electrical energy used for carrying out certain production work.

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