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# Factors Affecting the Sustainable Use of ICTs for Agriculture at the Farm: The Case of *Image Line Network* Community

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## ABSTRACT

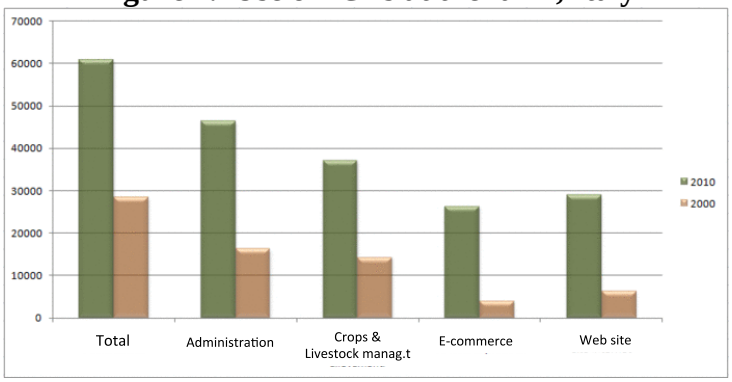
The application of ICTs is still quite low among the Italian farms; it differs according to the different regions, farms typologies and type of applications. Different studies analyzed the factors influencing the adoption of ICTs in agriculture. Less considered are the factors influencing the attitude towards the ICTs once they have been adopted (post-implementation stages of a technology adoption). The goal of this paper is to analyze the factors influencing a sustainable adoption of ICTs at the farm, also identifying possible intervention strategies for policy makers, farmers' organizations, extension services and ICTs providers. A Technology Adoption Model (TAM) was applied. A web survey was carried out based on the TAM theoretical approach and the data analyzed using a Structural Equation Model (SEM) applied to a sample of 766 farmers already using ICTs. The results showed that the *Perceived Ease of Use* of the ICTs is positively influencing the *Behavioral Intention to Use ICTs* at the farm; in turn the SEM showed that the *Perceived Ease Of Use* is influenced by the *Farm Turnover* and the farmers' *Level Of Education*.

**Keywords:** ICT, Agriculture, Farms, Technology Adoption Model, Structural Equation Model

## 1. INTRODUCTION

The available Information and Communication Technologies (ICTs) apply to the whole of the farm management processes; increasing their adoption will improve the technical and economical performances of the farms. The use of ICTs in agriculture more than doubled in the last ten years (Figure 1) but still remains quite low among the Italian farms, concerning around 60,000 farms, representing only 4% of the total farms (ISTAT, 2012). ICTs are likely to be adopted by the largest farms, making the influence of ICTs on agriculture possibly higher than implied by these statistics. Unfortunately data on ICTs use by farm size are not available.
The use of ICTs among the Italian farms includes different types of software applications (Figure 1). The use of Internet, and of the related e-commerce platforms, strongly increased in the decade from 2000 to 2010, as well as other applications for the technical and administrative management of the farm. In spite of its increase, the adoption of ICTs in agriculture is still constrained by different factors.

**Figure 1. Use of ICTs at the farm, Italy**




Source: ISTAT

Different studies showed that the main factors limiting the adoption of ICTs at the farm can be related to the difficulty to use the software, difficulty to appreciate its value, and lack of training; the difficulties resulted different for different types of software (Gelb and Voet, 2009). Other authors agree that factors like income, age, level of education farm size, turnover and type of production can influence the adoption of ICTs at the farm level, as reported in a recent study (Anastasios et al, 2010). According to the Technology Adoption Model (TAM) (Davis, 1989) technologies (in this case ICTs) are more easily adopted when they are perceived as useful (PU) and easy to use (PEU) (Figure 2).

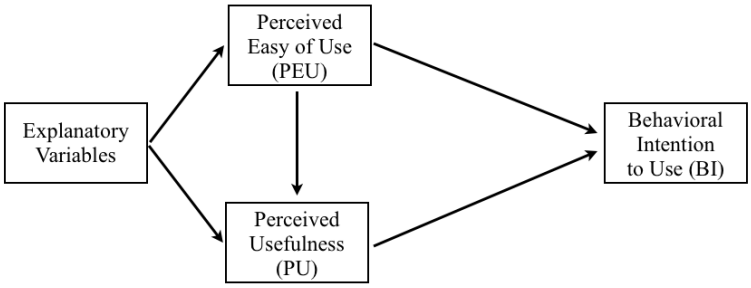



**Figure 2. The TAM model**

In turn PU and PEU are influenced by a set of explanatory variables, which the TAM model does not specify. The set of variables influencing the ICTs adoption in agriculture provided by Gelb and Voet (2009) and Anastasios et al (2010) above listed, can be used as a reference for the definition of the set of explanatory variables of PU and PEU.
In our opinion the post implementation stage is particularly relevant in influencing the behavioral intention to use the ICTs; as reported in a study on the relationship between Information Technologies adoption and their impact on the organizations in Italy, the failures recorded were due to problems related to the technologies' impact on the organization and the people involved (78%) while only 9% were due to technical problems; the remaining 13% was related to non specified factors (Ravagnani, 2000). The role played by ICTs providers, in implementing an after-sales service tailored to the farmers needs and "culture" is therefore crucial.
Based on the above-mentioned theoretical and methodological contributions, the aim of the present paper is to define the factors influencing a sustainable adoption of ICTs at the farm, providing a set of explanatory variables influencing PU and PEU and the behavioral intention to use ICTs (BI) at the farm.

## 2. MATERIALS AND METHODS

### 2.1 Theoretical approach: the Technology Adoption Model (TAM)

The theoretical model adopted, based on the TAM model (Davis, 1989), and on the literature analysis on the determinants of ICTs use, is designed to evaluate the factors influencing the use of ICTs at the farm in the post-implementation stage.
As a consequence the model tested includes the following set of variables:
Dependent variable: *Behavioral Intention* (BI); it is the frequency of use of the different farm management software (Likert scale: 1= almost never 2= once a year 3= once a month 4= once a week 5= every day).
Explanatory variables: *Perceived Usefulness* (*PU*) of the software, as a measure of the software perceived performance (Likert scale: 1= low; 2= sufficient; 3= fair; 4= high; 5= very high); *Perceived Ease Of Use (PEU)*: as a measure of the perceived effort

expectancy in using the software (Likert scale: 1= low; 2= sufficient; 3= fair; 4= high; 5= very high).
These variables were collected for each category of software related to the farm management: *Administration* (AD), *Traceability* (TC), *Crop Management* (CM), *Livestock Management* (LM), *Farm Input Database* (FID).
PEU and PU explanatory variables: following the indications coming from Anastasios et al., (2010) and Gelb and Voet (2009)the variables are: *Age* (AGE): years*; Education* (EDU): 1= primary, 2= intermediate, 3= secondary 4= university diploma[1]*); Farm Size* (FAS): ha*; Farm Turnover* (€/year) (FAT); *Support Received* (SUPP): 1= none; 2= little; 3= yes.

### 2.2 The analytical methods: Structural Equation Model (SEM)

The method of SEM (Structural Equation Modeling) is used for hypothesis testing. The overall models fit is tested using the chi-square fit test (CMIN/DF), the normed fit index (NFI), comparative fit index (CFI) and the root mean square error of approximation (RMSEA). The chi-square fit test (CMIN/DF) adjusts the chi-square index for the degrees of freedom. For this statistic a value as large as 5.0 are accepted as an adequate fit, a value less than 3.0 indicates a reasonable fit and a value less than 2.0 displays a good fit. Values of NFI and CFI equal or higher than 0.90 represent a good fit (Byrne, 2009). However, the NFI has a tendency to underestimate fit in small samples (Byrne, 2009) and CFI takes sample size into account. Bentler (1990) suggested that, of two, the CFI should be the index of choice. The RMSEA has to be less than or equal to 0.05 (0.08) for a good (adequate) model fit (Hu and Bentler, 1999).

### 2.3 The survey: questionnaire and sample definition

To this end a questionnaire was defined and the above-mentioned variables were collected. The questionnaire was distributed via web, in collaboration with Image Line; a farmers' web service provider; the farmers involved belong to the Image Line Network Community (www.imagelinenetwork.com). The data were collected in the year 2010. 10968 farms, representing 56% of the total Italian farms using Internet, were involved; 766 questionnaire integrally and correctly filled were selected and included in the sample. The respondents' rate was 7%.

## 3. RESULTS

### 3.1 Sample general structural characteristics description

The sample includes farmers belonging to a relatively more educated and younger share of the total farmers' population according to the last Italian Agriculture Census of 2010 (ISTAT, 2012). The farms' size is also bigger than the average Italian farms (Table 1).

[1] The variable EDU has been considered a quantitative variable whose increase includes fixed intervals, because the educational levels are assumed to refer to progressive degrees of increasing intensity. This allows for its inclusion in a quantitative model like a SEM.

The sample is biased since the respondents belong to a web community; an higher than average skill in computer use, motivation to use ICTs and interest in adopting software for farm management is expected. With respect to ICTs use the farms interviewed represent 1.2% of the total farms using ICTs, 3.6% of the farms using Internet, 3.2 % of the farms using livestock management software, 1.3% of the farms using administration software and 2,7 % of the farms using crop management software.
When interpreting the results these sample characteristics should be taken into account.

**Table 1.** Sample structural characteristics

| | **Agr. Census 2010** | **Sample** |
|---|---|---|
| Average farms' size (UGB/farm) | n.a | 211 |
| Average farms' size (ha) | 7,9 | 37 |
| Age (yrs.) | 58,5 | 46 |
| Education (most frequent) | primary | secondary |
| Graduated | 5,50% | 20% |

Source: our survey and ISTAT

### 3.2 The Structural Equation Model

Table 2 shows the descriptive statistics (mean and standard deviation) for the variables BI, PU and PEU related to the different software categories. Figure 3 shows the regression weights and the p-values related to the Technology Adoption Model (TAM) relationships. The analysis of the structural model indicates that all of the relationships among the variables are significant. Overall, the model fit is good (Table 3).
The SEM results show a general significant influence of the *Farm Turnover* (FAT) on the respondents' *Perceived Ease of Use* (PEU) for all the software categories considered, while the influence of FAT on the *Perceived Usefulness* (PU) results significant only for three software categories, excluding the Traceability (TR) and Livestock Management (LM) software. The influence of the *Level of Education* (EDU) on the *Perceived Usefulness* (PU), is not significant while it influences the *Perceived Ease of Use* (PEU). The software categories significantly involved are: AD, CM and FID. The influence of PEU on PU is in turn significant for all the software categories analyzed. Higher $R^2$ values are obtained when considering the contribution of FAT and PEU to the explanation of the variation of PU for all the software categories. Much lower $R^2$ values result for the models relating FAT and EDU to PEU. Last but not least is the significant influence of PEU and PU on the Behavioral Intention to use ICTs (BI) of the respondents and the high $R^2$ obtained for all the software categories regression models.

**Table 2. Descriptive statistics**

| Soft | AD | | TR | | CM | | LM | | FID | |
|---|---|---|---|---|---|---|---|---|---|---|
| Var | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| **BI** | 2.57 | 1.480 | 1.94 | 1.247 | 2.73 | 1.321 | 1.33 | 0.917 | 2.72 | 1.167 |
| **PU** | 3.10 | 1.435 | 2.58 | 1.413 | 3.26 | 1.338 | 1.84 | 1.341 | 3.33 | 1.304 |
| **PEU** | 2.59 | 1.334 | 2.22 | 1.258 | 2.86 | 1.314 | 1.56 | 1.063 | 2.99 | 1.293 |

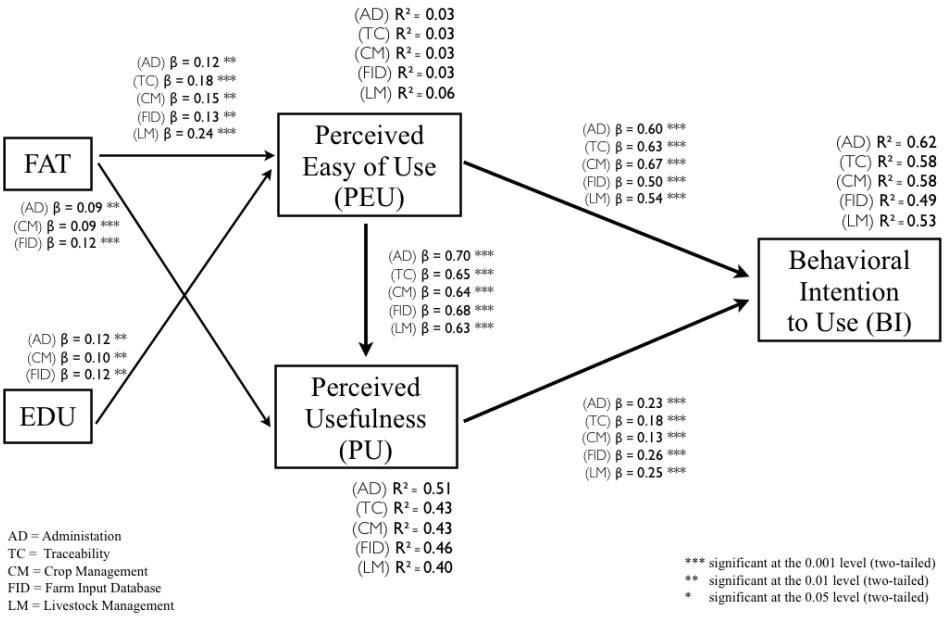



**Figure 3. The structural model**

**Table 3. Standardized model fit**

| Property | Recommended value | Admin. | Traceability | Crop Management | Farm Input Database | Livestock Management |
|---|---|---|---|---|---|---|
| CMIN/DF | ≤ 5.00 | 2.616 | 3.818 | 3.207 | 1.343 | 3.216 |
| NFI | ≥ 0.90 | 0.990 | 0.990 | 0.985 | 0.992 | 0.989 |
| CFI | ≥ 0.90 | 0.994 | 0.993 | 0.990 | 0.998 | 0.992 |
| RMSEA | ≤ 0.08 | 0.046 | 0.061 | 0.054 | 0.021 | 0.054 |

## 4. DISCUSSION AND CONCLUSIONS

The results confirms the theoretical assumptions of the Technology Acceptance Model (TAM) when describing the influence of the *Perceived Usefulness* (PU) and *Ease of Use* (PEU) on the *Behavioral Intention* (BI) of the respondents to use ICTs for the farm management. Only a limited number of explanatory variables influencing PEU and PU resulted significant: *Farm Turnover* (FAT) and *Level of Education* (EDU); *Age* (AGE) and the *Support to the Farmers* (SUPP) did not show a significant role. Possibly the sample characteristics, involving relatively young and "ICTs oriented" farmers, influenced these variables exclusion. This can also explain the relatively low influence of education (EDU) on the attitude of the respondents towards the adoption of ICTs (PEU and PE). Anyway, in spite of these sample characteristics, a not very high average value of the farmers' *Perceived Ease of Use* and *Usefulness* of the software resulted. This, and the relevant influence of the *Perceived Ease of Use* on the *Perceived Usefulness* shows how important it is for the ICTs providers to increase their software *Ease of Use* by tailoring their solutions to the farmers' needs. The choice of an online web survey provided an easier and larger data collection at the expenses of the sample representativeness. Further surveys should consider the inclusion of less specialized farmers in the sample. To increase the software *Ease of Use* the organization and management of the farms activities should be investigated to evaluate their influence on the software design.

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