Issues in New Technology Adoption in Agriculture: a Survey Among Italian Tractor's Users

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Abstract. New technologies have a potential to contribute to achieving significant economic, social and environmental benefits in agriculture sector. However, the adoption of Information and Communication Technologies (ICT) have encountered some difficulties among farmers. This paper reports investigations on the adoption of ICT in agriculture among Italian tractors users and explores their opinions on technologies applied to agricultural tractors. A survey was conducted during the International Exhibition of Agricultural Machinery (EIMA). The results show that, while economic benefit is recognized as the primary reason to adopt new agricultural technologies, other attitudes play roles in the adoption decision of the tractor users.

Keywords: adoption of new technology in agriculture, Italian tractor users, survey, opinions.

1 Introduction

Agriculture is an area with significant application of high technology and, during the last century, exceptional advances in the application of ICT (Information and Communication Technology) have revolutionized farming. Recent advances in ICT have allowed farmers to acquire vast amounts of data for their fields, ultimate helping them in the reduction of uncertainty in decision-making (Blackmore, 2000).

However, as it seems the case of the Italian market, sometimes technology advancements outpace the readiness of potential users.

Adoption of a new technological process or machine, even when it has obvious economic advantages, is often a very difficult action (Roger, 1995). May innovations require a long period from when they become available to the time they are widely adopted.

Although final users constitute a category of actors that in recent years has received considerable attention in research on technological development, published studies analyzing the impact of farmers' perceptions in agriculture sector are rare. Among those stands out Adesina and Baidu-Forson research study (1995) supporting

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the hypothesis that farmer's perceptions of technology characteristics significantly affect their opinion decision.

As in other domain, knowing who the future user is, understanding their priorities and believes, what they know, what they are after, and how they get the information is vital (Nielsen, 1993).

Having a good knowledge of this information can be very helpful for tractor manufactures in developing and designing innovative ICT technologies that satisfy user's needs and in speeding up the process of adopting the new technologies.

In order to understand the final user, it is important to determine who the targets are, their characteristics and demographics, their relative value to the business, and what they need and want to purchase. Their root motives can help the manufacture to react quickly to customers' needs, facilitating new product development and therefore the meeting of customer requirements in terms of the products they subsequently purchase (Jeffrey and Franco, 1996).

2 The Survey

The most innovative farmers are now using precision farming which combines telecommunications, computer technologies, and global positioning systems (GPS) to increase productivity and decrease costs of raising crops (Korsching, 2001).

According to Griffin and colleagues (2004), we consider important to understand farmers' reasons for non-adoption of ICT technology innovation.

The focus of analysis of the study reported in this paper is on the adoption of ICT technologies among Italian users and/or owners of agricultural tractors. Moreover, we aimed at gaining knowledge on farmer's attitudes, opinions and believes towards new technologies applied to agricultural tractors. A survey investigating their views and opinions on ISOBUS system, GPS (global positioning system), CVT (continuous variable transmission), fleet management and remote diagnostic system applied to agricultural tractors has been conduced.

ISOBUS system is a standardised communication system which links tractors and implements together, enabling data to be transferred quickly and simply between the tractor and the tools. With the help of a GPS system for positioning and devices for application control and data collection, these data can be used for monitoring actual field operations. GPS is often equipped with a automated steering system to assist guidance, reducing the use of fertilizer, seed, chemical and fuel costs, as well as driver fatigue and allowing a better oversee of the implement to improve the job quality.

A CVT is a transmission system characterized by infinite variability between highest gear and the lowest gear. It can change steplessly through an infinite number of effective gear ratios, with no discrete gear shifts involved in the process. During operation, the CVT allows the tractor to maximize field efficiency by being able to operate at optimum speed. Instead of separate speed ranges like in a powershift, the CVT gives the tractor infinite speeds. An operator can select the exact speed for the application whereas a powershift must operate within speed ranges.

Fleet management technology, called telematics, includes vehicle-tracking devices and software that show where all vehicles are located at all times. Remote diagnostic system allows diagnosing of a given issue or problem from a distance. Understanding how the machine is running also allow the operator to monitor potential problems and perform preventative maintenance before they equate to downtime. These technologies reduce redundancy, cut down labor costs and expand hours of operation (Adrian, Norwood, Mask, 2005).

2.1 Methodology

A survey is a tool to understand the views and attitudes of a population on a given topic. Data were collected by means of a questionnaire which was completed during a face-to-face interview.

Trained interviewers administered the questionnaire personally to respondents and questionnaire responses were directly recorded on a computer. The questionnaire was divided into several sections, and respondents had to use a 4 point Likert scale to express their opinion on different aspects. Assuming that it is not feasible to adopt a new technology if you don't have any knowledge about it, the questionnaire started asking to the participants to give information about their knowledge and perceived usefulness of the technology, their source of information, and to describe the aspects they considered important in the use of an agricultural tractor.

Propensity for technological innovation future use was investigated as well.

The survey ended with a description of the technology installed on their current machine and with some background questions to collect information on the sample of respondents.

2.2 Sample

The data set used in the analysis is based on a questionnaire completed by 305 people. The convenience sample was obtained through approaching visitors during the 5 days of the International Exhibition of Agricultural Machinery (EIMA), the biggest event in Italy with regard to technologies for agriculture, held in Bologna in November 2010.

Most of the participants were farmers, farm workers, or independent contractors (accounting for 75% of the total number of respondents). The others were students, people working in the machinery trade or service sector, or people whose primary work activity was not related to agricultural sector or tractors. All the subjects were users of agricultural tractors.

Respondents' age ranged between 18 and 75 years. Participants were grouped into five age classes of ten years each, with the exception of the class of the youngest participants, aged between 18 and 25 and the one of the oldest participants, aged over 55. The percentage distributions is provided in Table 1.

One of the peculiarity of Italian farms is their dimension. Based on the recent data of the National Institute of Statistics (Istat, 2009), 80% of the farms in Italy are smaller than 5 hectares and their average dimension is 7.6 hectares. The greater part

of our sample owns or works in a farm larger than 20 hectares. The majority of the sample owns or works with a number of tractor between 4 and 6.

Table 1. Sample age distribution

Age Class (years)	Frequency	Percentage
18-25	65	21,3
26-35	65	21,3
36-45	64	21,0
46-55	74	24,3
> 55	37	12,1
Total	*305*	*100*

2.3 Data analysis

Data analysis was conducted on 305 questionnaire collected from the sample of participants.

Data were entered into SPSS software version 16 for statistical analysis and subjected to univariate and bivariate analyses to know the relationship between and among the variables investigated. As the study was based on a convenience sample, violating the assumption of a normally distributed population, non-parametric data analysis were performed. A P-value<0.05 was considered statistically significant for all analyses.

3 Results

Survey's results show that ICT technological innovations applied to agricultural tractors were little known by the sample of respondents. Indeed, system like the ISOBUS was completely unknown by the 45,2% of the sample, the GPS assisted guidance system by the 33,3%, fleet management system by the 29,2% and remote diagnostic systems by the 20,7%.

Respondents reported that information on technological innovations were primarily obtained through exhibitions and/or conferences, and information given by colleagues. Only a reduced number of respondents gained information on new technologies through the use of internet. Data analysis shows association between respondents age and use of internet to get information on technologies innovations (χ^2=33.951, *df*=16, p=.006). Younger farmers utilize slightly more the internet as a source of information on technological innovation applied to agricultural tractors compared to older farmers (rho=-.166, *df*=303, p<.004).

As reported in Table 2 no statistical significant difference was found in the sample's answers for the ISOBUS system, while a significant association was found between age and knowledge of the GPS-assisted guidance system (χ^2=31.184, *df*=16, p=.013). Younger farmers were slightly more informed about GPS assisted guidance

system applied to agricultural tractors compared to older farmers (rho=-.159, *df*=303, p<.005).

At the same time a significant association was found between knowledge about the CVT system and farm's dimension (χ^2=18.883, *df*=8, p=.016); the bigger is the land they work (rho=.206, *df*=289, p<.000), the more they are informed.

Further, it was found a statistically significant positive correlation between the number of tractors owned or farm's dimension and the importance given to technological innovations such as remote diagnostics (χ^2=26.833, *df*=12, p=.008; χ^2=15.658, *df*=8, p=.048). It is well established in innovation studies that large firms are more often innovative than small firms (Christensen et al, 2011). Indeed, the analysis display a week but statistically significant positive correlation between those two variables (rho=.156, *df*=303, p<.006). A new trend in the farming business is to replace conventional farming devices with computerized farming devices (Iftikhar and Pedersen, 2011).

Table 2. Cross-tabulations results

	Age classes			**N° of tractors owned**			**Farm's dimension**		
	χ^2	*df*	*p*	χ^2	*df*	*p*	χ^2	*df*	*p*
ISOBUS	12.040	16	.741	12.358	12	.417	6.253	8	.619
GPS	31.184	16	.013*	20.700	12	.055	15.133	8	.057
CVT	14.973	16	.527	18.767	12	.094	18.833	8	.016*
Fleet management	15.659	16	.477	30.009	12	.003*	13.580	8	.093
Remote diagnostic	24.871	16	.072	26.833	12	.008*	15.658	8	.048*

* significant association between variables

Most respondents considered technological innovations applied to tractors very valuable for crop protection and sowing (Fig. 1). Beside, a significant positive association between farm dimension and the usefulness of technological innovations in tillage was found (χ^2=17.386, *df*=6, p=.008).

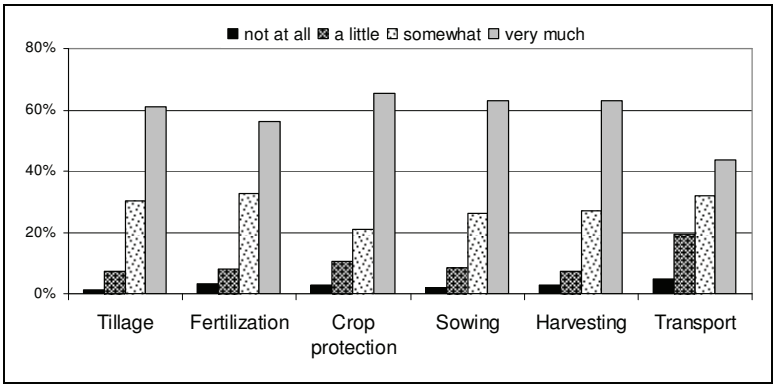

Fig. 1. Importance of technological innovation in agricultural tasks.

According to almost all participants, ICT technology applied to agricultural tractors positively affect the comfort of the operator, the safety, reliability and flexibility of the machine (Fig. 2). Differently, their believes regarding the reduction of environmental impact of the operations and the reduction of the costs are more spread on a negative side of the continuum.

Some final users firmly believe that the state of the art of this technology does not allow them to improve production in a way to gain profit from it, while others deem that there is a positive discrepancy between the high purchase cost to adopt the technology and the increased production and resulting higher profit. However, according to the users, too many variables affect that positive gain, making it not reliable. A technology is useful to the extent that it improves production and profit and it is applied to the extend that it generates and satisfies users' needs.

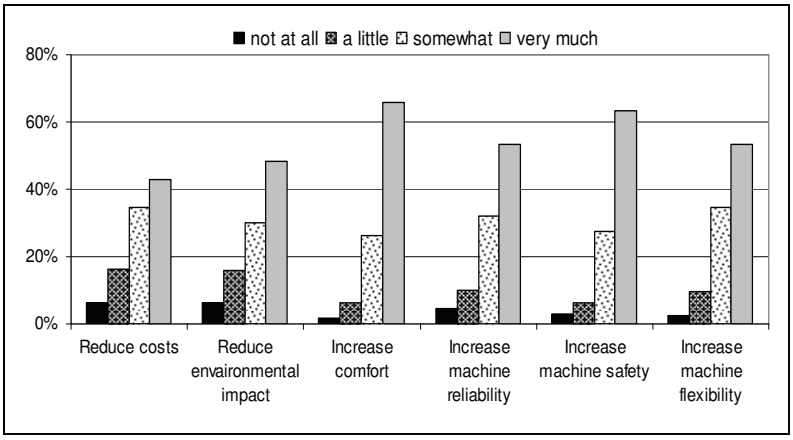

Fig. 2. Opinion of the sample's study on the results of adoption of ICT technological innovation .

The main impediments to the adoption of new technologies cited by the participants were the lack of "tailored" technologies and their increased sophistication which imposes enhanced mental workload, extension training necessary to learn and master the task. One of the main reasons related to the lack of adoption of ICT technologies is related to the interfaces issues: too complex and not "user friendly". To adopt and use these technologies, not only do the owners of the agricultural tractor(s) have to make financial investments, but they also make investments in learning new skills. However, users are aware that in a competitive global market they need to adopt new technology to differentiate itself from others and to push forward their production.

According to respondents' opinions future technological innovations that will be very useful are those providing infinite number of power take-off speeds independently from those of the engine, and safety and warning systems that enable driver identification, prevent risky maneuvers, give information to the driver about dangerous situation, and communicate any incidents to a business centre or an emergency service.

4 Conclusions

Adoption of technological innovations in agriculture has attracted considerable attention among economists and tractors manufacturers. Results of the survey shows that a technology is useful to the extent that it improves production and profit and it is applied to the extend that it generates and satisfies users' needs.

Therefore, it is paramount to gain knowledge of the end users' opinions when the manufactures are designing, developing and applying technological innovations to agricultural tractors. The involvement of the final users in planning future ICT development could be a possible solution to the problem of adoption of these technologies in the agricultural sector.

While economic benefit is recognized as the primary reason to adopt new agricultural technologies, other attitudes play roles in the adoption decision of the tractor users. The way an individual perceives the new technology is critical to whether they will eventually adopt the innovation.

Farmers are oriented towards "easy-to-use" new technology. They are aware of the need to adopt new technologies requested by a competitive global market, however they distrust technologies they perceive too sophisticated to interact with, requiring investments in learning new skills.

As the technology applied in the agriculture sector is becoming increasingly complex, the need for a simple and easy way to interact with it is growing among farmers. Therefore, man-machine-interfaces which are intuitive, based on natural communication channels, are most appreciated and sought-after.

Tractors manufactures needs to approach the customers by collecting information about them, describing them in sufficient detail so that management, salespeople, and people providing service can have the opportunity to access information while matching the customer needs with product plans and offerings. This continuous communication process helps the company manufacture to be in constant touch with the customers and it is done with the main aim of improving user satisfaction and maximizing profits.

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